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Does revenue momentum drive or ride earnings or price momentum? ☆

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ABSTRACT

This paper examines the profits of revenue, earnings, and price momentum strategies in an attempt to understand investor reactions when facing multiple information of firm performance in various scenarios. We first offer evidence that there is no dominating momentum strategy among the revenue, earnings, and price momentums, suggesting that revenue surprises, earnings surprises, and prior returns each carry some exclusive unpriced information content. We next show that the profits of momentum driven by firm fundamental performance information (revenue or earnings) depend upon the accompanying firm market performance information (price), and vice versa. The robust monotonicity in multivariate momentum returns is consistent with the argument that the market does not only underestimate the individual information but also the joint implications of multiple information on firm performance, particularly when they point in the same direction. A three-way combined momentum strategy may offer monthly return as high as 1.44%. The information conveyed by revenue surprises and earnings surprises combined account for about 19% of price momentum effects, which finding adds to the large literature on tracing the sources of price momentum.

1. Introduction

Financial economists have long been puzzled by two robust and persistent anomalies in the stock market: price momentum (see Jegadeesh and Titman, 1993, 2001; Rouwenhorst, 1998), and post-earnings-announcement drift (see Ball and Brown, 1968; Foster et al., 1984; Bernard and Thomas, 1989; Chan et al., 1996). More recently, Jegadeesh and Livnat (2006b) also find that price reactions to revenue surprises on announcement dates only partially reflect the incremental information conveyed by the surprises. The information contents carried by revenue, earnings and stock prices are intrinsically linked through firm operations and investor evaluation, and there is evidence of mutual predictability for respective future values (e.g., see Jegadeesh and Livnat, 2006b). Nonetheless, investors, aware of the linkages among the information content conveyed by revenue, earnings and prices (see Ertimur et al., 2003; Raedy et al., 2006; Heston and Sadka, 2008), may still fail to take full account of their joint implications when pricing the stocks.

This paper investigates how investors price securities when facing multiple information contents of a firm, particularly those firm performance information that are most accessible for investors – price, earnings, and revenue.[1] The long-short strategy of momentums, widely used in the literature, provides a venue to detect market reactions toward individual and multiple information contents. Accordingly, this study will start with documenting the

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[1] Researches in the literature offer some evidence on the information linkage among revenue, earnings and prices. For example, Lee and Zumwalt (1981) find that revenue information is complementary to earnings information in security rate of return determination. Bagnoli et al. (2001) find that revenue surprises but not earnings surprises can explain stock prices both during and after the internet bubble. Swaminathan and Weintrop (1991) and Ertimur et al. (2003) suggest that the market reacts significantly more strongly to revenue surprises than to expenses surprises. Rees and Sivaramakrishnan (2001) and Jegadeesh and Livnat (2006b) also find that, conditional on earnings surprises, there is still a certain extent of market reaction to the information conveyed by revenue surprises. Ghosh et al. (2005) find that sustained increases in earnings are supported by sustained increases in revenues rather than by cost reductions.

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revenue momentum profits and re-confirming the earnings and price momentums profits. Explorations with momentum strategies expect to yield implications that answer our two research questions. First, among the performance information of revenue surprises, earnings surprises, and prior returns, does each carry some exclusive information content that is not priced by the market? Second, do investors mis-react toward the joint implications as well as individual information of firm revenue, earnings, and price?

Our first research question is explored by testing momentum dominance. One momentum strategy is said to be dominated if its payoffs can be fully captured by the information measure serving as the sorting criterion of another momentum strategy. Note that our emphasis here is not asset pricing tests; instead, as in Chan et al. (1996) and Heston and Sadka (2008), we focus on the return both a pairwise nested comparison and a regression analysis indicate that revenue surprises, earnings surprises, and prior returns each lead to significant momentum returns that cannot be explained away by one another. That is, revenue momentum neither drives nor rides earnings or price momentum. Following the information diffusion hypothesis of Hong and Stein (1999), our evidence then suggests that revenue surprises, earnings surprises, and prior returns each contribute to the phenomenon of gradual information flow, or that each have some exclusive information content that is not priced by the market.[2] Further regression tests indicate that earnings surprise and revenue surprise information each accounts for about 14% and 10% of price momentum returns, and that these two fundamental performance information combined account for just about 19% of price momentum effects. These results provide additional evidence in the literature on the sources of price momentum (e.g., see Moskowitz and Grinblatt, 1999; Lee and Swaminathan, 2000; Piotroski, 2000; Grundy and Martin, 2001; Chordia and Shivakumar, 2002; Chordia and Shivakumar, 2005; Ahn et al., 2003; Griffin et al., 2003; Bulkley and Nawosah, 2009; Chui et al., 2010; Novy-Marx, 2012).

Our second research question inquires how the market reacts to the joint implications of multiple information measures. The three measures under our study all carry important messages on innovations in firm performance, and therefore expect to trigger investor reactions. They become ideal target to be studied to entail implications on how investors process multiple information interactively in pricing stocks. The results from two-way sorted portfolios find that the market anomalies vary monotonically with the joint condition of revenue surprises, earnings surprises, and prior returns, and anomalies tend to be strongest when stocks show the strongest signals in the same direction. The cross-contingencies of momentums are observed in that the momentum returns driven by *fundamental performance information* (revenue surprises or earnings surprises) change with the accompanying *market performance information* (prior returns), and vice versa. Such finding, as interpreted by the gradual-information-diffusion model, is consistent with the suggestion that the market not only underreacts to individual firm information but also underestimates the significance of the joint implications of revenue, earnings, and price information.[3] These results also have interesting implications for investment strategies that the fundamental performance information plays an important role in differentiating future returns among price winners, while the market performance information is particularly helpful in predicting future returns for stock with high surprises in revenue or earnings. Specifically, price winners, compared to price losers, yield higher returns from revenue/earnings momentum strategies; stock with greater surprises in fundamentals yield greater returns from price momentums.

The results of our dominance tests and multivariate momentum suggest that a combined momentum strategy should yield better results over single-criterion momentum strategies. A combined momentum strategy using all three performance measures is found to yield monthly returns as high as 1.44%, which amounts to an annual return of 17.28%. Such a combined momentum strategy outperforms single-criterion momentum strategies by at least 0.72 percentage points in monthly return. Our conclusions remain robust whether we use raw returns or risk-adjusted returns, whether we include January results or not, and whether we use dependent or independent sorts. Chan et al. (1996), Piotroski (2000), Griffin et al. (2005), Mohanram (2005), Sagi and Seasholes (2007), Asem (2009), and Asness et al. (2013) conduct similar tests on combined momentum strategies using alternative sorting criteria.[4] In comparison, our study is the first to document results considering these three firm performance information, revenue surprises, earnings surprises, and prior returns altogether.

In terms of persistency, the earnings momentum strategy is found to exhibit the strongest persistence, while the revenue momentum strategy is relatively short-lived. All the same, the short-lived revenue momentum effect is prolonged when the strategy is executed using stocks with the best prior price performance and more positive earnings surprises. In fact, the general conclusion supports our claim of cross-contingencies of momentum as applied to momentum persistence.

This study contributes to the finance literature in several respects. First, we specifically identify the profitability of revenue momentum and its relation with earnings surprises and prior returns in terms of momentum strength and persistence. A revenue momentum strategy executed with a 6-month formation period and 6-month holding-period strategy yields an average monthly return of 0.61% for the period between 1974 and 2009. Second, this study identifies empirical inter-relations of anomalies arising from three firm performance information – revenue, earnings and price. To the best of our knowledge, we are the first to offer evidence that there is no dominating momentum strategy among the three, and that the profits of momentum driven by firm fundamental performance information (revenue or earnings) depend upon the accompanying firm market performance information (price), and vice versa.[5] Third, aside from academic interest, the aforementioned findings may well serve as useful guidance for asset managers seeking profitable investment strategies. Fourth, this study also adds to the large literature attempting to trace the sources of price momentum. Our numbers indicate that the information conveyed by revenue

[2] The asset pricing tests of Chordia and Shivakumar (2006) support that price momentum is subsumed by the systematic component of earnings momentum, even though they also find earnings surprises and past returns have independent explanatory power for future returns. This latter finding is consistent with the results of Chan et al. (1996) and our results, as is reported later. In comparison, Chan et al. (1996) and Jegadeesh and Livnat (2006b), we focus on whether and how firm characteristics, such as revenue surprises, earnings surprises, and prior returns, are related to future cross-sectional returns, while Chordia and Shivakumar (2006) also conduct asset pricing tests.

[3] The firm performance measures, revenue, earnings, and stock price, do not only share common origins endogenously but also have added implications for future values of one another. Jegadeesh and Livnat (2006b) have documented evidence on the temporal linkages among these variables. In this paper, we focus on the further inquiry that whether investors fully exploit such temporal linkages among these firm performance information in pricing stocks.

[4] Chan et al. (1996) and Griffin et al. (2005) find that when sorting prior price performance and earnings surprises together, the profits of a zero-investment portfolio are higher than those of single sorting. Piotroski (2000) and Mohanram (2005) develop fundamental indicators, FSCORE and GSCORE, to separate winners from losers. Sagi and Seasholes (2007) find that price momentum strategy becomes even more profitable when applied to stocks with high revenue growth volatility, low costs, or valuable growth options. Asness et al. (2013) find that the combination of value strategy and momentum strategy can perform better than either one alone. Asem (2009) find the momentum profits can be enhanced combining prior price returns and dividend behaviors.

[5] Heston and Sadka (2008) and Novy-Marx (2012) also provide evidence that earnings surprises are unable to explain price momentum. However, this study is the first to consider earnings surprises and revenue surprises at the same time in explaining price momentum.

surprises and earnings surprises combined account for about 19% of price momentum effects. Last, our results offer additional evidence to the literature using the behavioral explanation for momentums.[6] Our empirical results are consistent with the suggestion that revenue surprises, earnings surprises, and prior returns each carry some exclusive unpriced information content. Moreover, the monotonicity of abnormal returns found in multivariate momentums suggests that the market does not only underestimate the individual information but also the joint implications of multiple information on firm performance. Such suggestion is new to the literature, and may also present a venue to track the sources of price momentum.

The paper is organized as follows. In Section 2, we develop our models and describe the methodologies. In Section 3, we describe the data. In Section 4, we report the results on momentum strategies based on a single criterion. In Section 5, we discuss the empirical results of exploration of inter-relations among revenue, earnings, and price momentums using strategies built on multiple sorting criteria. In Section 6, we test the persistency and seasonality of momentum strategies. Section 7 concludes.

2. Revenue, earnings, and price momentum strategies

2.1. Measures for earnings surprises and revenue surprises

We follow Jegadeesh and Livnat (2006a, 2006b) and measure revenue surprises and earnings surprises based on historical revenues and earnings.[7] Assuming that both quarterly revenue and quarterly earnings per share follow a seasonal random walk with a drift, we define the measure of revenue surprises for firm i in quarter t, standardized unexpected revenue growth (SURGE), as

$$SURGE_{i,t} = \frac{Q^R_{i,t} - E\left(Q^R_{i,t}\right)}{\sigma^R_{i,t}}, \quad (1)$$

where $Q^R_{i,t}$ is the quarterly revenue of firm i in quarter t, $E(Q^R_{i,t})$ is the expected quarterly revenue prior to earnings announcement, and $\sigma^R_{i,t}$ is the standard deviation of quarterly revenue growth.

