Technical, Fundamental, and Combined Information for Separating Winners from Losers

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Abstract

This study examines how fundamental accounting information can be used to supplement technical information to separate momentum winners from losers. We first introduce a ratio of liquidity buy volume to liquidity sell volume (BOS ratio) to proxy the level of information asymmetry for stocks and show that the BOS momentum strategy can enhance the profits of momentum strategy. We further propose a unified framework, produced by incorporating two fundamental indicators—the FSCORE (Piotroski, 2000) and the GSCORE (Mohanram, 2005)—into momentum strategy. Empirical results show that the combined investment strategy includes stocks with larger information content that the market cannot reflect in time, and therefore, the combined investment strategy outperforms momentum strategy by generating significantly higher returns.

Keywords: BOS ratio; Combined investment strategy; Financial statement analysis; Fundamental analysis; Momentum strategies; Technical analysis; Trading volume

JEL Classification: M41, G11, G12, G14

1. Introduction

Technical analysis and fundamental analysis frameworks have provided substantial evidence concerning their respective abilities to explain a cross section of stock prices or to forecast future price movement. Technical information about stocks has been frequently used by securities analysts, portfolio managers, and academic researchers. Technical analysts focus primarily on short-term price return and trading volume. One of the most notable lines of research using technical information in studying stock price behavior is momentum investment strategy. Using past performances of stocks, Jegadeesh and Titman (1993 and 2001) provide documentation based on cumulative returns in the past three to twelve months, showing that the highest-return decile portfolio outperforms the lowest-return decile portfolio in the following three to twelve months. This pricing anomaly is based solely on past returns, and investors do not use firm-specific information in separating winner stocks from loser stocks. A large body of follow-up literature shows the presence of price momentum across asset classes and countries. In addition to past returns, liquidity in terms of past trading volume has also been shown to predict future stock returns (e.g., Amihud and Mendelson, 1986; Conrad et al., 1994; and Datar et al., 1998) and to provide information about the magnitude and persistence of momentum returns (e.g., Chan et al., 2000; Lee and Swaminathan, 2000; and Chen et al., 2015;). Moreover, Wu (2007) proposes the ratio of liquidity buy volume to liquidity sell volume (the BOS ratio) to proxy for adverse selection between informed and uninformed investors, and shows that winner (loser) stocks with lower (higher) BOS ratios may suffer a higher level of information asymmetry and will experience a stronger momentum effect.

In addition to technical information, fundamental information provides investors guidance for making investment decisions. The linear information model (e.g., Ohlson, 1995; Feltham and Ohlson, 1995) involves the use of book value and earnings per share of the firm to estimate stock prices. Other financial statement information, such as revenue, expenses, inventory, accounts receivable, and gross margin, has also been employed to construct fundamental signals about firms. Ou and Penman (1989) show that price-to-earnings ratio information can reflect both future earnings and stock returns. Fama and French (1992 and 1995) find a strong return premium for value stocks (stocks with high book-to-market ratio) and demonstrate that a value premium is associated with relative distress. Abarbanell and Bushee (1997) show that analysts fail to completely integrate the information in the fundamental signals and that investors hence may benefit by exploiting the signals. Ertimur et al. (2003) show that investors underreact to revenue and expense surprises around earnings announcements. In addition to individual signals, researchers also construct an aggregate measurement to examine the overall performance of firms. Lev and Thiagarajan (1993) demonstrate an aggregate fundamental score is associated with subsequent earnings growth of a firm.

The findings of technical and fundamental information suggest the existence of a joint effect of various types of information content on future stock returns. Therefore, a recent and growing body of literature investigates the integration of both frameworks in equity valuation and in making investment decisions. Chan et al. (1996) and Griffin et al. (2005) show that a zero-investment portfolio with a double-sort of prior returns and earnings surprises can generate higher profits. Sagi and Seasholes (2007) show that momentum strategy becomes more profitable for stocks with higher revenue growth

volatility, higher growth options, or lower costs. Asem (2009) incorporates dividend information into the momentum strategy and finds a higher return. Asness et al. (2013) find that the value strategy is negatively correlated to the momentum strategy, and combining the value strategy and the momentum strategy may offset some of the common variation. Chen et al. (2014) demonstrate that a combined momentum strategy incorporating revenue, earnings, and price information could yield better return than single-criterion momentum strategies. In addition to individual signals for fundamental information, Piotroski (2000) and Mohanram (2005) develop fundamental indicators—the FSCORE and the GSCORE—in which firm-specific information is employed in evaluating value stocks and growth stocks, respectively. Piotroski (2000) and Mohanram (2005) find that a winner portfolio consisting of financially healthier firms, that is, firms with higher FSCORE or GSCORE, outperforms a loser portfolio consisting of low-score firms up to two years after the portfolios are formed.

Based on the fact that both technical information (past returns and past trading volume) and fundamental information (information on firm-specific financial statements) have been documented to identify winners and losers, this study tries to investigate whether the combination of fundamental and technical information can improve the investor's ability to analyze stocks and make an investment decision. We first propose a BOS momentum strategy, in which we incorporate prior price information and past trading volume. We demonstrate that winner (loser) stocks with lower (higher) BOS ratios suffer a higher level of information asymmetry, and investors will underreact to information content about such stocks. Therefore, an investment strategy with a long position of low-BOS winner stocks and a short position of high-BOS loser stocks can

generate a higher return. Empirical results show that the BOS momentum strategy can generate an average monthly return as high as 1.29 percent and outperform the momentum strategy by 0.41 percent monthly over a six-month holding period.

Applying combined forecasting models developed by Granger and Newbold (1974), Granger and Ramanathan (1984), Lee et al. (1986), Lee and Cummins (1998), and Chen et al. (2014), we also propose a combined investment strategy based on a firm's past returns, past trading volume, and its composite fundamental scores. Specifically, we form a long-short investment strategy with a long position in past winners with high fundamental scores and low covariance between returns and trading volume, and a short position in past losers with low fundamental scores and high covariance between returns and trading volume. Empirical results show that a combined investment strategy based on FSCORE (GSCORE) not only outperforms the price momentum strategy by 1.02 (0.72) percent monthly over a six-month holding period but also generates a higher information ratio. We also find that the returns to momentum strategy and accounting-based combined investment strategy are not highly correlated, suggesting that the higher information ratio generated in our combined investment strategy results not only from higher monthly abnormal returns but also from lower tracking errors by integrating different sorting variables.

Our results contribute to the finance and accounting literature associated with momentum strategy and accounting-based fundamental strategy. Specifically, we show that an investment strategy incorporating the BOS ratio can help investors choose stocks with a higher degree of information asymmetry in their portfolios and enjoy a larger price adjustment (momentum return) in the future. The superior performance of combined

investment strategies indicates that composite fundamental scores can capture more inefficient information content for the stocks and, therefore, that we can generate higher returns from the combined momentum strategy based on fundamental scores. Aside from the academic interest, the findings of this study also provide insights into the investment community using momentum strategy. Our combined investment strategy could provide quantitative fund managers with different performance metrics to separate momentum winners from losers.

The remainder of this paper is organized as follows. Section 2 describes indicators and investment strategies associated with technical and fundamental information. Section 3 presents criteria for sample selection and the methods for portfolio formulation used in the empirical test. Section 4 presents the empirical results of testing the performance of various investment strategies including the momentum strategy, the BOS momentum strategy, and the combined investment strategy. Section 5 provides the summary and conclusion of this paper.

2. Technical and fundamental analyses

2.1 Momentum strategies and the BOS ratio

The momentum returns in which past winner stocks keep winning and past loser stocks keep losing is a well-known anomaly in asset pricing. Jegadeesh and Titman (1993) show that an investment strategy with a long position of past winner stocks and a short position in past loser stocks in the past three to twelve months generates significantly positive returns in the ensuing three to twelve months. Momentum returns are also documented in international markets (e.g., Rouwenhorst, 1998; and Chui et al.,

2009). Researchers examine the causes of such phenomena (e.g., Barberis et al., 1998; Daniel et al., 1998; Hong and Stein, 1999; Moskowitz and Grinblatt, 1999; Lee and Swaminathan, 2000; Piotroski, 2000; Grundy and Martin, 2001; Chordia and Shivakumar, 2002 and 2005; Ahn et al., 2003; Griffin et al., 2005; Bulkley and Nawosah, 2009; and Novy-Marx, 2012). Moreover, past trading volumes along with past returns are documented to be associated with future returns (e.g., DeBondt and Thaler, 1985; Lee and Swaminathan, 2000; Chan et al., 2000; and Grinblatt and Moskowitz, 2004). In this study, we focus on one particular variable related to trading volume—the ratio of liquidity buy volume to liquidity sell volume developed by Wu (2007)—and examine how it improves investors' ability to separate momentum winners from losers.

Wu (2007) theoretically show that adverse selection between informed and uninformed investors leads to slow price adjustment. Due to the information asymmetry between informed and uninformed investors, uninformed investors are not willing to buy winner stocks if informed investors try to sell their excessive long position in winner stocks. Hence, to compensate uninformed investors, informed investors should sell winner stocks at lower prices than the reasonable prices they expect. It may take time to adjust such lower prices to a reasonable level, and thus the momentum for winner stocks rises. In contrast, when informed investors try to close out their short positions by purchasing back loser stocks, uninformed investors are not in the market to sell unless informed investors raise the bid price for loser stocks. Therefore, the prices of loser stocks cannot reflect information efficiently, and the momentum for loser stocks will be observed in the following periods. Wu (2007) proposes the ratio of liquidity buy volume to liquidity sell volume, hereafter referred to as the BOS ratio, to capture such adverse

selection between informed and uninformed investors and show winner (loser) stocks with a lower (higher) BOS ratio will experience stronger momentum effect. The BOS ratio is defined as the covariance of prior returns and current trading volume of each individual stock as an empirical proxy for the degree of information asymmetry. The BOS ratio for the i^{th} stock in month t can be written as

$$BOS_{i,t} = \text{cov}(r_{i,t}, \pi_{i,t}), \tag{3}$$

where

$$\pi_{i,t} = \frac{v_{i,t}}{E\left[v_{i,t}\right]}.$$

r_t^i is the monthly rate of return of stock i in month t, π_t^i is the relative trading volume of stock i in month t, v_t^i is the sum of daily dollar trading volume for stock i in month t, and $E\left[v_{i,t}\right]$ is the expected monthly trading volume for stock i in month t.[1] To empirically obtain $E\left[v_{i,t}\right]$, we assume that the monthly trading volume for stock i follows a random walk without a drift. Therefore, we use the cross-sectional average of the monthly trading volume for all stocks in the same quintile portfolio in the previous month, the period from month t-1 to month t. If a winner (loser) stock suffers a higher level of information asymmetry, uninformed investors will not trade with informed traders and a lower (higher) BOS ratio can be observed. Therefore, the winner (loser)

[1] Wu's (2007) BOS ratio differs from existing liquidity measures theoretically. The BOS ratio is based on a model assuming that the liquidity cost is from price-independent adverse selection. Therefore, the BOS ratio stands for a liquidity measure associated with firm-specific characteristics rather than an undiversified risk factor.

stocks with lower (higher) BOS ratios may indicate that those stocks subject to a higher degree of information asymmetry and large momentum returns are expected to be observed.[2]

To separate further winners from losers, the BOS momentum strategy in which a long position in past winners with low BOS ratios and a short position in past losers with high BOS ratios is expected to generate higher abnormal returns than the price momentum strategy. Prior studies examining trading volume and momentum returns, such as Lee and Swaminathan (2000), shows that momentum returns are more pronounced in high-volume stocks. However, the BOS ratio allows us to study further the strength of momentum returns in low-volume stocks because return predictability is determined by covariance between past trading volume and past returns.

2.2 Fundamental analysis

The fundamental analysis for share price valuation can be dated back to Graham and Dodd (1934), who argued the importance of fundamental factors in share price valuation. The dividend discount model developed by Gordon (1962) provides another building block for fundamental analysis. Subsequently, Ohlson's (1995) residual income valuation model further extended the dividend discount model to express share prices in terms of contemporaneous book value and earnings per share. Although Ohlson's residual income model is relatively easy to implement, the empirical results of testing Ohlson's residual model are mixed (e.g., Dechow et al., 1999; Myers, 1999). Other research focuses on fundamental analysis by calculating certain multiples for a set of benchmark

[2] Appendix A provides a comparison between the BOS ratio and other information asymmetry alternatives.

firms and finding the implied value of the firm of interest by using these benchmark multiples (e.g., Ou and Penman, 1989; Kaplan and Ruback, 1995; Gilson et al., 2000; Liu et al., 2002). However, a single financial multiple or ratio might not capture complete aspects of the firm; researchers subsequently constructed composite indicators using various fundamental information about firms to examine future performance of their share prices. Therefore, this study will focus on two prominent fundamental indicators developed by Piotroski (2000) and Mohanram (2005), FSCORE and GSCORE, and investigate whether fundamental indicators can further separate winners from losers. In addition, we will construct a combined investment strategy based on past returns, the BOS ratio, and the fundamental composite scores to examine the improvement of investors' ability to separate winner stocks from loser stocks.

