
CAN FUNDAMENTAL FACTORS ENHANCE THE PERFORMANCE OF TRADITIONAL MOMENTUM STRATEGIES?

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We test whether price-based momentum strategies can be improved by additional screening based on fundamental measures. Within the framework of portfolio formation based on recent winning or losing stocks, we further screen on the basis of fundamental measures of financial strength and gross profitability. Our key results are that the performance of long–short, price-based momentum strategies can be significantly improved when either fundamental measure is employed as a second screen. Of these two measures, the more effective appears to be gross profitability. These results support the hypothesis that fundamental financial information can be used by investors to improve portfolio performance.



1 Introduction

Fundamental analysis based upon historical financial statements and accounting information has been used to predict stock returns earned by investors. When applied to a group of stocks with similar characteristics (such as industry, valuation, or size), stocks with strong fundamentals are expected to produce better returns in the near future than stocks with weak fundamentals. For

example, Lev and Thiagarajan (1993) demonstrate that multiple financial signals correlate well with contemporaneous stock returns. Abarbanell and Bushee (1998) extend their study with a positive excess-return investment strategy based on the same fundamental signals. Piotroski (2000) concludes that high-book-to-market stocks with high scores using his measure of financial strength can improve the performance of high-book-to-market investors by an average of 7.5% annually.

George and Hwang (2004) propose a strategy based on the ratio of current price to 52-week high price, in which a long (short) portfolio is formed with stocks having current prices very near to or at (far from) their highest prices in

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the prior 52 weeks. In this paper, we apply similar methodology to a broader set of stocks. In addition to the price-to-52-week-high ratio, we introduce two similar measures, the 52-week-high and 52-week-low prices. Both of these prices are readily available to investors through financial websites and newspapers, and they serve as meaningful reference prices for mean-reversion strategies that require both upper and lower bounds.

In this paper we test whether price-based momentum strategies can be improved by additional screening based on fundamental measures. To do this, we apply measures of financial strength and gross profitability to both recent winning and losing stocks (as defined by the ratio of price-to-52-week-high or by the position-to-52-week-low). We compare the profitability of the strategy based on our new measure of momentum with the profitability of the price-to-52-week-high strategy, and then evaluate whether measures of financial strength and profitability can help predict stock returns of both recent winning and losing stocks.

Our analysis extends work in prior studies in several ways. First, we supplement the formation of price-based momentum strategies with additional screens based on fundamental information, and employ two fundamental measures for this. We further introduce the 52-week-low price to form a momentum strategy and compare its profitability with the similar, better-known strategy based on the 52-week high. Third, we examine the strategies using two different rebalancing periods, one rebalancing its portfolio only at the end of March and the other rebalancing its portfolio at the end of both March and September.

Our key findings are that momentum strategies can be improved when additional screening based on fundamental information is used. Moreover, momentum strategies based on the

position-off-52-week-low are as profitable as those based on the price-to-52-week-high ratio. We find that using gross profitability as a second screen is slightly more effective than using the composite financial strength score as both winning and losing portfolios are assigned to more than 30% of the sample stocks due to tied scores.

These results suggest that by adding the financial strength factor or gross profitability as a second screen improves the performance of a long-short price-based momentum strategy. This supports the hypothesis that fundamental financial information can be used by investors to improve portfolio performance.

The rest of this paper proceeds as follows. In the next section, we review prior studies on momentum strategies and application of earnings quality and profitability. The data and methodology are covered in Section 3. Empirical results are presented in Section 4, and Section 5 concludes.

2 Literature review

Price-based and earnings-based momentum strategies have long been shown to produce significant excess and risk-adjusted returns. Jegadeesh and Titman (1993) proposed and empirically demonstrated that momentum strategies that buy winning stocks in the past six months and sell losing stocks in the same period produced on average an annual excess return of 12%. They attributed their positive results to investors' under-reaction to new information. Chan *et al.* (1996) linked price-based momentum observed by Jegadeesh and Titman (1993) to earnings-based momentum. Testing their theories on stocks covered in the CRSP database over the 1977 to 1993 period, they found that winning stocks outperformed losing stocks in the 12 months following

the formation dates on all three earnings- and price-based momentum strategies.

George and Hwang (2004) proposed a strategy based on another measure of price-based momentum: the ratio of current price to 52-week high price, in which a long (short) portfolio is formed with stocks having current prices very near to or at (far from) their highest prices in the prior 52 weeks. Tested in the 1963 to 2001 period on a sample of all CRSP stocks, their strategy was as profitable as a single-stock momentum strategy and an industry momentum strategy, as winner portfolios outperformed loser portfolios by a monthly average of 0.45%. Moreover, all three strategies work well (or very well) in non-January months but did not work (or work very poorly) in January. By pairing their strategy with the other two strategies, George and Hwang (2004) also demonstrated how the ratio of current price to 52-week high price could enhance the results of the other two strategies.

Piotroski (2000) adopts a composite score, which he calls the *F*-Score. It is based on eight financial ratios, including return-on-asset, cash-flow-on-assets, long-term debt to asset, current ratio, profit margin, asset turnover, etc. He finds that the use of this fundamental score significantly enhances the performance of traditional value strategies. For example, high-book-to-market stocks with high *F*-Scores can improve the performance of high-book-to-market investors by an average of 7.5% annually.

Novy-Marx (2013) uses gross profitability, measured as the difference between yearly sales and total costs of goods sold, scaled by total assets. He finds that it has as much power predicting stock returns as the book-to-market metric. He further concludes that strategies based on gross profitability are highly negatively correlated with strategies based on price signals.

3 Data and empirical methodology

Sample stocks adopted in this study are covered in both the Center for Research in Security Price (CRSP) monthly databases and the Standard & Poor's Compustat Quarterly databases. We first use CRSP's monthly databases to identify all companies with Share Code 10 and 11 between 1980 and 2013 and CRSP's daily databases to determine 52-week high and low prices. Quarterly fundamental data are from Compustat. To mitigate the impact of small companies or new IPOs, only stocks ranked in the top 80% of market capitalization, with stock price no less than \$1, and with two full years of return-on-asset data are included in the sample.