The same method is applied to measure earnings surprises, specifically standardized unexpected earnings (SUE), defined as

$$SUE_{i,t} = \frac{Q^E_{i,t} - E\left(Q^E_{i,t}\right)}{\sigma^E_{i,t}}, \quad (2)$$

where $Q^E_{i,t}$ is the quarterly earnings per share from continuing operations, $E(Q^E_{i,t})$ is the expected quarterly earnings per share prior to earnings announcement, and $\sigma^E_{i,t}$ is the standard deviation of quarterly earnings growth.

2.2. Measuring the profitability of revenue, earnings, and price momentum strategies

We construct all three momentum strategies based on the approach suggested by Jegadeesh and Titman (1993). To evaluate the information effect of earnings surprises on stock returns, we form an earnings momentum strategy analogous to the one designed by Chordia and Shivakumar (2006). At the end of each month, we sort sample firms by SUE and then group the firms into ten deciles.[8] Decile 1 includes stocks with the most negative earnings surprises, and Decile 10 includes those with the most positive earnings surprises. The SUEs used in every formation month are obtained from the most recent earnings announcements, made within 3 months before the formation date.

We hold a zero-investment portfolio, long the most positive earnings surprises portfolio and short the most negative earnings surprises portfolio, for K (K = 3, 6, 9, and 12) subsequent months, not rebalancing the portfolios during the holding period. Such positive minus negative strategy (PMN) holds K different long-positive and short-negative portfolios each month. Accordingly, we obtain a series of zero-investment portfolio returns, which are the monthly returns to this earnings momentum strategy. Similarly, we apply this positive-minus-negative method to construct a revenue momentum strategy.

In the case of price momentum, we form a zero-investment portfolio each month by taking a long position in the top decile portfolio (winner) and a short position in the bottom decile portfolio (loser), and we hold this winner minus loser portfolio (WML) for subsequent K months. We thus obtain a series of zero-investment portfolio returns, i.e., the returns to the price momentum strategy.

3. Data and sample descriptions

3.1. Data

We collect from Compustat the firm basic information, earnings announcement dates, and firm accounting data. Stock prices, stock returns, share codes, and exchange codes come retrieved from the Center for Research in Security Prices (CRSP) files. The sample period is from 1974 through 2009. Only common stocks (SHRCD = 10, 11) and firms listed on New York Stock Exchange, American Stock Exchange, or Nasdaq (EXCE = 1, 2, 3, 31, 32, 33) are included in our sample. We exclude from the sample regulated industries (SIC = 4000–4999) and financial institutions (SIC = 6000–6999). We also exclude firms with stock prices below $5 on the formation date, considering that investors generally pay only limited attention to such stocks.

For the purpose of estimating their revenue surprises (SURGE), earnings surprises (SUE), and prior price performance, firms in the sample should have at least eight consecutive quarterly earnings announcements and six consecutive monthly returns before each formation month. To examine the return drift following the estimated SURGE, SUE, and prior price performance, firms in the sample need to have at least 12 consecutive monthly returns following each formation month. Firms in the sample should also have corresponding SURGE, SUE, size and book-to-market factors available in each formation month.

3.2. Sample descriptions

Table 1 presents the summary statistics for firm size, estimates of revenue surprises and estimates of earnings surprises for our sample firms between year 1974 and year 2009. Panel A shows that there are 223,831 firm-quarters during the sample period. Median firm market capitalization is $235 million. Panel B and Panel C describe the distributions the revenue surprises (SURGE) and the earnings surprises (SUE) across firms of different market

[6] Barberis et al. (1998), Daniel et al. (1998), Hong and Stein (1999), Jackson and Johnson (2006), Verardo (2009), and Moskowitz et al. (2012) provide evidence in support of behavioral explanation to momentum effect, while Grundy and Martin (2001), Johnson (2002), Ahn et al. (2003), Sagi and Seasholes (2007), Li et al. (2008), Liu and Zhang (2008), and Wang and Wu (2011) attribute momentum effect to missing risk factors. In addition, Korajczyk and Sadka (2004) and Lesmond et al. (2004) re-examine the profitability of momentum strategies after taking the transaction cost into account and get mixed results.

[7] See Appendix for a detailed discussion of measures to estimate revenue and earnings surprises.

[8] Note that we sort the sample firms into five quintile portfolios on each criterion in our later construction of multivariate momentum strategies. To conform to the same sorting break points, we also test the single momentum strategies based on quintile portfolios and find the results remain similar to those based on decile portfolios.

Table 1
Summary statistics of sample firm characteristics.

	Number of firm-quarters				Market cap (million dollars)				
					Mean	Median	Min		Max
Panel A: Sample size and firm market capitalization									
ALL	223,831				2276	235	0.91		602,433
	Positive SURGE				Negative SURGE				Zero SURGE
	N	Mean	Median	STD	*N*	Mean	Median	STD	*N*
Panel B. Descriptive statistics of SURGE									
ALL	121,525	3.31	2.84	2.34	102,306	−3.00	−2.56	2.21	0
Growth	45,670	3.63	3.25	2.4	27,829	−2.84	−2.35	2.21	0
Mid-BM	50,881	3.21	2.73	2.32	46,309	−3.05	−2.62	2.25	0
Value	24,974	2.91	2.41	2.2	28,168	−3.06	−2.69	2.15	0
Small	61,827	3.19	2.7	2.31	54,935	−2.96	−2.57	2.14	0
Mid-Size	38,338	3.41	2.98	2.37	30,591	−3.02	−2.56	2.28	0
Large	21,360	3.45	2.99	2.4	16,780	−3.06	−2.56	2.33	0
	Positive SUE				Negative SUE				Zero SUE
	N	Mean	Median	STD	*N*	Mean	Median	STD	*N*
Panel C. Descriptive statistics of SUE									
ALL	112,068	2.42	1.89	1.94	111,330	−2.92	−2.11	2.59	433
Growth	37,928	2.47	1.98	1.92	35,407	−2.83	−2.1	2.43	164
Mid-BM	48,767	2.41	1.88	1.94	48,221	−2.92	−2.09	2.6	202
Value	25,373	2.37	1.79	1.95	27,702	−3.04	−2.17	2.76	67
Small	56,746	4.42	1.87	1.94	59,765	−2.86	−2.04	2.54	251
Mid-Size	35,031	2.43	1.91	1.93	33,773	−2.98	−2.18	2.65	125
Large	20,291	2.42	1.92	1.92	17,792	−3.01	−2.21	2.66	57

This table presents the descriptive statistics for major characteristics of our sample stocks. Our sample includes stocks listed on the NYSE, the AMEX, and Nasdaq with data available to compute book-to-market ratios, revenue surprises, and earnings surprises. All financial service operations and utility companies are excluded. Firms with prices below $5 as of the earnings announcement date are also excluded. Panel A lists numbers of firm-quarter observations between January 1974 and December 2009. Panel B and Panel C respectively list the mean and median values the measure of revenue surprises (SURGE) and for the measure of earnings surprises (SUE) across all firm-quarters in our sample. Statistics for positive surprises, negative surprises, and zero surprises are presented separately. Sample firms are also classified into bottom 30%, middle 40%, and top 30% groups by their respective market capitalizations or book-to-market ratios. The breakpoints for the size subsamples are based on ranked values of market capitalization of NYSE firms. The breakpoints for the book-to-market subsamples are based on ranked values of book-to-market ratio of all sample firms.

capitalization and different book-to-market ratio. Around 54% of revenue surprises and 50% of earnings surprises are positive.[9]

The values of SURGE and SUE are expected to be positively correlated. After all, a firm's income statement starts with revenue (sales) and ends with earnings; these two attributes share common firm operational information to a great extent, and their innovations, SURGE and SUE, should be correlated as well. Table 2 shows the time-series average of the cross-sectional correlations between 1974 and 2009. Panel A and Panel B present, respectively, the Pearson correlations and Spearman rank correlations. The average of both types of correlations between SURGE and SUE is 0.32, while prior price performance is not as significantly correlated with SURGE or SUE, with average correlations equal to about 0.15 and 0.19, respectively.

We then partition the sample by book-to-market ratio (B/M) and size. Value firms and small firms are found to exhibit slightly higher correlations among SURGE, SUE, and prior price performance than growth firms and large firms, although the differences in correlations across B/M and size groups are not significant. Table 2 also shows the fractions of months where non-zero correlations are significant at the 1% level. These numbers again confirm that the correlations between SURGE and SUE tend to be strongest across various classifications of firms, followed by correlations between SURGE and prior returns, and then those between SUE and prior returns.

These preliminary results suggest that revenue surprises and earnings surprises share highly correlated information, while each still have a distinctive content, a conclusion consistent with Swaminathan and Weintrop (1991) and Jegadeesh and Livnat (2006b). The information content conveyed by market information, i.e., prior returns, differs more from that carried by the two fundamental information measures, SURGE and SUE.

3.3. Descriptive statistics for stocks grouped by SURGE, SUE, and prior returns

We next compare the firm characteristics for portfolios characterized by different revenue surprises (SURGE), earnings surprises (SUE) and prior returns. All sample stocks are sorted into quintiles based on their SURGE, SUE, and prior 6-month returns independently. The characteristics of those quintile portfolios are reported in Table 3. Several interesting observations emerge.

The price level, as expected, is found to be lowest for the price losers (P1). Stocks with negative revenue surprises (R1) or negative earnings surprises (E1) also have lower price levels, while the trend is not as obvious as for price losers. We also find price losers (P1) and price winners (P5) tend to be smaller stocks. Another interesting observation revealed in the book-to-market ratios is that stocks with the most positive SURGE or the most winning returns tend to be growth stocks. Stocks with the most positive SUE also have lower B/M ratios, but to much less of a degree. This suggests that growth stocks are characterized by strong revenue but not necessarily strong earnings.

The last three sections of Table 3 list the SURGE, SUE, and prior returns for those sorted portfolios. Stocks with strong SURGE also tend to have higher SUE and higher prior returns. A similar pattern

[9] To ensure that firm accounting information is available to public investors at the time the stock returns are recorded, we follow the approach of Fama and French (1992) and match the accounting data for all fiscal years ending in calendar year $t-1$ with the returns for July of year t through June of $t+1$. The market capitalization is calculated by the closing price on the last trading day of June of a year times the number of outstanding shares at the end of June of that year.

Table 2
Correlation among revenue surprises, earnings surprises, and prior price performance.