2.2.1 FSCORE system

Previous studies show that an investment strategy with a long position in low book-to-market stocks and a short position in high book-to-market stocks generates significantly abnormal returns in the periods after portfolio formation (e.g., Rosenberg et al. 1985; Fama and French 1992; and Lokonishok, 1994). Fama and French (1992) argue that book-to-market ratio is a proxy for financial distress of firms and that abnormal returns generated from this investment strategy represent investors' compensation for this financial distress risk factor. However, substantial variation in returns exists among such stocks, and further performance metrics are required to identify stocks exhibiting higher returns. Following Piotroski (2000), we demonstrate the FSCORE system to separate winners from losers among high book-to-market stocks. Piotroski (2000) uses nine signals to proxy the overall financial health of high book-to-market firms. These nine

signals can be categorized into three groups: profitability related signals, operating efficiency signals, and change in solvency/liquidity signals.

The profitability-related fundamental signals are used to measure a firm's ability to generate profits. Four profitability indicators are return on assets (*ROA*), change in return on assets (*AROA*), cash flow from operations scaled by total assets (*CFO*), and difference between *ROA* and *CFO* (*Accrual*). Indicators of *ROA* and *CFO* are assigned a value equal to one if they are positive, zero otherwise. Similarly, if firms experience a positive change in return on assets, the indicator of *AROA* is assigned a value of one and zero otherwise. Finally, given the negative relationship between firms' accrual and future expected returns documented by Sloan (1996), the indicator of *Accrual* is assigned a value of one if *Accrual* is negative and zero otherwise. The second group of fundamental variables is related to operating efficiency, for example, change in gross margin (*DMargin*) and change in asset turnover (*DTurn*). Positive changes in gross margin and asset turnover represent improvement in generating profits and efficient employment of a firm's assets. Thus, indicators *DMargin* and *DTurn* are assigned a value of one if positive, and zero otherwise. The third group of fundamental indicators relates to a firm's solvency and liquidity, for example, change in leverage (*DLever*), change in current ratio (*DLIQUD*), and equity issuance (*EQOFFER*). Firms issue debt when internally generated funds are not available (Myers and Majluf, 1984); thus, increases in financial leverage indicate a firm's difficulty in generating internal capital. Therefore, the *DLever* indicator is assigned a value of one if negative, and zero otherwise. Similarly, the *DLIQUD* indicator is assigned a value of one if the firm decreases its current ratio from last year, and zero otherwise. The last signal related to a firm's solvency and liquidity is the *EQOFFER*

indicator, which is equal to one if the firm has no equity issuance in the previous year, and zero otherwise. Equity issuance indicates the firm has difficulty raising capital from its own operation or long-term debt; such an action thus is considered a bad signal for the future prospects of a firm.

Given the nine signals discussed above, Piotroski (2000) constructed a composite score to assess the financial soundness of a firm—the FSCORE. The sums of these nine indicator-variables range from zero to nine, with nine (zero) indicating a firm with more (fewer) good signals.

$$FSCORE_{i,t} = ROA_{i,t} + AROA_{i,t} + CFO_{i,t} + Accrual_{i,t} + DMargin_{i,t} + DTurn_{i,t} + DLever_{i,t} + DLIQUID_{i,t} + EQOFFER_{i,t} \quad (1)$$

Firms with a higher FSCORE have better overall financial health than do ones with a low FSCORE. Piotroski (2000) finds that an investment strategy with a long position in high FSCORE firms and a short position in low FSCORE firms generates significant excess return up to two years after the formation of the portfolio. Therefore, for high book-to-market stocks (value stocks), FSCORE seems to be an appropriate candidate for the fundamental analysis indicator in our unified valuation framework.

2.2.2 GSCORE system

Although the FSCORE separates winners from losers among value stocks, it does not work well for low book-to-market ratio stocks, as documented by Mohanram (2005). Mohanram (2005) thus extends the FSCORE to construct the GSCORE measurement to examine the fundamentals for low book-to-market stocks (growth stocks). He argues that GSCORE is appropriate for the growth stocks because it accounts for the growth

fundamentals of these firms. Growth firms are usually those with stable earnings and sales growth, larger R&D expenses and capital expenditures, and more analysts following them. His results show that for low book-to-market stocks, firms with high GSCOREs are more likely to beat earnings forecasts and thus earn higher excess return than firms with low GSCOREs. The composite GSCORE is constructed with eight fundamental signals related to a firm's profitability, earnings stability, sales stability, and accounting conservatism. GSCORE, which emphasizes the firm's future performance and accounts for its growth factor, is constructed with three categories of eight signals.

The first category comprises profitability-related signals, which include *ROA*, *CFO*, and *Accrual*. The definition of these variables is identical to those used in FSCORE but with a difference in assigning indicator values. These profitability-related variables are assigned a value of one if they are greater than that of the industry median, and zero otherwise. The second group of fundamental signals is related to the earnings stability and sales stability of the firm. Those with stable earnings and sales convey to investors that they can consistently deliver superior performance in the future. Previous studies addressing earnings management contain documentation indicating that investors prefer stocks with stable earnings to those with a volatile earnings stream (e.g., Trueman and Titman, 1988; and Goel and Thakor, 2003). Indicator variables for earnings stability σ_{NI} (variance of a firm's *ROA* in the past five years) and sales-growth stability σ_{SG} (variance of a firm's sales growth in the past five years) are assigned a value of one if they are less than the median of all firms in the same industry, and zero otherwise. The third group of fundamental indicator variables relates to accounting conservatism. In low book-to-market firms, substantial research and development expenses, advertising expenses, and

capital expenditure in the current period generate unrecorded intangible assets because of accounting conservatism. These low book-to-market firms are currently undervalued, but better future growth is expected. Thus, the last three indicator variables, R&D expenses scaled by total assets (*RDINT*), advertising expenses scaled by total assets (*ADINT*), and capital expenditure scaled by total assets (*CAPINT*), are assigned a value of one if they are greater than the industry median, and zero otherwise.

Similar to the construction of the FSCORE, the composite GSCORE is the sum of indicator variables of these eight fundamental signals.

$$GSCORE_{i,t} = ROA_{i,t} + CFO_{i,t} + Accrual_{i,t} + \sigma_{NI\,i,t} + \sigma_{SG\,i,t} + RDINT_{i,t} + ADINT_{i,t} + CAPINT_{i,t} \quad (2)$$

A higher (lower) GSCORE indicates more (fewer) good fundamental signals of a firm and thus better financial health for growth stocks. Mohanram (2005) shows that an investment strategy with a long position in high GSCORE stocks and a short position in low GSCORE stocks generates excess returns up to two years after the formation of the portfolio. In our model, we employ the FSCORE and the GSCORE as fundamental analysis indicators for value stocks and growth stocks, respectively. These fundamental scores, in addition to technical information such as past returns and trading volume, are expected to improve investors' ability to separate winners from losers.

3. Sample selection and data description

3.1 Sample selection and methodology

We include all nonfinancial firms listed on the NYSE, AMEX, and NASDAQ that

have sufficient monthly return data on CRSP and price and book value data on Compustat from January 1973 to December 2013.[3,4] Foreign companies, closed-end funds, real estate investment trusts (REIT), American depository receipts (ADRs), firms with prices less than five dollars, and firms with negative book-to-market ratios are excluded from the sample. The monthly data on returns, prices, and trading volumes are obtained from CRSP. Annual financial data required to construct the FSCORE and GSCORE are obtained from Compustat.[5] We also exclude firms with insufficient time-series data required to compute the scores.

We conduct our empirical tests on whole sample stocks, high book-to-market stocks (value stocks), and low book-to-market stocks (growth stocks). At the end of each month from January 1973 to December 2013, based on the distribution of book-to-market ratio twelve months earlier, stocks with book-to-market ratio above (below) the median value of all sample stocks are selected as the value (growth) stocks sample.[6] We further sort the stocks sequentially by cumulative returns in the past twelve months, the BOS ratio, and fundamental scores.[7,8] For example, the portfolio consisting of the highest past

[3] Gould and Kleidon (1994) show that the trading volume for stocks listed on the NASDAQ may be inflated by double counting of dealer trades. To address the double-counting problem, we follow Gould and Kleidon (1994) and Lee and Swaminathan (2000) in adjusting the trading volume for NASDAQ-listed stocks to one-half of nominal amounts. In addition, we exclude NASDAQ-listed stocks in our empirical work and provide similar results.

[4] The unreported table shows that the number of observations drops sharply before 1982 because the variable of new equity issued and variables for calculating free cash flow were not provided for all firms in COMPUSTAT. We also use the sample period after 1982 and obtain consistent results.

[5] Following Mohanram (2005), we require that at least three other firms exist in the same industry defined by the two-digit SIC code in constructing the GSCORE for earnings stability σ_{NI} and sales growth stability σ_{SG}.

[6] We follow the approach of Fama and French (1992) to obtain book-to-market ratio as a firm's book value of common equity for the fiscal year ending in year t-1 divided by its market equity at the end of December in year t-1.

[7] The fundamental scores are calculated based on financial statement information in the previous fiscal year. For example, for a firm with fiscal year in June 1995, the FSCORE/GSCORE used in portfolio construction in May 1995 is based on information about the firm in the fiscal year ended in June 1994.

[8] Our dependent sorting might affect our empirical results specific to the sorting order employed. An independent sort cannot be applied in our sample because of the small number of securities in some of the

return, the lowest BOS ratio, and the highest FSCORE is denoted by (Q_{M5},Q_{B1},Q_{F5}). Similarly, (Q_{M1},Q_{B5},Q_{F1}) contains stocks with the highest past returns, the lowest BOS ratio, and the lowest FSCORE.

The performance of the combined investment strategy involving extreme portfolios, that is, portfolios (Q_{M5},Q_{B1},Q_{F5}) and (Q_{M1},Q_{B5},Q_{F1}), for holding periods of three, six, nine, and twelve months after the portfolio formation date are examined following the trading strategy suggested by Jegadeesh and Titman (1993). Specifically, at the end of each month, we form a zero investment portfolio by having a long position for stocks with top quintile return for the previous twelve months, lowest BOS ratio, and highest FSCORE, and having a short position for stocks with lowest quintile return for the previous twelve months, highest BOS ratio, and highest FSCORE. We hold this zero investment portfolio for the subsequent *K* months (*K* = 3, 6, 9, and 12), with a one month skip from the formation date, and rebalance it after *K* months.

3.2 Correlation between sorting variables

Table 1 provides the summary statistics for major financial characteristics of all sample stocks, value stocks, and growth stocks. Among 1,115,284 firm-months, 552,632 firms-months belong to value stocks, and 562,652 firm-months belong to growth stocks. The mean (median) of the book-to-market ratio is 1.3354 (1.0652) and 0.3947 (0.3572) for the value and growth stocks, respectively. Growth stocks have greater market value of equity compared with value stocks. Sales and sales growth for growth stocks are greater than are those of value stocks. This confirms that firms with lower book-to-market ratios

intersection portfolios. We repeat our test with the reverse sorting order, and the empirical results are qualitatively the same.

experience higher growth rates; moreover, the R&D intensity for growth stocks is also higher, indicating larger future potential growth opportunities for these firms.

(Insert Table 1 Here)

We next examine the correlation between the variables on which the investment strategies are constructed. Table 2 presents the average Spearman rank-order correlations among one-month future return, three-month future returns, composite fundamental scores, the BOS ratio, past returns, and indicators of fundamental signals for FSCORE and GSCORE in the sample period from 1973 to 2013. Consistent with the findings of Piotroski (2000) and Mohanram (2005), future performance of the stock returns is positively related to firms' financial condition, which is measured by fundamental scores. The FSCORE/GSCORE and one- and three-month future returns are positively correlated (0.0296/0.0469 and 0.0351/0.0498). These correlations are also stronger than are those between individual signals and future returns. This suggests that an investment strategy based on the aggregate information of the firm might outperform those based on individual signals. Moreover, past cumulative returns are also positively correlated with the future performance of the stocks in our sample, 0.0322 with a one-month future return and 0.0624 with a three-month future return, indicating that momentum profits will be observed as suggested by Jegadeesh and Titman (1993). In addition, correlations between past returns, the BOS ratio, and the fundamental scores are low. Three of six pairs are negatively correlated and none of correlations is higher than 0.12, indicating that past returns, the BOS ratio, and the fundamental scores can capture different information content of the firm. Therefore, we expect that the combined investment strategy incorporating past returns, the BOS ratio, and fundamental scores can generate better

performance than the momentum strategy can, which only uses prior price information.

