Mutual Funds and Stock Fundamentals†

by

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Abstract

Recent studies in the accounting and finance literature show that stocks with strong firm fundamentals have higher future returns than stocks with weak firm fundamentals using hypothetical portfolios. We examine whether mutual fund managers trade on and profit from one such firm fundamental trading strategy, the F_SCORE strategy developed by Piotroski [2000]. We find that in the aggregate, mutual fund managers and institutional investors do not slant their portfolios towards stocks with strong fundamentals by trading on the F_SCORE strategy. The fact that mutual fund managers do not trade on the strategy in the aggregate explains why the anomaly persists in recent years. Interestingly, we show that economically and statistically significant CAPM, 3-Factor and 4-Factor alphas are earned before and after transaction costs, price pressure effects and management fees by mutual funds holding stocks with strong fundamentals. Furthermore, using a mean-variance framework we show that mutual funds holding fundamentally strong stocks have higher Sharpe Ratios before and after transaction costs, price pressure effects and management fees. This is primarily because mutual funds holding stocks with stronger fundamentals have lower total risk, idiosyncratic risk, and systematic risk than mutual funds holding stocks with weaker fundamentals. It is surprising that mutual funds do not trade on the F_SCORE anomaly given the strategy generates superior risk adjusted performance after costs and fees using both factor models and the Sharpe Ratio.

JEL classifications: G11, G12, G20

Keywords: fundamental analysis, F_SCORE, mutual fund, mean-variance efficiency

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1. Introduction

Recent studies in the accounting and finance literature show that stocks of firms with stronger fundamentals based on financial statement analysis have higher future returns than stocks of firms with weaker fundamentals. For example, using hypothetical portfolios Piotroski [2000] finds that high book-to-market stocks with stronger or improving fundamentals (high F_SCORE) based on profitability, leverage, and operating efficiency have higher future returns than high book-to-market stocks with weaker fundamentals (low F_SCORE); Mohanram [2005] finds that low book-to-market stocks with stronger industry-adjusted fundamentals (high G_SCORE) based on profitability, volatility, and accounting conservatism have higher future returns than low book-to-market stocks with weaker fundamentals (low G_SCORE); and Dichev [1998] and Campbell, Hilscher, and Szilagyi [2008] find that stocks with a lower probability of bankruptcy have higher future returns than stocks with a higher probability of bankruptcy. [1] The findings in these studies appear to violate the efficient market hypothesis as stocks which are seemingly less risky (higher profitability, lower leverage, lower volatility in sales and earnings, lower probability of bankruptcy, and improving fundamentals) generate higher future returns.

The finding that stocks with stronger fundamentals have higher returns and lower risk than stocks with weaker fundamentals leads to some interesting research questions: Have the results weakened after the aforementioned studies were published and became part of the public domain? Do professional money managers invest in stocks based on firm fundamentals? Can

[1] Examples of other papers showing that stocks with strong or improving fundamentals have higher future returns include Soliman (2008); Beneish, Lee and Tarpley (2001); Abarbanell and Bushee (1998); and Holthausen and Larcker (1992). Also, see a recent literature survey by Richardson, Tuna and Wysocki (2010).

professional money managers achieve abnormal returns using a firm fundamental investment strategy after controlling for transaction costs (bid-ask spread and commissions), price pressure effects, and fees? We address these questions by examining whether mutual fund managers trade on and profit from one such firm fundamental trading strategy, the F_SCORE strategy developed by Piotroski [2000].[2] We use the F_SCORE as it uses nine simple yet comprehensive signals that are easy to calculate, it is based entirely on financial statements data that is very accessible, and it generates very high abnormal returns. Hence, professional money managers would be expected to use the methodology.[3] We use mutual funds in our tests as they are run by professional money managers, their holdings are disclosed quarterly so we can observe whether they are trading on the strategy, and we can examine their returns net of all costs and fees to see if the strategy generates realizable profits. [4]

Using the F_SCORE fundamental screen we show that one-year market-adjusted returns on a hypothetical portfolio of stocks with strong fundamentals (top decile) are 15.1% higher than the market-adjusted returns on a hypothetical portfolio of stocks with weak fundamentals (bottom decile). We find that the results are robust for both high B/M and low B/M sub-samples and the results have not significantly weakened in the sample period that follows the publication of Piotroski's [2000] paper. Next, we show that mutual funds in the aggregate (and institutional investors as a whole) tend to hold a larger fraction of the shares outstanding of stocks with stronger fundamentals (high F_SCOREs) than stocks with weaker fundamentals (low F_SCOREs). However, since stocks with high F_SCOREs tend to have larger market

[2] Details regarding how the F_SCORE is calculated are located in the Appendix.
[3] Earlier papers such as Holthausen and Larcker (1992) use a complicated methodology and require a vast amount of information to calculate.
[4] During our sample period, mutual funds have been required to report their equity holdings to SEC either quarterly (before 1985 or after May 2004) or semiannually (between 1985 and May 2004), although many funds voluntarily file their holdings quarterly even when not required.

capitalizations and institutional investors tend to hold stocks of large firms (e.g., Falkenstein [1996] and Gompers and Metrick [2001]), this finding may be spurious. In fact, further analysis shows that the average actively managed mutual fund tends to hold a portfolio of stocks with a value-weighted F_SCORE that is lower than the value-weighted average F_SCORE of the U.S. stock market as a whole.[5] We conclude that in the aggregate, actively managed mutual funds do not slant their portfolios towards stocks with stronger fundamentals.

Perhaps mutual funds do not slant their portfolios towards stocks with stronger fundamentals because abnormal returns from trading on firm fundamentals are not obtainable after costs and fees. To examine this we estimate the effect of the market value weighted F_SCORE (FIM) of the stock holdings of mutual funds on the CAPM alpha, the Fama-French 3-Factor alpha, and Carhart 4-Factor alpha. We control for fund investment type (small-cap/value; small-cap/growth; mid-cap/value; mid-cap/growth; large-cap/value; large-cap growth) in the regressions as mutual funds tend to classify themselves into these investment style categories, invest in stocks as specified by their style category, and compare themselves to other funds and benchmark indexes in the same investment style category.[6] We find that the higher the average F_SCORE (FIM) of mutual fund holdings, the higher the risk-adjusted return before and after transaction costs, price pressure effects, and management expenses. The sensitivity of the CAPM alpha, the Fama-French 3-Factor alpha and the Carhart 4-Factor alpha to the average F_SCORE of the stocks held by a mutual fund (FIM) are all statistically significant. The results are also economically significant. For example, if the market value weighted F_SCORE of a mutual fund

[5] This is true when we equal weight mutual funds. When we weight mutual funds by their net assets, the F-score of mutual funds is similar to the F-score of the U.S. stock market as a whole.
[6] For example, Morningstar classifies mutual funds into small-cap, mid-cap or large-cap paired with growth, blend or value categories. Furthermore, the industry has developed indices to serve as benchmarks for the various investment categories. For example, there is a S&P 500 value index, a S&P 500 growth index, a S&P 400 value index, a S&P 400 growth index, a S&P 600 value index, and a S&P 600 growth index.

rises by one point, there is a 1.6% increase in the CAPM alpha estimated using mutual fund returns net of transaction costs, price pressure effects and management fees.

Since mutual fund managers invest based on their investment style, we also examine whether mutual funds holding fundamentally stronger stocks generate higher risk-adjusted returns than mutual funds holding fundamentally weaker stocks within each fund type category. Overall, we find evidence that mutual funds holding fundamentally strong stocks generate significantly higher risk-adjusted returns than mutual funds holding fundamentally weak stocks within each fund type category.[7]

Given that we do not know which factor model, if any, is the correct model, we next compare and contrast the performance of mutual funds that hold fundamentally strong stocks to the performance of mutual funds that hold fundamentally weak stocks using a mean-variance framework and the Sharpe Ratio. In the aggregate, we find that mutual funds that invest in fundamentally strong stocks have a significantly lower standard deviation of monthly returns, significantly lower idiosyncratic volatility (standard error from the CAPM model), a significantly lower CAPM beta, significantly higher average returns before costs and fees, but similar returns after costs and fees as mutual funds that invest in fundamentally weak stocks. Similar returns after costs and fees in conjunction with lower total risk results in a higher Sharpe Ratio for mutual funds that hold fundamentally stronger stocks. The finding that mutual funds holding fundamentally stronger stocks have higher Sharpe Ratios after costs and fees is robust to including controls for fund type (small-cap/value; small-cap/growth; mid-cap/value; mid-cap/growth; large-cap/value; large-cap growth). We also examine whether mutual funds holding

[7] The exception to this is the large-cap growth mutual fund category. In this category, mutual fund FIM does not predict alpha using any of the factor models.

fundamentally stronger stocks generate a higher Sharpe Ratio than mutual funds holding fundamentally weaker stocks within each fund type category. Overall, we find evidence that mutual funds holding fundamentally strong stocks generate significantly higher Sharpe Ratios than mutual funds holding fundamentally weak stocks within each fund type category.[8]

It is of course possible that mutual funds holding stocks with strong fundamentals have lower risk, higher Sharpe Ratios and higher factor model alphas due to an unobservable characteristic that is correlated with firm fundamentals. For example, mutual funds holding stocks with strong fundamentals may have smarter managers and these managers may be selecting stocks based on some other metric which is correlated with firm fundamentals. For instance, funds holding the firms of stocks with strong fundamentals may have managers with excellent industry timing ability and it is industry timing ability rather than a slant towards stocks with strong fundamentals that is driving the results. As a robustness check we construct hypothetical portfolios of stocks sorted by F_SCORE to confirm that stock fundamentals rather than unobservable mutual fund manager behavior are behind these results. It is indeed the case that portfolios of stocks with strong fundamentals have a higher Sharpe ratio, higher returns, a lower standard deviation, lower idiosyncratic volatility (based on CAPM model), a lower CAPM beta, and a higher CAPM, 3-Factor, and 4-Factor alpha than stocks with weak fundamentals. Therefore, it appears that the superior mean-variance performance of mutual funds whose holdings are slanted towards strong firm fundamentals is attributable to the fundamentals of the stocks they hold.

Since trading on the F_SCORE strategy leads to superior risk-adjusted performance after

[8] The exception to this is the large-cap value mutual fund category. In this category, mutual fund FIM does not predict the Sharpe Ratio.

costs and fees using both factor models and the Sharpe Ratio, it is surprising to find that mutual funds managers and institutional managers do not slant their portfolios towards fundamentally strong stocks in the aggregate. It is also surprising that the difference in risk-adjusted returns after costs and fees between mutual funds that hold fundamentally strong and fundamentally weak stocks has not been arbitraged away since the Piotroski (2000) paper was published over a decade ago.

One possible explanation for our findings is based on the incentives of mutual funds. Though we find that trading on strong fundamentals results in higher risk-adjusted returns, it results in similar net returns (returns after costs and fees) in the aggregate. Studies which include Brown, Harlow, and Starks (1996) and Chevalier and Ellison (1997) report that mutual funds receive fees based on the total assets under management. Based on the implicit contract that arises from this incentive, Brown, Harlow and Starks (1996) suggest that the mutual fund market can be viewed as a tournament where funds compete against other funds in the same fund investment category to attract inflows. Since there is evidence that investors chase funds with high recent returns relative to the other funds in their investment category (Siiri and Tufano (1998)), mutual funds have an incentive to focus on generating higher returns than the other funds or benchmark index in their investment category rather than on beating their benchmark index based on risk-adjusted returns. For example, as shown in Sapp and Tiwari (2004), mutual funds will have an incentive to slant their portfolios towards stocks that generate higher returns, like relative momentum stocks, as this should attract an inflow of funds. Even if mutual funds have incentive fees, incentive fees are rare and are based on mutual fund returns relative to a benchmark index which again spurs a focus on relative returns (see Elton, Gruber and Blake (2003)).

Though the literature on market anomalies is large, there are only a few studies that examine whether professional money managers exploit market anomalies or that examine whether the abnormal returns generated by market anomalies are actually realizable in practice. Our paper complements this literature. Lewellen [2010] examines whether institutional investors exploit the B/M, momentum, or accruals anomalies. He finds there is only a slight tendency of institutional investors to trade on the B/M or momentum anomalies. He does not extend his analysis to examine whether trading on the B/M or momentum anomalies generate realizable abnormal returns after costs and fees. Grinblatt, Titman and Wermers [1995] find evidence that mutual funds holding momentum stocks generate abnormal performance before expenses and transaction costs, however, Carhart [1997] finds that these mutual funds generate lower abnormal returns after expenses. Carhart also finds that mutual funds with a one-year momentum strategy only happen by chance to hold momentum stocks. Ali, Chen, Yao, and Yu [2008] show that in the aggregate, mutual funds do not appear to trade on the accruals anomaly even though it is profitable after costs and fees. However, they find that the higher returns from trading on the accruals anomaly are associated with higher risk in fund returns.