Correlated variables	All firms	Subsample by B/M			Subsample by Size		
		Value	Mid	Growth	Small	Mid	Large
Panel A. Pearson correlations among SURGE, SUE, and prior 6-month returns							
(SURGE, SUE)	0.3200***	0.3331***	0.3361***	0.2818***	0.3641***	0.2917***	0.2362***
	(101.17)	(84.46)	(107.04)	(65.93)	(118.69)	(69.91)	(42.64)
	[100%]	[100%]	[100%]	[100%]	[100%]	[100%]	[71.1%]
(SURGE, Prior returns)	0.1458***	0.1272***	0.1263***	0.1353***	0.1686***	0.1304***	0.1061***
	(44.09)	(33.86)	(35.67)	(35.36)	(55.44)	(29.78)	(17.78)
	[88.7%]	[41.5%]	[64.6%]	[62.7%]	[86.9%]	[55.4%]	[35.9%]
(SUE, Prior returns)	0.1868***	0.2120***	0.2015***	0.1496***	0.2330***	0.1523***	0.0959***
	(65.54)	(57.68)	(54.40)	(47.01)	(75.82)	(40.74)	(20.93)
	[98.4%]	[81.9%]	[92.7%]	[68.1%]	[98.8%]	[67.1%]	[23.7%]
Panel B. Spearman rank correlations among SUE, SURGE, and prior 6-month-returns							
(SURGE, SUE)	0.3231***	0.3367***	0.3397***	0.2828***	0.3652***	0.2952***	0.2407***
	(106.09)	(93.92)	(112.08)	(68.22)	(124.45)	(72.92)	(45.40)
	[100%]	[100%]	[100%]	[99.8%]	[100%]	[100%]	[74.4%]
(SURGE, Prior returns)	0.1426***	0.1227***	0.1255***	0.1315***	0.1647***	0.1285***	0.1032***
	(42.61)	(33.68)	(36.33)	(33.09)	(55.45)	(29.37)	(17.58)
	[86.6%]	[41.8%]	[63.4%]	[58.2%]	[87.8%]	[53.3%]	[35.0%]
(SUE, Prior returns)	0.1834***	0.2117***	0.1980***	0.1383***	0.2314***	0.1501***	0.0959***
	(42.61)	(33.68)	(36.33)	(33.09)	(55.45)	(29.37)	(17.58)
	[97.2%]	[84.0%]	[91.1%]	[62.0%]	[99.3%]	[64.8%]	[23.2%]

This table presents the correlations among SURGE, SUE and prior returns of our sample firms. At the end of each month, each sample firm should have its corresponding most current SUE, most current SURGE, and previous 6-month return. SURGE and SUE are winsorized at 5% and 95%, setting all SURGE and SUE values greater than the 95th percentile to the value of the 95th percentile and all SURGE and SUE values smaller than the 5th percentile to the value of the 5th percentile. Panel A lists the average Pearson correlations among SUE, SURGE, and prior returns between 1974 and 2009. Panel B lists the average Spearman rank correlations, where all sample firms are grouped into ten portfolios based on SURGE, SUE, and prior-6-month-returns independently at the end of each month. Decile 1 portfolio consists of firms with the lowest value of the attribute (SURGE, SUE, or prior 6-month returns), and Decile 10 consists of firms with the highest value of the attribute. The correlations are calculated at the end of each month. The values reported in the table are monthly averages of those correlations. Sample firms are further classified into bottom 30%, middle 40%, and top 30% groups by their respective market capitalizations or book-to-market ratios at the end of the formation months. The breakpoints for the size subsamples are based on ranked values of market capitalization of NYSE firms. The breakpoints for the book-to-market subsamples are based on ranked values of book-to-market ratio of all sample firms. The numbers in parentheses are the average *t*-statistics under the null hypothesis that the correlation is zero. Percentages in brackets represent the fraction of the months with non-zero correlations that are significant at the 1% level.
*** Indicate statistical significance at 1%.

is seen for stocks with high SUE or high prior returns. Stocks with strong SURGE, strong SUE, or winning prior returns tend to excel on all three information dimensions. This relation is consistent with the positive correlations reported in Table 2.

4. Empirical results of univariate momentum strategies

Table 4 presents the monthly returns to momentum strategies based on firms' revenue surprises (SURGE), earnings surprises (SUE), and prior price performance, respectively termed as revenue momentum, earnings momentum, and price momentum strategies. Decile portfolio results are reported here.

We first examine the profitability of revenue momentum. We are interested in knowing whether the well-documented post-announcement revenue drift also enables a profitable investment strategy. Following a similar strategy of earnings momentum by Chordia and Shivakumar (2006), we define a revenue momentum portfolio as a zero-investment portfolio by buying stocks with the most positive revenue surprises and selling stocks with the most negative revenue surprises. Panel A of Table 4 reports significant returns to the revenue momentum strategies. These strategies yield average monthly returns of 0.94%, 0.93%, and 0.84%, respectively, by holding the relative-strength portfolios for 3, 6, and 9 months. This research, to the best of our knowledge, is the first to document specific evidence on the profitability of revenue momentum.

We also test with more recent data the profitability of earnings momentum and price momentum strategies, which have both been studied in the literature. Panel B of Table 4 reports the results for the earnings momentum strategies. We again find that these positive-minus-negative (PMN) zero-investment portfolios yield significantly positive returns for holding periods ranging from 3 to 12 months. The profit is strongest when the PMN portfolios are held for 3 months, leading to an average monthly return of 0.99%, significant at the 1% level. The results are consistent with those of Bernard and Thomas (1989) and Chordia and Shivakumar (2006). Chordia and Shivakumar (2006) find a significant monthly return of 0.96% on a 6-month holding-period earnings momentum strategy executed over 1972–1999, while we show a significant monthly return of 0.71% for a sample period extending to 2009.

Panel C shows the performance of price momentum strategies. Similar to the results in Jegadeesh and Titman (1993), price momentum strategies yield average monthly returns of 0.94%, 0.93%, 0.84%, and 0.61%, for the 3, 6, 9, and 12 months holding-period respectively.

A comparison of the three momentum strategies indicates that the highest returns are for price momentum, followed by earnings momentum and revenue momentum. Meanwhile, the profitability for earnings momentum portfolio deteriorates faster than for price momentum as the holding period extends from 3 to 12 months.[10] The revenue momentum strategy yields the smallest and the shortest-lived profits, with returns diminishing to an insignificant level when the holding period is extended to 12 months.

Following a similar approach by Fama and French (1996) and Jegadeesh and Titman (2001), we implement the capital asset

[10] We show later that earnings momentum actually demonstrates stronger persistence than price momentum when the momentum portfolios are held over 2 years.

Table 3
Descriptive statistics of characteristics of various portfolio groups.

	SURGE					SUE					Prior 6-month returns				
	R1	R2	R3	R4	R5	E1	E2	E3	E4	E5	P1	P2	P3	P4	P5
Price															
Mean	22.05	23.5	24.13	25.03	27.27	23.16	23.59	23.93	25.26	26.03	16.86	23.39	26.62	28.29	26.83
Median	16.38	17.75	18.13	19	21.13	17.8	17.38	17.75	19.5	19.63	12.63	18.12	21.13	22.5	20.13
STD	25.92	26.41	27.11	30.71	29.78	27.27	32.49	26.73	25.36	28.05	21.33	27.84	27.77	29.17	31.85
Mkt Cap (million dollars)															
Mean	2117	2312	2483	2400	2567	2247	2111	2189	2771	2561	1316	2524	3018	3120	1902
Median	218	239	239	250	286	238	227	236	275	253	169	256	310	322	222
STD	12,173	13,316	14,720	12,593	14,426	12,883	12,774	11,838	15,122	14,516	8,718	14,233	15,384	16,527	10,874
B/M															
Mean	0.7426	0.713	0.6782	0.6389	0.5529	0.6868	0.6762	0.6765	0.6485	0.6378	0.7774	0.7317	0.6793	0.6148	0.5223
Median	0.6085	0.5769	0.5381	0.4948	0.4133	0.5446	0.5389	0.5371	0.5103	0.4988	0.6408	0.6027	0.5471	0.4822	0.3836
STD	0.5284	0.5215	0.5119	0.5034	0.4695	0.525	0.5226	0.5157	0.4975	0.4948	0.5595	0.5209	0.4991	0.476	0.4566
Prior-6-month-returns															
Mean	−0.0026	0.0056	0.0107	0.0153	0.022	−0.0037	0.0054	0.0107	0.0156	0.0229	−0.0443	−0.0109	0.009	0.0297	0.0676
Median	−0.0025	0.0052	0.01	0.0145	0.0209	−0.0038	0.0047	0.0098	0.0145	0.0216	−0.0403	−0.0093	0.0096	0.0294	0.0637
STD	0.0452	0.0446	0.0457	0.0464	0.0488	0.046	0.0461	0.0459	0.0453	0.0469	0.0322	0.0236	0.022	0.0236	0.0359
SUE															
Mean	−1.9168	−0.7191	−0.0497	0.5215	1.08	−5.2584	−1.5994	0.0029	1.475	4.3051	−1.4463	−0.6197	−0.1473	0.2722	0.8561
Median	−1.5894	−0.4592	0.1297	0.66	1.1971	−4.9957	−1.4842	0.0169	1.4329	4.1362	−1.055	−0.3205	0.0709	0.4132	0.8788
STD	3.5535	3.2176	3.11	3.1184	3.4312	2.213	0.8896	0.6252	0.6952	1.513	3.5826	3.3691	3.315	3.2623	3.2648
SURGE															
Mean	−4.7404	−1.6453	0.3942	2.4354	5.7428	−1.2127	−0.2628	0.4276	1.0688	2.156	−0.6392	−0.0739	0.3424	0.8732	1.673
Median	−4.5579	−1.5386	0.5175	2.5045	5.6739	−1.5664	−0.418	0.4178	1.1661	2.3349	−0.7582	−0.1127	0.3592	0.9336	1.777
STD	1.8859	1.3789	1.2745	1.2251	1.7428	4.0386	3.7035	3.5492	3.5099	3.66	3.858	3.7885	3.7861	3.7634	3.745

This table presents the descriptive statistics of firm characteristics for stocks sorted on SURGE, SUE, and prior returns. All sample stocks are sorted independently according to their SURGE, SUE, and prior 6-month returns. R1 (E1) represents the quintile portfolio of stocks with the most negative SURGE (SUE), and R5 (E5) represents the quintile portfolio of stocks with the most positive SURGE (SUE). Similarly, P1 denotes the quintile portfolio of stocks with the lowest prior 6-month returns while P5 denotes the portfolio of stocks with the highest prior 6-month returns. Reported characteristics include price level, market capitalization, B/M ratio, SURGE, SUE and prior 6-month returns for component stocks in each corresponding quintile portfolio. The reported mean values are the equally weighted averages for stocks in each quintile portfolio.

Table 4
Returns to revenue momentum, earnings momentum, and price momentum strategies.

Holding period	Low	High	PMN	CAPM_Adj. (1)	FF3_Adj. (2)
Panel A. Revenue momentum returns					
3 months	0.0074***	0.0163***	0.0089***	0.0084***	0.0105***
	(2.56)	(5.37)	(7.19)	(6.88)	(9.22)
6 months	0.0097***	0.0158***	0.0061***	0.0056***	0.0079***
	(3.34)	(5.17)	(5.10)	(4.71)	(7.32)
9 months	0.0118***	0.0154***	0.0036***	0.0030***	0.0054***
	(4.01)	(5.03)	(3.03)	(2.58)	(5.16)
12 months	0.0131***	0.0145***	0.0014	0.001	0.0034***
	(4.43)	(4.78)	(1.24)	(0.87)	(3.36)
Panel B. Earnings momentum returns					
3 months	0.0079***	0.0178***	0.0099***	0.0099***	0.0102***
	(2.71)	(6.14)	(9.77)	(9.71)	(9.90)
6 months	0.0098***	0.0169***	0.0071***	0.0070***	0.0077***
	(3.35)	(5.81)	(7.82)	(7.71)	(8.42)
9 months	0.0116***	0.0164***	0.0048***	0.0048***	0.0056***
	(3.92)	(5.65)	(5.68)	(5.59)	(6.63)
12 months	0.0127***	0.0155***	0.0028***	0.0028***	0.0037***
	(4.28)	(5.37)	(3.60)	(3.64)	(4.47)
Panel C. Price momentum returns					
Holding Period	Loser	Winner	WML	CAPM_Adj. (1)	FF3_Adj. (2)
3 months	0.0085**	0.0179***	0.0094***	0.0101***	0.0113***
	(2.18)	(4.81)	(3.23)	(3.48)	(3.80)
6 months	0.0088**	0.0182***	0.0093***	0.0098***	0.0112***
	(2.29)	(4.94)	(3.47)	(3.62)	(4.09)
9 months	0.0099***	0.0183***	0.0084***	0.0085**	0.103***
	(2.62)	(5.02)	(3.57)	(3.62)	(4.32)
12 months	0.0109***	0.0171***	0.0061***	0.0062***	0.0085***
	(2.94)	(4.72)	(2.93)	(2.94)	(4.06)