The two price momentum strategies examined in this study are the price-to-52-week-high strategy and the position-off-52-week-low strategy. In the first of these strategies, we use George and Hwang's (2004) definition, or $\frac{Price_t}{52WH_t}$, where $52WH_t$ stands for 52-week-high-price at t , in forming the winning and losing portfolios at the beginning of each month t . Therefore, stocks with the highest 30% price-to-52-week-high ratios are assigned to the winning portfolio, while stocks with the lowest 30% price-to-52-week-high ratios are assigned to the losing portfolio. Similarly, in the position-off-52-week-low strategy, we define the measure as $\frac{Price_t - 52WL_t}{52WH_t - 52WL_t}$, where $52WL_t$ stands for 52-week-low-price at t .

Evaluating whether earnings quality and profit margin measures can enhance the performance of a momentum strategy, stocks in the winning and losing portfolios are further assigned to three sub-portfolios: top 30%, middle 40%, and bottom 30%, according to two fundamental analysis measures: a modified composite fundamental score (*F*-Score) used in Piotroski (2000) and the gross profitability adopted in Novy-Marx (2013). The *F*-Score is formed from eight binary variables

based on financial ratios. Each of these variables has a value of one if the following conditions are met, and zero otherwise:

- (1) if consecutive four-quarter net income before extraordinary items scaled by beginning total assets (or ROA) is positive;
- (2) if four-quarter cash flow from operations scaled by beginning total assets (or CFO) is positive;
- (3) if current year's ROA is higher than the prior year's ROA (or $\Delta ROA > 0$);
- (4) if current period's CFO is greater than current periods' ROA;
- (5) if the firm uses less leverage, measured as the ratio of total long-term debt to average total assets, from prior period's leverage;
- (6) if the firm improves its coverage of short-term liabilities, measured as current ratio or the ratio of current assets to current liabilities;

- (7) if the firm's gross margin ratio improves, where gross margin ratio is measured as the difference between four-quarter total sales and total cost of goods sold scaled by the total sales; and
- (8) if the firm improves its asset turnover ratio measured as total sales scaled by beginning assets.

Gross profitability (GP/A) is defined as gross margin or the difference between four-quarter total sales and total cost of goods sold scaled by beginning assets.

Shown in Table 1 is a description of our sample, and yearly average financial strength score and gross profitability (or GP/A ratio). At March end of each year, stocks are ranked into three subgroups according to either (a) price-to-52-week-high ratio or (b) position-off-52-week-low. Yearly average financial strength score (*F*-Score) and

Table 1 Statistical description of sample.

Year	# Stocks in sample	Price-to-52-week high ratio				Position-off-52-week-low			
		Winners		Losers		Winners		Losers	
		AVG <i>F</i> -score	AVG GP/A	AVG <i>F</i> -score	AVG GP/A	AVG <i>F</i> -score	AVG GP/A	AVG <i>F</i> -score	AVG GP/A
1980	1,818	3.75	0.43	3.09	0.39	3.89	0.44	3.12	0.34
1981	1,788	3.31	0.40	3.20	0.35	3.38	0.41	3.09	0.32
1982	1,818	3.83	0.37	2.90	0.36	3.83	0.40	2.99	0.32
1983	1,766	3.32	0.37	2.66	0.33	3.34	0.40	2.72	0.30
1984	2,525	3.73	0.30	3.26	0.41	3.82	0.33	3.33	0.39
1985	3,159	3.54	0.37	2.64	0.36	3.54	0.38	2.74	0.35
1986	2,745	3.31	0.41	2.48	0.33	3.32	0.42	2.45	0.32

The sample space adopted in this study includes stocks that are covered by both CRSP and COMPUSTAT, are ranked in the top 80% in market capitalizations with stock price no less than \$1 per share, and have at least two years of return-on-asset information. Qualified stocks at March end of each year are ranked into three subgroups (30%, 40%, 30%) according to either (a) price-to-52-week-high ratio or (b) position-off-52-week-low. Yearly average financial strength score (*F*-Score)¹ and gross profit/asset (GP/A)² of both the top 30% group (winners) and the bottom 30% group (losers) are presented.

¹Six fundamental factors are used before 1991, while eight are used in 1991 and all later years.

²Yearly outliers of gross profit/asset ratio are Winsorized at the 0.01 level.

Table 1 (Continued)

Year	# Stocks in sample	Price-to-52-week high ratio				Position-off-52-week-low			
		Winners		Losers		Winners		Losers	
		AVG <i>F</i> -score	AVG GP/A	AVG <i>F</i> -score	AVG GP/A	AVG <i>F</i> -score	AVG GP/A	AVG <i>F</i> -score	AVG GP/A
1987	3,158	3.34	0.40	2.59	0.33	3.37	0.42	2.66	0.31
1988	3,295	3.63	0.40	2.64	0.34	3.68	0.43	2.65	0.31
1989	3,384	3.53	0.38	2.66	0.37	3.52	0.41	2.71	0.34
1990	3,349	3.53	0.41	2.49	0.36	3.61	0.44	2.58	0.34
1991	3,269	3.63	0.41	2.62	0.34	3.66	0.43	2.69	0.32
1992	3,336	4.61	0.34	4.12	0.37	4.76	0.38	4.14	0.35
1993	3,437	4.99	0.33	4.05	0.38	5.02	0.35	4.15	0.39
1994	3,721	4.93	0.39	3.98	0.35	4.97	0.46	4.01	0.30
1995	3,960	5.01	0.41	3.84	0.38	5.04	0.45	3.98	0.35
1996	4,524	4.53	0.33	4.07	0.42	4.57	0.36	4.05	0.41
1997	4,695	4.47	0.28	3.85	0.42	4.53	0.30	3.89	0.40
1998	4,872	4.56	0.36	3.95	0.38	4.56	0.37	3.96	0.37
1999	4,671	4.48	0.36	3.70	0.36	4.48	0.40	3.85	0.33
2000	4,365	4.82	0.39	3.87	0.33	4.74	0.42	3.91	0.32
2001	4,241	4.27	0.27	3.91	0.35	4.39	0.29	3.96	0.35
2002	4,090	4.35	0.29	3.62	0.23	4.42	0.31	3.69	0.22
2003	3,759	4.54	0.26	4.12	0.28	4.67	0.29	4.41	0.29
2004	3,636	4.90	0.30	4.53	0.33	4.93	0.31	4.46	0.31
2005	3,511	5.50	0.34	4.41	0.33	5.58	0.37	4.45	0.28
2006	3,447	5.08	0.31	4.32	0.33	5.10	0.33	4.30	0.30
2007	3,390	5.34	0.34	4.36	0.32	5.30	0.36	4.36	0.26
2008	3,279	5.05	0.31	4.07	0.31	4.93	0.33	4.33	0.30
2009	3,085	4.67	0.31	3.85	0.25	4.55	0.31	4.05	0.26
2010	3,030	5.15	0.33	4.30	0.23	5.13	0.34	4.31	0.22
2011	2,925	5.65	0.34	4.58	0.30	5.69	0.35	4.60	0.29
2012	2,825	5.36	0.34	4.31	0.30	5.30	0.36	4.40	0.30
2013	2,709	5.22	0.29	4.04	0.33	5.23	0.30	4.09	0.32