Our finding that in the aggregate, mutual fund managers and institutional investors as a whole do not exploit the F_SCORE strategy anomaly to maximize mean-variance efficiency is similar to Lewellen [2010] who finds that in the aggregate, institutional investors do not exploit the B/M or momentum anomalies to maximize the mean-variance trade-off of their portfolios. Our mean-variance results are also similar to Frazzini and Pedersen [2010] and Karceski [2002] who find that mutual funds chase high beta stocks even though portfolios of low beta stocks generate a higher Sharpe ratio.

The paper proceeds as follows: Section 2 describes the construction of the individual stock sample and mutual fund sample respectively, and how we calculate the F_SCORE investing measure and gross returns of a mutual fund; Section 3 reports the empirical results; Section 4 concludes.

2. Sample

2.1 Individual Stock Sample

We start by replicating Piotroski's [2000] findings on the profitability of the F_SCORE strategy at the individual stock level. Each year between 1979 and 2006, we obtain all stocks with sufficient data to calculate the F_SCORE and one-year buy-and-hold returns starting from the fifth month after the Compustat fiscal year end. The F-SCORE data is calculated using fiscal year end data from Compustat and SDC data (for equity issuance part of the F_SCORE) while monthly returns are from CRSP. Our sample starts from 1979 instead of 1976 as in Piotroski [2000] because 1980 is the earliest year with available mutual fund holdings data and we need to match mutual fund holdings with F_SCOREs of the prior year. Our sample ends in fiscal year 2006 because we need returns data up to 2008, the latest year with complete data when we started the project. We end up with 106,825 firm-years in this sample.

2.2 Mutual Fund Sample

To investigate whether mutual funds invest in the F_SCORE strategy, we obtain fund stock holdings from the Thomson Financial CDA/Spectrum Database (henceforth, the CDA data) for each actively managed equity fund. Following Wermers [2000], actively managed equity funds include aggressive growth funds, growth funds, growth and income funds, and balanced funds from 1980 to 2007. [9] We eliminate index funds, funds with total net assets less than one million dollars and funds with total market value of reported domestic equity holdings less than 50% or more than 150% of the reported total net assets of the fund. We match a fund's reported equity holdings with each stock's most recently available F_SCORE (calculated using fiscal year end data) between fifteen months and three months before the reporting date. We require the F_SCORE to be available at least three months before the reporting date to ensure that financial statements containing information to calculate F_SCORE are publicly available. We require the F_SCORE to be at most 15 months old to eliminate obsolete information. Then following Ali et al.'s [2008] measure to estimate a fund's exposure to accruals (Accruals Investing Measure (*AIM*)) and Grinblatt, Titman and Wermers's [1995] measure to estimate a fund's exposure to momentum (Momentum Investing Measure), we calculate the F_SCORE investing measure (*FIM*) of a mutual fund on a reporting date *t* as the weighted average F_SCORE of the stocks held by the fund. Specifically,

$$FIM_{i,t} = \sum_{j=1}^{N} \omega_{i,j,t} * F\_SCORE_{j,t-1} \qquad (1)$$

where $F\_SCORE_{j,t-1}$ is the F_SCORE of stock *j* using data for the most recent fiscal year that ended three to fifteen months ago, *N* is the number of stocks with a F_SCORE held by mutual fund *i* at reporting date t, $\omega_{i,j,t}$ is the value of stock *j* held by fund *i* as a percentage of total value of stocks the fund holds at reporting date *t*. Stocks with missing F_SCOREs are excluded from the calculation.

During our sample period, mutual funds were required to report their equity holdings to the SEC either quarterly (before 1985 or after May 2004) or semiannually (between 1985 and

[9] Ali et al. [2008] exclude balanced funds from actively managed mutual funds. Our results are robust to the exclusion of balanced funds.

May 2004), although many funds voluntarily file their holdings quarterly even when not required. We thus calculate *FIM* every quarter, and if a mutual fund does not report holdings in a quarter, we take its holdings reported in the prior quarter to calculate *FIM*.

Following the same approach, for the three months immediately after a reporting date *t*, we calculate the gross monthly returns of a mutual fund (*gross_ret*) as the weighted average of individual stock monthly returns held by this fund. That is,

$$gross\_ret_{i,t+1,2,3} = \sum_{j=1}^{N} \omega_{i,j,t} * ret_{j,t+1,2,3} \quad (2)$$

where $ret_{j,t+1,2,3}$ is the monthly return of stock *j* one, two or three months after reporting date *t*. Other acronyms are defined as in Eq. (1). *Gross_ret* measures the returns a fund would earn over the next three months before transaction costs, price pressure effects or management fees on the stocks that a fund holds at reporting date t.

To examine the association between *FIM* and fund returns after transaction costs, price pressure effects or management fees, we collect fund monthly returns and expense ratios from the CRSP Survivorship Bias Free Mutual Fund Database (henceforth, the CRSP data). Mutual funds report monthly returns that are net of all costs and fees (*net_ret*). Following Ali et al. [2008], we define fund monthly returns before administration and management fees (*raw_ret*) as fund monthly net returns (*net_ret*) plus one-twelfth of its annual expense ratio. The variable *raw_ret* captures the returns a mutual fund can earn after transaction costs and price pressures, but before fees imposed by the fund. We match a mutual fund's *FIM* at reporting date t with the fund returns for the next three months before and after management fees. The final sample includes 237,411 fund-months. Later we estimate alphas and Sharpe ratios for each fund-year with at least seven monthly returns available each year, resulting in 18,787 fund-years.

Given that mutual fund managers are often evaluated against peer funds that invest in stocks with similar market capitalizations and value/growth style, we classify funds into six fund types based on the average size and book-to-market ratio of firms held by these funds. Specifically, we first use Eq. (1) to calculate a fund's size investment measure (*SIM*) and book-to-market investment measure (*BIM*) with a firm's size decile and book-to-market quintile replacing the *F_SCORE,* respectively. We assign a firm's size decile based on the market value of a firm on the last trading day before the mutual funds report their stock holdings for the quarter. We assign a firm's book-to-market quintile based on the book-to-market ratio of a firm at the beginning of the fiscal year for which F_SCORE is calculated. We calculate the book-to-market ratio at the beginning rather than the end of the fiscal year to increase the probability that the book-to-market ratio is not influenced by the F_SCORE so it is orthogonal to FIM. Then according to each fund's *SIM* and *BIM* at the beginning of each year, we assign it to one of the six categories: small-cap value (lowest *SIM* tercile and above median *BIM*), small-cap growth (lowest *SIM* tercile and below median *BIM*), mid-cap value (middle *SIM* tercile and above median *BIM*), mid-cap growth (middle *SIM* tercile and below median *BIM*), large-cap value (highest *SIM* tercile and above median *BIM*) and large-cap growth (highest *SIM* tercile and below median *BIM*).

3. Empirical Results

3.1 Replication and Extension of Piotroski [2000]

Piotroski [2000] documents that a simple accounting-based fundamental analysis strategy earns abnormal returns when applied to high book-to-market (*BM*) firms. He selects nine fundamental signals that can be calculated from a firm's financial statements to measure three aspects of a firm's financial condition including profitability (*ROA, CFO, ΔROA*, and *ACCRUAL*), financial leverage/liquidity (Δ*LEVER, ΔLIQUID*, and *EQ_OFFER*), and operating efficiency (Δ*MARGIN* and Δ*TURN*).[10] Each signal is assigned a score of one (zero) if its realization is good (bad) for future prices.[11] The aggregate signal, F_SCORE, measures the overall fundamental strength of a firm and can take a value of zero to nine. A trading strategy that takes a long position in firms with F_SCORE greater or equal to eight and a short position in firms with F_SCORE less or equal to one generates a 23% buy-and-hold return in one year.

Piotroski [2000] only applies the F_SCORE strategy to firms in the highest BM quintile because he expects the ability of simple fundamental analysis to differentiate firms to be greater for value stocks. However, Piotroski [2000] does not empirically test whether the F_SCORE strategy works for low BM firms. Table 1 Panel A shows that the F_SCORE strategy is profitable both for firms in the highest BM quintile and firms in the lowest BM quintile. From 1979 to 2006, the average one-year buy-and-hold return for a hedge portfolio which takes a long position in high F_SCORE (>=7) firms and a short position in low F_SCORE (<=3) firms is 11.8% for high BM firms, and 19.8% for low BM firms.[12] The profitability of the F_SCORE strategy is actually higher for low BM firms than for high BM firms at the 1% level (t-statistic = 3.02). For high BM

[10] *ROA*: net income before extraordinary items scaled by beginning-of-year assets; *CFO*: cash flow from operations scaled by beginning-of-year assets; *ΔROA*: change in *ROA; ACCRUAL: ROA – CFO; ΔLEVER*: change in the ratio of long-term debt to average total assets; Δ*LIQUID*: change in the ratio of current assets to current liabilities; *EQ_OFFER*: equal to one if the firm did NOT issue common equity in the year preceding portfolio formation, zero otherwise; Δ*MARGIN*: the change in the firm's gross margin ratio (gross-margin divided by sales); Δ*TURN*: change in asset turnover ratio (sales divided by beginning-of-year total assets).

[11] *ACCRUAL* and Δ*LEVER* are assigned the score one when they are negative. Other signals are assigned score one when they are positive.

[12] We create high and low F_SCORE portfolios by combining F_SCORES at the high (>=7) and low (<=3) ends of the spectrum instead of only using only the extreme scores as there are few observations with extreme F_SCOREs, especially the F_SCORE of zero.

firms, the profit of the F_SCORE strategy is mostly driven by the long position: the high F_SCORE firms generate a positive return of 12.1%, while the low F_SCORE firms' return is almost zero. In contrast, the profit of the F_SCORE strategy for low BM firms is primarily driven by the short position: the return of high F_SCORE firms is close to zero, while the return of low F_SCORE firms is significantly negative at -18.1%. Having established the profitability of the F_SCORE strategy for both high and low BM firms, we include all firms with available data in our analyses in the remaining part of the paper.

Table 1 Panel B demonstrates that the profitability of the F_SCORE strategy does not change significantly after 2000, the year Piotroski [2000] was published. The hedge portfolio that takes a long position in high F_SCORE firms and a short position in low F_SCORE firms remains profitable and earns, on average, 8.9% a year in the post-Piotroski period, which is not significantly different than the 11.9% per year earned in the pre-Piotroski period. Hence the following analyses include all observations from 1979 to 2006.

Table 1 Panel C presents the one-year market-adjusted buy-and-hold returns for all firms with a F_SCORE equal to one to nine. Very few firms have F_SCORE equal to zero and thus these firms are combined with firms with F_SCORE equal to one. Most firms have conflicting performance signals and are clustered at F_SCOREs between three and eight.

Consistent with Piotroski [2000], Panel C shows a strikingly positive correlation between F_SCORE and future returns. The mean return increases monotonically from -6.5% for firms with a F_SCORE equal to one to 8.5% for firms with a F_SCORE equal to nine. The difference of

15.1% is significant at the 1% level. [13] This increase in returns also extends to the 10th percentile, 25th percentile, median, and the 75th percentile. The 90th percentile returns, on the other hand, generally decline with F_SCOREs, indicating that low F_SCORE firms tend to have greater dispersion in returns. In addition, the percentage of firms with positive returns also increases monotonically with F_SCOREs.

Overall we are able to replicate Piotroski's [2000] results. We find that firms with a higher F_SCORE have higher subsequent returns, and we show that these results can be extended from low BM firms to all firms. Moreover, the profitability of the F_SCORE strategy does not disappear after the publication of Piotroski [2000].

3.2 Institutional and Mutual Fund Holdings

The above findings demonstrate that a trading strategy based on simple heuristics from financial statements can earn significant abnormal returns. Do sophisticated investors utilize the F_SCORE strategy by investing more money in firms with higher F_SCOREs? In this section, we investigate the holdings of institutional investors (who file a 13F with the SEC) and mutual funds across F_SCORE categories.