This table presents monthly returns and associated *t*-statistics from revenue, earnings, and price momentum strategies executed during the period from 1974 through 2009. For the revenue momentum strategy, firms are grouped into ten deciles based on the measure SURGE during each formation month. Decile 1 represents the most negative revenue surprises, and Decile 10 represents the most positive revenue surprises. The values of SURGE for each formation month are computed using the most recent revenue announcements made within three months before the formation date. The zero-investment portfolios-long the most positive revenue surprises portfolio and short the most negative revenue surprises portfolio (PMN) – are held for K (K = 3, 6, 9, and 12) subsequent months and are not rebalanced during the holding period. Panel A lists the average monthly returns earned from the portfolio of those firms with the most negative SURGE (low), from the portfolio of those with the most positive SURGE (high), and from the earnings momentum strategies (PMN). Earnings momentum strategies are developed with the same approach of revenue momentum strategies, by buying stocks with the most positive earnings surprises and selling stocks with the most negative earnings surprises. The zero investment portfolios are then held for K subsequent months. Panel B lists the average monthly returns earned from the portfolio of those firms with the most negative SUE (low), from the portfolio of those with the most positive SUE (high), and from the earnings momentum strategies (PMN). For the price momentum strategy, firms are sorted into 10 ascending deciles on the basis of previous 6 months returns. Portfolios of buying Decile 1 (winner) and selling Decile 10 (loser) are held for K subsequent months and not rebalanced during the holding period. The average monthly returns of winner, loser, and price momentum strategies are presented in Panel C. Risk-adjusted momentum returns are also provided in this table. Adj. (1) is momentum returns adjusted by CAPM, and Ad.j (2) is momentum returns adjusted by the Fama–French 3-factor model.
*** Indicate statistical significance at 1%.

pricing model and a Fama–French three factor (FF-3) model to examine whether the momentum returns can be explained by pricing factors.[11] The last two columns in Panel A of Table 4 list the risk-adjusted returns to revenue momentum, which remain significant. The market risk premium, size factor, and book-to-market factor, while serving to capture partial effects of the revenue momentum strategy, are still unable to explain away abnormal returns entirely. The FF-3 factor adjusted return for 6 months remains strong at 0.79% with a *t*-statistic equal to 7.32. The risk-adjusted returns to earnings momentum and price momentum in Panels B and C of Table 4 are similar to those in the literature (see Jegadeesh and Titman, 1993; and Chordia and Shivakumar, 2006) and generally confirm the conclusion of Fama (1998) that post-earnings-announcement drift and price momentum profits remain significant.

5. Interrelation of revenue, earnings, and price momentum

We further examine the interrelation of momentum strategies through tests of dominance, cross-contingencies, and combined strategies. The objective is to find empirical support for hypotheses for our two research questions. First, we hypothesize that revenue surprises, earnings surprises, and prior returns each have some exclusive information content that is not captured by the market. Under this hypothesis, a particular univariate momentum strategy should not be subsumed by another strategy, which we examine through dominance tests. Second, we hypothesize that the market not only underreacts to individual firm information, but also underestimates the significance of the joint implications of revenue, earnings, and price information. Under this hypothesis, return anomalies are likely to be most pronounced when the information variables all point in the same direction.

5.1. Testing for dominance among the momentum strategies

To tackle the interrelation of momentums, we first explore whether any of the three momentum strategies is entirely subsumed by another strategy. Stock price represents the firm value evaluated by investors in the aggregate, given their available information. The most important firm fundamental information for investors is undoubtedly firm earnings, which summarize firm performance. Jegadeesh and Livnat (2006b) point out that an important reference for investors regarding the persistence of firm

[11] We obtain monthly data on market return, the risk-free rate, and SMB and HML from Kenneth French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/).

earnings is offered by firm revenue information. Obviously, these three pieces of firm-specific information, revenue, earnings and stock price, share significant information content with each other. The anomalies of their corresponding momentums therefore may arise from common sources. That is, payoffs to a momentum strategy based on one measure, being revenue surprises, earnings surprises, or prior returns, may be fully captured by another measure. The dominance tests serve to test for such a possibility.

We first apply the pairwise nested comparison model introduced by George and Hwang (2004) and test whether one particular momentum strategy dominates another. Table 5 reports the results in three panels. Panel A compares the revenue momentum and earnings momentum strategies. In Panel A.1, stocks are first sorted on earnings surprises, with each quintile further sorted on revenue surprises. We find that, when controlling for the level of earnings surprises, the revenue momentum strategy still yields significant profits. The zero-investment portfolio returns for 6-month holding periods range from 0.26% to 0.36%. In Panel A.2, stocks are first sorted on revenue surprises, and then on earnings surprises. Likewise, the returns to an earnings momentum strategy, when controlling for the level of revenue surprises, are still significantly positive. These paired results indicate that neither earnings momentum nor revenue momentum dominates one another.

We follow the same process in comparing revenue momentum and price momentum strategies. Results in Panel B indicate that all the nested revenue momentum strategies and the nested price momentum strategies are found profitable, with the exception of revenue momentum in the loser stock group. In general, we still conclude that neither revenue momentum nor price momentum is dominated by the other. Panel C of Table 5 presents the results of the nested momentum strategies based on two-way sorts on earnings surprises and prior returns. Returns to all these nested momentum strategies remain significantly positive.

The pairwise nested comparisons suggest that revenue surprises, earnings surprises, and prior returns each convey some unpriced information which is not shared by each other, and therefore further contributes to a momentum effect.

A second approach allows us to simultaneously isolate the returns contributed by each momentum portfolio. Taking advantage of George and Hwang's (2004) model, we implement a panel data analysis with six performance dummies.

$$R_{it} = \alpha_{jt} + \beta_{1jt}R_{i,t-1} + \beta_{2jt}size_{i,t-1} + \beta_{3jt}R1_{i,t-j} + \beta_{4jt}R5_{i,t-j} + \beta_{5jt}E1_{i,t-j} + \beta_{6jt}E5_{i,t-j} + \beta_{7jt}P1_{i,t-j} + \beta_{8jt}P5_{i,t-j} + e_{it}, \quad (3)$$

where $j = 1,\ldots,6$. We first regress firm i's return in month t on control variables and six dummies for the portfolio ranks. We include the previous month return $R_{i,t-1}$ to control for the bid-ask bounce effect and the market capitalization $size_{i,t-1}$ to control for the size effect in the cross-sectional regressions. Momentum portfolio dummies, $R1_{i,t-j}$, $R5_{i,t-j}$, $E1_{i,t-j}$, $E5_{i,t-j}$, $P1_{i,t-j}$, and $P5_{i,t-j}$, indicate whether firm i is included in one or more momentum portfolios based on their scores in month $t-j$. To obtain momentum profits corresponding to the Jegadeesh and Titman (1993) strategies, we average the estimated coefficients of the independent variable over $j = 1,\ldots,6$, and then subtract the coefficient average for the bottom quintile portfolio from that for the top quintile portfolio. These are the returns contributed by each momentum strategy when the contributions from other momentum strategies are controlled for.

Panel A of Table 6 reports the regression results. The returns isolated for revenue momentum, earnings momentum, and price momentum are listed in the last three rows. The results are all significant in terms of either raw returns or FF-3 factor adjusted returns when all months are included or when all non-January months are included. Note, however, that the isolated returns to revenue momentum (R5–R1) and to price momentum (P5–P1) strategies are no longer significantly positive in January. The insignificant returns in January are consistent with the tax-loss-selling hypothesis, proposing that investors sell poorly performing stocks in October through December and buy them back in January (e.g., see Keim, 1989; Odean, 1998; Grinblatt and Moskowitz, 2004).

The overall significant profits contributed by R5–R1 (E5–E1 or P5–P1) indicate market underreactions with respect to the information content of revenue surprises (earnings surprises or prior price performance) unrelated to the other two information measures. The isolated returns are greatest for price momentum (0.66%), followed by earnings momentum (0.43%) and then revenue momentum (0.28%). This is similar to our earlier results on single-criterion momentum. Such a finding again rejects the existence of a dominating momentum strategy among the three.

We do not find that information leading to revenue momentum or earnings momentum fully captures the price momentum returns. Similar findings are documented by Chan et al. (1996), Heston and Sadka (2008), and Novy-Marx (2012) for the relation between earnings surprises and price momentum. We would like to examine specifically how much of the price momentum can be explained by revenue surprises and/or earnings surprises information. For this reason, we perform similar regressions by including only a subset of portfolio dummies. The results are reported in Panel B of Table 6. In the case of raw returns, the return to price momentum without isolating other momentum sources is 0.81%, while it is only reduced to 0.73% after controlling for revenue momentum, to 0.70% after controlling for earnings momentum, and to 0.66% after controlling for both. In other words, information leading to revenue momentum and earnings momentum each accounts for about 10% and 14% of price momentum, and the two pieces of information combined account for just about 19% of price momentum effects. The results for risk-adjusted returns are similar. This conclusion adds to the large literature attempting to trace the sources of price momentum. Our numbers indicate that the information conveyed by revenue surprises or earnings surprises seems to make only a limited contribution to price momentums.

Results of the pairwise nested comparisons in Table 5 and the regression analysis in Table 6 both support the hypothesis that revenue surprises, earnings surprises, and prior returns each have some unpriced information content that is exclusive to each measure itself. This conclusion also suggests the possibility that one can improve momentum strategies by using all three information measures.

5.2. Two-way sorted portfolio returns and momentum cross-contingencies

Here and in the next section, we examine the momentum strategies using multiple sorting criteria. These results serve to answer the research question of whether investors underestimate the implications of joint information of revenue surprises, earnings surprises, and prior returns.

Given that the market usually informs investors with not just a single piece but multiple pieces of firm information, the incremental information content of additional firm data is likely to be contingent upon other information for the stock. Jegadeesh and Livnat (2006b) suggest that the information content of SURGE has implications for the future value of SUE and such information linkage is particularly significant when both measures point in the same direction. Jegadeesh and Livnat (2006a) further find that the market, including financial analysts, underestimates the joint implications of these measures and thus firm market value.

Our second research question extends Jegadeesh and Livnat (2006b) by additionally considering the information of prior price performance. We hypothesize that return anomalies should be most pronounced when the joint implications of multiple

Table 5
Momentum strategies: two-way dependent sorts by revenue surprises, earnings surprises, and prior returns.