gross profit/asset (GP/A) of both the top 30% group and the bottom 30% group are shown in Table 1.

Overall, stocks with the 30% highest price-to-52-week-high ratios have significantly higher

average *F*-Scores but not higher average profitability than stocks with the 30% lowest price-to-52-week-high ratios; the average yearly *F*-Score difference is 0.79 [$t=4.52$] and the average yearly GP/A difference is 0.01 [$t=0.98$]. When the position-off-52-week-lows are used in defined

winning and losing stocks, both the average F -Score and GP/A differences are positive and statistically significant; the average yearly F -Score difference is 0.76 [$t = 4.36$] and the average yearly GP/A difference is 0.05 [$t = 4.46$].

As most companies report their fourth quarter and full fiscal year performance in the first quarter of a new year, we start all strategies in this study at the end of March, 1980, and rebalance portfolios in March and September according to each strategy's holding period length, either 6 months or 12 months. Stocks in each portfolio are equally weighted. Following traditional practice, portfolios formed with common stocks with the lowest 30% momentum are the losing portfolios, while portfolios formed with common stocks with the highest 30% momentum are the winning portfolios. Therefore, at the beginning of each month t , the strategy buys the winning portfolio and sells the losing portfolio and holds the position for 6 or 12 months.

We first examine the average monthly raw returns and excess returns from April 1980 to September 2013. Monthly returns of each portfolio are compared with the CRSP equal-weighted returns.

$$ER_{j,t} = R_{j,t} - R_{m,t} \quad (1)$$

where $ER_{j,t}$ = excess return for portfolio j in month t , $R_{j,t}$ = raw return monthly for portfolio j in month t , and $R_{m,t}$ = the CRSP equal-weighted return in month t . Monthly returns of the long and short portfolios and their differences are averaged over the entire period and tested for statistical significance. Significant returns of these strategies would support the predictability of future stock returns.

In the risk-adjusted return analysis, we investigate whether the behavior of returns on portfolios can be explained by factors related to beta, size, and book-to-market. This is done in the context of a single-index market model and the

Fama–French (1993) three-factor model, which incorporates factors including the market risk premium (MKTRF), the size premium (SMB), and value premium (HML).

$$R_{p,t} - RF_t = \alpha_p + \beta_p(MKTRF) + \varepsilon_{p,t} \quad (2)$$

$$R_{p,t} - RF_t = \alpha_p + \beta_p(MKTRF)_t + \lambda_p(SMB)_t + \gamma_p(HML)_t + \varepsilon_{p,t} \quad (3)$$

Monthly stock returns and returns of the CRSP equal-weighted index are obtained from the CRSP database and time series of the three risk factors and the risk-free rate are obtained from Dr. Ken French's online data library at Dartmouth College.

The risk-adjusted returns are estimated as the intercepts from the model regressions. The null hypotheses are that the intercept terms in Equations (2) and (3), α_p , are not significantly different from zero.

4 Empirical results

In the first set of empirical analyses, we start by assigning qualified stocks to three (30% highest, 40%, 30% lowest) portfolios based on the price-to-52-week-high (or P/52WH) ratios and rebalancing portfolios every six months beginning from 3/31/1980. Stocks in the highest (lowest) portfolio are further divided into three portfolios (30% highest, 40%, 30% lowest) based on the fundamental score (F -Score) or the gross-profit-to-asset ratio (GP/A). Stocks in each portfolio are equally weighted. Monthly portfolio returns are compared with returns of the CRSP EW Portfolio and adjusted for risk using the market model and the three-factor Fama–French model. t -Statistics are used in testing coefficients' statistical significance. Results are presented in Table 2.

Table 2 Analysis of performance impact of *F*-Score and GP/A on price momentum strategy based on the price-to-52-week-high ratio (six-month holding) (4/1980–9/2013).