Table 2 shows that both institutional and mutual fund holdings increase fairly monotonically with firm F_SCOREs. Institutional holdings increase from 21.9% for firms with an F_SCORE equal to one, to 34.4% for firms with an F_SCORE equal to nine, and the difference of 12.5% is significant at the 1% level. Mutual fund holdings increase from 4.5% to 6.8%, and the difference of 2.3% is significant at 1% level. Decomposition of mutual fund

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[13] More than half of the 15.1% difference in market-adjusted returns, or 8.5%, comes from a long position in a portfolio of firms with strong fundamentals, the rest comes from a short position in a portfolio of firms with weak fundamentals.

holdings according to investment types indicates that the holdings of small-cap value, mid-cap value and growth, large-cap value and growth funds increase significantly with F_SCOREs, while the holdings of small-cap growth funds decline with F_SCORE.

These results seem to suggest that institutional investors and mutual funds, with the exception of small-cap growth funds, do invest more heavily in firms with higher F_SCOREs. However, Table 2 reports that the average firm size also increases with F_SCOREs. As prior studies find that institutional investors and mutual funds tend to hold large firms (e.g., Falkenstein 1996), the increase in their holdings might be a result of the increase in firm size, rather than an intentional investment in firms with high F_SCOREs. We further explore whether institutional investors and mutual funds slant their holdings towards higher F_SCORE stocks in the next section.

3.3 Do Institutional Investors Trade on the F_SCORE Strategy?

To examine whether sophisticated investors invest using the F_SCORE strategy, we calculate the F_SCORE investing measure, *FIM*, as explained in Section 2.2 for institutional investors and mutual funds according to their reported stock holdings, and compare it with the market average *FIM*. We calculate the market average *FIM* by weighting each firm's most recently available F_SCORE (between 15 months and three months before the end of each calendar quarter) by its market value at the end of each calendar quarter. If sophisticated investors do invest on the F_SCORE strategy, their *FIM* should be higher than the market average *FIM*.

Table 3 reports that the market average *FIM* is 6.23, higher than 4.5, the arithmetic average of F_SCORE which ranges from 0 to 9. This can be driven by two factors. First, as shown in Table 1 Panel C, there are less firms with low F_SCOREs than firms with high F_SCOREs.

Second, the market values of high F_SCORE firms tend to be greater than that of low F_SCORE firms as demonstrated in Table 2.

Table 3 also shows that the mean *FIM* of institutional investors and actively managed mutual funds are 6.18 and 6.16, respectively, both lower than the market average *FIM*, though the difference is only significantly lower for mutual funds.[14] The result suggests that on average, institutional investors and mutual funds do not invest in the F_SCORE strategy.

When we decompose mutual funds by their investment styles, Table 3 shows that *FIM* of both small-cap value (5.96) and small-cap growth (5.83) are significantly lower than the market average, while the differences between mid-cap value (6.23) and mid-cap growth (6.19) and the market average are insignificant. On the other hand, large-cap value and large-cap growth funds do have significantly higher *FIM* than the market average (6.33 and 6.36, respectively). These results are consistent with Table 2 which shows that F_SCORE is positively correlated with firm size, leading to higher *FIM* for funds invest in large-cap stocks. However, in the aggregate, the mutual fund *FIM* and the institutional investor *FIM* are either statistically lower or similar to the *FIM* of the market. This suggests that in the aggregate, institutional investors and actively managed mutual funds do not slant their portfolios towards stocks with strong fundamentals based on the F_SCORE strategy.

3.4 Do Mutual Funds Who Hold High F_SCORE Stocks Earn Abnormal Returns?

Section 3.3 demonstrates that in the aggregate, mutual funds do not invest according to

[14] A possible reason for mutual funds to have lower *FIM* than the market average is that the reported mean *FIM* of mutual funds is equal weighted across funds. Thus, a small mutual fund's *FIM* has the same impact on the mean *FIM* as a large mutual fund's *FIM*. Later we find that small mutual funds tend to invest more heavily in companies with lower F_SCOREs (Table 4), thus the equal weighted mean *FIM* will be lower than the mean *FIM* weighted by mutual fund size. The difference between the average *FIM* of mutual funds weighted by a fund's net assets and the market average *FIM* is insignificant.

the F_SCORE strategy. We now investigate whether the funds that hold high F_SCORE stocks generate abnormal returns.

Table 4 presents summary statistics at the fund-quarter level. We rank mutual funds by their *FIM* and create *FIM* deciles. For each decile we report the mean *FIM*, *SIM*, *BIM*, net assets (*NA*), expense ratio (*fundexp*), turnover ratio (*turnover*), and the percentage of funds within each category. Please refer to the Appendix for more detailed description of the variables.

Table 4 yields several important observations. First, the variation in average *FIM* across the ten deciles is small. The difference in average fund *FIM* between the top decile (6.83) and the bottom decile (5.30) is only 1.53. Although the difference is statistically significant, the magnitude is much smaller than the variation in firm F_SCORE which ranges from zero to nine. That is because few firms have extreme F_SCOREs and firms with extreme F_SCORES tend to be smaller firms as shown in Table 2, offering limited investment opportunities to mutual funds. The smaller size of firms with extreme F_SCOREs also means that their F_SCOREs have less impact on *FIM* which is weighted by firm market capitalization. The diminished variation in *FIM* suggests that the difference in abnormal returns across extreme *FIM* deciles is also likely to be diminished compared with the variation in returns across extreme F_SCOREs. Second, mutual funds' net assets and *SIM* increase with *FIM*, while *BIM*, expense ratio and turnover ratio decline with *FIM* deciles. That is, mutual funds that hold firms with higher F_SCOREs are larger, have lower expenses, have a lower turnover ratio, and invest in larger firms with higher growth. Third, the percentage of small-cap value and small-cap growth funds decline with *FIM* deciles, while the percentage of all other types of funds increase with *FIM* deciles.

Next we examine whether funds with higher *FIM* earn higher abnormal returns as measured by alphas. We estimate alphas for each fund-year with monthly fund returns using the CAPM, three-factor, and four-factor models, respectively, as shown below.

$$R - RF = \alpha + \beta\ MRP + e \qquad (3)$$
$$R - RF = \alpha + \beta\ MRP + s\ SMB + h\ HML + e \qquad (4)$$
$$R - RF = \alpha + \beta\ MRP + s\ SMB + h\ HML + p\ UMD + e \qquad (5)$$

where *R* is the monthly return of a mutual fund (*gross_ret*, *raw_ret* or *net_ret*), *RF* is the monthly risk-free rate (measured by the yield on Treasury Bills with one-month maturity), *MRP* is the CRSP value-weighted index return minus the risk-free rate, *SMB*, *HML*, and *UMD* are the size, book-to-market, and momentum factors, respectively. [15] We require at least seven monthly returns each year to estimate these models, which yields 18,787 fund-year observations. We then calculate the annualized alpha by multiplying the estimated coefficient α by 12.

To test the association between *FIM* and alphas we first regress fund alphas on fund *FIM* as follows.

$$alpha = \beta_0 + \beta_1\ FIM\ (+\beta_2\ SV + \beta_3\ SG + \beta_4\ MG + \beta_5\ LV + \beta_6\ LG) + Year\_\ Dummies + \varepsilon \qquad (6)$$

where alpha is one of the annualized alphas estimated from Eq. (3) – (5) using gross, raw or net fund returns. Because a mutual fund's alpha is estimated annually, *FIM* in Eq. (6) is the average of the four quarterly calculated F_SCORE investing measures in a year. Given that mutual funds are generally restricted to an investment universe based on their fund investment category, and that different fund types frequently have different levels of abnormal returns, we add indicator variables for fund investment categories (*SV*: small-cap value funds, *SG*: small-cap growth funds, *MG*: mid-cap growth funds, *LV*: large-cap value funds, *LG*: large-cap growth funds) to control for

[15] Data for *RF*, *RMRF*, *SMB*, *HML* and *UMD* are obtained from Ken French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/.

the effect of mutual fund category on alphas. To avoid singularity, we leave out mid-cap value funds so the coefficients on these indicator variables can be interpreted as the difference in alphas between these types of mutual funds and mid-cap value funds. We estimate Eq. (6) with robust estimators of variance clustered at fund level.

Table 5 Panel A presents the estimation results for the univariate regression. The coefficient on *FIM* is significantly positive for all three versions of alphas based on gross returns, suggesting that mutual funds do earn higher abnormal returns before transaction costs and fees by investing in firms with high F_SCOREs. When a mutual fund increases its *FIM* from 5.5 to 6.5, approximately from the second *FIM* decile to the ninth *FIM* decile, its abnormal gross returns as measured by the CAPM, three-factor, and four-factor models will rise annually by 1.7%, 2.3%, and 2.2%, respectively. However, the coefficient on *FIM* is generally insignificant for alphas based on raw or net returns. The only exception is the three-factor alpha using net returns (*net_3alpha*) which is significantly positive at 10% level (coefficient = 0.0055, t-statistic = 1.74).

Table 5 Panel B shows the estimation results for the multivariate regression which controls for mutual fund type. When mutual funds type controls are included in the regression the coefficient on *FIM* is significantly positive for all three versions of alphas (CAPM, three-factor, and four-factor models) calculated with gross, raw and net fund returns. When a mutual fund increases its *FIM* from 5.5 to 6.5, its abnormal gross, raw and net returns as measured by the CAPM model will rise annually by 3.0%, 1.4%, and 1.6%, respectively. The increase in raw and net fund returns alphas with *FIM* is similar or slightly smaller with the Fama-French three-factor and four-factor models. These results indicate that mutual funds who tend to hold higher F_SCORE stocks, have higher abnormal returns, both before and after considering transaction costs, price pressure effects and management fees.

Turning to the control variables, we find that the coefficients on *SV*, *SG* and *MG* are generally significantly positive, the coefficients on *LV* are insignificant, and the coefficients on *LG* are generally negative, indicating that small-cap value, small-cap growth and mid-cap growth funds tend to earn higher abnormal returns than mid-cap value funds, large-cap value funds have similar abnormal returns as mid-cap value funds, and large-cap growth funds have lower abnormal returns than mid-cap value funds. [16]

Given that mutual funds' performances are evaluated against peer funds in the same investment category, we examine whether a fund's *FIM* is associated with higher abnormal returns within each category. Table 5 Panels C to H report the results of regressing mutual fund alphas on mutual fund *FIMs* for each fund category. For small-cap and mid-cap funds, the coefficient on *FIM* is always positive. This means that increases in *FIM* are associated with increases in fund alphas. For small-cap and mid-cap funds, the majority of the coefficients on *FIM* are significant using gross fund returns (10 out of 12) and using net fund returns (7 out of 12). The results are also economically significant. For example, for small-cap growth funds, a one unit increase in *FIM* will result in an 8.0% increase in alpha using gross returns (CAPM model), and a 2.2% increase in alpha using net returns (CAPM model). These findings suggest that small-cap and mid-cap mutual funds can earn higher abnormal returns by investing in the F_SCORE strategy, however these returns are largely absorbed by high transaction costs so the effect of *FIM* on abnormal net returns is smaller. For large-cap value funds, an increase in mutual fund *FIM* does not increase the gross return alpha, but does improve both the raw and net return alphas with all three models. This suggests that although the F_SCORE strategy is less profitable for large firms as shown in Piotroski [2000], it does improve raw and net returns probably because

[16] The results are also robust to including controls for fund expenses and fund turnover. These regressions are not shown for brevity.

higher *FIM* is associated with lower turnover, transaction costs, and fund fees as shown in Table 4. For large-cap growth funds, the coefficient on mutual fund FIM is not significant in explaining any of the alphas.

Overall, our results indicate that mutual funds who slant their portfolios towards high F_SCORE stocks earn higher risk-adjusted returns, even after considering transaction costs, price pressure effects and management fees. It is thus an anomaly why in the aggregate, mutual funds do not trade on the F_SCORE strategy.

3.5 Mean-Variance Analysis

Since there is no widespread acceptance of any one factor model and popular mutual fund resources report mutual fund Sharpe Ratios, we next explore the performance of the F_SCORE strategy in the mean-variance framework.[17] We examine whether mutual funds can obtain a higher Sharpe ratio, lower total risk, lower systematic risk, and lower idiosyncratic risk by trading on firm F_SCOREs. We use the following model to calculate Sharpe ratio:

$$\text{Sharpe ratio} = \frac{mean(R - RF)}{std(R - RF)} \tag{7}$$

where *R* is the monthly fund returns (*gross_ret* or *net_ret*), and *RF* is the monthly risk-free rate defined before. We calculate Sharpe ratios for each fund-year with at least seven monthly returns. The results with raw fund returns are very similar to net returns given that raw returns are defined as net returns plus one twelfth of annual fund expense ratio, and thus are not tabulated for brevity.