A.1 Revenue momentum in various SUE groups				A.2 Earnings momentum in various SURGE groups			
Portfolios classified by SUE	Portfolios classified by SURGE	Ave. Monthly Return	*t*-stats	Portfolios classified by SURGE	Portfolios classified by SUE	Ave. Monthly Return	*t*-stats
Panel A. Revenue momentum versus earnings momentum							
E1 (Low)	R1 (Low)	0.0065		R1 (Low)	E1 (Low)	0.0064	
	R5 (High)	0.0101			E5 (High)	0.0104	
	R5–R1	0.0036	(3.24)		E5–E1	0.004	(4.66)
E2	R1 (Low)	0.0086		R2	E1 (Low)	0.0079	
	R5 (High)	0.0115			E5 (High)	0.0113	
	R5–R1	0.0028	(2.85)		E5–E1	0.0034	(4.91)
E3	R1 (Low)	0.009		R3	E1 (Low)	0.0089	
	R5 (High)	0.0119			E5 (High)	0.0131	
	R5–R1	0.0029	(3.29)		E5–E1	0.0042	(6.03)
E4	R1 (Low)	0.0096		R4	E1 (Low)	0.0096	
	R5 (High)	0.0122			E5 (High)	0.014	
	R5–R1	0.0026	(2.7)		E5–E1	0.0043	(5.59)
E5 (High)	R1 (Low)	0.0116		R5 (High)	E1 (Low)	0.0112	
	R5 (High)	0.0149			E5 (High)	0.0152	
	R5–R1	0.0033	(3.22)		E5–E1	0.004	(4.74)
B.1 Revenue momentum in various PriorRet groups				B.2 Price momentum in various SURGE groups			
Portfolios classified by Prior Ret	Portfolios classified by SURGE	Ave. Monthly Return	*t*-stats	Portfolios classified by SURGE	Portfolios classified by Prior Ret	Ave. Monthly Return	*t*-stats
Panel B. Revenue momentum versus price momentum							
P1 (Loser)	R1 (Low)	0.007		R1 (Low)	P1 (Loser)	0.0072	
	R5 (High)	0.0077			P5 (Winner)	0.0095	
	R5–R1	0.0008	(0.67)		P5–P1	0.0024	(1.35)
P2	R1 (Low)	0.0083		R2	P1 (Loser)	0.0084	
	R5 (High)	0.0099			P5 (Winner)	0.011	
	R5–R1	0.0015	(1.82)		P5–P1	0.0026	(1.51)
P3	R1 (Low)	0.0091		R3	P1 (Loser)	0.0092	
	R5 (High)	0.0123			P5 (Winner)	0.0135	
	R5–R1	0.0032	(4.33)		P5–P1	0.0042	(2.29)
P4	R1 (Low)	0.0089		R4	P1 (Loser)	0.0092	
	R5 (High)	0.0132			P5 (Winner)	0.0149	
	R5–R1	0.0042	(5.53)		P5–P1	0.0057	(3.35)
P5 (Winner)	R1 (Low)	0.0106		R5 (High)	P1 (Loser)	0.008	
	R5 (High)	0.0175			P5 (Winner)	0.0176	
	R5–R1	0.007	(7.03)		P5–P1	0.0096	(4.82)
C.1 Earnings momentum in various PriorRet groups				C.2 Price momentum in various SUE groups			
Portfolios classified by SURGE	Portfolios classified by Prior Ret	Ave. Monthly Return	*t*-stats	Portfolios classified by Prior Ret	Portfolios classified by SURGE	Ave. Monthly Return	*t*-stats
Panel C. Earnings momentum versus price momentum							
P1 (Loser)	E1 (Low)	0.0063		E1 (Low)	P1 (Loser)	0.0066	
	E5 (High)	0.0096			P5 (Winner)	0.0097	
	E5–E1	0.0034	(3.73)		P5–P1	0.0031	(1.62)
P2	E1 (Low)	0.0082		E2	P1 (Loser)	0.0083	
	E5 (High)	0.0106			P5 (Winner)	0.0118	
	E5–E1	0.0024	(3.67)		P5–P1	0.0035	(1.8)
P3	E1 (Low)	0.009		E3	P1 (Loser)	0.0081	
	E5 (High)	0.0126			P5 (Winner)	0.0134	
	E5–E1	0.0036	(5.96)		P5–P1	0.0052	(2.87)
P4	E1 (Low)	0.0091		E4	P1 (Loser)	0.0096	
	E5 (High)	0.0137			P5 (Winner)	0.0143	
	E5–E1	0.0046	(7.69)		P5–P1	0.0047	(2.65)
P5 (Winner)	E1 (Low)	0.0104		E5 (High)	P1 (Loser)	0.01	
	E5 (High)	0.0178			P5 (Winner)	0.0177	
	E5–E1	0.0073	(8.78)		P5–P1	0.0077	(4.16)

This table presents the results of pairwise nested comparison between momentum strategies. Panel A shows the comparison between revenue momentum and earnings momentum during the period from 1974 to 2009. In each month, stocks are first sorted into five groups by earnings surprises (revenue surprises), then further sorted by revenue surprises (earnings surprises) in each group. All portfolios are held for 6 months. The monthly returns to 10 extreme portfolios and 5 conditional earnings (revenue) momentum strategies are presented. Pair tests are provided under the hypothesis that conditional earnings (revenue) momentum profits are the same. Panel B shows the comparison between revenue and price momentum strategies, and Panel C shows the comparison between earnings and price momentum strategies.

measures are most underestimated by the market, and this likely occurs when all information variables point in the same direction. In addition, a different but related issue is that any momentum profits driven by one measure may well depend on the accompanying alternative information, which we call the *cross-contingencies of momentum*. We use multivariate sorted portfolios to test this hypothesis.

5.2.1. Two-way sorts on revenue surprises and earnings surprises

We start by testing the performance of investment strategies based on the joint information of revenue surprises and earnings surprises. We sort stocks into quintiles on the basis of their revenue surprises and then independently into quintiles based on earnings surprises during the 6-month formation period on each portfolio formation date. Panel A of Table 7 presents the raw

returns of these 25 two-way sorted portfolios. The intersection of R1 and E1, labeled as R1 × E1, is the portfolio formed by the stocks with both the lowest SURGE and the lowest SUE, and the intersection of R5 and E5 labeled as R5 × E5, represents the portfolio formed by the stocks with both the highest SURGE and the highest SUE.

We first note that the next-period returns of the 25 two-way sorted portfolios increase monotonically with SURGE as well as with SUE. The return to the portfolio with a similar level of SURGE increases with SUE (e.g., the return increases from 0.88% for R1 × E1 to 1.21% for R1 × E5). Similarly, the payoffs to the portfolio of stocks with a similar level of SUE increase with SURGE (e.g., the return increases from 1.23% for R1xE5 to 1.70% for R5 × E5). That is, stocks that have performed well in terms of revenue and earnings continue to outperform expectations and yield higher future returns.

Panel D of Table 7 shows the corresponding risk-adjusted abnormal returns for each of the 5x5 double-sorted portfolios based on SURGE and SUE. The monotonicity we see in raw returns in Panel A persists for the risk-adjusted returns. The most positive abnormal returns are for the portfolio of high-SURGE and high-SUE stocks (R5 × E5) while the most negative abnormal returns are for the portfolio of low-SURGE and low-SUE stocks (R1 × E1). This provides direct and robust evidence that the return anomalies tend to be most pronounced when SURGE and SUE point in the same direction.

The evidence of monotonicity suggests that the market underreaction is at its extreme when different elements of stock performance information signal in the same direction, i.e., the scenarios of R1 × E1 or R5 × E5. These are the scenarios where the information of SURGE and SUE are expected to have the most significant joint implications for firm value, while market underestimation of their joint implications is found to be strongest, leading to the most pronounced return drifts in the next period. This observation is consistent with the suggestion by Jegadeesh and Livnat (2006a, 2006b).

Investors may execute various long-short strategies with those 25 portfolios. Those listed in the farthest right column of Panel A indicate earnings momentum returns for stocks with a particular level of SURGE, while those listed in the last row are returns on revenue momentum for stocks with a given level of SUE.[12]

We now examine the cross-contingencies of momentum. The revenue momentum measure is 0.36% per month in the high-SUE subsample E5 and 0.43% per month in the low-SUE subsample E1. Meanwhile, the earnings momentum measure is 0.39% per month in the high-SURGE subsample R5, and 0.49% per month in the low-SURGE subsample R1. We do not observe significant variations in momentum returns across SUE or SURGE. Panel D shows similar patterns when returns to momentum portfolios are adjusted for size and B/M risk factors. All of the profits generated earnings momentum strategies or revenue momentum strategies remain significantly positive.

5.2.2. Two-way sorts on revenue surprises and prior returns

We apply similar sorting procedures based on the joint information of revenue surprises and prior price performance. The results for raw returns as shown in Panel B of Table 7, generally exhibit a pattern similar to Panel A but with the following differences. Although the future returns still rise with SURGE among the average and winner stocks, they become insensitive to SURGE for loser stocks. A closer look at the return for portfolio R1 × P1 down to the return for portfolio R5 × P1 indicates that loser portfolio returns simply do not vary much with the level of SURGE.

[12] Similar to Hong et al. (2000), one may characterize the former strategy as earnings momentum strategies that are "revenue-momentum-neutral" and the latter as revenue momentum strategies that are "earnings-momentum-neutral".

Panel E lists risk-adjusted returns for the 5 × 5 portfolios sorted on prior returns and SURGE. A similar monotonic pattern, now in relation with SURGE as well as with prior returns, is observed for most of those abnormal returns. That is, stocks that have performed well in terms of revenue (firm fundamental information) and prior returns (firm market information) continue to outperform expectations and yield higher future returns, and vice versa.

As to the cross-contingencies of momentums, the results in Panel B indicate that the revenue momentum strategies executed with winner stocks yield higher returns than those executed with loser stocks. For example, the revenue momentum strategy executed with the most winning stocks yields a monthly return of 0.78% (R5 × P5 − R1 × P5), while with the most losing stocks it yields only a monthly return of 0.01% (R5 × P1 − R1 × P1). Likewise, the price momentum strategy executed with stocks with greater SURGE yields higher returns than with those with lower SURGE. For example, the price momentum strategy executed with the lowest SURGE stocks yields a monthly return of 0.34% (R1 × P5 − R1 × P1), while with the highest SUE stocks it yields a monthly return as high as 1.08% (R5 × P5 − R5 × P1). The difference of 0.74 percentage between R1 and R5 subsamples is statistically and economically significant, with price momentum profits more than 200% higher in R5 than in R1.

These observations suggest that the revenue surprise information is least efficient among winner stocks, producing the greatest revenue drift for the next period, and that the prior return information is least efficient among stocks with the most positive SURGE producing the strongest return continuation. One noteworthy point is that revenue momentum is no longer profitable among loser stocks. Panel E shows similar patterns of momentum cross-contingencies when returns to momentum portfolios are adjusted for size and B/M risk factors.

The message for investment strategy is that prior returns are most helpful in distinguishing future returns among stocks with high SURGE, and the same is true for the implications of revenue surprises for stocks of high prior returns. On the other hand, when a stock is priced unfavorably by the market, the information of revenue surprises does not offer much help in predicting its future returns.

5.2.3. Two-way sorts on earnings surprises and prior returns

Panel C of Table 7 shows the raw returns for multivariate momentum strategies based on the joint information of earnings surprises and prior returns. Several findings are observed. First, as in the cases shown in Panels A and B, the next-period returns of the 25 two-way sorted portfolios increase monotonically with SUE as well as with prior returns. For example, when a firm has a highly positive earnings surprises (E5) while having had winning stock returns (P5), these two pieces of information together are likely to have particularly strong joint implications for firm value. Such condition leads to an average monthly return as high as 2.01% in the next 6-month period, possibly attributable to even greater investor underreactions.

Panel F of Table 7 shows the risk-adjusted abnormal returns for each of the 5x5 double-sorted portfolios based on SUE and prior returns. The monotonicity we see in raw returns in Panel C persists for the risk-adjusted returns. The most positive abnormal returns are for the portfolio of high-SUE and high-prior-return stocks (E5 × P5) while the most negative abnormal returns are for the portfolio of low-SUE and low-prior-return stocks (E1 × P1).

Looking now at the cross-contingencies between earnings momentum and price momentum, the earnings momentum strategy executed with winner stocks yields higher returns (0.78%) than that executed with loser stocks (0.30%), and that the price momentum strategy executed with positive-SUE stocks yields higher returns (0.92%) than that executed with negative-SUE stocks

Table 6
Comparison of revenue, earnings, and price momentum strategies.