Strategy	Return		Market model		Fama–French three-factor model			
	Raw	Excess	Alpha	β (MKTRF)	Alpha	β (MKTRF)	λ (SML)	γ (HML)
Panel A: Original Price-to-52-Week-High (P/52WH) Strategy								
High P/52WH	0.0147	0.0029	0.0052	0.8656	0.0038	0.8483	0.4662	0.2304
	6.76	2.19	5.33	40.47	5.41	52.29	19.65	9.40
Low P/52WH	0.0078	−0.0040	−0.0051	1.3957	−0.0069	1.2826	1.0670	0.2146
	2.01	−2.65	−2.23	27.57	−3.98	31.76	18.07	3.52
High P/52WH vs Low P/52WH	0.0069	−0.0049	0.0064	−0.5274	0.0068	−0.4331	−0.5955	0.0124
	2.66	−1.01	2.76	−10.38	3.11	−8.59	−8.08	0.16
Panel B: Within 30% Highest Price-to-52-Week-High Portfolio								
High <i>F</i> -Score	0.0149	0.0030	0.0054	0.8598	0.0042	0.8393	0.4240	0.1894
	6.85	2.20	5.50	40.20	5.46	47.41	16.38	7.09
Low <i>F</i> -Score	0.0136	0.0018	0.0044	0.8180	0.0028	0.8018	0.4996	0.2568
	6.42	1.29	4.15	35.43	3.71	45.64	19.45	9.68
High <i>F</i> -Score vs Low <i>F</i> -Score	0.0013	−0.0106	−0.0030	0.0445	−0.0026	0.0386	−0.0702	−0.0708
	1.89	−3.88	−4.45	3.05	−3.88	2.50	−3.11	−3.03
High GP/A	0.0164	0.0045	0.0060	0.9946	0.0055	0.9107	0.5810	0.0219
	6.45	3.47	5.02	38.00	6.53	46.93	20.47	0.75
Low GP/A	0.0133	0.0014	0.0046	0.7301	0.0025	0.7570	0.4009	0.3757
	6.64	0.87	4.05	29.36	2.80	35.87	12.99	11.79
High GP/A vs Low GP/A	0.0031	−0.0087	−0.0026	0.2672	−0.0010	0.1547	0.1855	−0.3572
	2.37	−3.75	−2.17	10.31	−1.02	6.64	5.45	−10.16
Panel C: Within 30% Lowest Price-to-52-Week-High Portfolio								
High <i>F</i> -Score	0.0106	−0.0012	−0.0020	1.3325	−0.0035	1.2396	0.8952	0.1888
	2.96	−0.93	−0.99	30.70	−2.31	35.18	17.38	3.55
Low <i>F</i> -Score	0.0050	−0.0068	−0.0081	1.4111	−0.0101	1.2868	1.1868	0.2453
	1.21	−3.84	−3.05	24.25	−4.92	27.02	17.04	3.41
High <i>F</i> -Score vs Low <i>F</i> -Score	0.0056	−0.0062	0.0022	−0.0759	0.0027	−0.0461	−0.2862	−0.0599
	4.30	−1.82	1.65	−2.64	2.10	−1.57	−6.67	−1.35

Qualified stocks are assigned to three (30% highest, 40%, 30% lowest) portfolios based on the price/52-week high ratio (P/52WH) and rebalanced every six months beginning from 3/31/1980. Stocks in the highest (lowest) portfolio are further divided into three portfolios (30% highest, 40%, 30% lowest) based on the fundamental score or the gross profit/asset ratio (GP/A). Stocks in each portfolio are equally weighted. Monthly portfolio returns are compared with returns of the CRSP EW Portfolio and adjusted for risks using the market model and the three-factor Fama–French model. *t*-Statistics are in the 2nd rows.

Table 2 (Continued)

Strategy	Return		Market model		Fama–French three-factor model			
	Raw	Excess	Alpha	β (MKTRF)	Alpha	β (MKTRF)	λ (SML)	γ (HML)
High GP/A	0.0100	−0.0018	−0.0031	1.4153	−0.0039	1.2581	1.0321	0.0046
	2.54	−1.10	−1.34	27.81	−2.21	30.85	17.31	0.08
Low GP/A	0.0032	−0.0086	−0.0098	1.4078	−0.0119	1.2979	1.1248	0.2662
	0.78	−4.71	−3.74	24.44	−5.68	26.69	15.82	3.63
High GP/A vs Low GP/A	0.0068	−0.0051	0.0028	0.0102	0.0041	−0.0387	−0.0872	−0.2649
	4.53	−1.58	1.81	0.31	2.70	−1.11	−1.71	−5.03
Panel D: High/High versus Low/Low Strategy								
(P/52WH)/ <i>F</i> -Score	0.0099	−0.0019	0.0095	−0.5486	0.0103	−0.4464	−0.7574	−0.0593
High/High vs Low/Low	3.36	−0.37	3.54	−9.34	4.17	−7.76	−9.01	−0.68
(P/52WH)/(GP/A)	0.0131	0.0013	0.0119	−0.4105	0.0134	−0.3862	−0.5384	−0.2477
High/High vs Low/Low	4.80	0.27	4.57	−7.22	5.34	−6.63	−6.32	−2.81

In the column of raw returns, stocks with superior price momentum or gross profitability outperform stocks with lower price momentum or fundamentals in Panels A, B, and C (0.69% [$t = 2.66$], 0.13% [1.89] for *F*-Score and 0.31% [2.37] for GP/A, and 0.56% [4.30] for *F*-Score and 0.68% [4.53] for GP/A). Using GP/A as the second screen appears to generate better returns than using *F*-Score, as seen in both Panel B (among 30% highest price-to-52-week-high stocks) and Panel C (among 30% lowest price-to-52-week-high stocks).

In the column of excess returns (versus the CRSP EW Portfolio) for long-only strategies (the first and the second in Panel A), stocks with better (poorer) price momentum continue to outperform (underperform) the market proxy in the six-month period after formation, as the former portfolio exhibits a monthly excess return of 0.29% (or 3.54% annually) and the latter portfolio shows

a monthly excess return of −0.40% (or −5.72% annually). The significantly positive (negative) excess return in Panel A is mainly due to stocks with superior (inferior) *F*-Score or GP/A as documented in Panel B (Panel C). For example, while the high GP/A stocks in Panel B result in an excess return of 0.45% [$t = 3.47$], their low GP/A counterparts in Panel B result in an excess return of only 0.14% [$t = 0.87$]. These observations also lead us to study two double-screen long–short strategies presented in Panel D, Table 2. It seems again using GP/A as the second screen generates more significant results than using *F*-Score as the second screen in both Panel B (among 30% highest price-to-52-week-high stocks) and Panel C (among 30% lowest price-to-52-week-high stocks).