Table 6 Panel A reports the mean Sharpe ratio calculated with mutual funds' gross

[17] For example, Morningstar reports mutual fund Sharpe Ratios.

returns (*Sharpe_gross*) and net returns (*Sharpe_net*), respectively, for each *FIM* decile. Both Sharpe ratios demonstrate a fairly monotonic positive relationship with mutual fund *FIM* deciles. *Sharpe_gross* increases from 0.14 for the bottom *FIM* decile to 0.21 for the top *FIM* decile, and the difference between the two extreme deciles is significant at 1% level. Similarly, *Sharpe_net* increases from 0.15 for the bottom *FIM* decile to 0.19 for the top *FIM* decile, and the difference between the two extreme deciles is significant at 1% level. These results indicate that a mutual fund can improve its Sharpe ratio, or its mean-variance efficiency, by following the F_SCORE strategy.

To show whether the increase in Sharpe ratio is driven by the numerator (excess returns), or the denominator (return volatility), Table 6 Panel A also presents the average excess gross and net returns (*Gross_ret-rfr* and *Net_ret-rfr*) and their volatility, or the standard deviation of fund returns in excess of the risk-free rate (*Std_gross* and *Std_net*). The difference in excess returns between the top and bottom *FIM* decile are significant at the ten percent level for gross excess returns, but insignificant for net excess returns. However, volatility drops significantly with *FIM* deciles, suggesting that the increase in Sharpe ratio is mostly driven by the decline in volatility. From the bottom to the top *FIM* decile, the average standard deviation of excess gross returns, *Std_gross*, declines from 0.07 to 0.05, while the standard deviation of excess net returns, *Std_net*, declines from 0.06 to 0.04. The differences between the extreme deciles are both significant at the one percent level. The standard deviation of excess raw returns is equal to that of excess net returns because monthly raw returns are equal to monthly net returns plus a constant (one-twelfth of annual expense ratios), and thus is not tabulated.

To further explore the effect of *FIM* on firm risk, we investigate whether fund *FIM* affects the volatility of fund returns through systematic risk or idiosyncratic volatility. We use the standard error from the CAPM model, Eq. (3), to measure idiosyncratic volatility. Table 6 Panel A shows that the idiosyncratic volatility declines significantly with *FIM* deciles for both gross fund returns and net fund returns (*IV_gross* and *IV_net*). Again, we do not report the idiosyncratic volatility for raw fund returns because it is identical to that of net fund returns. Moreover, the CAPM beta for gross returns (*CAPM_beta_gross*) and net returns (*CAPM_beta_net)*) also decline monotonically from 1.38 (1.23) for the bottom *FIM* decile to 0.96 (0.85) for the top *FIM* decile. These results suggest that following the F_SCORE strategy will lower a mutual fund's total return volatility by lowering both its systematic risk and idiosyncratic risk.

We also show the mean-variance analysis summary statistics for the *FIM* deciles for each mutual fund investment category type. These results are shown in Table 6 Panels B – G. With respect to Sharpe ratios, the top *FIM* decile average Sharpe ratio is significantly higher than the bottom *FIM* decile average Sharpe ratio for mid-cap value, mid-cap growth and large-cap growth funds whether returns are measured by gross or net fund returns. The gross return Sharpe ratio for small-cap value funds also demonstrates marginally significant increase from the bottom to the top FIM decile. The difference in gross or net fund excess returns between the top and bottom *FIM* decile is significantly positive for mid-cap value, mid-cap growth and large-cap growth funds. Turning to risk measures, we find that with the exception of large-cap value funds, for all other investment categories, mutual funds' total volatility, idiosyncratic volatility and CAPM beta calculated with gross or net returns demonstrate significant decline with *FIM* deciles. For large-cap value funds, only the decline in volatility, idiosyncratic volatility and CAPM beta measured with gross returns is significant.

To further explore the effect of *FIM* on mutual funds' Sharpe ratio, we examine regression results for the following model:

$$\text{Sharpe\_ratio} = \beta_0 + \beta_1 \, FIM \; (+\beta_2 \, SV + \beta_3 \, SG + \beta_4 \, MG + \beta_5 \, \text{LV} + \beta_6 \, LG) + Year\_\,Dummies + \varepsilon \quad (8)$$

where Sharpe ratio is *Sharpe_gross* or *Sharpe_net*, and other variables in Eq. (8) are the same as defined before.

The regression results are presented in Table 6 Panel H. As expected, the coefficient on *FIM* is significantly positive in both the univariate and multivariate regressions for *Sharpe_gross* and *Sharpe_net*. Hence we focus on the multivariate regressions to interpret the economic significance of the results. If a fund increases its *FIM* from 5.5 to 6.5, its gross return Sharpe ratio will improve by 6.8%, and its net return Sharpe ratio will improve by 5.3%.

Turning to control variables, we find that *SV* has significantly positive coefficients, while *SG*, *MG* and *LG* have significantly negative coefficients, i.e., growth funds tend to have lower Sharpe ratios than mid-cap value funds, while small-cap value funds tend to have higher Sharpe ratios than mid-cap value funds. Large-cap value funds also tend to have Sharpe ratios higher than mid-cap value funds, but the coefficient is significant only for the gross return Sharpe ratio. These results are confirmed in Table 6 Panel I which shows the estimation results for regressing Sharpe ratios on FIM within each mutual fund category. Except for large-cap value funds, the coefficient on *FIM* is significantly positive for all other types of mutual funds.

3.6 Robustness Check Using Synthetic Portfolios

The results in sections 3.4 and 3.5 show that investing in the F_SCORE strategy can improve a mutual fund's mean-variance efficiency, reduce its total, systematic, and idiosyncratic risk, and generate positive alphas using multi-factor models. To show that these findings are driven by the F_SCORE instead of variables potentially correlated with F_SCORE like managers' experience, we construct synthetic portfolios based on F_SCORE. We then examine whether the Sharpe ratios, alphas, and volatility of the synthetic portfolios vary with F_SCORE. Specifically, we group all stocks according to their most recent F_SCORE available between 15 months and three months before the end of each calendar quarter. Again given the limited number of firms with F_SCORE equal to zero, these firms are combined with firms with F_SCORE equal to one. Thus we have nine portfolios with F_SCORE equal to one to nine. These portfolios are rebalanced at the end of each quarter. We then calculate portfolio monthly returns (*portret*) as the average monthly returns of individual stocks in the portfolio, weighted by their market capitalization at the beginning of a quarter. The synthetic portfolio returns are similar to gross returns of mutual funds, and do not take into consideration transaction costs and other costs associated with forming the portfolio. We then use *portret* to estimate alphas and Sharpe ratio etc. similar to what we have done in previous sections.

Table 7 shows the average monthly excess portfolio returns (*portret-rfr*), the annualized CAPM alpha (*CAPM_alpha*), the annualized three-factor and four-factor alpha (*3factor_alpha, 4factor_alpha*), the Sharpe ratio (*Sharpe_ratio*) using monthly returns, the monthly standard deviation of *portret* in excess of the risk free-rate (*std*), and the standard error from the CAPM model (*CAPM_IV*) for each synthetic F_SCORE portfolio. We find that the abnormal returns of synthetic portfolios increase with F_SCORE. The difference in monthly excess returns between the F_SCORE equal to one portfolio and the F_SCORE equal to nine portfolio is 1.38% which is significant at the 10% level with t-statistic = 1.94.[18] The difference in the CAPM alpha is

[18] This difference in returns is smaller than the reported difference in table 1 of 15%. In Table 7 returns are value weighted but in table 1, they are equal weighted. Also in table 7 the returns are aggregated at the portfolio level at each quarter end.

significant at the 10% level (t-statistic=1.90). The differences in the three-factor and four-factor alphas are also significant at the 10% level.

Turning to the mean-variance analysis, results on the synthetic portfolios in Table 7 are consistent with results on mutual funds in Table 6 Panel A. The average Sharpe ratio increases from -0.024 for the F_SCORE equal to one portfolio to 0.235 for the F_SCORE equal to nine portfolio, and the difference of 0.258 between the two extreme portfolios is significant at 1% level (t-statistic = 2.72). Total risk, proxied by the standard deviation of monthly excess portfolio returns, declines from 0.098 to 0.049 when F_SCORE increases from one to nine and the difference between the two extreme portfolios is significant at 1% level. Similarly, idiosyncratic volatility and CAPM beta also drop significantly from the F_SCORE equal to one portfolio to the F_SCORE equal to nine portfolio. These results are consistent with the observed improvement in Sharpe ratio and the decline in risk for mutual funds being driven by F_SCORE.

The findings in this section indicate that slanting their portfolio towards fundamentally strong stocks (high F_SCORE) can help mutual funds improve their risk-adjusted returns by increasing their factor model alphas. It can also help mutual funds improve their mean-variance efficiency by increasing their Sharpe ratio and lowering their total, systematic and idiosyncratic risk.

Conclusion

In this paper, we find that sophisticated investors like mutual funds do not invest in the F_SCORE strategy in the aggregate. The F_SCORE strategy is a fundamental analysis screen that has been shown to generate abnormal returns when applied to individual stocks. The inability of mutual funds to utilize the F_SCORE strategy may explain why this simple heuristic based on financial statements continues to be profitable using hypothetical portfolios of stocks.

More interestingly, we document that mutual funds who hold fundamentally stronger stocks (higher *FIM*) generate higher risk-adjusted returns as measured by CAPM alpha, Fama-French 3-Factor alpha, Carhart 4-Factor alpha, and the Sharpe Ratio. Mutual funds with a higher *FIM* also have higher gross returns, similar net returns, lower systematic volatility, and lower idiosyncratic volatility, than mutual funds with a lower FIM. Most of these findings also hold within each mutual fund investment category type (small-cap value; small-cap growth; mid-cap value; mid-cap growth; large-cap value; large-cap growth).

Since abnormal risk-adjusted returns are possible after all costs and fees from trading on the F_SCORE strategy, and the results were published over a decade ago, it is surprising that mutual funds do not trade on the strategy. One possible explanation for our findings is based on the incentives of mutual funds. Though we find that trading on strong fundamentals results in higher risk-adjusted returns and higher gross returns, it results in similar net returns (after costs and fees) in the aggregate. Since mutual funds receive fees based on the total assets under management, and inflows to the mutual funds might be driven by net returns rather than risk-adjusted returns (Siiri and Tufano (1998)), mutual fund managers may slant their portfolios towards stocks that generate higher returns instead of slanting their portfolios towards stocks that generate higher risk-adjusted returns. Since trading on the F_SCORE strategy results in a higher Sharpe Ratio and a lower standard deviation in monthly returns, investors who trade on the strategy will create more wealth over time with lower volatility.