	Raw returns			Risk-adjusted returns		
	All months	January	February–December	All months	January	February–December
Panel A. Contribution of momentum returns solely from prior performance information						
Intercept	0.0130	0.0354	0.0110	0.0051	0.0075	0.0048
	(4.96)	(3.13)	(4.14)	(6.31)	(2.79)	(5.64)
$R_{i,t-1}$	−0.0412	−0.1146	−0.0346	−0.0371	−0.0851	−0.0327
	(−8.95)	(−6.04)	(−7.55)	(−8.54)	(−4.60)	(−7.48)
Size	>−0.0001	>−0.0001	>−0.0001	>−0.0001	>−0.0001	>−0.0001
	(−2.94)	(−2.64)	(−1.88)	(−1.12)	(−0.02)	(−0.99)
R1 Dummy	−0.0015	0.0042	−0.0020	−0.0020	0.0015	−0.0023
	(−3.39)	(2.81)	(−4.43)	(−4.68)	(1.02)	(−5.20)
R5 Dummy	0.0013	−0.0002	0.0014	0.0021	0.0019	0.0021
	(2.18)	(−0.07)	(2.31)	(4.09)	(1.06)	(3.81)
E1 Dummy	−0.0018	−0.0037	−0.0017	−0.0016	−0.0028	−0.0015
	(−5.07)	(−2.89)	(−4.42)	(−4.43)	(−1.96)	(−4.03)
E5 Dummy	0.0024	0.0045	0.0023	0.0026	0.0055	0.0023
	(6.86)	(3.61)	(6.09)	(6.81)	(4.05)	(6.06)
P1 Dummy	−0.0026	0.0125	−0.0040	−0.0036	0.0072	−0.0048
	(−2.14)	(1.96)	(−3.35)	(−3.17)	(1.13)	(−4.43)
P5 Dummy	0.0040	0.0023	0.0041	0.0044	0.0033	0.0045
	(2.92)	(0.53)	(2.88)	(3.39)	(0.67)	(3.33)
R5–R1	0.0028	−0.0044	0.0035	0.0041	0.0004	0.0044
	(3.23)	(−1.50)	(3.82)	(5.45)	(0.18)	(5.48)
E5–E1	0.0043	0.0082	0.0039	0.0041	0.0083	0.0038
	(7.89)	(4.64)	(6.92)	(7.45)	(4.34)	(6.66)
P5–P1	0.0066	−0.0102	0.0081	0.0080	−0.0039	0.0092
	(3.35)	(−1.15)	(4.10)	(3.95)	(−0.39)	(4.59)

Panel B. Univariate price momentum return and conditional price momentum returns								
Intercept	0.0131	0.0129	0.0131	0.0130	0.0053	0.0051	0.0053	0.0051
	(4.97)	(4.92)	(5.03)	(4.96)	(6.62)	(6.36)	(6.58)	(6.31)
$R_{i,t-1}$	−0.0404	−0.0409	−0.0407	−0.0412	−0.0363	−0.0368	−0.0368	−0.0371
	(−8.72)	(−8.83)	(−8.87)	(−8.95)	(−8.29)	(−8.41)	(−8.46)	(−8.54)
Size	−0.0003	−0.0003	−0.0003	>−0.0001	−0.0001	−0.0001	−0.0001	>−0.0001
	(−2.72)	(−2.75)	(−2.97)	(−2.94)	(−0.83)	(−0.88)	(−1.16)	(−1.12)
R1 Dummy			−0.0021	−0.0015			−0.0026	−0.0020
			(−4.53)	(−3.39)			(−5.69)	(−4.68)
R5 Dummy			0.0018	0.0013			0.0026	0.0021
			(2.88)	(2.18)			(4.87)	(4.09)
E1 Dummy		−0.0022		−0.0018		−0.0021		−0.0016
		(−5.78)		(−5.07)		(−5.53)		(−4.43)
E5 Dummy		0.0028		0.0024		0.0030		0.0026
		(6.95)		(6.86)		(7.47)		(6.81)
P1 Dummy	−0.0034	−0.0029	−0.0030	−0.0026	0.0044	−0.0038	−0.0039	−0.0036
	(−2.74)	(−2.31)	(−2.44)	(−2.14)	(−3.83)	(−3.36)	(−3.48)	(−3.17)
P5 Dummy	0.0046	0.0042	0.0043	0.0040	0.0052	0.0047	0.0047	0.0044
	(3.33)	(3.01)	(3.14)	(2.92)	(3.98)	(3.59)	(3.64)	(3.39)
R5–R1			0.0039	0.0028			0.0051	0.0041
			(4.26)	(3.23)			(6.45)	(5.45)
E5–E1		0.0050		0.0043		0.0051		0.0041
		(8.07)		(7.89)		(8.26)		(7.45)
P5–P1	0.0081	0.0070	0.0073	0.0066	0.0096	0.0085	0.0086	0.0080
	(4.02)	(3.52)	(3.70)	(3.35)	(4.70)	(4.18)	(4.29)	(3.95)

This table presents returns to relative strength portfolios and momentum strategies. Each month during the period from 1974 through 2009, six cross-sectional regressions are estimated for revenue, earnings, and price momentum strategies: $R_{it} = \alpha_{jt} + \beta_{1jt}R_{i,t-1} + \beta_{2jt}size_{i,t-1} + \beta_{3jt}R1_{i,t-j} + \beta_{4jt}R5_{i,t-j} + \beta_{5jt}E1_{i,t-j} + \beta_{6jt}E5_{i,t-j} + \beta_{7jt}P1_{i,t-j} + \beta_{8jt}P5_{i,t-j} + e_{it}$, where R_{it} and $size_{i,t}$ are the return and the market capitalization of stock i in month t; and $R1_{i,t-j}$ ($R5_{i,t-j}$) is the most negative (positive) revenue surprise dummy that takes the value of 1if revenue surprises for stock i is ranked in the bottom (top) quintile in month $t-j$, and zero otherwise. The dummies with respect to earnings surprises ($E1_{i,t-j}$ and $E5_{i,t-j}$), and the dummies with respect to prior 6 month price returns ($P1_{i,t-j}$ and $P5_{i,t-j}$) are similar to the settings of $R1_{i,t-j}$ and $R5_{i,t-j}$. The estimated coefficients of independent variable are averaged over $j = 1,\ldots,6$. The numbers reported for raw returns are the time-series average of these averages. The t-statistics calculated from the time series are in parentheses. The risk adjusted returns are intercepts from Fama–French 3-factor regressions on raw returns; their t-statistics are in parentheses. Panel A presents returns to relative strength portfolios and momentum strategies solely belong to each of prior price performance, earnings surprise, and revenue surprises. Panel B presents raw return and conditional returns of price momentum strategy.

(0.45%). Panel F shows risk-adjusted returns for these momentum strategies and reveals a similar pattern as in Panel C for raw returns. Results indicate that the market underreactions to price performance are contingent upon the accompanying earnings performance, and vice versa.

Can we reconcile our results on momentum cross-contingencies with the behavioral explanations for momentum returns? Barberis et al. (1998) observe that a conservatism bias might lead investors to underreact to information and then result in momentum profits. The conservatism bias, described by Edwards (1968), suggests that investors underweight new information in updating their prior beliefs. If we accept the conservatism bias explanation for momentum profits, one might interpret our results as follows.

Investors update their expectations of stock value using firm fundamental performance information as well as technical information, and their information updates are subject to conservatism biases. The evidence of momentum cross-contingencies suggests that the speed of adjustment to market performance information

Table 7
Momentum strategies: two-way sorts by revenue surprises, earnings surprises, and prior returns.

		SUE					Arbitrage returns on portfolios sorted by earnings	
		E1(Low)	E2	E3	E4	E5(High)		
Panel A. Raw returns sorted on revenue surprises (SURGE) and earnings surprise (SUE)								
SURGE	R1(Low)	0.0088	0.0107	0.0109	0.0112	0.0121	0.0049	(4.63)
	R2	0.0098	0.0112	0.0117	0.0129	0.0139	0.0041	(4.71)
	R3	0.0106	0.0121	0.0134	0.0142	0.0154	0.0048	(5.40)
	R4	0.0108	0.0124	0.0133	0.0137	0.0165	0.0057	(5.84)
	R5(High)	0.0123	0.0141	0.0141	0.0146	0.017	0.0039	(3.43)
Arbitrage returns on portfolios sorted by revenue		0.0043	0.0034	0.0032	0.0034	0.0036		
		(2.86)	(2.59)	(2.84)	(2.84)	(2.70)		
Revenue-Earnings combined momentum strategy: R5 × E5 − R1 × E1							**0.0081**	**(6.25)**
		Prior price performance					Arbitrage returns on portfolios sorted by price	
		P1(Loser)	P2	P3	P4	P5(Winner)		
Panel B. Raw returns sorted on revenue surprises (SURGE) and prior price performance								
SURGE	R1(Low)	0.0089	0.0104	0.0109	0.0109	0.0122	0.0034	(1.45)
	R2	0.0099	0.0112	0.0121	0.0121	0.0135	0.0036	(1.59)
	R3	0.0108	0.0125	0.0133	0.0139	0.0161	0.0053	(2.26)
	R4	0.01	0.0125	0.0131	0.0141	0.0176	0.0076	(3.66)
	R5(High)	0.009	0.0112	0.0143	0.0156	0.0198	0.0108	(4.67)
Arbitrage returns on portfolios sorted by price		0.0001	0.0008	0.0033	0.0048	0.0078		
		(0.06)	(0.79)	(3.69)	(5.21)	(6.43)		
Revenue-Price combined momentum strategy: R5 × P5 − R1 × P1							**0.0109**	**(4.53)**
		Prior price performance					Arbitrage returns on portfolios sorted by price	
		P1(Loser)	P2	P3	P4	P5(Winner)		
Panel C. Raw returns sorted on earnings surprises (SUE) and prior price performance								
SUE	E1(Low)	0.0083	0.0103	0.0109	0.0107	0.0105	0.0045	(1.94)
	E2	0.0098	0.0115	0.0119	0.0126	0.0141	0.0044	(1.89)
	E3	0.0099	0.0117	0.0127	0.0134	0.0162	0.0062	(2.73)
	E4	0.0106	0.012	0.0133	0.0138	0.0168	0.0062	(2.81)
	E5(High)	0.0107	0.0127	0.0149	0.016	0.0201	0.0092	(4.01)
Arbitrage returns on portfolios sorted by earnings		0.003	0.0023	0.004	0.0053	0.0078		
		(2.66)	(3.10)	(5.49)	(7.51)	(7.79)		
Price-Revenue combined momentum strategy: E5 × P5 − E1 × P1							**0.0118**	**(5.47)**
		SUE					Risk-adjusted returns on portfolios sorted by earnings	
		E1(Low)	E2	E3	E4	E5(High)		
Panel D. Risk-adjusted returns sorted on revenue surprises (SURGE) and earnings surprise (SUE)								
SURGE	R1(Low)	−0.0043	−0.0026	−0.002	−0.0013	0.0005	0.0049	(4.52)
	R2	−0.0029	−0.0017	−0.0008	0.0002	0.0013	0.0043	(4.79)
	R3	−0.0016	−0.0004	0.0008	0.0017	0.0032	0.0049	(5.38)
	R4	−0.0008	0.0006	0.0011	0.0018	0.0044	0.0052	(5.21)
	R5(High)	0.0021	0.0027	0.0023	0.0033	0.0054	0.0033	(2.86)
Risk-adjusted returns on portfolios sorted by revenue		0.0064	0.0053	0.0043	0.0046	0.0045		
		(4.78)	(4.32)	(3.98)	(4.16)	(3.54)		
Revenue-Earnings combined momentum strategy: R5 × E5 − R1 × E1							**0.0081**	**(6.25)**
		Prior price performance					Risk-adjusted returns on portfolios sorted by price	
		P1(Loser)	P2	P3	P4	P5(Winner)		
Panel E. Risk-adjusted returns sorted on revenue surprises (SURGE) and prior price performance								
SURGE	R1(Low)	−0.005	−0.0028	−0.0018	−0.0015	0.0002	0.0052	(2.22)
	R2	−0.0037	−0.0018	−0.0004	−0.0002	0.0015	0.0052	(2.26)
	R3	−0.0025	−0.0002	0.0009	0.0017	0.004	0.0066	(2.76)
	R4	−0.0026	0.0002	0.0013	0.0025	0.0059	0.0085	(4.05)
	R5(High)	−0.0032	−0.0005	0.0029	0.0044	0.0086	0.0118	(4.98)
Risk-adjusted returns on portfolios sorted by price		0.0018	0.0023	0.0047	0.0059	0.0087		