(Insert Table 2 Here)

4. Performance of alternative investment strategies

4.1 Momentum strategy

Table 3 provides average monthly excess returns for five quintile portfolios constructed based on the past twelve-month cumulative returns and average arbitrage returns for the momentum portfolio in different holding periods. In Panel A, for all sample firms, the average monthly returns are 1.06%, 0.88%, 0.68%, and 0.53% for momentum strategies with three-, six-, nine-, and twelve-month holding periods, respectively. Our results are consistent with those of Jegadeesh and Titman (1993), that is, that trading strategies based on past twelve-month winners/losers and one-month to twelve-month holding periods exhibit strong momentum returns. Moreover, Table 4 reports the risk-adjusted return from the Fama-French three-factor model for each winners and losers portfolio and long-short investment strategy. The risk-adjusted return of the portfolio relative to three factors is the estimated intercept coefficient from the following time-series regression using monthly portfolio returns:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_i (r_{m,t} - r_{f,t}) + \phi_i SMB_t + \varphi_i HML_t + e_{i,t}, \qquad (4)$$

where $r_{i,t}$ is monthly return for the long-short portfolio *i*, $r_{f,t}$ is monthly return on a three-month T-bill, $r_{m,t}$ is the value-weighted return on NYSE/AMEX/NASDAQ market indexes, SMB_t is the Fama-French small-firm factor, HML_t is the Fama-French

book-to-market factor, and β_i, ϕ_i, and φ_i are corresponding factor loadings. Consistent with results found from monthly excess returns, momentum strategy can generate significantly positive risk-adjusted returns in different holding periods. Panels B and C present momentum returns for value stocks and growth stocks, respectively. Similar to the results in Panel A, momentum returns is positive and significant for value stocks and growth stocks, whereas the higher momentum returns can be observed from growth stocks.

(Insert Table 3 Here)

4.2 Fundamental momentum strategy

Table 4 presents monthly average excess return for portfolios double sorted by past twelve-month returns and the fundamental score (FSCORE or GSCORE) for different holding periods. In terms of a six-month holding period, Panel B shows that the fundamental momentum strategy based on FSCORE can yield a monthly return of 1.442%, or a risk-adjusted return of 1.5493. The fundamental momentum strategy based on FSCORE can significantly outperform the momentum strategy by 0.3862%. Panel F shows that the fundamental momentum strategy based on GSCORE can generate a monthly return and a risk-adjusted return as high as 1.2831% and 1.4771%, which are higher than the performance of the momentum strategy. The positive returns and the superior performance for the fundamental strategies can also be found in the value stock portfolio and the growth stock portfolio. Therefore, results in Table 4 are consistent with those findings from Piotroski (2000) and Mohanram (2005), that is, that fundamental scores can further separate winners (losers) from the winner (loser) group.

(Insert Table 4 Here)

Results in Tables 3 and 4 suggest that returns to the momentum strategy and the fundamental momentum strategy documented in the literature also exist in the sample and the sample period we choose in this study. We next examine the strength of momentum returns when past trading volume is considered.

4.3 BOS momentum strategy

As discussed in Section 2, Wu (2007) argues that a momentum effect arises because of the information asymmetry between informed and uninformed investors in the market. Wu (2007) also indicates that stronger momentum returns are expected for stocks subject to a larger degree of information asymmetry. Therefore, using the BOS ratio as a proxy of information asymmetry, we may find that winner (loser) stocks with lower (higher) BOS ratios are those subject to a higher degree of information asymmetry and are expected to generate higher momentum returns.

If the information asymmetry between informed and uninformed investors causes momentum returns, the trading strategy constructed by these extreme portfolios is expected to generate higher long-short portfolio returns than would momentum strategy based solely on past returns. Therefore, we introduce the BOS momentum strategy by buying winner stocks with lower BOS ratios, selling loser stocks with higher BOS ratios and holding for three, six, nine, or twelve months before rebalancing the portfolio. Specifically, at the end of each month in the sample period, we sort stocks based on their past twelve-month returns to form five quintile portfolios Q_{M1} to Q_{M5}. We then sort stocks in each quintile portfolio based on their BOS ratios, the covariance between their past

twelve-month returns and trading volume to form five quintile portfolios Q_{B1} to Q_{B5}. That is, the Q_{B5} (Q_{B1}) portfolio consists of stocks having the greatest (least) covariance between past cumulative returns and past trading volume. Returns to the BOS momentum strategy, which is based on both past returns and the BOS ratio, are expected to be greater than returns to the momentum strategy found in Table 4. We therefore formulate a testable hypothesis.

H1: The BOS momentum strategy based on both past cumulative returns and the BOS ratio generates greater returns than the momentum strategy based solely on past cumulative returns.

We can test the hypothesis in the following manner:

$$\Delta_{BOS-MOM} = \left[\left(Q_{M5}, Q_{B1}\right) - \left(Q_{M1}, Q_{B5}\right)\right] - \left[Q_{M5} - Q_{M1}\right], \quad \geq 0 \tag{5}$$

where $\Delta_{BOS\text{-}MOM}$ is the return differences between the BOS momentum strategy and the momentum strategy, $\left[\left(Q_{M1}, Q_{B5}\right) - \left(Q_{M5}, Q_{B5}\right)\right]$ is the return to the BOS momentum strategy, and $\left[Q_{M5} - Q_{M1}\right]$ is the return to the momentum strategy.

Table 5 presents the returns to portfolios double sorted with respect to previous twelve-month returns and the BOS ratio. Controlling for loser momentum, the long-short investment strategy with a long position in quintile portfolio Q_{B1} and a short position in quintile portfolio Q_{B5} generates a significantly positive return (e.g., 0.4780% of six-month average return for all stocks). This return indicates that using an additional sorting variable, the BOS ratio, allows investors to obtain the worst loser (Q_{M1}, Q_{B5}) among the loser portfolio. Similarly, controlling for winner momentum, portfolio (Q_{B5}-Q_{B1}) among

the loser portfolios generates positive returns, but those returns are only significant in nine-month and twelve-month holding periods for all stocks and growth stocks. These returns suggest that the BOS ratio can only marginally separate the best winners from the winner portfolio.

(Insert Table 5 Here)

Table 5 also provides returns to the BOS momentum strategy. In terms of a six-month holding period, the BOS momentum strategy can generate an average monthly return as high as 1.2898% with *t*-statistics of 6.68 and a risk-adjusted monthly return as high as 1.3510% with *t*-statistics of 6.94. Compared to the return and risk-adjusted return to momentum strategy, the BOS momentum strategy significantly outperforms the momentum strategy by 0.4053% and 0.3156% in terms of monthly return and risk-adjusted return, respectively. The basis of superior performance of the BOS momentum strategy can be found in different holding periods. When we apply the BOS momentum strategy to value stocks and growth stocks, BOS momentum strategies can still generate significant profits and outperform the momentum strategy. Our results therefore demonstrate that the BOS ratio indeed helps investors to measure the level of information asymmetry and identify the best (worst) stocks among winner (loser) portfolio.

In addition, one may observe a smaller difference between high-BOS group (Q_{B5}) and low-BOS group (Q_{B1}) for winner stocks in Table 5. The difference may indicate that the momentum effect is stronger for loser stocks with a higher level of the information asymmetry problem. This can be explained by the limit of arbitrage proposed by Shleifer and Vishny (1997) and Arena et al. (2008). As mentioned above, a momentum strategy is suggested for investors long for winner stocks and short for loser stocks. However, short

selling for loser stocks is relatively difficult compared to buying winner stocks in practice. Due to the limitation on short selling for loser stocks, loser stocks with higher information asymmetry may take a longer time to reflect inefficient information, and therefore a stronger momentum effect can be observed for loser stocks with higher BOS ratios. In contrast, investors can buy winner stocks with higher information asymmetry without limitation, so there is little difference between a low-BOS winner and a high-BOS winner.

Studying trading volume literature, Datar et al. (1998) found a negative relationship between past trading volume and future returns for stocks. They demonstrated that stocks with a low trading volume in the recent past generate higher future returns than do those with a high trading volume. Lee and Swaminathan (2000) found that low-volume stocks outperform high-volume stocks after controlling for price momentum, and momentum is stronger among high-volume stocks. Simple trading volume could proxy for many different factors, such as size, liquidity, and degree of asymmetric information. However, the BOS ratio provides a proxy for asymmetric information by measuring the covariance between past returns and past trading volume and therefore narrows down subsets concerning our investment strategy. In general, momentum returns are stronger when past trading volume is incorporated into separating winners from losers when forming an investment strategy. Because these winner and loser stocks could have fundamentally different financial characteristics, however, we wonder whether further analyses concerning the firm's fundamentals could aid investors in selecting the best (worst) among winner (loser) stocks. We next examine the combined investment strategy when fundamental analysis indicators FSCORE/GSCORE are incorporated.

4.4 Combined investment strategy based on technical and fundamental information

Piotroski (2000) and Mohanram (2005) show that fundamental indicators FSCORE and GSCORE do help investors to separate winner stocks from loser stocks based on firm-specific financial characteristics for value stocks and growth stocks, respectively. Their results indicate that financially healthier firms will enjoy a higher price appreciation than will their counterparts with more financial constraints. In this section, we propose a combined investment strategy based on past returns, the BOS ratio, and fundamental indicators FSCORE/GSCORE. Specifically, at the end of each month in the sample period, we apply a three-way sort based on past twelve-month return, the BOS ratio, and FSCORE/GSCORE, and group sample stocks into 125 portfolios. The combined investment strategy is constructed by holding a long position in winner stocks with a lower BOS ratio and higher FSCORE/GSCORE, and a short position in loser stocks with a higher BOS ratio and lower FSCORE/GSCORE. Similar to the momentum strategy and the BOS momentum strategy, we hold the long-short portfolio for three, six, nine, and twelve months and then rebalance it. We conjecture that the combination of the technical information (past returns and the BOS ratio) and fundamental information (composite fundamental scores) is useful to separate momentum winners from losers. Therefore, we expect that post-formation returns to the combined investment strategy will be significantly higher than will be those to the momentum strategy and the BOS momentum strategy. Testable hypotheses are formulated as follows.

H2: The combined investment strategy based on portfolios sorted by past cumulative returns, BOS ratio, and FSCORE/GSCORE generates higher returns than does the momentum strategy.

H3: The combined investment strategy based on portfolios sorted by past cumulative returns, BOS ratio, and FSCORE/GSCORE generates higher returns than does the BOS momentum strategy.

We can test these hypotheses in the following manner:

$$\Delta_{CS-MOM} = \left[\left(Q_{M5}, Q_{B1}, Q_{F5}\right) - \left(Q_{M1}, Q_{B5}, Q_{F1}\right)\right] - \left[Q_{M5} - Q_{M1}\right] \geq 0 \quad (6)$$

$$\Delta_{CS-BOS} = \left[\left(Q_{M5}, Q_{B1}, Q_{F5}\right) - \left(Q_{M1}, Q_{B5}, Q_{F1}\right)\right] - \left[\left(Q_{M5}, Q_{B1}\right) - \left(Q_{M1}, Q_{B5}\right)\right], \geq 0 \quad (7)$$

where Δ_{CS-MOM} and Δ_{CS-BOS} are the return differences between the combined investment strategy and the momentum strategy and between the combined investment strategy and the BOS momentum strategy, $\left[\left(Q_{M5}, Q_{B1}, Q_{F5}\right) - \left(Q_{M1}, Q_{B5}, Q_{F1}\right)\right]$ is the return to the combined investment strategy based on FSCORE, $\left[Q_{M5} - Q_{M1}\right]$ is the return to the momentum strategy, and $\left[\left(Q_{M5}, Q_{B1}\right) - \left(Q_{M1}, Q_{B5}\right)\right]$ is the return to the BOS momentum strategy. The combined investment strategy in equations (6) and (7) uses FSCORE as the fundamental indicator. We also construct the combined investment strategy based on GSCORE and compare the combined investment strategy with the momentum strategy and the BOS momentum strategy.

Panel A of Table 6 provides a summary of returns to the combined investment strategy based on FSCORE. We first observe that financially healthier firms indeed outperform those with more financial constraints. For example, in terms of a six-month holding period, financially healthy firms based on FSCORE outperform financial constraint firms by 1.0505% and 0.2931% for winner stocks and loser stocks with higher

information asymmetry. In addition, the combined investment strategy can generate a significant average monthly return and a risk-adjusted return as high as 1.9051% and 1.9288% with *t*-statistics of 7.51 and 7.93, respectively. The returns to the combined investment strategy are significantly higher than are those to the momentum strategy and the BOS momentum strategy by 1.0206% and 0.6153% in terms of a six-month holding period. Findings that can be observed in different holding periods indicate that the top quintile portfolio outperforms the bottom quintile portfolio, sorted by FSCORE after controlling for previous twelve-month returns and the BOS ratio. The significantly higher return to the combined investment strategy indicates a stronger momentum return when fundamental indicators are considered to identify winners and losers.