In the section of the market model in Table 2, the signs of the estimated alpha coefficients and their *t*-statistics generally match with those in the

excess-return columns for the first and the second (or the fourth and the fifth) strategies in Panels A, B, and C. While the long–short strategy in Panel A, Table 2 (longing stocks with superior P/52WH and shorting stocks with inferior P/52WH) produces an alpha estimate of 0.64% [$t = 2.76$]. Alpha estimates for the two long–short strategies in Panel B (among 30% highest P/52WH stocks) are negative (–0.30% and –0.26%) and statistically different from zero, but alpha estimates for the two long–short strategies in Panel C (among 30% lowest P/52WH stocks) are positive (0.22% and 0.28%) but with smaller statistical significance once adjusted for the market risk.

In the section of the three-factor Fama–French model in Table 2, estimated alpha and beta coefficients generally match with those from market models in Panels A, B, and C. Stocks with poorer price momentum or fundamentals (both F -Score and GP/A) are found to be more exposed to both the small-firm risk and the valuation risk than stocks with superior measures as the estimated coefficients of small-minus-large (SML) risk and high-minus-low (HML) are generally higher for stocks with poorer price momentum or fundamentals. For example, the coefficients of SML and HML for the low GP/A group in Panel C, Table 2, are 1.1248 and 0.2662, higher than the coefficients 1.0321 and 0.0046 for the high GP/A group in Panel C, Table 2.

Panel D in Table 2 presents the results based on two special double-screen long–short strategies differed by the second screen they adopt. Overall, the GP/A ratio outperforms the F -Score as the second screen because it has both higher raw returns (1.31% vs. 0.99%) and alpha estimates (1.19% vs. 0.95%, or 1.34% vs. 1.03%). One plausible explanation for the lower effectiveness of the F -Score as a second screen is due to the inclusion of more than 30% of stocks in the so-called 30% highest portfolio and the 30% lowest

portfolio because of F -Score’s discreteness (an integer between 0 and 8).

Overall, our results provide support to the hypothesis that fundamental analysis like the gross-profit-to-asset ratio can enhance the performance of a trading strategy based on public information like the price-to-52-week-high ratios.

In our second empirical analysis, we first assign stocks in the sample to three (30% highest, 40%, 30% lowest) portfolios based on the position-off-52-week-low (or (P-52WL)/(52WH–52WL)) ratios and rebalance portfolios every six months beginning from 3/31/1980. Stocks in the highest (lowest) portfolio are further divided into three portfolios (30% highest, 40%, 30% lowest) based on the gross profit/asset ratio (GP/A). Stocks in each portfolio are equally weighted. Monthly portfolio returns are compared with returns of the CRSPEW Portfolio and adjusted for risk using the market model and the three-factor Fama–French model. t -Statistics are used in testing coefficients’ statistical significance. Results are in Table 3.

In the column of raw returns, stocks with superior price momentum or gross profitability outperform stocks with lower price momentum or gross profitability in Panels A, B, and C (0.75% [$t = 3.52$], 0.32% [2.35], and 0.63% [4.77]). In the column of excess returns (versus the CRSP EW Portfolio) for long-only strategies (the first and the second in Panel A), stocks with better (poorer) price momentum continue to outperform (underperform) the market proxy in the six-month period after formation, as the former portfolio exhibits a monthly excess return of 0.39% and the latter portfolio shows a monthly excess return of –0.36%. The significantly positive (negative) excess return in Panel A is mainly due to stocks with superior (inferior) GP/A as documented in Panel B (Panel C). For example, while the high GP/A stocks in Panel B result in an excess return

Table 3 Analysis of performance impact of gross profitability on price momentum strategy based on the position-off-52-week-low measure (six-month holding) (4/1980–9/2013).

Strategy	Return		Market Model		Fama–French three-factor model			
	Raw	Excess	Alpha	β (MKTRF)	Alpha	β (MKTRF)	λ (SML)	γ (HML)
Panel A: Original Position-off-52-Week-Low (Position-off-Low) Strategy								
High Position-off-Low	0.0157 6.35	0.0039 3.22	0.0055 4.86	0.9810 39.80	0.0043 6.07	0.9235 56.03	0.6074 25.20	0.1513 6.08
Low Position-off-Low	0.0082 2.42	−0.0036 −2.89	−0.0037 −1.84	1.2282 28.06	−0.0058 −3.58	1.1815 31.28	0.8158 14.77	0.3334 5.84
High Position-off-Low vs. Low Position-off-Low	0.0075 3.52	−0.0043 −1.04	0.0052 2.49	−0.2444 −5.36	0.0062 2.97	−0.2569 −5.31	−0.2030 −2.87	−0.1854 −2.54
Panel B: Within 30% Highest off-52-Week-Low Strategy								
High GP/A	0.0175 6.21	0.0057 4.32	0.0065 4.80	1.1013 37.36	0.0063 7.43	0.9795 49.56	0.6759 23.38	−0.0769 −2.58
Low GP/A	0.0143 6.24	0.0025 1.65	0.0049 3.83	0.8470 29.99	0.0031 3.17	0.8299 36.13	0.5646 16.81	0.2954 8.52
High GP/A vs Low GP/A	0.0032 2.35	−0.0086 −3.62	−0.0024 −1.95	0.2570 9.42	−0.0008 −0.68	0.1507 5.91	0.1167 3.13	−0.3757 −9.75
Panel C: Within 30% Lowest off-52-Week-Low Strategy								
High GP/A	0.0106 2.99	−0.0012 −0.86	−0.0016 −0.74	1.2689 27.26	−0.0028 −1.60	1.1637 29.01	0.8698 14.83	0.1200 1.98
Low GP/A	0.0043 1.23	−0.0076 −5.13	−0.0074 −3.38	1.1933 24.85	−0.0099 −5.27	1.1719 26.81	0.7812 12.22	0.4184 6.34
High GP/A vs Low GP/A	0.0063 4.77	−0.0055 −1.92	0.0019 1.40	0.0783 2.65	0.0032 2.53	−0.0071 −0.24	0.0940 2.17	−0.3017 −6.75
Panel D: High/High versus Low/Low Strategy								
Position-off-Low/(GP/A)	0.0133	0.0014	0.0099	−0.0893	0.0123	−0.1913	−0.0999	−0.4987
High/High vs Low/Low	5.66	0.36	4.20	−1.73	5.38	−3.60	−1.29	−6.21