(*continued on next page*)

Table 7 (*continued*)

		SUE					Arbitrage returns on portfolios sorted by earnings	
		E1(Low)	E2	E3	E4	E5(High)		
		(1.38)	(2.49)	(5.80)	(6.86)	(7.49)		
Revenue-Price combined momentum strategy: R5 × P5 – R1 × P1							**0.0097**	**(7.86)**
		Prior price performance					Risk-adjusted returns on portfolios sorted by price	
		P1(Loser)	P2	P3	P4	P5(Winner)		
Panel F. Risk-adjusted returns sorted on earnings surprises (SUE) and prior price performance								
SUE	E1(Low)	−0.0051	−0.0024	−0.0012	−0.001	0.001	0.0062	(2.65)
	E2	−0.0039	−0.0014	−0.0005	0.0006	0.0027	0.0066	(2.79)
	E3	−0.0033	−0.0011	0.0004	0.0013	0.0042	0.0075	(3.20)
	E4	−0.0025	−0.0004	0.0012	0.002	0.0051	0.0076	(3.35)
	E5(High)	−0.0018	0.0003	0.0029	0.0041	0.0083	0.0096	(4.07)
Risk-adjusted returns on portfolios sorted by earnings		0.0036	0.0027	0.0041	0.0051	0.0072		
		(3.25)	(3.64)	(5.61)	(7.07)	(7.05)		
Price-Revenue combined momentum strategy: E5 × P5 – E1 × P1							**0.0133**	**(6.09)**

For each month, we form equal-weighted portfolios according to the breakpoints of two of three firm characteristics: a firm's revenue surprises (SURGE), its earnings surprises (SUE), and its prior 6-month stock performance. Panel A and Panel D present raw returns and risk-adjusted returns of the 25 portfolios independently sorted on SURGE and on SUE. The returns of a revenue-earnings combined momentum strategy are obtained by buying the portfolio of the best SURGE stocks and the stocks with the best SUE (SURGE = 5 and SUE = 5) and selling the portfolio of the poorest SURGE stocks and the stocks with the poorest SUE (SURGE = 1 and SUE = 1). Panel B and Panel E present raw returns and risk-adjusted returns of the 25 portfolios independently sorted on SURGE and on prior price performance. The returns of a revenue-price combined momentum strategy is obtained by buying stocks in the portfolio of the best SURGE and the highest price performance and selling stocks in the portfolio of the poorest SURGE and the lowest price performance. Panel C and Panel F present the raw returns and risk-adjusted of the 25 portfolios independently sorted on SUE and on prior price performance. The returns of a earnings-price combined momentum strategy is obtained by buying stocks in the portfolio of the best SUE and the highest price performance and selling stocks in the portfolio of the poorest SUE and the lowest price performance. We also present the arbitrage returns and risk-adjusted arbitrage returns of single sorted portfolios based on the quintiles of price performance, SUE or SURGE at the bottom (and on the right hand side) of each panel for the purpose of comparisons. Risk-adjusted return is the intercept of the Fama–French 3-factor regression where the dependent variable is the arbitrage return or the excess return which is the difference between the raw return and the risk-free rate.

(historical price) is contingent upon the accompanying fundamental performance information (earnings and/or revenue), and vice versa. Our results in Panel B and Panel C of Table 7 suggest that stock prices suffer from a stronger conservatism bias from investors and thus delay more in their adjustment to firm fundamental performance information (earnings or revenue) when those stocks experience good news, instead of bad news, as to market performance (prior returns). This then leads to greater earnings or revenue momentum returns for winner stocks than for loser stocks. Similar scenario also leads to greater price momentum returns for high-SUE or high-SURGE stocks than for low-SUE or low-SURGE stocks.

This would mean that investors are subject to a conservatism bias that is asymmetric with respect to good news vis-à-vis bad news. That is, investors tend to be even more conservative in reacting to information on firm fundamental performance (market performance) for stocks issuing good news than those issuing bad news about their market performance (fundamental performance).

5.3. Combined momentum strategies

The negative results on dominance tests in Tables 5 and 6 mean that each of the information variables, SURGE, SUE, and prior returns, at least to some extent, independently leads to abnormal returns. This then suggests that a combined momentum strategy using more than one of these information measures should offer improved momentum profits. While Chan et al. (1996), Piotroski (2000), Griffin et al. (2005), Mohanram (2005), Sagi and Seasholes (2007), Asness et al. (2013), and Asem (2009) have examined the profitability of combined momentum strategies based on other measures, to the best of our knowledge, we offer the first evidence on the profitability of combined momentum strategies using the three most accessible information on firm performance, i.e., prior returns, earnings surprises, and revenue surprises altogether.

5.3.1. Bivariate combined momentums

Table 8 compares and analyzes the combined momentum returns. Panel A shows raw and FF-3 factor adjusted returns to momentum strategies based on one-way, two-way, and three-way sorts. We start with bivariate combined momentums.

If we buy stocks with the highest SURGE and the highest SUE (R5 × E5) while selling stocks with the lowest SURGE and the lowest SUE (R1 × E1), such a *revenue-and-earnings combined momentum strategy* yields a monthly return as high as 0.81%, which is higher than the univariate momentum return earned solely on the basis of revenue surprises (0.47%) or earnings surprises (0.58%) when using quintile portfolios. This result is also a consequence of our observation that the sorted portfolio returns increase monotonically with both SURGE and SUE.

Panel A of Table 8 also shows that investors earn an average monthly return of 1.09% by buying stocks with the highest SURGE and the most winning prior returns (R5 × P5) and selling stocks with the lowest SURGE and the most losing prior returns (R1 × P1). This *revenue-and-price combined momentum strategy* again outperforms the simple revenue momentum (0.47%) and the simple price momentum strategy (0.72%). Similarly, an *earnings-and-price combined momentum strategy* offers an average monthly return of 1.18%, which outperforms the univariate earnings momentum (0.58%) and the price momentum strategy (0.72%).

Note that the strategy using SURGE and SUE yields a return (0.81%) poorer than that using SURGE and prior returns (1.09%) or that using SUE and prior returns (1.18%). This suggests that it is important to take advantage of market information (prior returns) as well as firm fundamental information (SURGE and SUE) when it comes to formulation of investment strategies.

Table 8
Comparisons of assorted single and combined momentum strategies.

One-way sorts			Two-way sorts			Three-way sorts		
Momentum strategy	Raw return	Adj. return	Momentum strategy	Raw return	Adj. return	Momentum strategy	Raw return	Adj. return
Panel A. Summary of momentum returns from various single/multiple sorting criteria								
Mom(R)	0.0047***	0.0063***	Mom(R + E)	0.0081***	0.0097***	Mom(R + E + P)	0.0144***	0.0168***
	(4.42)	(6.77)		(6.25)	(7.86)		(6.06)	(7.12)
Mom(E)	0.0058***	0.0063***	Mom(R + P)	0.0109***	0.0136***			
	(8.17)	(8.81)		(4.53)	(5.75)			
Mom(P)	0.0072***	0.0087***	Mom(E + P)	0.0118***	0.0133***			
	(3.36)	(4.01)		(6.25)	(6.09)			
Incremental return contribution of revenue momentum			Incremental return contribution of earnings momentum			Incremental return contribution of price momentum		
Diff. in momentum strategies	Return difference		Diff. in momentum strategies	Return difference		Diff. in momentum strategies	Return difference	
Panel B. Contribution of momentum returns from single prior performance information								
Mom(R + P) − Mom(P)	0.0038***		Mom(E + P) − Mom(P)	0.0048***		Mom(E + P) − Mom(E)	0.0061***	
	(3.91)			(6.69)			(3.48)	
Mom(R + E) − Mom(E)	0.0023**		Mom(R + E) − Mom(R)	0.0035***		Mom(R + P) − Mom(R)	0.0063***	
	(2.28)			(5.76)			(3.58)	
Mom(R + E + P) − Mom(P + E)	0.0024***		Mom(R + E + P) − Mom(R + P)	0.0033***		Mom(R + E + P) − Mom(R + E)	0.0062***	
	(2.7)			(4.47)			(4.04)	
Incremental return contribution of (revenue + earnings) momentum			Incremental return contribution of (revenue + price) momentum			Incremental return contribution of (earnings + price) momentum		
Diff. in momentum strategies	Return difference		Diff. in momentum strategies	Return difference		Diff. in momentum strategies	Return difference	
Panel C. Contribution of momentum returns from multiple prior performance information								
Mom(R + E + P) − Mom(P)	0.0072***		Mom(R + E + P) − Mom(E)	0.0085***		Mom(R + E + P) − Mom(R)	0.0096***	
	(5.47)			(4.38)			(5.54)	

This table presents the return contribution by considering additional sorting criterion, being revenue surprises, earnings surprises or prior returns. In the table, ***R***, ***E***, and ***P*** respectively refer to revenue momentum, earnings momentum, and price momentum strategy. Momentum strategies based on combined criteria are indicated with plus signs. For example, ***R*** + ***P*** denotes *revenue-price combined momentum strategy*, that is, R5 × P5 − R1 × *P*1. Panel A summarizes raw returns and risk-adjusted returns obtained from momentum strategies based on one-way sorts, two-way sorts, and three-way sorts. Risk-adjusted return is the intercept of the Fama–French 3-factor regression on raw return. Panel B lists the return contributions of each additional sorting criterion based on the return differences. The associated *t*-statistics are in parentheses. Panel C lists the incremental returns obtained by applying additional two sorting criteria. All returns are expressed as monthly returns.

** Indicate statistical significance at 5%.

*** Indicate statistical significance at 1%.

5.3.2. Multivariate combined momentums

Next, we further sort stocks into quintiles independently and simultaneously based on SURGE, SUE, and prior price performance to obtain three-way sorted portfolios. A *revenue-earnings-price combined momentum* strategy is performed by buying the stocks with the most positive revenue surprises, the most positive earnings surprises, and the highest prior returns (R5 × E5 × P5), and selling the stocks with the most negative revenue surprises, the most negative earnings surprises, and the lowest prior returns (R1 × E1 × P1). This leads to a monthly momentum return of 1.44%, which provides the highest investment returns of all the paired momentum strategies discussed so far.

Panels B and C of Table 8 present the differences in portfolio performance, which indicate the incremental contribution to momentum portfolio returns from each additional sorting criterion. The results are straightforward. The joint consideration of each additional performance measure, whether it is revenue surprises, earnings surprises, or prior returns, helps improve the profits of momentum strategies significantly. The net contribution from price momentum is the greatest (0.62%), followed by earnings momentum (0.33%), and then revenue momentum (0.24%). This result further supports the argument that revenue, earnings, and price all convey to some extent exclusive but unpriced information.

5.3.3. Dependent sorts versus independent sorts

With highly correlated sorting criteria, as indicated in Table 2, independent multiple sorts may result in portfolios with limited numbers of stocks and therefore insufficient diversification. This will then lead to results that might be confounded by factors other than the intended sorting features. More important, only dependent sorts provide a way to identify the precise conditional momentum returns.