(Insert Table 6 Here)

Panel B shows the summary of returns to the combined investment strategy based on GSCORE. We can find similar results as the combined investment strategy based on FSCORE. Firms with healthier finances have higher future returns than do firms with financial constraints, but the differences in winner stocks with higher information asymmetry are not significant for three-, six-, and nine-month holding periods. The returns to the combined investment strategy based on GSCORE are all positive at the 0.01 significance level, although those returns are slightly lower than are returns to the combined investment strategy based on FSCORE. In addition, the combined investment strategy based on GSCORE can generate momentum returns superior to those from the momentum strategy and the BOS momentum strategy. In only one case can the combined investment strategy based on GSCORE not outperform the BOS momentum strategy in a three-month holding period. Therefore, in general, our results in Table 6 suggest that

incorporating fundamental indicators can improve investors' ability in separating winners from losers and obtain a higher return from the combined investment strategy.

We further investigate the effectiveness of the combined investment strategy in two subsamples, value stocks and growth stocks. Panels A and B of Table 7 present returns to the combined investment strategy based on FSCORE and GSCORE for value stocks; Panels C and D presents returns to the combined investment strategy based on FSCORE and GSCORE for growth stocks. The results for value stocks are similar to those for all samples. The combined investment strategy based on both FSCORE and GSCORE can generate significantly positive returns and outperform the momentum strategy and the BOS momentum strategy. This result indicates that fundamental indicators can provide more information content, which the previous twelve-month return and the BOS ratio do not capture, and further separate winners from losers among value stocks. Therefore, a higher momentum return from the combined investment strategy can be observed.

(Insert Table 7 Here)

Panels C and D show that combined investment strategies are profitable and outperform momentum strategies for growth stocks. Compared to the BOS momentum strategies, the combined investment strategies based on FSCORE provide better returns for six-, nine, and twelve-month holding periods, whereas the combined investment strategies based on GSCORE can only have better returns for nine- and twelve-month holding periods. This result implies that, for growth stocks, the BOS ratio may already capture most of the short-term information content offered by fundamental scores. Therefore, we can only see a marginal improvement when we introduce FSCORE and GSCORE to the BOS momentum strategy with holding periods less than six months. If

we apply the combined investment strategy with a longer holding period (nine months or twelve months), we can still obtain a significant combined investment return that outperforms the momentum strategy and the BOS momentum strategy.

Understanding that the combined investment strategy can generate a higher return than the other two investment strategies, we further compare risk-return characteristics across three different investment strategies. Table 8 provides average long-short returns and information ratios for the momentum strategy, the BOS momentum strategy, and the combined investment strategy with different holding periods. The information ratio is defined as the active return divided by tracking error,

$$IR_i = \frac{\overline{r}_i - \overline{r}_m}{\sigma_{(r_i - r_m)}}, \tag{8}$$

where active return, $\overline{r}_i - \overline{r}_m$, is the difference between the return on different strategies and the NYSE/AMEX/NASDAQ value-weighted return, and tracking error $\sigma_{(r_i - r_m)}$ is the standard deviation of the active return. Panel A presents average long-short returns and information ratios of investment strategies for all sample stocks, and Panels B and C present average long-short returns and information ratios for value stocks and growth stocks, respectively. We find that, in terms of a six-month holding period for all sample stocks, the combined investment strategy based on FSCORE (GSCORE) can produce an information ratio of 0.1865 (0.1401), which is higher than 0.1223 in the momentum strategy and 0.5079 in the BOS momentum strategy. Therefore, when we consider the risk, the combined investment strategy can still outperform the other two investment strategies.

(Insert Table 8 Here)

Table 8 also reports the correlation between returns to the combined investment strategies and the momentum strategy or the BOS momentum strategy. For all stocks, in terms of a six-month holding period, the correlation between the combined investment strategy based on FSCORE (GSCORE) and the momentum strategy is 0.6765 (0.6591), indicating that combined investment strategy and momentum strategy share some correlated information, but each still has a distinctive content. That is, the information content carried by fundamental indicators differs from information content in prior returns. Therefore, the combination of technical information and the fundamental information can improve investors' ability to further separate winner stocks from loser stocks. Furthermore, the correlations between the combined investment strategy based on FSCORE (GSCORE) and the BOS momentum strategy yield a higher value, 0.8102 (0.8232). The higher correlations confirm the role of the BOS ratio. That is, although only using price and trading volume information, the BOS ratio can capture a certain extent of information content that belongs to FSCORE and GSCORE.

5. Conclusion

In this study, we develop a BOS momentum strategy by introducing the BOS ratio to the momentum strategy and find that the BOS momentum strategy can outperform the momentum strategy. That is, the BOS ratio can effectively capture the information asymmetry between informed and uninformed investors, and therefore, the investment strategy incorporating the BOS ratio can help investors choose stocks with a higher degree of information asymmetry in their portfolios and enjoy a larger price adjustment (momentum return) in the future. We also construct a combined investment strategy by incorporating FSCORE and GSCORE into the momentum strategy. We find that

combined investment strategies can a generate higher return than the momentum strategy and the BOS momentum strategy, indicating that composite fundamental scores can help investors to include stocks with more inefficient information content in their portfolios and with a larger momentum effect in the future. Our findings suggest that fundamental analysis indeed provides information to investors in addition to technical information for selecting winner and loser stocks.

We also consider that our results contribute to security analysts and portfolio managers using momentum strategy. These momentum investors usually had success during the period when the performance of winners was distinguishable from that of losers. When the market experiences an overall rally such as the one occurring in March and April of 2009, however, these momentum investors suffer substantially from the loss on the short side of their portfolio. By incorporating fundamental analysis into momentum strategy, we believe our results should be useful for the security analysis and portfolio management of these investors.

Appendix A: Relationship between the BOS ratio and alternative information-asymmetry measures

In this appendix, we compare the BOS ratio with three information-asymmetry alternatives, market capitalization (Atiase, 1985; and Huddart and Ke, 2007), idiosyncratic volatility (Roll, 1988; Mork et al., 2000; and Ferreira and Laux, 2007), and institutional ownership (Shiller and Pound, 1989; and Huddart and Ke, 2007). It has been documented that stocks with smaller market capitalization, higher idiosyncratic volatility, and lower institutional ownership are associated with a higher degree of information asymmetry. We here try to show that the BOS ratio can be a candidate for the information asymmetry measure. As Panel A of Appendix Table A.1 shows, for winner stocks, the BOS ratio is positively correlated to market capitalization, negatively correlated to idiosyncratic volatility, and negatively correlated to institutional ownership, indicating that winner stocks with a greater negative BOS ratio may suffer a higher degree of information asymmetry. Moreover, Panel B shows that, for loser stocks, a higher BOS ratio is associated with a higher degree of information asymmetry in terms of market capitalization, idiosyncratic volatility, and institutional ownership. Therefore, besides the theoretical model proposed by Wu (2007), the empirical evidence also shows that winner (loser) stocks with lower (higher) BOS ratios are those subject to a higher degree of information asymmetry.

As shown in Appendix Table A, correlations between information asymmetry measures are low, indicating that information asymmetry measures may represent different views of information asymmetry. Therefore, we admit that this method is not completely correct but, to some extent, does provide us some evidence that the BOS ratio is associated with information asymmetry.

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Table 1. Summary statistics for major variables

This table presents summary statistics for major financial characteristics of the sample. *MV Equity* and *B/M* are the market capitalization and book-to-market ratio for sample stocks. *ROA* is return on total assets. *AROA* is change of return on total assets. *CFO* is defined as a firm's cash flow from operation scaled by its total assets. *Accrual* is defined as a firm's current year net income before extraordinary items less cash flow from operation and scaled by its total assets. *DMargin* is defined as the change in the ratio of a firm's gross profit scaled by its total sales. *DTurn* is the change in the ratio of a firm's total sales scaled by its total assets. *DLever* is the change in the ratio of total long term debt to total assets. *DLIQUD* is a firm's change in current ratio between the current year and previous year. *EQOFFER* is the amount of equity issuance in the previous year. σ_{NI} is the variance of a firm's *ROA* in the past five years. σ_{SG} is the variance of a firm's sales growth in the past five years. *RDINT* is defined as R&D expenses scaled by total assets. *ADINT* is defined as a firm's advertising expenses scaled by the total assets. *CAPINT* is defined as a firm's capital expenditure scaled by its total assets. *FScore*, *GScore*, *P12*, and *BOS* are FSCORE, GSCORE, previous 12-month buy-and-hold return, and BOS ratio. Summary statistics for value stocks and growth stocks based on the book-to-market ratio are also presented.

	All firms (N=1,115,284)			**Value firms (N=552,632)**			**Growth firms (N=562,652)**		
Variables	Mean	Median	Std Dev	Mean	Median	Std Dev	Mean	Median	Std Dev
MV Equity ($mil)	1027.31	122.52	2520.70	383.21	58.47	862.55	1876.74	261.95	4487.21
B/M	0.8464	0.6348	0.7060	1.3354	1.0652	0.8436	0.3947	0.3572	0.2347
ROA	0.0087	0.0429	0.1387	0.0004	0.0273	0.0998	0.0154	0.0653	0.1760
AROA	-0.0027	-0.0003	0.1098	-0.0121	-0.0043	0.0940	0.0072	0.0031	0.1270
CFO	0.0683	0.0864	0.1149	0.0602	0.0701	0.0817	0.0745	0.1088	0.1481
Accrual	-0.0016	-0.0002	0.0044	-0.0014	-0.0002	0.0035	-0.0017	-0.0002	0.0055
DMargin	0.0007	0.0002	0.0639	-0.0043	-0.0024	0.0494	0.0079	0.0025	0.0932
DTurn	0.0003	0.0078	0.2209	0.0021	0.0088	0.2156	-0.0014	0.0069	0.2261
DLever	0.0018	-0.0002	0.0685	0.0034	-0.0002	0.0649	0.0003	-0.0003	0.0721
DLiquid	-0.0551	-0.0171	1.0238	-0.0574	-0.0219	0.9538	-0.0546	-0.0125	1.1028
EQOFFER ($mil)	9.6544	0.3600	25.5063	4.7544	0.0870	14.0628	14.9749	1.1250	36.0857
σ_{NI}	0.0111	0.0012	0.0276	0.0072	0.0012	0.0162	0.0158	0.0012	0.0401
σ_{SG}	0.1793	0.0195	0.5839	0.1010	0.0199	0.2645	0.3221	0.0191	1.1809
R&D/TA	0.0371	0.0015	0.0652	0.0245	0	0.0461	0.0511	0.0104	0.0845
AD/TA	0.0132	0	0.0275	0.0114	0	0.0239	0.0150	0	0.0312
CAPEX/TA	0.0628	0.0454	0.0567	0.0565	0.0408	0.0514	0.0690	0.0506	0.0614
FScore	5.1810	5	1.7290	5.1381	5	1.7580	5.2231	5	1.6989
Gscore	4.9783	5	1.6916	4.6588	5	1.6077	5.2921	5	1.7130
P12 (%)	11.0662	4.8037	47.1001	11.5361	4.6119	47.6058	10.6104	4.9999	46.6231
BOS	0.0116	0.0056	0.0294	0.0116	0.0061	0.0300	0.0117	0.0051	0.0289

Table 2. Correlation among fundamental signals, BOS ratio, and past returns for value stocks

This table presents the average Spearman rank-order correlation among fundamental signals, past returns, and BOS ratio for sample stocks. Panel A includes FSCORE and its fundamental signals. FSCORE is the sum of nine fundamental signals, which is assigned a value of 1, otherwise 0 if the following criteria are met: F1: *ROA*>0, F2: *AROA*>0, F3: *CFO*>0, F4: *Accrual*<0, F5: *DMargin*>0, F6: *DTurn*>0, F7: *DLever*<0, F8: *DLIQUD*>0, and F9: *EQOFFER*=0. Panel B includes GSCORE and its fundamental signals. GSCORE is the sum of eight fundamental signals, which is assigned a value of 1, otherwise 0 if the following criteria are met: G1: *ROA*≥Ind_M, G2: *CFO*≥ Ind_M, G3: Accrual<0, G4: σ_{NI}≤ Ind_M, G5: σ_{SG} ≤ Ind_M, G6: *RDINT*≥ Ind_M, G7: *ADINT*≥ Ind_M, and G8: *CAPINT*≥ Ind_M. Definitions of these variables are provided in Section 2 and Table 1. P12 is the buy-and-hold over the twelve-month period for each stock before portfolio formation. BOS ratio is defined as the covariance between the monthly return and the adjusted trading volume over the twelve-month period for each stock before the portfolio formation.