Qualified stocks are assigned to three (30% highest, 40%, 30% lowest) portfolios based on the position-off-52-week-low ratio ((P-52WL)/(52WH-52WL)) and rebalanced every six months starting from 3/31/1980. Stocks in the highest (lowest) portfolio are further divided into three portfolios (30% highest, 40%, 30% lowest) based on the gross profit/asset ratio (GP/A). Stocks in each portfolio are equally weighted. Monthly portfolio returns are compared with returns of the CRSP EW Portfolio and adjusted for risks using the market model and the three-factor Fama–French model. *t*-Statistics are in the 2nd rows.

of 0.57% [$t = 4.32$], their low GP/A counterparts in Panel B result in an excess return of only 0.25% [$t = 1.65$]. These observations also lead us to study the double-screen long–short strategies presented in Panel D, Table 3.

In the section of the market model in Table 2, the signs of the estimated alpha coefficients and their t -statistics generally match with those in the excess-return columns for the first and the second strategies in Panels A, B, and C. While the long–short strategy in Panel A, Table 3 (longing stocks with superior position-off-low and shorting stocks with inferior position-off-low), produces an alpha estimate of 0.52% [$t = 2.49$], the alpha estimate for the long–short strategy in Panel B (among 30% highest position-off-low stocks) is negative (–0.24%) and statistically different from zero, but alpha estimate for the long–short strategy in Panel C (among 30% lowest position-off-low) is positive (0.19%) but with smaller statistical significance once adjusted for the market risk.

In the section of the three-factor Fama–French model in Table 3, estimated alpha and beta coefficients generally match with those from market models in Panels A, B, and C. Stocks with poorer price momentum or GP/A are found to be more exposed to the valuation risk than stocks with superior measures as the estimated coefficients of high-minus-low (HML) are generally higher for stocks with poorer price momentum or fundamentals. The same conclusion does not apply to the small-to-large (SML) risk regarding the GP/A ratio. For example, the coefficients of SML and HML for the low GP/A group in Panel C, Table 3, are 0.7812 and 0.4184 and are 0.8698 and 0.1200 for the high GP/A group in Panel C, Table 3.

Panel D in Table 3 presents the results based on the special double-screen long–short strategy, longing stocks with the 30% highest gross profitability

among stocks with the 30% highest position-off-52-week-low and shorting stocks with the 30% lowest gross profitability among stocks with the 30% lowest position-off-52-week-low. The raw return of 1.33% ($t = 5.66$) and the risk-adjusted returns or alpha estimates of 0.99% ($t = 4.20$) and 1.23% ($t = 5.38$), while other estimated coefficients in both the market model and the three-factor Fama–French model are negative with various levels of statistical significance.

As in the analysis from Table 2, these results also provide support to the hypothesis that fundamental analysis based on the gross-profit-to-asset ratios can enhance the performance of a trading strategy based on public information like the position-off-52-week-low.

As a robustness test, we repeat our analysis by extending our analysis of six-month holding periods to 12 months. We rebalance portfolios at the end of each March between 1980 and 2013. Results are presented in Table 4.

In the column of raw returns, stocks with superior price momentum or gross profitability outperform stocks with lower price momentum or gross profitability in Panels A, B, and C (0.44% [$t = 1.86$], 0.18% [1.34], and 0.58% [$t = 3.64$]). It seems the gross profitability screen has greater ability in distinguishing future returns of stocks in the 30% lowest price-to-52-week-high space than in the 30% highest price-to-52-week-high space.

In the column of excess returns (versus the CRSP EW Portfolio) for long-only strategies (the first and the second in Panels A, B, and C), three out of these six strategies beat the market proxy significantly. They consist of the original strategy of the 30% highest P/52WH portfolio in Panel A (0.23%, $t = 1.91$), the high price-to-52-week-high/high gross profitability strategy in Panel B (0.33%, $t = 2.61$) and the low price-to-52-week-high/low gross profitability strategy in Panel C

Table 4 Analysis of performance impact of gross profitability measure on price momentum strategy based on the price-to-52-week-high ratio (12-month holding) (4/1980–9/2013).

Strategy	Return		Market model		Fama–French three-factor model			
	Raw	Excess	Alpha	β (MKTRF)	Alpha	β (MKTRF)	λ (SML)	γ (HML)
Panel A: Original Price-to-52-Week-High (P/52WH) Strategy								
High P/52WH	0.0141	0.0023	0.0043	0.9147	0.0031	0.8901	0.4296	0.1757
	6.27	1.91	4.70	45.83	4.69	57.28	18.91	7.49
Low P/52WH	0.0097	−0.0021	−0.0031	1.3681	−0.0052	1.2621	1.1322	0.2878
	2.54	−1.47	−1.33	27.09	−3.19	33.11	20.31	5.00
High P/52WH vs Low P/52WH	0.0044	−0.0074	0.0034	−0.4507	0.0044	−0.3709	−0.6972	−0.1154
	1.86	−1.59	1.57	−9.54	2.30	−8.27	−10.63	−1.70
Panel B: Within 30% Highest Price-to-52-Week-High Portfolio								
High GP/A	0.0151	0.0033	0.0045	1.0334	0.0042	0.9497	0.5115	−0.0224
	5.80	2.61	3.85	40.46	4.79	46.42	17.10	−0.72
Low GP/A	0.0133	0.0015	0.0044	0.7672	0.0026	0.7905	0.3455	0.3243
	6.55	0.94	4.12	32.79	2.93	38.00	11.36	10.32
High GP/A vs low GP/A	0.0018	−0.0100	−0.0039	0.2689	−0.0024	0.1602	0.1714	−0.3501
	1.34	−4.28	−3.15	10.00	−2.19	6.44	4.71	−9.32
Panel C: Within 30% Lowest Price-to-52-Week-High Portfolio								
High GP/A	0.0118	0.0000	−0.0010	1.3834	−0.0023	1.2349	1.1256	0.1023
	3.04	0.01	−0.44	26.71	−1.37	31.11	19.39	1.71
Low GP/A	0.0060	−0.0058	−0.0069	1.3863	−0.0093	1.2693	1.2511	0.3181
	1.46	−3.10	−2.52	23.22	−4.49	26.48	17.85	4.40
High GP/A vs low GP/A	0.0058	−0.0060	0.0019	−0.0001	0.0030	−0.0333	−0.1201	−0.2192
	3.64	−1.84	1.15	0.00	1.84	−0.88	−2.17	−3.84
Panel D: High/High versus Low/Low Strategy								
(P/52WH)/ (GP/A)	0.0091	−0.0027	0.0074	−0.3502	0.0096	−0.3185	−0.7342	−0.3439
High/High vs Low/Low	3.37	−0.57	2.86	−6.16	3.99	−5.72	−9.02	−4.09