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Appendix: Variable Definitions

F_SCORE:	Sum of nine binary fundamental signals that can be calculated from a firm's financial statements including *ROA, CFO, ΔROA*, *ACCRUAL*, Δ*LEVER, ΔLIQUID*, *EQ_OFFER*, Δ*MARGIN* and Δ*TURN*. *ROA*: net income before extraordinary items scaled by beginning-of-year assets; *CFO*: cash flow from operations scaled by beginning-of-year assets; *ΔROA*: change in *ROA*; *ACCRUAL: ROA – CFO*; *ΔLEVER*: change in the ratio of long-term debt to average total assets; Δ*LIQUID*: change in the ratio of current assets to current liabilities; *EQ_OFFER*: equal to one if the firm did NOT issue common equity in the year preceding portfolio formation, zero otherwise; Δ*MARGIN*: the change in the firm's gross margin ratio (gross-margin scaled by sales); Δ*TURN*: change in asset turnover ratio (sales scaled by beginning-of-year total assets). *ACCRUAL* and Δ*LEVER* are assigned the score one when they are negative, zero otherwise. Other signals are assigned the score one when they are positive, zero otherwise. The F_SCORE can range from zero to nine.
FIM:	Average of the most recently available F_SCOREs of the stocks held by a mutual fund weighted by the market value of each stock in the mutual fund's portfolio at the end of each calendar quarter; the end of the fiscal year for which F_SCORE is based upon must be between 15 months and 3 months before the calendar quarter end when we calculate *FIM*. In regressions using annual data, this variable is averaged across the four quarters.
SIM:	Average size decile of stocks held by a fund weighted by the fund's investment in each stock; size deciles are assigned based on the most recent market value of a firm before a mutual fund reports its stock holdings and NYSE/AMEX decile break points.
BIM:	Average book-to-market quintiles of stocks held by a fund weighted by the fund's investment in each stock; book-to-market quintiles are assigned based on the book-to-market ratio at the beginning of a fiscal year for which the *F_SCORE* is calculated.
SV:	An indicator variable equal to one if a fund is a small-cap value fund, zero otherwise. A small-cap value fund is in the lowest SIM tercile with above median BIM.
SG:	An indicator variable equal to one if a fund is a small-cap growth fund, zero otherwise. A small-cap growth fund is in the lowest SIM tercile with below median BIM.
MV:	An indicator variable equal to one if a fund is a mid-cap value fund, zero otherwise. A mid-cap value fund is in the middle SIM tercile with above median BIM.
MG:	An indicator variable equal to one if a fund is a mid-cap growth fund, zero otherwise. A mid-cap growth fund is in the middle SIM tercile with below median BIM.
LV:	An indicator variable equal to one if a fund is a large-cap value fund, zero otherwise. A large-cap value fund is in the highest SIM tercile with above median BIM.
LG:	An indicator variable equal to one if a fund is a large-cap growth fund, zero otherwise. A large-cap growth fund is in the highest SIM tercile with below median BIM.
size:	Market capitalization of a firm at the beginning of a fiscal year.
NA:	Net assets of a fund.

fundexp: Annual expense ratio of a fund.

turnover: Annual turnover ratio of a fund.

gross_ret: Weighted average monthly stock returns for a fund where weights are based on the market value of each stock held by the fund at the beginning of a quarter.

raw_ret: Reported fund monthly returns + 1/12 annual expense ratio.

net_ret: Reported fund monthly returns which are net of expenses.

g_alpha: Annualized fund alpha estimated with *gross_ret* using the CAPM model in Eq. (3) and monthly data.

g_3alpha: Annualized fund alpha estimated with *gross_ret* using the Fama-French three-factor model in Eq. (4) and monthly data.

g_4alpha: Annualized fund alpha estimated with *gross_ret* using the Carhart four-factor model in Eq. (5) and monthly data.

raw_alpha: Annualized fund alpha estimated with *raw_ret* using the CAPM model in Eq. (3) and monthly data.

raw_3alpha: Annualized fund alpha estimated with *raw_ret* using the Fama-French three-factor model in Eq. (4) and monthly data.

raw_4alpha: Annualized fund alpha estimated with *raw_ret* using the Carhart four-factor model in Eq. (5) and monthly data.

net_alpha: Annualized fund alpha estimated with *net_ret* using the CAPM model in Eq. (3) and monthly data.

net_3alpha: Annualized fund alpha estimated with *net_ret* using the Fama-French three-factor model in Eq. (4) and monthly data.

net_4alpha: Annualized fund alpha estimated with *net_ret* using the Carhart four-factor model in Eq. (5) and monthly data.

Sharpe_gross: The Sharpe ratio calculated for each fund-year by scaling the mean monthly (*gross_ret – rfr*) by its standard deviation.

Sharpe_net: The Sharpe ratio calculated for each fund-year by scaling the mean monthly (*net_ret – rfr*) by its standard deviation.

gross_ret-rfr: Average monthly stock returns weighted by a fund's holdings in each stock at the beginning of a quarter minus risk free rate of return.

net_ret-rfr: Reported fund net monthly returns minus the risk free rate of return.

std_gross The standard deviation of (*gross_ret – rfr*) calculated for each fund-year.

std_net:	The standard deviation of monthly (*net_ret– rfr*) calculated for each fund-year.
IV_gross:	The standard error of the CAPM regression model in Eq. (3) using monthly *gross_ret*, calculated for each fund-year.
IV_net:	The standard error of the CAPM regression model in Eq. (3) using monthly *net_ret*, calculated for each fund-year.
CAPM_beta_gross:	The coefficient estimated with monthly *gross_ret* using the CAPM model in Eq. (3).
CAPM_beta_net:	The coefficient estimated with monthly *net_ret* using the CAPM model in Eq. (3).
portret:	The average monthly stock returns weighted by the market capitalization of each stock.
Portret-rfr:	The average monthly stock returns weighted by the market capitalization of each stock minus the risk-free rate of return.
CAPM_alpha:	The annualized alpha estimated with monthly *portret* using the CAPM model in Eq. (3).
CAPM_beta:	The coefficient estimated with monthly *portret* using the CAPM model in Eq. (3).
Sharpe_ratio:	The Sharpe ratio for a synthetic portfolio of stocks based on F_SCORE deciles calculated according to Eq. (7).
std:	The standard deviation of monthly (*portret – rfr*) calculated for each fund-year.
CAPM_IV:	The standard error of the CAPM regression model in Eq. (3) using monthly *portret*, calculated for each portfolio-year.
3factor_alpha	The annualized alpha estimated with *portret* using the Fama-French three-factor in Eq. (4).
4factor_alpha:	The annualized alpha estimated with *portret* using the Carhart four-factor model in Eq. (5).

TABLE 1

Replication and Extension of Piotroski [2000]

Panel A: The profitability of the F_SCORE strategy for firms in high BM and low BM quintiles.
This table reports, for firms in the highest BM quintile and lowest BM quintile, respectively, the mean, 10th percentile, 25th percentile, median, 75th percentile, and 90th percentile of one-year market-adjusted buy-and-hold returns, the proportion of firms with positive one-year market-adjusted buy-and-hold returns, and number of observations (N) across the low F_SCORE (<=3), middle F_SCORE (4<=F_SCORE<=6), and high F_SCORE (>=7) categories. p-value for the difference in portfolio means (medians) is based on two-sample t-tests (signed rank Wilcoxon tests). p-value for %Positive is based on a binomial test of proportions.

Firms in the highest BM quintile								
F_SCORE	mean	10%	25%	Median	75%	90%	%Positive	N
Low	0.003	-0.755	-0.493	-0.160	0.207	0.800	0.374	2,572
Middle	0.079	-0.618	-0.354	-0.056	0.281	0.808	0.448	9,594
High	0.121	-0.496	-0.269	0.002	0.319	0.798	0.501	6,235
High-Low	0.118	0.259	0.224	0.161	0.112	-0.002	0.127	
t-stat / (p-value)	5.43 (<.01)			(<.01)			(<.01)	
Firms in the lowest BM quintile								
F_SCORE	mean	10%	25%	Median	75%	90%	%Positive	N
Low	-0.181	-0.883	-0.661	-0.352	0.053	0.610	0.277	3,629
Middle	-0.075	-0.772	-0.528	-0.197	0.147	0.652	0.341	11,398
High	0.016	-0.608	-0.366	-0.077	0.231	0.652	0.425	4,282
High-Low	0.198	0.275	0.295	0.275	0.178	0.042	0.148	
t-stat / (p-value)	10.84 (<.01)			(<.01)			(<.01)	
Difference in the mean High-Low returns between firms in the lowest and highest BM quintile								
		t-stat	p-value					
	0.079	3.02	<.01					

Panel B: The profitability of the F_SCORE strategy for firms in the pre-Piotroski period (1979-2000) and post-Piotroski period (2001-2006).

This table reports, for the pre-Piotroski (1979-2000) and post-Piotroski (2000-2006) periods, respectively, the mean, 10^{th} percentile, 25^{th} percentile, median, 75^{th} percentile, and 90^{th} percentile of one-year market-adjusted buy-and-hold returns, the proportion of firms with positive one-year market-adjusted buy-and-hold returns, and number of observations (N) across the low F_SCORE (<=3), middle F_SCORE (4<=F_SCORE<=6), and high F_SCORE (>=7) categories. p-value for the difference in portfolio means (medians) is based on two-sample t-tests (signed rank Wilcoxon tests). p-value for %Positive is based on a binomial test of proportions.

Pre-Piotroski period: 1979-2000								
F_SCORE	mean	10%	25%	Median	75%	90%	%Positive	N
Low	-0.072	-0.829	-0.582	-0.247	0.143	0.717	0.327	11,632
Middle	-0.013	-0.658	-0.391	-0.105	0.192	0.630	0.397	46,174
High	0.047	-0.511	-0.277	-0.039	0.229	0.627	0.455	24,358
High-Low	0.119	0.318	0.305	0.209	0.087	-0.090	0.127	
t-stat / (p-value)	11.67 (<.01)			(<.01)			(<.01)	
Post-Piotroski period: 2001-2006								
F_SCORE	mean	10%	25%	Median	75%	90%	%Positive	N
Low	0.028	-0.719	-0.484	-0.148	0.272	0.902	0.395	3,926
Middle	0.099	-0.548	-0.287	-0.018	0.273	0.744	0.481	13,418
High	0.117	-0.389	-0.185	0.027	0.282	0.642	0.534	7,317
High-Low	0.089	0.330	0.299	0.175	0.011	-0.260	0.139	
t-stat / (p-value)	5.75 (<.01)			(<.01)			(<.01)	
Difference in the mean High-Low returns between firms in the post-Piotroski and pre-Piotroski periods								
		t-stat	p-value					
	-0.029	-0.40	0.693					

Panel C: Distribution of one-year market-adjusted buy-and-hold returns across F_SCOREs

This table shows, for each F_SCORE category, the mean, 10th percentile, 25th percentile, median, 75th percentile, and 90th percentile of one-year market-adjusted buy-and-hold returns, the proportion of firms with positive one-year market-adjusted buy-and-hold returns, and number of observations (N). F_SCORE = 1 includes both F_SCORE=0 and 1 firms because very few firms have F_SCORE = 0. Total number of observations is 106,825. p-value for the difference in portfolio means (medians) is based on two-sample t-tests (signed rank Wilcoxon tests). p-value for %Positive is based on a binomial test of proportions.

F_SCORE	mean	10%	25%	Median	75%	90%	%Positive	N
1	-0.065	-0.824	-0.581	-0.256	0.127	0.715	0.319	699
2	-0.051	-0.829	-0.589	-0.246	0.165	0.801	0.330	4311
3	-0.044	-0.783	-0.542	-0.207	0.182	0.745	0.351	10548
4	-0.016	-0.724	-0.460	-0.144	0.199	0.710	0.379	16684
5	0.016	-0.629	-0.367	-0.082	0.215	0.657	0.416	21168
6	0.031	-0.557	-0.307	-0.052	0.218	0.613	0.443	21740
7	0.051	-0.497	-0.262	-0.029	0.234	0.621	0.465	17788
8	0.076	-0.479	-0.250	-0.017	0.247	0.645	0.480	10960
9	0.085	-0.450	-0.245	-0.003	0.267	0.650	0.495	2927
F9-F1	0.151	0.374	0.336	0.253	0.140	-0.065	0.176	
t-stat / (p-value)	3.46 (<.01)			(<.01)			(<.01)	

TABLE 2

Institutional and Mutual Fund Holdings across F_SCORE Categories

This table shows the fraction of shares held by institutional investors, actively managed mutual funds, and each type of mutual funds for each F_SCORE category, and the difference between the F_SCORE=9 and F_SCORE=1 firms (F_SCORE=1 category also includes F_SCORE=0 firms). *size* is the market value of firms at the beginning of the fiscal year. Numbers in parentheses are t-statistics.