Panel A: Fundamental signals for FSCORE

	Ret3	FSCORE	BOS	P12	F1	F2	F3	F4	F5	F6	F7	F8	F9
Ret1	0.5418	0.0296	-0.0192	0.0322	0.0367	0.0063	0.0408	0.0101	0.0039	0.0045	0.0124	0.0045	0.0031
Ret3		0.0469	-0.0261	0.0624	0.0533	0.0089	0.0619	0.0153	0.0064	0.0086	0.0200	0.0064	0.0089
FSCORE			0.0153	0.1187	0.4581	0.6163	0.4539	0.1828	0.4649	0.3891	0.4391	0.3286	0.2274
BOS				-0.0445	-0.0876	0.0750	-0.0975	-0.0250	0.0478	0.0315	0.0004	-0.0001	0.0577
P12					0.1082	0.0522	0.1243	0.0361	0.0356	0.0226	0.0487	0.0105	0.0282
F1: *ROA*>0						0.2357	0.5310	-0.0843	0.1170	-0.0470	0.1319	0.1230	-0.0703
F2: *AROA*>0							0.1137	-0.0689	0.3090	0.2160	0.1787	0.1032	-0.0126
F3: *CFO*>0								0.2730	0.0737	-0.0096	0.1156	0.0688	-0.0287
F4: *Accrual*<0									0.0014	0.0304	0.0221	-0.0625	-0.0060
F5: *DMargin*>0										-0.0058	0.0639	0.0495	-0.0144
F6: *DTurn*>0											0.1176	-0.0224	0.0254
F7: *DLever*<0												-0.0948	-0.0114
F8: *DLIQUD*>0													-0.0125

Panel B: Fundamental signals for GSCORE

	Ret3	GSCORE	BOS Ratio	P12	G1	G2	G3	G4	G5	G6	G7	G8
Ret1	0.5418	0.0351	-0.0192	0.0322	0.0236	0.0285	0.0101	0.0308	0.0253	-0.0015	-0.0034	0.0066
Ret3		0.0498	-0.0261	0.0624	0.0332	0.0405	0.0153	0.0448	0.0382	-0.0036	-0.0056	0.0074
GSCORE			-0.1501	0.0995	0.6026	0.6886	0.2674	0.5405	0.5269	0.2228	0.1855	0.4705
BOS Ratio				-0.0445	-0.0905	-0.0884	-0.0250	-0.1335	-0.0820	-0.0133	0.0076	-0.0881
P12					0.0735	0.0920	0.0361	0.0818	0.0704	-0.0043	-0.0119	0.0010
G1: *ROA*≥Ind_M						0.5515	-0.0863	0.2541	0.1691	-0.0379	0.0097	0.1334
G2: *CFO*≥ Ind_M							0.2263	0.2026	0.1749	-0.0157	-0.0029	0.2131
G3: Accrual<0								0.0411	0.0546	0.0354	-0.0134	0.0617
G4: σ_{NI}≤ Ind_M									0.3105	-0.0659	-0.0026	0.1004
G5: σ_{SG} ≤ Ind_M										-0.0235	0.0295	0.0947
G6: *RDINT*≥ Ind_M											-0.0234	0.0421
G7: *ADINT*≥ Ind_M												-0.0154

Table 3. Returns to momentum strategy

This table provides momentum returns of three-, six-, nine- and twelve-month holding period returns from a long-short portfolio constructed from the past twelve months' winner and loser stocks. We reported average monthly excess returns and Fama-French three-factor model monthly adjusted returns in percentage terms (associated White heteroskedasticity corrected *t*-statistics are reported below the returns). Monthly excess return is the difference between portfolio return and monthly return on a three-month Treasury bill. Fama-French risk-adjusted return is the estimated intercept coefficient from the Fama-French three-factor model. At the end of each month *t*, stocks are sorted into five quintile portfolios independently by cumulative returns in the previous year, from month *t*-12 to *t*-1. Q_{M5} (Q_{M1}) is the portfolio consisting of stocks with the past twelve months' cumulative returns in the top (bottom) 20 percent. (Q_{M5}- Q_{M1}) is profits from the long-short investment strategy, in which the long position consisted of past winner stocks and the short position consisted of past loser stocks. We measure the difference in average three-, six-, nine-, and twelve-month returns between the monthly rebalanced winner and loser portfolios. The differences between winner and loser portfolios are calculated by averaging monthly profits for an overlapping portfolio that in each month contains an equally weighted portfolio of long-short momentum portfolios selected in the previous twelve months. Panel A presents momentum returns for all sample stocks. Panels B and C present momentum returns for a value stock portfolio and a growth stock portfolio.

Panel A: All firms

Average monthly excess returns (%)

	Q_{M1}	Q_{M2}	Q_{M3}	Q_{M4}	Q_{M5}	Q_{M5}- Q_{M1}
3-month	0.0819	0.6300**	0.8371***	0.9628***	1.1399***	1.0580***
	(0.27)	(2.47)	(3.53)	(4.09)	(4.22)	(5.96)
6-month	0.1754	0.6684***	0.8462***	0.9460***	1.0598***	0.8844***
	(0.59)	(2.65)	(3.59)	(4.02)	(3.92)	(5.22)
9-month	0.2866	0.7071***	0.8395***	0.9058***	0.9660***	0.6794***
	(0.97)	(2.81)	(3.56)	(3.84)	(3.57)	(4.21)
12-month	0.3937	0.7615***	0.8706***	0.9118***	0.9196***	0.5259***
	(1.37)	(3.09)	(3.76)	(3.90)	(3.41)	(3.54)

Fama-French 3-factor model monthly adj. returns (%)

	Q_{M1}	Q_{M2}	Q_{M3}	Q_{M4}	Q_{M5}	Q_{M5}- Q_{M1}
3-month	-0.7388***	-0.1560*	0.0892	0.2441***	0.4423***	1.1811***
	(-5.03)	(-1.66)	(1.26)	(3.69)	(4.68)	(6.98)
6-month	-0.6669***	-0.1334	0.0904	0.2228***	0.3685***	1.0354***
	(-4.54)	(-1.44)	(1.27)	(3.34)	(4.06)	(6.30)
9-month	-0.5663***	-0.0969	0.0828	0.1881***	0.2797***	0.8459***
	(-3.94)	(-1.06)	(1.17)	(2.85)	(3.28)	(5.53)
12-month	-0.4816***	-0.0610	0.0934	0.1748***	0.2034**	0.6850***
	(-3.40)	(-0.69)	(1.35)	(2.66)	(2.47)	(4.87)

Panel B: Value stocks

Average monthly excess returns (%)

	Q_{M1}	Q_{M2}	Q_{M3}	Q_{M4}	Q_{M5}	Q_{M5}- Q_{M1}
3-month	0.3628	0.8277***	1.0225***	1.1245***	1.2749***	0.9121***
	(1.21)	(3.20)	(4.23)	(4.65)	(4.77)	(5.38)
6-month	0.4463	0.8764***	1.0276***	1.1152***	1.1981***	0.7518***
	(1.51)	(3.42)	(4.25)	(4.63)	(4.49)	(4.65)
9-month	0.5377*	0.9002***	1.0102***	1.0692***	1.0934***	0.5557***
	(1.82)	(3.51)	(4.17)	(4.44)	(4.12)	(3.61)
12-month	0.6247**	0.9417***	1.0322***	1.0640***	1.0435***	0.4188***
	(2.17)	(3.76)	(4.34)	(4.50)	(3.97)	(2.97)

Fama-French 3-factor model monthly adj. returns (%)

	Q_{M1}	Q_{M2}	Q_{M3}	Q_{M4}	Q_{M5}	Q_{M5}- Q_{M1}
3-month	-0.5337***	-0.0451	0.1870**	0.2923***	0.4594***	0.9930***
	(-3.31)	(-0.44)	(2.31)	(3.96)	(4.80)	(5.95)
6-month	-0.4682***	-0.0104	0.1838**	0.2831***	0.3903***	0.8585***
	(-2.94)	(-0.10)	(2.32)	(3.87)	(4.20)	(5.26)
9-month	-0.3818**	0.0186	0.1695**	0.2517***	0.3043***	0.6861***
	(-2.42)	(0.19)	(2.15)	(3.48)	(3.40)	(4.42)
12-month	-0.3062**	0.0489	0.1798**	0.2401***	0.2396***	0.5458***
	(-1.96)	(0.50)	(2.31)	(3.28)	(2.74)	(3.71)

Panel C: Growth stocks

Average monthly excess returns (%)

	Q_{M1}	Q_{M2}	Q_{M3}	Q_{M4}	Q_{M5}	Q_{M5}- Q_{M1}
3-month	-0.1406	0.4471*	0.6435***	0.7892***	0.9898***	1.1304***
	(-0.46)	(1.71)	(2.66)	(3.30)	(3.56)	(5.89)
6-month	-0.0621	0.4715*	0.6539***	0.7705***	0.9292***	0.9913***
	(-0.21)	(1.83)	(2.73)	(3.23)	(3.33)	(5.44)
9-month	0.0630	0.5248**	0.6690***	0.7347***	0.8444***	0.7815***
	(0.21)	(2.06)	(2.81)	(3.07)	(3.01)	(4.47)
12-month	0.1946	0.5963**	0.7062***	0.7552***	0.7945***	0.5999***
	(0.67)	(2.39)	(3.01)	(3.17)	(2.84)	(3.69)

Fama-French 3-factor model monthly adj. returns (%)

	Q_{M1}	Q_{M2}	Q_{M3}	Q_{M4}	Q_{M5}	Q_{M5}- Q_{M1}
3-month	-0.8839***	-0.2534**	-0.0127	0.1810***	0.3962***	1.2801***
	(-5.98)	(-2.53)	(-0.16)	(2.71)	(3.91)	(7.25)
6-month	-0.8262***	-0.2460**	-0.0132	0.1532**	0.3389***	1.1651***
	(-5.59)	(-2.50)	(-0.17)	(2.25)	(3.53)	(6.80)
9-month	-0.7191***	-0.2023**	-0.0041	0.1122*	0.2496***	0.9687***
	(-4.98)	(-2.06)	(-0.06)	(1.65)	(2.81)	(6.09)
12-month	-0.6208***	-0.1582*	0.0016	0.1007	0.1596*	0.7804***
	(-4.34)	(-1.65)	(0.02)	(1.49)	(1.88)	(5.35)

Table 4. Returns to fundamental momentum strategy

This table provides returns of three-, six-, nine- and twelve-month holding periods from a long-short investment strategy based on past twelve-month returns and fundamental scores. Returns to a fundamental momentum strategy for all sample stocks, value stocks, and growth stocks are presented. Average monthly excess returns and monthly returns adjusted by the Fama-French three-factor model are presented in percentage terms (associated White heteroskedasticity corrected *t*-statistics are reported below returns). At the end of each month, sample stocks are sorted sequentially by cumulative returns in the past twelve months and fundamental scores. Q_{M5} (Q_{M1}) is the portfolio consisting of stocks with the past twelve-month cumulative returns in the bottom (top) 20 percent. Q_{F5} and Q_{G5} (Q_{F1} and Q_{G1}) are portfolios with the highest (lowest) FSCORE and GSCORE. $\Delta_{FMOM\text{-}MOM}$ and $\Delta_{GMOM\text{-}MOM}$ are the differences between returns, where $\Delta_{FMOM\text{-}MOM}$ =[(Q_{M5}, Q_{F5})-(Q_{M1}, Q_{F1})]-[Q_{M5}- Q_{M1}] and $\Delta_{GMOM\text{-}MOM}$ =[(Q_{M5}, Q_{G5})-(Q_{M1}, Q_{G1})]-[Q_{M5}- Q_{M1}]. The paired-difference *t*-test is used to test whether $\Delta_{FMOM\text{-}MOM}$ ($\Delta_{GMOM\text{-}MOM}$) is statistically significantly different from zero. Panels A, B, C, and D present returns to fundamental momentum strategy based on FSCORE; Panels E, F, G, and H present returns to a fundamental momentum strategy based on GSCORE.