Qualified stocks are assigned to three (30% highest, 40%, 30% lowest) portfolios based on the price/52-week high ratio (P/52WH) and rebalanced every 12 months beginning from 3/31/1980. Stocks in the highest (lowest) portfolio are further divided into three portfolios (30% highest, 40%, 30% lowest) based on the gross profit/asset ratio (GP/A). Stocks in each portfolio are equally weighted. Monthly portfolio returns are compared with returns of the CRSP EW Portfolio and adjusted for risks using the market model and the three-factor Fama–French model. *t*-Statistics are in the 2nd rows.

(-0.58% , $t = -3.10$). Panel D presents the result of a long–short strategy buying the high/high portfolio in Panel B and selling short the low/low portfolio in Panel C.

In the section of the market model in Table 4, the signs of the estimated alpha coefficients and their t -statistics generally match with those in the excess-return columns for the first and the second strategies in Panels A, B, and C, except for the second strategy in Panel B (high price-to-52-week-high/low gross profitability) having a 0.44% with a t -statistic of 4.12 . While the long–short strategy in Panel B results in a negative and significant alpha estimate of -0.39% [$t = -3.15$], the long–short strategy in Panel C only results in an insignificant alpha estimate of 0.19% [$t = 1.15$]. This supports the null hypothesis that strategies using public information like the price-to-52-week-high ratio and the gross-profit-to-asset ratio should not generate significantly positive returns after risk adjustment.

In the section of the three-factor Fama–French model in Table 4, estimated alpha and beta coefficients generally match with those from market models in Panels A, B, and C. The estimated coefficient of small-minus-large (SML) of the long–short strategy (the third strategy) shifts from -0.6972 in Panel A (original price-to-52-week high strategy) to 0.1714 in Panel B and -0.1201 in Panel C, when gross profitability is used as the second screen in addition to the original price-to-52-week-high ratio screen. All three coefficients are statistically different from zero. The estimated coefficient of high-minus-low (HML) of the long–short strategy shifts lower from a significant -0.1154 in Panel A to significant -0.3501 in Panel B and -0.2192 in Panel C.

Panel D of Table 4 presents the results based on a special double screen long–short strategy, longing stocks with the 30% highest gross profitability among stocks with the 30% highest P/52WH

ratios and shorting stocks with the 30% lowest gross profitability among stocks with the 30% lowest P/52WH ratios. The raw return (0.91%) and the risk-adjusted returns (0.74% and 0.96%) are positive with statistical significance, while other estimated coefficients in both the market model and the three-factor Fama–French model are negative and statistically different from zero. This provides additional support to the notion that fundamental analysis like the gross-profit-to-asset ratios can enhance the performance of a trading strategy based on public information like the price-to-52-week-high ratios.

To test the robustness of trading strategies combining both price momentum and fundamental analysis screens, we also switch the order and use the gross profitability as our initial screen and the price-to-52-week-high as the second screen.

Performance impact of the price-to-52-week-high ratio on a fundamental strategy based on the gross-profit-to-asset ratio is summarized in Table 5. In the column of raw returns, stocks with superior price momentum or gross profitability outperform stocks with lower price momentum or gross profitability in all four Panels (0.40% , 0.65% , 0.95% , and 1.30%) with high t -statistics (no less than 2.75) and the original gross profitability strategy in Panel A ranked the lowest. In the column of excess returns (versus the CRSP EW Portfolio) the excess returns are positive (negative) in Panels A, B, and C for the first (second) strategy consisting of stocks with superior (lower) price momentum or gross profitability. The most significant two strategies are the 0.46% [$t = 3.50$] of the high gross profitability/high price-to-52-week-high strategy in Panel B and the -0.84% [$t = -4.67$] of the low gross profitability/low price-to-52-week-high strategy in Panel C. Panel D presents the result of a long–short strategy buying the high/high portfolio in

Table 5 Analysis of performance impact of price momentum measures on gross profitability strategy based on the gross profit/asset ratio (GP/A) (six-month holding) (4/1980–9/2013).