F_SCORE	Institutional Holdings	Active Mutual Funds	Small/ Value	Small/ Growth	Mid / Value	Mid/ Growth	Large/ Value	Large/ Growth	Mean *size*
1	0.2187	0.0451	0.0247	0.0107	0.0029	0.0053	0.0004	0.0011	258.04
2	0.2000	0.0402	0.0233	0.0080	0.0030	0.0044	0.0006	0.0009	327.54
3	0.2247	0.0466	0.0257	0.0098	0.0037	0.0053	0.0010	0.0012	434.99
4	0.2616	0.0553	0.0284	0.0106	0.0058	0.0064	0.0019	0.0022	693.31
5	0.2971	0.0621	0.0301	0.0112	0.0072	0.0073	0.0030	0.0033	1195.90
6	0.3259	0.0674	0.0311	0.0110	0.0086	0.0086	0.0038	0.0043	1437.31
7	0.3454	0.0703	0.0318	0.0100	0.0098	0.0091	0.0046	0.0049	1629.71
8	0.3499	0.0715	0.0320	0.0097	0.0104	0.0090	0.0049	0.0055	1691.20
9	0.3440	0.0680	0.0321	0.0081	0.0097	0.0082	0.0050	0.0050	1648.57
F9-F1	0.1253	0.0229	0.0074	-0.0026	0.0068	0.0029	0.0046	0.0039	1390.53
	(12.18)	(7.32)	(3.55)	(-2.15)	(9.16)	(3.42)	(13.40)	(8.82)	(7.26)

TABLE 3

Institutional Investors' and Mutual Funds' FIM vs. Market Average FIM

This table compares the equal-weighted institutional investors' and mutual funds' average FIM with the market FIM. At the end of each quarter, the market *FIM* is calculated by weighting each firm's most recently available F_SCORE (fiscal year end must be between 15 months and 3 months before the calendar quarter end) by its market value. Institutional investors' and mutual funds' *FIM* are calculated in the same way except that the weights are their investment in each firm. We have 112 quarterly observations from 1980 to 2007. Numbers in parentheses are t-statistics.

	FIM	Difference from market FIM
Market	6.2282	-
Institutions	6.1770	-0.051 (-1.60)
Actively managed mutual funds	6.1558	-0.072** (-2.34)
Small-cap Value funds	5.9644	-0.2638*** (-9.10)
Small-cap Growth funds	5.8270	-0.4012*** (-13.08)
Mid-cap Value funds	6.2329	0.0047 (0.13)
Mid-cap Growth funds	6.1883	-0.0399 (-1.27)
Large-cap Value funds	6.3327	0.1045*** (2.67)
Large-cap Growth funds	6.3551	0.1270*** (3.73)

TABLE 4

Mutual Fund Summary Statistics

This table provides summary statistics for the mutual funds in the sample at quarterly level based on their FIM deciles. Total number of observations = 79,552. *N*: number of observations in each decile. *NA*: net assets of a fund. *fundexp*: expense ratio of a fund. *Turnover*: fund turnover ratio. *SIM*: value-weighted market size deciles for stocks held by a fund. *BIM*: value-weighted book-to-market quintiles for stocks held by a fund. Numbers in parentheses are t-statistics.

FIM Decile	N	*FIM*	*NA*	*fundexp*	*Turnover*	*SIM*	*BIM*	*Small/ Value*	*Small/ Growth*	*Mid / Value*	*Mid / Growth*	*Large/ Value*	*Large/ Growth*
D1	7906	5.2986	48209.92	0.0158	1.0290	6.3707	1.4074	0.4452	0.3305	0.0746	0.0963	0.0282	0.0252
D2	7958	5.7208	80024.15	0.0133	0.9313	6.9926	1.3988	0.4142	0.2116	0.1137	0.1534	0.0418	0.0652
D3	7971	5.9032	97488.44	0.0129	0.8683	7.4322	1.3772	0.3415	0.1474	0.1472	0.1906	0.0591	0.1143
D4	7965	6.0367	107224.57	0.0126	0.8691	7.7344	1.3576	0.2713	0.1144	0.1659	0.2025	0.0848	0.1612
D5	7945	6.1476	115747.53	0.0123	0.8135	7.9773	1.3296	0.2111	0.0832	0.1743	0.2130	0.1002	0.2183
D6	7985	6.2445	129260.37	0.0121	0.7894	8.1592	1.2978	0.1621	0.0655	0.1882	0.2029	0.1083	0.2730
D7	7975	6.3365	126081.63	0.0119	0.7789	8.2966	1.2753	0.1283	0.0509	0.1763	0.1835	0.1297	0.3314
D8	7960	6.4330	117995.11	0.0118	0.7727	8.3640	1.2710	0.1139	0.0430	0.1818	0.1555	0.1416	0.3642
D9	7969	6.5523	135279.80	0.0119	0.7722	8.4377	1.2806	0.0942	0.0333	0.1901	0.1477	0.1541	0.3806
D10	7918	6.8339	90439.47	0.0125	0.8024	8.3379	1.3521	0.1257	0.0347	0.2045	0.1420	0.1743	0.3189
D10-D1		1.5352	42229.55	-0.0033	-0.2265	1.9672	-0.0553	-0.3196	-0.2958	0.1298	0.0457	0.1461	0.2937
		(252.85)	(10.13)	(-13.44)	(-14.48)	(92.11)	(-5.57)	(-47.57)	(-52.10)	(24.00)	(8.90)	(31.40)	(53.15)

TABLE 5

FIM and Alphas

This table examines whether higher fund FIM is associated with a higher fund alpha. *g_alpha:* annualized alpha estimated with monthly *gross_ret* using the CAPM model in Eq. (3) for each fund-year. *g_3alpha:* annualized alpha estimated with monthly *gross_ret* using the Fama-French three-factor model in Eq. (4) for each fund-year. *g_4alpha:* annualized alpha estimated with monthly *gross_ret* using the Carhart four-factor model in Eq. (5) for each fund-year. *raw_alpha:* annualized alpha estimated with monthly *raw_ret* using the CAPM model in Eq. (3) for each fund-year. *raw_3alpha:* annualized alpha estimated with monthly *raw_ret* using the Fama-French three-factor model in Eq. (4) for each fund-year. *raw_4alpha:* annualized alpha estimated with monthly *raw_ret* using the Carhart four-factor model in Eq. (5) for each fund-year. Raw returns are defined as mutual funds' monthly net returns plus 1/12 annual expense ratio. *net_alpha:* annualized alpha estimated with monthly *net_ret* using the CAPM model in Eq. (3) for each fund-year. *net_3alpha:* annualized alpha estimated with monthly *net_ret* using the Fama-French three-factor model in Eq. (4) for each fund-year. *net_4alpha:* annualized alpha estimated with monthly *net_ret* using the Carhart four-factor model in Eq. (5) for each fund-year. *SV*: an indicator variable equal to one if a fund is a small-cap value fund, zero otherwise. *SG*: an indicator variable equal to one if a fund is a small-cap growth fund, zero otherwise. *MG*: an indicator variable equal to one if a fund is a mid-cap growth fund, zero otherwise. *LV*: an indicator variable equal to one if a fund is a large-cap value fund, zero otherwise. *LG*: an indicator variable equal to one if a fund is a large-cap growth fund, zero otherwise. *fundexp*: expense ratio of a fund. *Turnover*: fund turnover ratio. Regressions are estimated using robust estimator of variance clustered at fund level. Numbers in parentheses are t-statistics. * p<0.10, ** p<0.05, *** p<0.01.

Panel A: Univariate results from regressing alphas on mutual funds' annual average FIM.

	g_alpha	*g_3alpha*	*g_4alpha*	*raw_alpha*	*raw_3alpha*	*raw_4alpha*	*net_alpha*	*net_3alpha*	*net_4alpha*
FIM	0.0171***	0.0225***	0.0219***	-0.0008	0.0022	0.0009	0.0025	0.0055*	0.0042
	(3.35)	(3.93)	(3.85)	(-0.27)	(0.74)	(0.28)	(0.84)	(1.74)	(1.23)
constant	-0.0448	-0.1260***	-0.1068***	0.0520***	-0.0007	0.0186	0.0216	-0.0315	-0.0123
	(-1.34)	(-3.37)	(-2.86)	(2.70)	(-0.03)	(0.90)	(1.12)	(-1.53)	(-0.55)
Year Dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Adj. R^2	10.74%	8.44%	8.68%	10.28%	4.63%	5.77%	10.27%	4.77%	5.85%
N	18,787	18,787	18,787	18,787	18,787	18,787	18,787	18,787	18,787

Panel B: Multivariate results from regressing alphas on mutual funds' annual average FIM.

	g_alpha	*g_3alpha*	*g_4alpha*	*raw_alpha*	*raw_3alpha*	*raw_4alpha*	*net_alpha*	*net_3alpha*	*net_4alpha*
FIM	0.0305***	0.0308***	0.0288***	0.0138***	0.0098***	0.0077**	0.0162***	0.0123***	0.0101***
	(5.52)	(4.94)	(4.62)	(4.26)	(2.91)	(2.11)	(4.99)	(3.41)	(2.57)
SV	0.0315***	0.0189***	0.0193***	0.0240***	0.0111***	0.0102***	0.0229***	0.0101***	0.0092***
	(9.12)	(5.44)	(5.34)	(8.57)	(4.02)	(3.65)	(8.07)	(3.57)	(3.21)
SG	0.0001	0.0204***	0.0153***	0.0116***	0.0197***	0.0150***	0.0100**	0.0181***	0.0134***
	(0.02)	(4.46)	(3.12)	(2.86)	(5.24)	(3.62)	(2.44)	(4.75)	(3.18)
MG	0.0061*	0.0186***	0.0178***	0.0034	0.0067***	0.0023	0.0030	0.0064**	0.0020
	(1.82)	(5.69)	(5.28)	(1.24)	(2.57)	(0.83)	(1.11)	(2.42)	(0.71)
LV	0.0035	-0.0017	0.0015	0.0007	-0.0030	-0.0004	0.0019	-0.0017	0.0008
	(1.14)	(-0.60)	(0.53)	(0.27)	(-1.21)	(-0.19)	(0.73)	(-0.71)	(0.33)
LG	-0.0177***	0.0057**	0.0057**	-0.0190***	0.0013	-0.0014	-0.0186***	0.0016	-0.0010
	(-6.53)	(2.03)	(2.09)	(-8.56)	(0.57)	(-0.64)	(-8.43)	(0.73)	(-0.47)
constant	-0.1331***	-0.1884***	-0.1599***	-0.0436**	-0.0544**	-0.0284	-0.0681***	-0.0793***	-0.0534**
	(-3.65)	(-4.63)	(-3.90)	(-2.04)	(-2.50)	(-1.20)	(-3.18)	(-3.43)	(-2.08)
Year Dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Adjusted R^2	11.80%	8.76%	8.93%	11.40%	4.93%	5.97%	11.32%	5.01%	6.00%
N	18787	18787	18787	18787	18787	18787	18787	18787	18787

Panel C: Small-cap Value funds-results from regressing alphas on mutual funds' annual average FIM.

	g_alpha	*g_3alpha*	*g_4alpha*	*raw_alpha*	*raw_3alpha*	*raw_4alpha*	*net_alpha*	*net_3alpha*	*net_4alpha*
FIM	0.0127	0.0378***	0.0370***	0.0017	0.0096	0.0074	0.0041	0.0120**	0.0098
	(1.64)	(3.79)	(3.68)	(0.29)	(1.58)	(1.25)	(0.72)	(1.97)	(1.60)
constant	0.0297	-0.2548***	-0.2287***	0.0884**	-0.0611	-0.0332	0.0621	-0.0875**	-0.0597
	(0.57)	(-3.94)	(-3.49)	(2.22)	(-1.51)	(-0.83)	(1.60)	(-2.16)	(-1.45)
Year Dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Adj. R^2	41.84%	10.03%	9.70%	42.56%	7.42%	9.20%	42.65%	7.51%	9.25%
N	4354	4354	4354	4354	4354	4354	4354	4354	4354

Panel D: Small-cap Growth funds-results from regressing alphas on mutual funds' annual average FIM.

	g_alpha	*g_3alpha*	*g_4alpha*	*raw_alpha*	*raw_3alpha*	*raw_4alpha*	*net_alpha*	*net_3alpha*	*net_4alpha*
FIM	0.0807***	0.0725***	0.0693***	0.0155	0.0139	0.0123	0.0222**	0.0212*	0.0196
	(3.37)	(3.03)	(2.93)	(1.44)	(1.27)	(1.05)	(2.12)	(1.72)	(1.52)
constant	-0.3054**	-0.3661**	-0.3305**	0.0189	-0.0481	-0.0319	-0.0324	-0.1032	-0.0870
	(-2.01)	(-2.37)	(-2.13)	(0.29)	(-0.74)	(-0.46)	(-0.51)	(-1.41)	(-1.13)
Year Dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Adj. R^2	36.43%	16.19%	14.88%	43.23%	12.49%	11.96%	43.52%	13.15%	12.47%
N	2093	2093	2093	2093	2093	2093	2093	2093	2093

Panel E: Mid-cap Value funds-results from regressing alphas on mutual funds' annual average FIM.