Panel A: FSCORE, 3-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{F1}	Q_{F5}	$(Q_{F5}$- $Q_{F1})$	Q_{F1}	Q_{F5}	$(Q_{F5}$- $Q_{F1})$	Q_{F1}	Q_{F5}	$(Q_{F5}$- $Q_{F1})$
Q_{M1} (Losers)	-0.2450	0.4796*	0.7245***	0.0524	0.6801**	0.6277***	-0.5147	0.3522	0.8669***
	(-0.74)	(1.67)	(5.49)	(0.16)	(2.32)	(4.06)	(-1.48)	(1.17)	(5.02)
Q_{M5} (Winners)	0.9685***	1.1992***	0.2308**	1.1025***	1.3441***	0.2415*	0.7735***	1.0424***	0.2689**
	(3.34)	(4.51)	(2.33)	(3.76)	(4.95)	(1.92)	(2.57)	(3.81)	(2.25)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5}, Q_{F5}) - (Q_{M1}, Q_{F1})		1.4442***	1.5493***		1.2917***	1.3398***		1.5571***	1.7211***
		(6.39)	(7.67)		(5.55)	(6.30)		(6.21)	(7.53)
$\Delta_{FMOM\text{-}MOM}$		0.3862***	0.3682***		0.3796***	0.3468***		0.4267***	0.4410***
		(3.45)	(3.21)		(2.80)	(2.62)		(3.18)	(3.35)

Panel B: FSCORE, 6-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{F1}	Q_{F5}	$(Q_{F5}$- $Q_{F1})$	Q_{F1}	Q_{F5}	$(Q_{F5}$- $Q_{F1})$	Q_{F1}	Q_{F5}	$(Q_{F5}$- $Q_{F1})$
Q_{M1} (Losers)	-0.2007	0.5536*	0.7543***	0.0703	0.7564	0.6862	-0.5039	0.4071	0.9111***
	(-0.61)	(1.94)	(6.13)	(0.21)	(2.60)	(4.83)	(-1.48)	(1.38)	(5.70)
Q_{M5} (Winners)	0.8650***	1.1628***	0.2978***	1.0170	1.3103	0.2933	0.7097***	1.0215***	0.3118***
	(2.97)	(4.39)	(3.12)	(3.46)	(4.87)	(2.41)	(2.37)	(3.75)	(2.84)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5}, Q_{F5}) - (Q_{M1}, Q_{F1})		1.3634***	1.4903***		1.2400***	1.3209***		1.5254***	1.7093***
		(6.37)	(7.68)		(5.69)	(6.48)		(6.38)	(7.92)
$\Delta_{FMOM\text{-}MOM}$		0.4790***	0.4549***		0.4883***	0.4624***		0.5341***	0.5442***
		(4.63)	(4.41)		(3.99)	(3.81)		(4.29)	(4.63)

Panel C: FSCORE, 9-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{F1}	Q_{F5}	$(Q_{F5}$- $Q_{F1})$	Q_{F1}	Q_{F5}	$(Q_{F5}$- $Q_{F1})$	Q_{F1}	Q_{F5}	$(Q_{F5}$- $Q_{F1})$
Q_{M1} (Losers)	-0.1071	0.6471**	0.7542***	0.1698	0.8459***	0.6761***	-0.3967	0.4850*	0.8817***
	(-0.33)	(2.27)	(6.38)	(0.52)	(2.92)	(4.99)	(-1.18)	(1.66)	(5.75)
Q_{M5} (Winners)	0.7545***	1.1003***	0.3458***	0.9019***	1.2061***	0.3042***	0.6143**	0.9728***	0.3585***
	(2.58)	(4.15)	(3.77)	(3.06)	(4.51)	(2.60)	(2.05)	(3.55)	(3.47)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5}, Q_{F5}) - (Q_{M1}, Q_{F1})		1.2075***	1.3397***		1.0362***	1.1341***		1.3695***	1.5526***
		(5.86)	(7.11)		(4.98)	(5.67)		(5.95)	(7.56)
$\Delta_{FMOM\text{-}MOM}$		0.5281***	0.4937***		0.4805***	0.4480***		0.5880***	0.5838***
		(5.34)	(5.00)		(4.14)	(3.88)		(5.05)	(5.27)

Panel D: FSCORE, 12-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{F1}	Q_{F5}	$(Q_{F5}- Q_{F1})$	Q_{F1}	Q_{F5}	$(Q_{F5}- Q_{F1})$	Q_{F1}	Q_{F5}	$(Q_{F5}- Q_{F1})$
Q_{M1} (Losers)	0.0172	0.7469***	0.7297***	0.2953	0.9321***	0.6368***	-0.2557	0.5853**	0.8411***
	(0.05)	(2.70)	(6.44)	(0.93)	(3.29)	(4.98)	(-0.78)	(2.07)	(5.77)
Q_{M5} (Winners)	0.7152**	1.0651***	0.3499***	0.8641***	1.1879***	0.3238***	0.5707**	0.9094***	0.3387***
	(2.46)	(4.03)	(3.96)	(2.97)	(4.49)	(2.96)	(1.91)	(3.32)	(3.41)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
$(Q_{M5}, Q_{F5}) - (Q_{M1}, Q_{F1})$		1.0480***	1.1692***		0.8926***	0.9774***		1.1651***	1.3360***
		(5.43)	(6.37)		(4.55)	(5.01)		(5.38)	(6.81)
$\Delta_{FMOM-MOM}$		0.5220***	0.4842***		0.4738***	0.4317***		0.5652***	0.5556***
		(5.51)	(5.09)		(4.26)	(3.90)		(5.11)	(5.31)

Panel E: GSCORE, 3-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$
Q_{M1} (Losers)	-0.2447	0.5401*	0.7848***	0.0478	0.7134***	0.6656***	-0.5370	0.4669	1.0039***
	(-0.73)	(1.87)	(4.54)	(0.15)	(2.41)	(3.91)	(-1.55)	(1.55)	(4.97)
Q_{M5} (Winners)	1.0109***	1.1519***	0.1410	1.1230***	1.2998***	0.1768	0.7799***	0.9849***	0.2050
	(3.38)	(4.51)	(1.12)	(3.85)	(4.96)	(1.30)	(2.46)	(3.74)	(1.40)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
$(Q_{M5}, Q_{G5}) - (Q_{M1}, Q_{G1})$		1.3967***	1.5678***		1.2520***	1.2645***		1.5219***	1.7304***
		(5.57)	(7.71)		(5.14)	(5.78)		(5.78)	(8.00)
$\Delta_{GMOM-MOM}$		0.3386***	0.3867***		0.3399**	0.2715**		0.3915***	0.4502***
		(2.57)	(3.48)		(2.41)	(2.08)		(2.73)	(3.59)

Panel F: GSCORE, 6-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$
Q_{M1} (Losers)	-0.1670	0.5880**	0.7550***	0.1467	0.7719***	0.6252***	-0.5234	0.4612	0.9847***
	(-0.50)	(2.07)	(4.53)	(0.45)	(2.66)	(3.84)	(-1.54)	(1.57)	(5.16)
Q_{M5} (Winners)	0.8977***	1.1161***	0.2184*	1.0008***	1.2728***	0.2720**	0.6857**	0.9921***	0.3063**
	(3.03)	(4.35)	(1.87)	(3.49)	(4.89)	(2.14)	(2.19)	(3.74)	(2.30)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
$(Q_{M5}, Q_{G5}) - (Q_{M1}, Q_{G1})$		1.2831***	1.4771***		1.1261***	1.1714***		1.5155***	1.7401***
		(5.33)	(7.48)		(4.81)	(5.44)		(5.99)	(8.37)
$\Delta_{GMOM-MOM}$		0.3986***	0.4416***		0.3743***	0.3129***		0.5243***	0.5750***
		(3.20)	(4.26)		(2.80)	(2.57)		(3.83)	(4.81)

Panel G: GSCORE, 9-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$
Q_{M1} (Losers)	-0.0879	0.6907**	0.7786***	0.2314	0.8756***	0.6442***	-0.3921	0.5578*	0.9499***
	(-0.27)	(2.45)	(4.77)	(0.71)	(3.03)	(4.11)	(-1.15)	(1.91)	(5.07)
Q_{M5} (Winners)	0.7725***	1.0743***	0.3018***	0.8858***	1.1918***	0.3060**	0.5620*	0.9724***	0.4103***
	(2.62)	(4.17)	(2.71)	(3.11)	(4.64)	(2.54)	(1.81)	(3.65)	(3.24)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
$(Q_{M5}, Q_{G5}) - (Q_{M1}, Q_{G1})$		1.1622***	1.3713***		0.9604***	1.0441***		1.3644***	1.5938***
		(4.94)	(7.17)		(4.25)	(5.02)		(5.47)	(7.87)
$\Delta_{GMOM-MOM}$		0.4828***	0.5254***		0.4047***	0.3580***		0.5829***	0.6251***
		(3.95)	(5.23)		(3.16)	(3.05)		(4.32)	(5.43)

Panel H: GSCORE, 12-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$	Q_{G1}	Q_{G5}	$(Q_{G5}- Q_{G1})$
Q_{M1} (Losers)	0.0086	0.7751***	0.7665***	0.3247	0.9305***	0.6058***	-0.2847	0.6796***	0.9643***
	(0.03)	(2.82)	(4.80)	(1.03)	(3.31)	(3.98)	(-0.86)	(2.39)	(5.31)
Q_{M5} (Winners)	0.7013**	1.0586***	0.3573***	0.8118***	1.1885***	0.3767***	0.5030	0.9523***	0.4493***
	(2.41)	(4.13)	(3.31)	(2.89)	(4.67)	(3.36)	(1.63)	(3.59)	(3.67)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
$(Q_{M5}, Q_{G5}) - (Q_{M1}, Q_{G1})$		1.0499***	1.2480***		0.8639***	0.9474***		1.2371***	1.4552***
		(4.73)	(6.70)		(4.05)	(4.63)		(5.20)	(7.42)
$\Delta_{GMOM-MOM}$		0.5240***	0.5630***		0.4450***	0.4017***		0.6372***	0.6748***
		(4.41)	(5.70)		(3.60)	(3.38)		(4.85)	(6.13)

Table 5. Returns to BOS momentum strategy

This table provides returns of three-, six-, nine- and twelve-month holding periods from a long-short investment strategy based on the past twelve-month returns and BOS ratios. Returns to a BOS momentum strategy for all sample stocks, value stocks, and growth stocks are presented. Average monthly excess returns and monthly returns adjusted by the Fama-French three-factor model are presented in percentage terms (associated White heteroskedasticity corrected *t*-statistics are reported below returns). At the end of each month, sample stocks are sorted sequentially by cumulative returns in the past twelve months and BOS ratios. Q_{M5} (Q_{M1}) is a portfolio consisting of stocks with the past twelve-month cumulative returns in the bottom (top) 20 percent. Q_{B5} (Q_{B1}) is the portfolio with the highest (lowest) BOS ratio. $\Delta_{BOS\text{-}MOM}$ is the difference between returns; $\Delta_{BOS\text{-}MOM}$ =[(Q_{M5}, Q_{B1})-(Q_{M1}, Q_{B5})]-[Q_{M5}- Q_{M1}]. The paired difference *t*-test is used to test whether $\Delta_{BOS\text{-}MOM}$ is statistically significantly different from zero.

Panel A: 3-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{B1}	Q_{B5}	$(Q_{B1}$- $Q_{B5})$	Q_{B1}	Q_{B5}	$(Q_{B1}$- $Q_{B5})$	Q_{B1}	Q_{B5}	$(Q_{B1}$- $Q_{B5})$
Q_{M1} (Losers)	0.2149	-0.2882	0.5031***	0.5031	-0.0231	0.5262***	-0.0271	-0.5398	0.5127***
	(0.70)	(-0.91)	(4.08)	(1.61)	(-0.07)	(3.80)	(-0.08)	(-1.61)	(3.04)
Q_{M5} (Winners)	1.1556***	1.0969***	0.0587	1.1999***	1.3373***	-0.1374	1.0548***	0.8629***	0.1919
	(4.24)	(3.69)	(0.53)	(4.35)	(4.66)	(-1.09)	(3.75)	(2.72)	(1.36)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5}, Q_{B1}) - (Q_{M1}, Q_{B5})		1.4438***	1.4778***		1.2230***	1.2139***		1.5945***	1.7168***
		(7.12)	(7.53)		(6.07)	(5.83)		(6.70)	(8.18)
$\Delta_{BOS\text{-}MOM}$		0.3858***	0.2967***		0.3109***	0.2209*		0.4642***	0.4367***
		(3.51)	(2.76)		(2.63)	(1.93)		(3.22)	(3.32)

Panel B: 6-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{B1}	Q_{B5}	$(Q_{B1}$- $Q_{B5})$	Q_{B1}	Q_{B5}	$(Q_{B1}$- $Q_{B5})$	Q_{B1}	Q_{B5}	$(Q_{B1}$- $Q_{B5})$
Q_{M1} (Losers)	0.2655	-0.2125	0.4780***	0.5191*	0.0418	0.4773***	0.0273	-0.4404	0.4677***
	(0.88)	(-0.68)	(4.10)	(1.69)	(0.13)	(3.71)	(0.09)	(-1.34)	(3.07)
Q_{M5} (Winners)	1.0772***	0.9697***	0.1075	1.1333***	1.1886***	-0.0553	1.0068***	0.7849**	0.2218*
	(3.97)	(3.28)	(1.10)	(4.18)	(4.17)	(-0.50)	(3.57)	(2.51)	(1.79)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5}, Q_{B1}) - (Q_{M1}, Q_{B5})		1.2898***	1.3510***		1.0915***	1.1033***		1.4472***	1.5838***
		(6.68)	(6.94)		(5.76)	(5.37)		(6.48)	(7.73)
$\Delta_{BOS\text{-}MOM}$		0.4053***	0.3156***		0.3397***	0.2449**		0.4559***	0.4187***
		(3.92)	(3.24)		(3.15)	(2.44)		(3.46)	(3.56)