Strategy	Return		Market model		Fama–French three-factor model			
	Raw	Excess	Alpha	β (MKTRF)	Alpha	β (MKTRF)	γ (SML)	λ (HML)
Panel A: Original Gross Profit/Asset Ratio (GP/A) Strategy								
High GP/A	0.0138	0.0020	0.0023	1.1756	0.0016	1.0623	0.7734	0.0226
	4.64	2.24	1.66	38.57	2.08	58.18	28.97	0.82
Low GP/A	0.0099	−0.0019	−0.0005	0.9879	−0.0027	0.9712	0.6790	0.3716
	3.86	−2.27	−0.35	35.36	−3.47	53.98	25.81	13.68
High GP/A minus Low GP/A	0.0040	−0.0079	−0.0012	0.1904	0.0004	0.0922	0.0998	−0.3524
	3.48	−3.15	−1.10	7.96	0.40	4.20	3.11	−10.64
Panel B: Within 30% Highest Gross Profit/Asset Ratio Portfolio								
High P/52WH	0.0164	0.0046	0.0060	1.0006	0.0056	0.9111	0.5723	−0.0071
	6.44	3.50	5.03	38.29	6.72	46.99	20.18	−0.24
Low P/52WH	0.0099	−0.0019	−0.0032	1.4139	−0.0038	1.2483	1.0506	−0.0191
	2.51	−1.11	−1.33	27.26	−2.15	30.14	17.35	−0.31
High P/52WH vs Low P/52WH	0.0065	−0.0053	0.0052	−0.4106	0.0055	−0.3361	−0.4729	0.0086
	2.75	−1.18	2.39	−8.62	2.64	−6.94	−6.68	0.12
Panel C: Within 30% Lowest Gross Profit/Asset Ratio Portfolio								
High P/52WH	0.0130	0.0011	0.0045	0.7015	0.0024	0.7324	0.3856	0.3827
	6.70	0.67	4.01	28.60	2.69	35.22	12.68	12.19
Low P/52WH	0.0034	−0.0084	−0.0095	1.3959	−0.0116	1.2849	1.1331	0.2668
	0.85	−4.67	−3.66	24.49	−5.66	27.02	16.30	3.72
High P/52WH vs Low P/52WH	0.0095	−0.0023	0.0100	−0.6917	0.0101	−0.5514	−0.7421	0.1125
	3.06	−0.43	3.71	−11.67	4.05	−9.58	−8.82	1.29
Panel D: High/High versus Low/Low Combination Strategy								
(GP/A)/(P/52WH)	0.0130	0.0011	0.0116	−0.3926	0.0133	−0.3727	−0.5555	−0.2772
High/High vs Low/Low	4.82	0.24	4.52	−7.00	5.38	−6.52	−6.64	−3.21

Qualified stocks are assigned to three (30% highest, 40%, 30% lowest) portfolios based on the gross profit/asset ratio (GP/A) and rebalanced every six months beginning from 3/31/1980. Stocks in the highest (lowest) portfolio are further divided into three portfolios (30% highest, 40%, 30% lowest) based on the price/52-week high ratio (P/52WH). Stocks in each portfolio are equally weighted. Monthly portfolio returns are compared with returns of the CRSP EW Portfolio and adjusted for risks using the market model and the three-factor Fama–French model. *t*-Statistics are in the 2nd rows.

Panel B and selling short the low/low portfolio in Panel C.

In the section of the market model in Table 5, estimated alpha coefficients are generally positive (negative) for the first (the second) strategy in Panels A, B, and C, using stocks with superior (poorer) gross profitability or price-to-52-week-high ratios. Interestingly, while the long–short strategy in Panel A (longing stocks with superior gross profitability and shorting stocks with inferior gross profitability) produce an insignificant but negative alpha (-0.12%), both long–short strategies in Panels B and C, using double screens, produce positive and statistically significant estimated alphas (0.52% and 1.00%) and negative and statistically significant estimated betas (-0.4106 and -0.6917). This rejects the null hypothesis that strategies using public information like the price-to-52-week-high ratio and the gross-profit-to-asset ratio should not generate significantly positive returns after risk adjustment.

In the section of the three-factor Fama–French model in Table 5, estimated alpha and beta coefficients generally match with those from the market model in Panels A, B, and C. The estimated coefficient of small-minus-large (SML) of the long–short strategy (the third strategy) shifts from 0.0998 in Panel A (original gross profitability strategy) to -0.4729 in Panel B and -0.7421 in Panel C, when price-to-52-week-high ratio is used as the second screen in addition to the original gross profitability screen. All three coefficients are statistically different from zero. The estimated coefficient of high-minus-low (HML) of the long–short strategy shifts from a significant -0.3524 in Panel A to insignificant 0.0086 in Panel B and 0.1125 in Panel C. Once again, while the alpha of the long–short strategy in Panel A is not statistically different from zero (0.04% and $t = 0.40$), similar alphas in Panels B and C are positive and

statistically different from zero. This further supports the potential for using public information such as the price-to-52-week-high ratio and the gross-profit-to-asset ratio.

Panel D in Table 5 presents the results based on a special double screen long–short strategy, longing stocks with the 30% highest P/52WH ratios among stocks with the 30% highest gross profitability and shorting stocks with the 30% lowest P/52WH ratios among stocks with the 30% lowest gross profitability. The raw return (1.30%) and the risk-adjusted returns (1.16% and 1.33%) are positive with statistical significance, while other estimated coefficients in both the market model and the three-factor Fama–French model are negative and statistically different from zero. This provides additional support to the notion that public information like the price-to-52-week-high ratios can enhance the performance of a trading strategy based on fundamental analysis like the gross-profit-to-asset ratios.

5 Summary and conclusions

In this study, we test whether either of two fundamental financial measures can result in improved performance of price-based momentum strategies. We apply the financial strength and gross profitability screens to both recent winning and losing stocks, defined as the price-to-52-week-high or the position-to-52-week-low. We first compare the profitability of a strategy based on our new measure of momentum with the profitability of the price-to-52-week-high strategy. Second, we test whether the application of the financial strength and profitability using only accounting information can help predict stock returns of both recent winning and losing stocks.

Overall, we find that momentum strategies based on the position-off-52-week-low are as profitable as the momentum strategies based on the price-to-52-week-high ratio. Using gross profitability as a

second screen is slightly more effective than using the eight-factor composite financial strength score as both winning and losing portfolios are assigned more than 30% of the sample stocks due to tied scores. We also find that adding either the financial strength factor or gross profitability as a second screening mechanism improves the performance of a long–short price-based momentum strategy, and vice versa.

The significance of our results is that they suggest that by adding the financial strength factor or gross profitability as a second screen improves the performance of a long–short price-based momentum strategy. This supports the hypothesis that fundamental financial information can be used by investors to improve portfolio performance over what is possible based on price momentum strategies alone.

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