	g_alpha	*g_3alpha*	*g_4alpha*	*raw_alpha*	*raw_3alpha*	*raw_4alpha*	*net_alpha*	*net_3alpha*	*net_4alpha*
FIM	0.0181*	0.0207**	0.0112	0.0124**	0.0131**	0.0096	0.0136**	0.0143**	0.0109
	(1.73)	(2.23)	(1.42)	(2.02)	(2.28)	(1.35)	(2.20)	(2.47)	(1.50)
constant	-0.0850	-0.1320**	-0.0630	-0.0582	-0.0864**	-0.0569	-0.0756*	-0.1040***	-0.0746
	(-1.23)	(-2.14)	(-1.19)	(-1.40)	(-2.22)	(-1.19)	(-1.80)	(-2.65)	(-1.54)
Year Dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Adj. R^2	12.03%	10.59%	12.09%	16.93%	10.32%	9.45%	17.13%	10.42%	9.45%
N	3088	3088	3088	3088	3088	3088	3088	3088	3088

Panel F: Mid-cap Growth funds-results from regressing alphas on mutual funds' annual average FIM.

	g_alpha	*g_3alpha*	*g_4alpha*	*raw_alpha*	*raw_3alpha*	*raw_4alpha*	*net_alpha*	*net_3alpha*	*net_4alpha*
FIM	0.0241***	0.0233**	0.0222*	0.0124*	0.0150*	0.0096	0.0140**	0.0166**	0.0112
	(2.72)	(2.06)	(1.84)	(1.81)	(1.79)	(1.09)	(2.04)	(1.98)	(1.27)
constant	-0.1118**	-0.1443**	-0.1231	-0.0477	-0.0909*	-0.0471	-0.0667	-0.1097**	-0.0659
	(-1.98)	(-2.00)	(-1.61)	(-1.05)	(-1.65)	(-0.81)	(-1.48)	(-2.01)	(-1.14)
Year Dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Adj. R^2	23.84%	17.03%	14.72%	19.97%	9.05%	9.64%	20.00%	9.28%	9.82%
N	3188	3188	3188	3188	3188	3188	3188	3188	3188

Panel G: Large-cap Value funds-results from regressing alphas on mutual funds' annual average FIM.

	g_alpha	*g_3alpha*	*g_4alpha*	*raw_alpha*	*raw_3alpha*	*raw_4alpha*	*net_alpha*	*net_3alpha*	*net_4alpha*
FIM	0.0000	0.0150	0.0149	0.0126**	0.0193***	0.0180**	0.0127**	0.0193***	0.0180**
	(0.00)	(1.00)	(0.83)	(2.21)	(2.76)	(2.21)	(2.16)	(2.72)	(2.18)
constant	0.0109	-0.0793	-0.0629	-0.0673*	-0.1063**	-0.0854	-0.0763*	-0.1150**	-0.0940*
	(0.23)	(-0.81)	(-0.54)	(-1.73)	(-2.30)	(-1.59)	(-1.91)	(-2.46)	(-1.74)
Year Dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Adj. R^2	21.91%	12.01%	15.35%	21.36%	7.00%	5.45%	21.47%	7.13%	5.62%
N	1905	1905	1905	1905	1905	1905	1905	1905	1905

Panel H: Large-cap Growth funds-results from regressing alphas on mutual funds' annual average FIM.

	g_alpha	*g_3alpha*	*g_4alpha*	*raw_alpha*	*raw_3alpha*	*raw_4alpha*	*net_alpha*	*net_3alpha*	*net_4alpha*
FIM	-0.0033	-0.0007	-0.0046	0.0054	-0.0015	-0.0057	0.0085	0.0016	-0.0027
	(-0.39)	(-0.08)	(-0.52)	(0.76)	(-0.20)	(-0.75)	(1.08)	(0.20)	(-0.33)
constant	0.0178	0.0369	0.0815	-0.0364	0.0434	0.0868*	-0.0638	0.0162	0.0597
	(0.32)	(0.61)	(1.40)	(-0.76)	(0.88)	(1.69)	(-1.22)	(0.31)	(1.10)
Year Dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Adj. R^2	29.59%	21.58%	17.96%	15.41%	6.80%	5.23%	15.27%	6.82%	5.16%
N	4159	4159	4159	4159	4159	4159	4159	4159	4159

TABLE 6

Mean-Variance Analysis

N: number of observations in each FIM decile. *Sharpe_gross (_net*) is the Sharpe ratio calculated using monthly gross (net) returns, *Gross_ret-rfr (Net_ret-rfr)* is the monthly gross (net) return minus the monthly risk-free rate, *Std_gross* (*_net*) is the standard deviation of gross (net) returns, *IV_gross* (*_net*) is the standard error of the residuals from the CAPM model using gross (net) returns, *CAPM_beta_gross (_net)* is the beta from the CAPM model estimated using gross (net) returns. Numbers in parentheses are t-statistics.

Panel A: Reward to volatility analysis for mutual funds across FIM deciles.

FIM Decile	N	*Sharpe _gross*	*Sharpe _net*	*Gross _ret-rfr*	*Net_ret - rfr*	*Std_ gross*	*Std_ net*	*IV_ gross*	*IV_ net*	*CAPM_ beta_ gross*	*CAPM_ beta_ net*
D1	1867	0.1445	0.1495	0.0056	0.0051	0.0723	0.0616	0.0473	0.0379	1.3848	1.2292
D2	1879	0.1637	0.1626	0.0065	0.0050	0.0613	0.0535	0.0365	0.0301	1.2395	1.1248
D3	1884	0.1791	0.1667	0.0068	0.0052	0.0562	0.0495	0.0322	0.0269	1.1850	1.0582
D4	1878	0.1912	0.1773	0.0066	0.0052	0.0520	0.0454	0.0283	0.0230	1.1176	1.0065
D5	1880	0.1928	0.1874	0.0065	0.0052	0.0502	0.0435	0.0264	0.0211	1.0852	0.9657
D6	1886	0.2030	0.1801	0.0068	0.0049	0.0481	0.0416	0.0243	0.0193	1.0623	0.9456
D7	1881	0.2052	0.1843	0.0065	0.0049	0.0460	0.0398	0.0227	0.0177	1.0222	0.9124
D8	1881	0.2107	0.1856	0.0068	0.0050	0.0443	0.0388	0.0217	0.0171	0.9916	0.8891
D9	1882	0.2086	0.1841	0.0069	0.0051	0.0440	0.0383	0.0224	0.0174	0.9766	0.8776
D10	1869	0.2117	0.1866	0.0070	0.0050	0.0461	0.0387	0.0273	0.0203	0.9562	0.8454
D10-D1		0.0669	0.0365	0.0014	-0.0001	-0.0262	-0.0229	-0.0200	-0.0176	-0.4286	-0.3838
		(5.16)	(2.71)	(1.67)	(-0.07)	(-25.05)	(-25.55)	(-21.97)	(-25.81)	(-27.89)	(-27.09)

Panel B: Small-cap Value funds-Reward to volatility analysis for mutual funds across FIM deciles.

FIM Decile	N	*Sharpe gross*	*Sharpe net*	*Gross ret minus rfr*	*Net ret minus rfr*	*Std gross*	*Std net*	*IV gross*	*IV net*	*CAPM beta gross*	*CAPM beta net*
D1	842	0.1804	0.1836	0.0082	0.0067	0.0691	0.0580	0.0474	0.0375	1.3509	1.1934
D2	794	0.1623	0.1528	0.0060	0.0041	0.0599	0.0526	0.0368	0.0307	1.2425	1.1223
D3	677	0.2033	0.1872	0.0083	0.0060	0.0553	0.0483	0.0344	0.0285	1.1523	1.0327
D4	515	0.1886	0.1804	0.0070	0.0056	0.0521	0.0451	0.0313	0.0259	1.1111	0.9905
D5	408	0.2263	0.2402	0.0095	0.0081	0.0530	0.0455	0.0329	0.0267	1.0555	0.9311
D6	289	0.2385	0.2197	0.0091	0.0069	0.0513	0.0441	0.0336	0.0274	1.0749	0.9553
D7	230	0.2347	0.2330	0.0086	0.0072	0.0506	0.0419	0.0323	0.0255	1.0645	0.9029
D8	202	0.2071	0.1936	0.0078	0.0060	0.0512	0.0443	0.0326	0.0270	0.9948	0.8866
D9	172	0.3240	0.3258	0.0129	0.0108	0.0488	0.0414	0.0353	0.0279	0.9548	0.8245
D10	225	0.2471	0.2297	0.0094	0.0064	0.0566	0.0458	0.0432	0.0326	0.9461	0.8411
D10-D1		0.0667	0.0461	0.0011	-0.0003	-0.0125	-0.0122	-0.0042	-0.0049	-0.4048	-0.3523
		(1.80)	(1.30)	(0.60)	(-0.18)	(-5.76)	(-7.23)	(-1.91)	(-3.30)	(-10.52)	(-10.95)

Panel C: Small-cap Growth funds-Reward to volatility analysis for mutual funds across FIM deciles.

FIM Decile	N	*Sharpe gross*	*Sharpe net*	*Gross ret minus rfr*	*Net ret minus rfr*	*Std gross*	*Std net*	*IV gross*	*IV net*	*CAPM beta gross*	*CAPM beta net*
D1	626	0.1301	0.1449	0.0064	0.0074	0.0760	0.0657	0.0517	0.0421	1.4271	1.2831
D2	429	0.1606	0.1854	0.0093	0.0089	0.0654	0.0568	0.0417	0.0341	1.3340	1.1956
D3	285	0.1974	0.1921	0.0106	0.0088	0.0601	0.0533	0.0367	0.0310	1.3333	1.2011
D4	220	0.1902	0.1795	0.0088	0.0068	0.0577	0.0507	0.0332	0.0272	1.2774	1.1726
D5	147	0.1293	0.1158	0.0070	0.0048	0.0620	0.0533	0.0352	0.0279	1.3360	1.1892
D6	123	0.1550	0.1405	0.0098	0.0076	0.0628	0.0553	0.0353	0.0294	1.3196	1.2014
D7	90	0.1354	0.1280	0.0060	0.0052	0.0531	0.0469	0.0286	0.0233	1.2224	1.1066
D8	64	0.1791	0.1683	0.0107	0.0088	0.0584	0.0510	0.0325	0.0270	1.3215	1.1696
D9	53	0.1324	0.1098	0.0055	0.0032	0.0605	0.0529	0.0330	0.0293	1.2761	1.0861
D10	56	0.1933	0.1962	0.0088	0.0079	0.0636	0.0466	0.0445	0.0288	1.1975	0.9694
D10-D1		0.0633	0.0512	0.0024	0.0005	-0.0124	-0.0190	-0.0072	-0.0133	-0.2296	-0.3136
		(1.15)	(0.75)	(0.70)	(0.18)	(-2.98)	(-5.83)	(-1.86)	(-5.90)	(-3.05)	(-4.38)

Panel D: Mid-cap Value funds-Reward to volatility analysis for mutual funds across FIM deciles.

FIM Decile	N	*Sharpe gross*	*Sharpe net*	*Gross ret minus rfr*	*Net ret minus rfr*	*Std gross*	*Std net*	*IV gross*	*IV net*	*CAPM beta gross*	*CAPM beta net*
D1	144	0.1173	0.1165	0.0011	0.0010	0.0601	0.0495	0.0330	0.0253	1.1831	1.0090
D2	208	0.1848	0.1895	0.0055	0.0045	0.0502	0.0433	0.0291	0.0230	1.0285	0.9243
D3	267	0.1592	0.1412	0.0043	0.0027	0.0497	0.0437	0.0275	0.0230	1.0188	0.8952
D4	313	0.1942	0.1717	0.0062	0.0046	0.0490	0.0424	0.0276	0.0220	0.9915	0.8881
D5	337	0.2149	0.2153	0.0061	0.0049	0.0472	0.0407	0.0257	0.0200	0.9864	0.8770
D6	364	0.2393	0.2250	0.0080	0.0060	0.0445	0.0387	0.0234	0.0189	0.9486	0.8453
D7	359	0.2240	0.1994	0.0070	0.0051	0.0442	0.0385	0.0237	0.0187	0.9290	0.8312
D8	345	0.2293	0.2027	0.0076	0.0058	0.0414	0.0361	0.0226	0.0180	0.9310	0.8318
D9	367	0.1888	0.1681	0.0055	0.0042	0.0421	0.0367	0.0242	0.0188	0.8969	0.8203
D10	384	0.2047	0.1858	0.0071	0.0052	0.0444	0.0379	0.0279	0.0213	0.8996	0.7968
D10-D1		0.0874	0.0693	0.0060	0.0042	-0.0157	-0.0116	-0.0051	-0.0040	-0.2836	-0.2122
		(2.31)	(1.79)	(2.65)	(2.22)	(-5.65)	(-4.52)	(-2.85)	(-2.67)	(-6.23)	(-5.12)

Panel E: Mid-cap Growth funds-Reward to volatility analysis for mutual funds across FIM deciles.