Panel C: 9-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{B1}	Q_{B5}	$(Q_{B1}$- $Q_{B5})$	Q_{B1}	Q_{B5}	$(Q_{B1}$- $Q_{B5})$	Q_{B1}	Q_{B5}	$(Q_{B1}$- $Q_{B5})$
Q_{M1} (Losers)	0.3678	-0.0882	0.4560***	0.5864*	0.1606	0.4258***	0.1613	-0.3159	0.4773***
	(1.22)	(-0.28)	(4.20)	(1.93)	(0.52)	(3.59)	(0.52)	(-0.97)	(3.38)
Q_{M5} (Winners)	0.9906***	0.8382***	0.1524*	1.0147***	1.0505***	-0.0358	0.9506***	0.6391**	0.3115***
	(3.66)	(2.85)	(1.70)	(3.80)	(3.71)	(-0.36)	(3.35)	(2.05)	(2.73)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5}, Q_{B1}) - (Q_{M1}, Q_{B5})		1.0788***	1.1540***		0.8541***	0.8883***		1.2665***	1.4039***
		(5.82)	(6.34)		(4.73)	(4.64)		(5.84)	(7.25)
$\Delta_{BOS\text{-}MOM}$		0.3994***	0.3081***		0.2984***	0.2022**		0.4850***	0.4352***
		(4.14)	(3.49)		(2.97)	(2.23)		(3.92)	(3.96)

Panel D: 12-month average excess returns (%)

	All stocks			Value stocks			Growth stocks		
	Q_{B1}	Q_{B5}	$(Q_{B1}- Q_{B5})$	Q_{B1}	Q_{B5}	$(Q_{B1}- Q_{B5})$	Q_{B1}	Q_{B5}	$(Q_{B1}- Q_{B5})$
Q_{M1} (Losers)	0.5048*	0.0446	0.4602***	0.7014**	0.2832	0.4182***	0.3192	-0.1738	0.4930***
	(1.71)	(0.15)	(4.42)	(2.36)	(0.94)	(3.76)	(1.05)	(-0.55)	(3.59)
Q_{M5} (Winners)	0.9452***	0.7624***	0.1828**	0.9603***	0.9948***	-0.0345	0.9232***	0.5464*	0.3768***
	(3.50)	(2.62)	(2.28)	(3.65)	(3.57)	(-0.39)	(3.26)	(1.77)	(3.59)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
$(Q_{M5}, Q_{B1}) - (Q_{M1}, Q_{B5})$		0.9006***	0.9637***		0.6771***	0.7109***		1.0970***	1.2214***
		(5.30)	(5.72)		(4.09)	(4.05)		(5.39)	(6.74)
$\Delta_{BOS-MOM}$		0.3747***	0.2788***		0.2583***	0.1652*		0.4971***	0.4410***
		(4.17)	(3.34)		(2.76)	(1.95)		(4.27)	(4.19)

Table 6. Returns to combined investment strategy

This table provides a summary of momentum returns when sample stocks are sorted by past returns, BOS ratio, and the fundamental indicator FSCORE or GSCORE. Average monthly excess returns and monthly returns adjusted by the Fama-French three-factor model are presented in percentage terms (associated White heteroskedasticity corrected *t*-statistics are reported below returns). At the end of each month, stocks are sorted sequentially by cumulative returns in the past twelve months, BOS ratio, and fundamental score. Portfolios Q_{Mi} and Q_{Bi} have the same definition as in previous tables. Q_{F5} (Q_{F1}) is the portfolio consisting of stocks with highest (lowest) FSCORE. Q_{G5} (Q_{G1}) is the portfolio consisting of stocks with highest (lowest) GSCORE. (Q_{M5}, $Q_{B1,}$ Q_{F5})-(Q_{M1}, $Q_{B5,}$ Q_{F1}) is profits generated from the long-short investment strategy with a long position in top winners-lowest BOS-highest FSCORE stocks and a short position in top losers-highest BOS-lowest FSCORE stocks. (Q_{M5}, $Q_{B1,}$ Q_{G5})-(Q_{M1}, $Q_{B5,}$ Q_{G1}) is profits generated from the long-short investment strategy with a long position in top winners-lowest BOS-highest GSCORE stocks and a short position in top losers-highest BOS-lowest GSCORE stocks. $\Delta_{CS\text{-}MOM}$ is the difference in long-short portfolio returns between the combined strategy and momentum strategy. $\Delta_{CS\text{-}BOS}$ is the difference in long-short portfolio returns between the combined strategy and BOS momentum strategy. The paired difference *t*-test is used to test whether the differences are statistically significantly different from zero.

Panel A: Combined with FSCORE

	3-month			6-month			9-month			12-month		
	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}
(Q_{M1}, Q_{B5})	-0.7298**	0.1154	0.8451***	-0.7288**	0.3217	1.0505***	-0.5853*	0.4732	1.0585***	-0.3879	0.6272**	1.0152***
	(-2.01)	(0.35)	(3.88)	(-2.06)	(1.02)	(5.49)	(-1.69)	(1.52)	(5.94)	(-1.15)	(2.09)	(6.12)
(Q_{M5}, Q_{B1})	0.9903***	1.2021***	0.2118	0.8831***	1.1762***	0.2931**	0.7681***	1.0960***	0.3280**	0.7468***	1.0481***	0.3013**
	(3.29)	(4.30)	(1.25)	(3.02)	(4.31)	(2.06)	(2.63)	(4.05)	(2.54)	(2.57)	(3.88)	(2.55)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5},Q_{B1},Q_{F5}) -(Q_{M1},Q_{B5},Q_{F1})		1.9319***	1.9442***		1.9051***	1.9288***		1.6814***	1.7033***		1.4361***	1.4527***
		(6.99)	(7.06)		(7.51)	(7.93)		(6.93)	(7.63)		(6.32)	(6.86)
$\Delta_{CS\text{-}MOM}$		0.8738***	0.7631***		1.0206***	0.8934***		1.0020***	0.8573***		0.9102***	0.7677***
		(4.12)	(3.48)		(5.46)	(4.78)		(5.77)	(5.43)		(5.62)	(5.33)
$\Delta_{CS\text{-}BOS}$		0.4880***	0.4664***		0.6153***	0.5778***		0.6025***	0.5493***		0.5354***	0.4890***
		(2.89)	(2.91)		(4.12)	(3.94)		(4.37)	(4.16)		(4.19)	(3.98)
$\Delta_{CS\text{-}FMOM}$		0.4877***	0.3949*		0.5416***	0.4385**		0.4739***	0.3636***		0.3881***	0.2835**
		(2.64)	(1.90)		(3.46)	(2.54)		(3.44)	(2.64)		(3.13)	(2.37)

Panel B: Combined with GSCORE

	3-month			6-month			9-month			12-month		
	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}
(Q_{M1}, Q_{B5})	-0.4239	0.1721	0.5960**	-0.4520	0.2757	0.7277***	-0.4018	0.4169	0.8187***	-0.3256	0.5130*	0.8386***
	(-1.17)	(0.55)	(2.49)	(-1.27)	(0.92)	(3.54)	(-1.15)	(1.41)	(4.39)	(-0.95)	(1.80)	(4.75)
(Q_{M5}, Q_{B1})	1.0087***	1.1833***	0.1746	1.0198***	1.1541***	0.1343	0.8642***	1.0786***	0.2144	0.7622***	1.0671***	0.3050**
	(3.31)	(4.29)	(0.99)	(3.41)	(4.16)	(0.86)	(2.93)	(3.91)	(1.49)	(2.61)	(3.91)	(2.29)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5},Q_{B1},Q_{G5}) -(Q_{M1},Q_{B5},Q_{G1})		1.6071***	1.6625***		1.6061***	1.6963***		1.4804***	1.6049***		1.3927***	1.5165***
		(5.46)	(6.21)		(5.67)	(6.60)		(5.53)	(6.56)		(5.49)	(6.64)
$\Delta_{CS\text{-}MOM}$		0.5491**	0.4814**		0.7216***	0.6609***		0.8010***	0.7590***		0.8668***	0.8315***
		(2.37)	(2.11)		(3.38)	(3.36)		(4.09)	(4.12)		(4.64)	(4.78)
$\Delta_{CS\text{-}BOS}$		0.1633	0.1847		0.3163*	0.3452**		0.4016***	0.4509***		0.4921***	0.5527***
		(0.90)	(1.07)		(1.91)	(2.36)		(2.69)	(3.28)		(3.49)	(4.33)
$\Delta_{CS\text{-}GMOM}$		0.2105	0.0947		0.3230**	0.2192		0.3182**	0.2336*		0.3428***	0.2685**
		(1.14)	(0.52)		(2.02)	(1.45)		(2.26)	(1.68)		(2.62)	(2.03)

Table 7. Returns to combined investment strategy – value stocks and growth stocks

This table provides a summary of momentum returns when sample stocks are sorted by past returns, BOS ratio, and the fundamental indicator FSCORE or GSCORE. Average monthly excess returns and monthly returns adjusted by the Fama-French three-factor model are presented in percentage terms (associated White heteroskedasticity corrected *t*-statistics are reported below returns). Returns to combined investment strategy for value stocks are presented in Panels A and B, and those for growth stocks are presented in Panels C and D. At the end of each month, stocks are sorted sequentially by cumulative returns in the past twelve months, BOS ratio, and fundamental score. Portfolios Q_{Mi} and Q_{Bi} have the same definition as in previous tables. Q_{F5} (Q_{F1}) is the portfolio consisting of stocks with highest (lowest) FSCORE. Q_{G5} (Q_{G1}) is the portfolio consisting of stocks with highest (lowest) GSCORE. (Q_{M5}, $Q_{B1,}$ Q_{F5})-(Q_{M1}, $Q_{B5,}$ Q_{F1}) is profits generated from the long-short investment strategy with a long position in top winners-lowest BOS-highest FSCORE stocks and a short position in top losers-highest BOS-lowest FSCORE stocks. (Q_{M5}, $Q_{B1,}$ Q_{G5})-(Q_{M1}, $Q_{B5,}$ Q_{G1}) is profits generated from the long-short investment strategy with a long position in top winners-lowest BOS-highest GSCORE stocks and a short position in top losers-highest BOS-lowest GSCORE stocks. $\Delta_{CS\text{-}MOM}$ is the difference i long-short portfolio returns between the combined strategy and momentum strategy. $\Delta_{CS\text{-}BOS}$ is the difference in long-short portfolio returns between the combined strategy and BOS momentum strategy. The paired difference *t*-test is used to test whether the differences are statistically significantly different from zero.

Panel A: Combined with FSCORE – Value stocks

	3-month			6-month			9-month			12-month		
	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}
(Q_{M1}, Q_{B5})	-0.5044	0.4434	0.9479***	-0.5117	0.6964**	1.2081***	-0.3577	0.7979***	1.1556***	-0.1931	0.9286***	1.1217***
	(-1.33)	(1.28)	(3.31)	(-1.40)	(2.11)	(4.85)	(-1.00)	(2.54)	(4.89)	(-0.56)	(3.05)	(5.00)
(Q_{M5}, Q_{B1})	1.0391***	1.3813***	0.3422	0.9322***	1.2877***	0.3555*	0.8340***	1.1400***	0.3060*	0.7973***	1.0915***	0.2942**
	(3.28)	(4.50)	(1.56)	(3.07)	(4.39)	(1.86)	(2.80)	(4.02)	(1.78)	(2.73)	(3.98)	(1.97)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5},Q_{B1},Q_{F5}) -(Q_{M1},Q_{B5},Q_{F1})		1.8857***	1.8686***		1.7994***	1.7447***		1.4977***	1.4648***		1.2846***	1.2435***
		(5.91)	(6.05)		(6.30)	(5.90)		(5.53)	(5.37)		(5.10)	(4.88)
$\Delta_{CS\text{-}MOM}$		0.9736***	0.8756***		1.0477***	0.8862***		0.9419***	0.7787***		0.8658***	0.6977***
		(3.66)	(3.54)		(4.53)	(3.89)		(4.36)	(3.72)		(4.41)	(3.62)
$\Delta_{CS\text{-}BOS}$		0.6627***	0.6547***		0.7079***	0.6414***		0.6435***	0.5766***		0.6076***	0.5325***
		(2.84)	(3.00)		(3.50)	(3.08)		(3.50)	(2.97)		(3.58)	(2.88)
$\Delta_{CS\text{-}FMOM}$		0.5940**	0.5288**		0.5594***	0.4239**		0.4614**	0.3307*		0.3921**	0.2660
		(2.45)	(2.22)		(2.72)	(2.02)		(2.44)	(1.73)		(2.30)	(1.49)

Panel B: Combined with GSCORE – Value stocks

	3-month			6-month			9-month			12-month		
	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}
(Q_{M1}, Q_{B5})	-0.4508	0.4830	0.9338***	-0.3731	0.5679*	0.9410***	-0.2606	0.6429**	0.9035***	-0.1335	0.7053**	0.8388***
	(-1.16)	(1.44)	(2.99)	(-0.99)	(1.79)	(3.49)	(-0.71)	(2.07)	(3.66)	(-0.38)	(2.37)	(3.68)
(Q_{M5}, Q_{B1})	1.2744***	1.1363***	-0.1381	1.1507***	1.1816***	0.0309	0.9586***	1.1054***	0.1469	0.8168***	1.0913***	0.2745*
	(3.95)	(3.89)	(-0.63)	(3.71)	(4.19)	(0.16)	(3.17)	(4.05)	(0.87)	(2.76)	(4.12)	(1.81)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5},Q_{B1},Q_{G5}) -(Q_{M1},Q_{B5},Q_{G1})		1.5871***	1.4745***		1.5547***	1.4658***		1.3660***	1.3103***		1.2248***	1.1942***
		(4.76)	(4.79)		(4.98)	(5.13)		(4.70)	(5.20)		(4.57)	(5.23)
$\Delta_{CS\text{-}MOM}$		0.6750**	0.4815*		0.8029***	0.6073***		0.8103***	0.6243***		0.8060***	0.6485***
		(2.40)	(1.91)		(3.14)	(2.77)		(3.43)	(3.16)		(3.68)	(3.42)
$\Delta_{CS\text{-}BOS}$		0.3641	0.2605		0.4632**	0.3624*		0.5119***	0.4221**		0.5477***	0.4833***
		(1.52)	(1.15)		(2.10)	(1.88)		(2.58)	(2.51)		(2.99)	(2.95)
$\Delta_{CS\text{-}GMOM}$		0.3352	0.2099		0.4286**	0.2943*		0.4056**	0.2662*		0.3610**	0.2468*
		(1.42)	(1.00)		(2.11)	(1.70)		(2.24)	(1.75)		(2.18)	(1.64)

Panel C: Combined with FSCORE – Growth stocks

	3-month			6-month			9-month			12-month		
	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}	Q_{F1}	Q_{F5}	Q_{F5}- Q_{F1}
(Q_{M1}, Q_{B5})	-0.8579**	-0.1659	0.6919**	-0.8948**	-0.0797	0.8151***	-0.7207*	0.0967	0.8174***	-0.5401	0.2629	0.8030***
	(-2.15)	(-0.45)	(2.22)	(-2.32)	(-0.23)	(3.11)	(-1.91)	(0.28)	(3.45)	(-1.47)	(0.80)	(3.69)
(Q_{M5}, Q_{B1})	1.0040***	0.9362***	-0.0678	0.9536***	0.9798***	0.0262	0.8129***	1.0381***	0.2252	0.7717***	1.0056***	0.2339
	(3.15)	(3.22)	(-0.34)	(3.09)	(3.46)	(0.15)	(2.66)	(3.68)	(1.42)	(2.56)	(3.57)	(1.59)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5},Q_{B1},Q_{F5}) -(Q_{M1},Q_{B5},Q_{F1})		1.7941***	1.9239***		1.8746***	2.0255***		1.7588***	1.9001***		1.5457***	1.6818***
		(5.39)	(6.33)		(6.16)	(7.30)		(6.07)	(7.41)		(5.67)	(6.81)
$\Delta_{CS\text{-}MOM}$		0.6637**	0.6438**		0.8833***	0.8603***		0.9773***	0.9314***		0.9457***	0.9014***
		(2.45)	(2.40)		(3.69)	(3.63)		(4.46)	(4.45)		(4.60)	(4.57)
$\Delta_{CS\text{-}BOS}$		0.1995	0.2071		0.4274**	0.4417**		0.4923***	0.4962***		0.4486***	0.4604***
		(0.92)	(1.00)		(2.24)	(2.28)		(2.78)	(2.82)		(2.73)	(2.80)
$\Delta_{CS\text{-}FMOM}$		0.2370	0.2028		0.3492*	0.3161		0.3893**	0.3475**		0.3805**	0.3458**
		(1.00)	(0.80)		(1.74)	(1.50)		(2.21)	(1.97)		(2.31)	(2.07)

Panel D: Combined with GSCORE – Growth stocks

	3-month			6-month			9-month			12-month		
	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}	Q_{G1}	Q_{G5}	Q_{G5}- Q_{G1}
(Q_{M1}, Q_{B5})	-0.5085	-0.1167	0.3917	-0.5406	-0.0197	0.5208	-0.5758	0.1973	0.7731***	-0.4968	0.3319	0.8054***
	(-1.28)	(-0.33)	(1.21)	(-1.41)	(-0.06)	(1.91)	(-1.53)	(0.62)	(3.22)	(-1.36)	(1.08)	(3.66)
(Q_{M5}, Q_{B1})	0.7584**	1.1032***	0.3448	0.8312***	1.0655***	0.2343	0.7385**	0.9923***	0.2538	0.7199**	1.0017***	0.2818*
	(2.34)	(3.74)	(1.51)	(2.60)	(3.66)	(1.17)	(2.36)	(3.43)	(1.43)	(2.33)	(3.51)	(1.76)
		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*		Return	FF-*adj*
(Q_{M5},Q_{B1},Q_{G5}) -(Q_{M1},Q_{B5},Q_{G1})		1.6117***	1.7669***		1.6061***	1.7996***		1.5680***	1.7976***		1.4985***	1.7357***
		(4.72)	(5.68)		(4.96)	(5.99)		(5.03)	(5.99)		(5.14)	(6.14)
$\Delta_{CS\text{-}MOM}$		0.4813*	0.4867*		0.6148**	0.6344***		0.7866***	0.8289***		0.8986***	0.9553***
		(1.69)	(1.78)		(2.36)	(2.56)		(3.26)	(3.43)		(4.04)	(4.30)
$\Delta_{CS\text{-}BOS}$		0.0171	0.0501		0.1589	0.2158		0.3015*	0.3937**		0.4015**	0.5143***
		(0.08)	(0.24)		(0.81)	(1.17)		(1.68)	(2.12)		(2.45)	(3.03)
$\Delta_{CS\text{-}GMOM}$		0.0898	0.0365		0.0906	0.0594		0.2036	0.2038		0.2615	0.2805
		(0.38)	(0.16)		(0.45)	(0.30)		(1.12)	(1.05)		(1.57)	(1.54)

Table 8. Comparison of investment strategies

This table provides a comparison of investment strategies based on different sorting variables. *MOM* is the momentum strategy, based solely on past returns. *BOS* is the BOS momentum strategy, based on past returns and the *BOS* ratio. *CS-F* (*CS-G*) is the combined investment strategy, based on past returns, *BOS* ratio, and fundamental scores FSCORE (GSCORE). Returns, *t*-statistics, and information ratios for long-short investment strategies with different holding periods are presented. The information ratio is defined as the active return divided by tracking error. Active return is the difference between the return on different strategies and NYSE/AMEX/NASDAQ value-weighted return, and tracking error is the standard deviation of the active return. Correlations among returns to the momentum strategy, the BOS momentum strategy, and the combined investment strategies are also presented. Panel A presents the comparison for all sample stocks, and Panels B and C present comparisons for value stocks and growth stocks.

Panel A: All Stocks

	Momentum Return				Correlation					
	MOM	*BOS*	*CS-F*	*CS-G*	(*MOM, BOS*)	(*MOM, CS-F*)	(*MOM, CS-G*)	(*BOS, CS-F*)	(*BOS, CS-G*)	(*CS-F, CS-G*)
3-month	1.0580***	1.4438***	1.9319***	1.6071***	0.8413	0.6424	0.6165	0.7940	0.7965	0.7111
t-stat	(5.96)	(7.12)	(6.99)	(5.46)						
Information ratio	0.0857	0.1434	0.1801	0.1352						
6-month	0.8844***	1.2898***	1.9051***	1.6061***	0.8451	0.6765	0.6591	0.8102	0.8232	0.7353
t-stat	(5.22)	(6.68)	(7.51)	(5.67)						
Information ratio	0.0579	0.1223	0.1865	0.1401						
9-month	0.6794***	1.0788***	1.6814***	1.4804***	0.8542	0.6999	0.6869	0.8250	0.8447	0.7510
t-stat	(4.21)	(5.82)	(6.93)	(5.53)						
Information ratio	0.0223	0.0897	0.1612	0.1286						
12-month	0.5259***	0.9006***	1.4361***	1.3927***	0.8490	0.7040	0.6826	0.8310	0.8501	0.7594
t-stat	(3.54)	(5.30)	(6.32)	(5.49)						
Information ratio	-0.0111	0.0575	0.1282	0.1179						

Panel B: Value Stocks

	Momentum Return				Correlation					
	MOM	*BOS*	*CS-F*	*CS-G*	(*MOM, BOS*)	(*MOM, CS-F*)	(*MOM, CS-G*)	(*BOS, CS-F*)	(*BOS, CS-G*)	(*CS-F, CS-G*)
3-month	0.9121***	1.2230***	1.8857***		0.8112	0.5533	0.5403	0.6835	0.7006	0.5760
t-stat	(5.38)	(6.07)	(5.91)							
Information ratio	0.0632	0.1094	0.1607							
6-month	0.7518***	1.0915***	1.7994***		0.8235	0.5870	0.5780	0.7075	0.7157	0.6229
t-stat	(4.65)	(5.76)	(6.30)							
Information ratio	0.0359	0.0904	0.1624							
9-month	0.5557***	0.8541***	1.4977***		0.8311	0.6043	0.5840	0.7379	0.7386	0.6616
t-stat	(3.61)	(4.73)	(5.53)							
Information ratio	0.0001	0.0513	0.1275							
12-month	0.4188***	0.6771***	1.2846***		0.8245	0.6290	0.5771	0.7440	0.7397	0.6609
t-stat	(2.97)	(4.09)	(5.10)							
Information ratio	-0.0318	0.0167	0.1005							

Panel C: Growth Stocks

	Momentum Return				Correlation					
	MOM	*BOS*	*CS-F*	*CS-G*	(*MOM, BOS*)	(*MOM, CS-F*)	(*MOM, CS-G*)	(*BOS, CS-F*)	(*BOS, CS-G*)	(*CS-F, CS-G*)
3-month	1.1304***	1.5945***		1.6117***	0.7957	0.5803	0.5565	0.7628	0.7736	0.6493
t-stat	(5.89)	(6.70)		(4.72)						
Information ratio	0.0938	0.1521		0.1206						
6-month	0.9913***	1.4472***		1.6061***	0.8072	0.6186	0.5960	0.7806	0.8070	0.6759
t-stat	(5.44)	(6.48)		(4.96)						
Information ratio	0.0739	0.1369		0.1252						
9-month	0.7815***	1.2665***		1.5680***	0.8212	0.6571	0.6398	0.7928	0.8302	0.6913
t-stat	(4.47)	(5.84)		(5.03)						
Information ratio	0.0394	0.1128		0.1245						
12-month	0.5999***	1.0970***		1.4985***	0.8199	0.6596	0.6539	0.7998	0.8392	0.7049
t-stat	(3.69)	(5.39)		(5.14)						
Information ratio	0.0028	0.0860		0.1195						

Appendix Table A.1 Correlation among BOS ratio, market capitalization, idiosyncratic volatility, and institutional ownership

This table presents the average Spearman rank-order correlation among BOS ratio, market capitalization, and idiosyncratic volatility for winner stocks and loser stocks. A stock's market capitalization is the multiple of its price per share and the number of shares outstanding at the end of each month. Idiosyncratic volatility is the residual variance from regressing a firm's daily excess returns on market daily excess returns over the previous twelve months. Institutional ownership is the percentage of outstanding shares held by institutional investors. Panel A shows the average correlation for negative-BOS winner stocks, and Panel B shows the average correlation for positive-BOS loser stocks.

Panel A. Winner stocks

	Market capitalization	Idiosyncratic volatility	Institutional ownership
BOS	0.0843	-0.0039	0.0927
Market capitalization		-0.0168	0.0944
Idiosyncratic volatility			-0.0995

Panel B. Loser stocks

	Market capitalization	Idiosyncratic volatility	Institutional ownership
BOS	-0.0557	0.0143	-0.2905
Market capitalization		-0.0106	0.1082
Idiosyncratic volatility			-0.0874