FIM Decile	N	*Sharpe gross*	*Sharpe net*	*Gross ret minus rfr*	*Net ret minus rfr*	*Std gross*	*Std net*	*IV gross*	*IV net*	*CAPM beta gross*	*CAPM beta net*
D1	174	0.0518	0.0504	-0.0034	-0.0041	0.0896	0.0797	0.0506	0.0423	1.6377	1.4792
D2	263	0.1531	0.1358	0.0069	0.0044	0.0713	0.0626	0.0391	0.0324	1.3163	1.2493
D3	361	0.1585	0.1496	0.0067	0.0053	0.0627	0.0559	0.0343	0.0289	1.3103	1.1875
D4	380	0.2153	0.2084	0.0090	0.0077	0.0550	0.0487	0.0291	0.0237	1.2093	1.1011
D5	422	0.1549	0.1427	0.0061	0.0049	0.0524	0.0462	0.0252	0.0210	1.1844	1.0624
D6	390	0.1847	0.1632	0.0068	0.0050	0.0486	0.0421	0.0233	0.0184	1.1436	1.0136
D7	359	0.1907	0.1752	0.0071	0.0055	0.0496	0.0421	0.0242	0.0183	1.1044	0.9768
D8	305	0.2292	0.2128	0.0078	0.0059	0.0460	0.0396	0.0218	0.0172	1.0866	0.9556
D9	275	0.1951	0.1840	0.0071	0.0054	0.0474	0.0400	0.0236	0.0177	1.0843	0.9590
D10	259	0.2139	0.1887	0.0079	0.0060	0.0495	0.0404	0.0302	0.0212	1.0146	0.8974
D10-D1		0.1621	0.1384	0.0113	0.0101	-0.0401	-0.0393	-0.0204	-0.0211	-0.6231	-0.5818
		(4.18)	(3.56)	(4.00)	(3.84)	(-9.86)	(-10.29)	(-7.18)	(-8.68)	(-10.49)	(-9.74)

Panel F: Large-cap Value funds-Reward to volatility analysis for mutual funds across FIM deciles.

FIM Decile	N	*Sharpe gross*	*Sharpe net*	*Gross ret minus rfr*	*Net ret minus rfr*	*Std gross*	*Std net*	*IV gross*	*IV net*	*CAPM beta gross*	*CAPM beta net*
D1	50	0.2151	0.2048	0.0075	0.0053	0.0448	0.0338	0.0255	0.0162	1.0164	0.8398
D2	73	0.2184	0.2161	0.0062	0.0042	0.0437	0.0374	0.0202	0.0158	0.9704	0.8459
D3	109	0.2212	0.2212	0.0061	0.0053	0.0400	0.0357	0.0188	0.0159	0.9253	0.7362
D4	156	0.2385	0.2274	0.0069	0.0053	0.0400	0.0348	0.0185	0.0142	0.9415	0.8395
D5	184	0.2550	0.2267	0.0077	0.0057	0.0399	0.0350	0.0179	0.0141	0.8968	0.8062
D6	198	0.2699	0.2354	0.0079	0.0057	0.0405	0.0348	0.0185	0.0139	0.9135	0.8142
D7	235	0.2709	0.2477	0.0082	0.0062	0.0389	0.0341	0.0172	0.0137	0.9086	0.8055
D8	273	0.2365	0.1940	0.0066	0.0043	0.0389	0.0344	0.0178	0.0142	0.8886	0.8066
D9	275	0.2418	0.1996	0.0074	0.0051	0.0381	0.0337	0.0177	0.0140	0.8918	0.8101
D10	352	0.2560	0.2177	0.0074	0.0052	0.0382	0.0327	0.0196	0.0148	0.9362	0.8166
D10-D1		0.0409	0.0129	-0.0001	-0.0001	-0.0066	-0.0011	-0.0059	-0.0014	-0.0803	-0.0232
		(0.78)	(0.24)	(-0.03)	(-0.05)	(-2.36)	(-0.47)	(-2.85)	(-0.98)	(-1.72)	(-0.57)

Panel G: Large-cap Growth funds-Reward to volatility analysis for mutual funds across FIM deciles.

FIM Decile	N	*Sharpe_ gross*	*Sharpe_ net*	*Gross_ ret - rfr*	*Net_ret - rfr*	*Std_ gross*	*Std_ net*	*IV_ gross*	*IV_ net*	*CAPM_ beta_ gross*	*CAPM_ beta_ net*
D1	31	-0.0050	-0.0683	-0.0128	-0.0165	0.0871	0.0764	0.0397	0.0340	1.5675	1.3609
D2	112	0.1352	0.1223	0.0004	-0.0009	0.0649	0.0558	0.0329	0.0267	1.2431	1.1327
D3	185	0.1061	0.0905	0.0001	-0.0001	0.0593	0.0518	0.0283	0.0232	1.2245	1.1035
D4	294	0.1372	0.1096	0.0016	0.0006	0.0536	0.0467	0.0241	0.0194	1.1182	1.0029
D5	382	0.1741	0.1642	0.0032	0.0025	0.0477	0.0412	0.0220	0.0172	1.0887	0.9648
D6	522	0.1578	0.1279	0.0035	0.0019	0.0478	0.0412	0.0204	0.0153	1.0695	0.9490
D7	608	0.1764	0.1461	0.0046	0.0031	0.0447	0.0397	0.0189	0.0145	1.0272	0.9384
D8	692	0.1871	0.1610	0.0054	0.0038	0.0439	0.0388	0.0185	0.0139	0.9893	0.8956
D9	740	0.1897	0.1586	0.0059	0.0042	0.0435	0.0384	0.0190	0.0145	0.9912	0.8983
D10	593	0.1773	0.1506	0.0052	0.0036	0.0447	0.0388	0.0226	0.0171	0.9604	0.8611
D10-D1		0.1823	0.2189	0.0180	0.0201	-0.0424	-0.0376	-0.0170	-0.0168	-0.6071	-0.4998
		(2.41)	(2.84)	(2.52)	(3.12)	(-5.27)	(-4.53)	(-6.39)	(-3.90)	(-5.01)	(-3.87)

Panel H: Regression results for the following model:

Sharpe_ratio = $\beta_0 + \beta_1$ *FIM* (+β_2 *SV* + β_3 *SG* + β_4 *MG* + β_5 LV + β_6 *LG*) + *Year_ Dummies* + ε (8)

The dependent variables are *Sharpe_gross (net*), respectively. *Sharpe_gross (_net*) is the Sharpe ratio calculated using monthly gross (net) returns. *FIM*: average quarterly calculated F_SCORE investing measure for a fund over a year. *SV*: an indicator variable equal to one if a fund is a small-cap value fund, zero otherwise. *SG*: an indicator variable equal to one if a fund is a small-cap growth fund, zero otherwise. *MG*: an indicator variable equal to one if a fund is a mid-cap growth fund, zero otherwise. *LV*: an indicator variable equal to one if a fund is a large-cap value fund, zero otherwise. *LG*: an indicator variable equal to one if a fund is a large-cap growth fund, zero otherwise. Regressions are estimated using robust estimator of variance clustered at fund level. Numbers in parentheses are t-statistics. * p<0.10, ** p<0.05, *** p<0.01.

	Sharpe gross	*Sharpe gross*	*Sharpe net*	*Sharpe net*
FIM	0.0623***	0.0683***	0.0383***	0.0530***
	(14.90)	(14.15)	(7.48)	(9.00)
SV		0.0204***		0.0248***
		(3.77)		(4.23)
SG		-0.0403***		-0.0249***
		(-6.25)		(-3.69)
MG		-0.0195***		-0.0191***
		(-3.79)		(-3.68)
LV		0.0127**		0.0019
		(2.13)		(0.33)
LG		-0.0382***		-0.0475***
		(-7.85)		(-9.93)
constant	0.1539***	0.1265***	0.2828***	0.2006***
	(5.35)	(3.81)	(8.06)	(4.99)
Year Dummies	Included	Included	Included	Included
Adjusted R^2	69.87%	70.25%	71.27%	71.66%
N	18787	18787	18787	18787

Panel I: Regression results for each mutual fund type.

	Small-cap Value Funds		Small-cap Growth Funds		Mid-cap Value Funds		Mid-cap Growth Funds		Large-cap Value Funds		Large-cap Growth Funds	
	Sharpe_ gross	*Sharpe_ net*	*Sharpe_ gross*	*Sharpe_ net*	*Sharpe_ gross*	*Sharpe_ net*	*Sharpe_ gross*	*Sharpe_ net*	*Sharpe_ gross*	*Sharpe_ net*	*Sharpe_ gross*	*Sharpe_ net*
FIM	0.0671***	0.0471***	0.0894***	0.0583***	0.0570***	0.0520***	0.0673***	0.0532***	-0.0118	0.0068	0.0328***	0.0364***
	(7.60)	(4.10)	(6.22)	(3.54)	(4.36)	(3.79)	(6.20)	(5.31)	(-0.98)	(0.47)	(2.94)	(2.99)
Constant	0.1903***	0.3137***	0.1221	0.2662***	0.1507*	0.1543	0.1015	0.1782**	0.5752***	0.4278***	0.2397***	0.2000**
	(2.88)	(3.91)	(1.39)	(2.66)	(1.68)	(1.59)	(1.42)	(2.54)	(7.11)	(4.32)	(3.25)	(2.48)
Year Dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included
Adj. R^2	73.20%	72.79%	67.23%	66.66%	69.33%	71.73%	77.38%	79.29%	80.45%	83.20%	85.53%	85.09%
N	4354	4354	2093	2093	3088	3088	3188	3188	1905	1905	4159	4159

Table 7

Additional Mean-Variance Analysis Based on Synthetic Portfolios

This tables shows the results for synthetic portfolios formed by sorting individual firms based on F_SCORE. Variables are defined as follows: *Sharpe_ratio*: Sharpe ratio calculated according to Eq. (7) using monthly returns. *portret-rfr:* the average monthly portfolio excess returns. *std*.: standard deviation of excess *portret*. *CAPM_IV:* regression standard error from the CAPM model estimated using monthly *portret* and Eq. (3). *CAPM_beta* (*CAPM_alpha*): the beta (annualized alpha) from the CAPM model estimated using monthly *portret* and Eq. (3). *3factor_(4factor_)alpha*: the alpha (annualized) from the three-factor (four-factor) model estimated using monthly *portret* and Eq. (4) (Eq. (5)). Numbers in parentheses are t-statistics.

F_SCORE	*Sharpe ratio*	*Portret-rfr*	*std*	*CAPM IV*	*CAPM beta*	*CAPM alpha*	*3factor_ alpha*	*4factor_ alpha*
1	-0.0239	-0.0048	0.0984	0.0778	1.6079	-0.1120	-0.0984	-0.1002
2	0.0068	-0.0024	0.0771	0.0522	1.4286	-0,1049	-0.0832	-0.0928
3	0.0441	0.0004	0.0610	0.0333	1.2670	-0.0663	-0.0496	-0.0427
4	0.1323	0.0030	0.0482	0.0206	1.0980	-0.0352	-0.0246	-0.0163
5	0.2078	0.0059	0.0431	0.0141	1.0209	0.0035	0.0117	0.0251
6	0.2259	0.0061	0.0382	0.0109	0.9352	0.0074	0.0184	0.0125
7	0.2358	0.0075	0.0386	0.0115	0.9383	0.0110	0.0272	0.0305
8	0.2126	0.0073	0.0417	0.0154	0.9961	0.0059	0.0217	0.0114
9	0.2345	0.0090	0.0486	0.0280	1.0372	0.0232	0.0273	0.0254
	0.2584	0.0138	-0.0498	-0.0498	-0.5707	0.1352	0.1257	0.1256
F9 – F1	(2.72)	(1.94)	(-5.32)	(-7.40)	(-2.63)	(1.90)	(1.71)	(1.71)