Table 9 presents the returns and the associated *t*-statistics for two-way and three-way sorted combined momentum strategies using independent sorts and dependent sorts in different orders. For two-way sorted combined momentum strategies, dependent sorts are found to generate returns that are insignificantly different from those from independent sorts. For three-way sorted combined momentum strategies, however, the results are found to vary significantly with the sorting method. The three-way dependent sorts, in any order, yield investment strategies that significantly outperform those using independent sorts; independent sorts create an average monthly return of 1.44%, while dependent sorts lead to an average monthly return ranging from 1.66% to 1.89%. Yet to take advantage of a more simplified presentation, we report results from only independent sorts in Tables 7 and 8. Note that the general conclusions we have drawn remain unchanged with dependent sorts.

6. Persistency and seasonality

6.1. Persistence of momentum effects

We next examine the persistence of momentum effects driven by revenue surprises, earnings surprises, and prior price performance. Stock prices tend to adjust slowly to information, and abnormal returns will not continue once information is fully incorporated into prices. Following the argument of conservatism bias (see Edwards, 1968; and Barberis et al., 1998), an examination of the persistence of momentum returns will reveal the speed of adjustment in reaction to revenue surprises, earnings surprises, and prior returns. More interestingly, the variations of persistence in conditional momentums will demonstrate how one element of information (e.g., revenue surprises) affects the speed of adjustment to another (e.g., prior returns).

Table 10 presents the cumulative returns from revenue, earnings, and price momentum strategies. The formation period is kept at 6 months, and the cumulative returns are calculated up to 36 months after the event time. Panel A shows that the zero-investment portfolios built upon revenue surprises maintain their return momentum for 6 months. The buy-and-hold returns drop to insignificance 21 months after the portfolio formation. In Panel

Table 9
Returns of combined momentum strategies – a comparison between dependent sorts and independent sorts.

Momentum Strategies	Independent sorts	Dependent sorts					
		SURGE | SUE	SUE | SURGE				
Mom(R + E)	0.0081***	0.0084***	0.0088***				
	(6.25)	(6.95)	(6.88)				
Dep_sorts – Indep_sorts (*t*-statistic only)		(0.55)	(1.49)				
		P6 | SURGE	SURGE | P6				
Mom(R + P)	0.0109***	0.0104***	0.0106***				
	(4.53)	(4.66)	(5.19)				
Dep_sorts – Indep_sorts (*t*-statistic only)		(−1.17)	(−0.57)				
		P6 | SUE	SUE | P6				
Mom(E + P)	0.0118***	0.0111***	0.0115***				
	(5.47)	(5.24)	(6.20)				
Dep_sorts – Indep_sorts (*t*-statistic only)		(−1.76)	(−0.55)				
		P6|SURGE|SUE	SURGE|P6|SUE	P6|SUE|SURGE	SUE|P6|SURGE	SURGE|SUE|P6	SUE|SURGE|P6
Mom(R + E + P)	0.0144***	0.0175***	0.0166***	0.0189***	0.0188***	0.0171***	0.0168***
	(6.06)	(4.16)	(4.12)	(4.29)	(4.45)	(4.47)	(4.36)
Dep_sorts – Indep_sorts (*t*-statistic only)		(1.86)	(1.45)	(2.44)	(2.60)	(1.61)	(1.39)

This table presents returns and the associated *t*-statistics from two-way and three-way sorted combined momentum strategies, which are formed using independent sorts or dependent sorts. A momentum strategy formed on the basis of multiple criteria, which we call combined momentum strategy, is said to apply independent sorts if portfolios are independently sorted into quintiles according to their SURGE, SUE, and prior price performance, with the partition points being independent across these criteria. A combined momentum strategy is said to apply dependent sorts if portfolios are sorted into quintiles according to their SURGE, SUE, and prior price performance, with a particular sorting order. For example, a two-way sorted momentum strategy based on SURGE and SUE using dependent sorts could be formed by first sorting on SURGE then on SUE (*SUE|SURGE*) or first sorting on SUE then on SURGE (*SURGE|SUE*). We present here the returns of momentum strategies following all possible sequences of two-way dependent sorts and three-way dependent sorts.

*** Indicate statistical significance at 1%.

Table 10
Cumulative returns from revenue, earnings, and price momentum strategies.

t (month)	Negative SURGE (%)	Positive SURGE (%)	PMN (%)	*t* (month)	Negative SUE (%)	Positive SUE (%)	PMN (%)	*t* (month)	Loser (%)	Winner (%)	WMN (%)
Panel A. Revenue momentum				*Panel B. Earnings momentum*				*Panel C. Price momentum*			
1	0.68	1.69	1.02***	1	0.66	1.83	1.17***	1	1.12	1.48	0.36
2	1.50	3.26	1.75***	2	1.53	3.47	1.94***	2	1.96	3.19	1.23***
3	2.45	4.66	2.21***	3	2.50	4.95	2.44***	3	2.79	4.76	1.97***
4	3.57	6.06	2.49***	4	3.59	6.42	2.83***	4	3.69	6.42	2.74***
5	4.78	7.49	2.71***	5	4.76	7.92	3.17***	5	4.67	8.10	3.4 ***
6	6.13	8.87	2.75***	6	5.97	9.40	3.43***	6	5.66	9.86	4.21***
7	7.49	10.21	2.72***	7	7.19	10.80	3.61***	7	6.64	11.62	4.99***
8	8.92	11.51	2.59***	8	8.51	12.14	3.63***	8	7.76	13.21	5.45***
9	10.40	12.82	2.42***	9	9.88	13.50	3.62***	9	9.00	14.77	5.78***
10	11.93	14.02	2.09***	10	11.27	14.75	3.49***	10	10.22	16.18	5.95***
11	13.44	15.19	1.76***	11	12.66	16.00	3.34***	11	11.52	17.54	6.02***
12	14.95	16.39	1.44***	12	14.05	17.33	3.28***	12	12.91	18.80	5.89***
13	16.26	17.57	1.31***	13	15.28	18.69	3.41***	13	14.31	19.91	5.60***
14	17.59	18.78	1.19***	14	16.49	20.05	3.57***	14	15.73	21.04	5.31***
15	18.86	20.01	1.15***	15	17.66	21.42	3.76***	15	17.13	22.19	5.06***
16	20.23	21.33	1.09**	16	18.95	22.89	3.94***	16	18.64	23.43	4.79***
17	21.61	22.67	1.07**	17	20.26	24.41	4.15***	17	20.15	24.72	4.57***
18	22.96	24.03	1.07**	18	21.56	25.94	4.37***	18	21.59	26.09	4.50***
19	24.40	25.38	0.98**	19	22.90	27.44	4.54***	19	22.91	27.71	4.79***
20	25.94	26.79	0.85*	20	24.34	28.95	4.62***	20	24.33	29.29	4.96***
21	27.45	28.13	0.68	21	25.77	30.41	4.64***	21	25.79	30.89	5.10***
22	28.91	29.48	0.57	22	27.21	31.88	4.67***	22	27.23	32.38	5.14***
23	30.37	30.91	0.54	23	28.67	33.39	4.72***	23	28.74	33.90	5.17***
24	31.83	32.38	0.55	24	30.18	34.90	4.72***	24	30.29	35.41	5.12***
25	33.24	33.79	0.54	25	31.62	36.36	4.74***	25	31.87	36.67	4.79***
26	34.68	35.19	0.51	26	33.11	37.80	4.69***	26	33.48	38.00	4.52***
27	36.08	36.57	0.49	27	34.54	39.22	4.68***	27	35.03	39.29	4.26***
28	37.53	37.98	0.45	28	36.01	40.69	4.67***	28	36.67	40.61	3.94***
29	39.06	39.41	0.35	29	37.52	42.18	4.66***	29	38.38	41.90	3.53***
30	40.58	40.85	0.26	30	39.04	43.62	4.58***	30	40.00	43.31	3.31***
31	42.13	42.38	0.25	31	40.54	45.14	4.60***	31	41.54	44.86	3.32***
32	43.77	43.93	0.16	32	42.08	46.66	4.59***	32	43.10	46.50	3.39***
33	45.38	45.44	0.06	33	43.60	48.14	4.53***	33	44.70	48.09	3.39***
34	46.96	46.95	−0.01	34	45.11	49.62	4.51***	34	46.35	49.61	3.27***
35	48.49	48.46	−0.03	35	46.59	51.20	4.60***	35	47.86	51.15	3.29***
36	50.06	49.97	−0.10	36	48.15	52.80	4.65***	36	49.46	52.68	3.22***

This table reports the cumulative returns of zero-cost momentum portfolio in each month following the formation period. *t* is the month after portfolio formation. Three different momentum strategies are tested. The sample period is from 1974 through 2009. Panel A reports the results from the revenue momentum strategy, where sample firms are grouped into five groups based on the measure SURGE during each formation month. The revenue momentum portfolios are formed by buying stocks with the most positive SURGE and selling stocks with the most negative SURGE. Listed are the cumulative portfolio returns for the portfolio with the most negative SURGE, the portfolio with the most positive SURGE, and the revenue momentum portfolio. Panel B reports the results from the earnings momentum strategy, where firms are grouped into five groups based on the measure SUE during each formation month. The earnings momentum portfolios are formed by buying stocks with the most positive SUE and selling stocks with the most negative SUE. Listed are the cumulative portfolio returns for the portfolio with the most negative SUE, the portfolio with the most positive SUE, and the earnings momentum portfolio. Panel C reports the results from the price momentum strategy. The price momentum portfolios are formed by buying Quintile 1 (winner) stocks and selling Quintile 5 (loser) stocks on the basis of previous six months returns. Listed are the cumulative portfolio returns for the loser portfolio, the winner portfolio, and the price momentum portfolio.

* Indicate statistical significance at 10%.
** Indicate statistical significance at 5%.
*** Indicate statistical significance at 1%.

B, the profits of earnings momentum portfolios, although are not as high as on price momentum in the short term, demonstrate greater persistence than price momentum, with the cumulative returns continuing to drift upward for 25 months after portfolio formation. The cumulative returns still remain significant at 4.65% 3 years after portfolio formation. Panel C shows that the profits to price momentum portfolio drift upward for 11 months after portfolio formation and start to reverse thereafter. The cumulative returns remain significant at 3.22% on monthly terms 36 months after portfolio formation.

Fig. 1 compares the cumulative returns to those three univariate momentum strategies. Price momentum generates the highest cumulative returns in the short term (for a 1 year holding period), while earnings momentum demonstrates the most persistent performance, as cumulative returns continue to grow up to 2 years after portfolio formation. On the other hand, the payoffs to revenue momentum seem to be neither as persistent nor as strong as the other two strategies.

Fig. 2 presents the cumulative returns for momentum strategies conditional on alternative performance measures. Fig. 2A and B present the cumulative returns of revenue momentum conditional on high-low SUEs and prior returns. They show that the revenue momentums remain short-lived, regardless of the level of SUE or the level of prior returns. The portfolio returns to a revenue momentum strategy with loser stocks not only quickly dissipate in the short term and actually reverse to negative returns starting 7 months after portfolio formation.

Fig. 2C and D demonstrate the cumulative returns for earnings momentums conditional on high-low SURGE and prior returns. Fig. 2C shows that the earnings momentum returns remain similar for the low-SURGE and the high-SURGE stocks during the first 20 months after portfolio formation. Such finding of momentum contingencies in fact conforms to our results in Panel A of Table 8. More interesting, as we hold the portfolio for over 20 months, the earnings momentum strategy with low-SURGE stocks starts deteriorating while the strategy with high-SURGE stocks still maintain

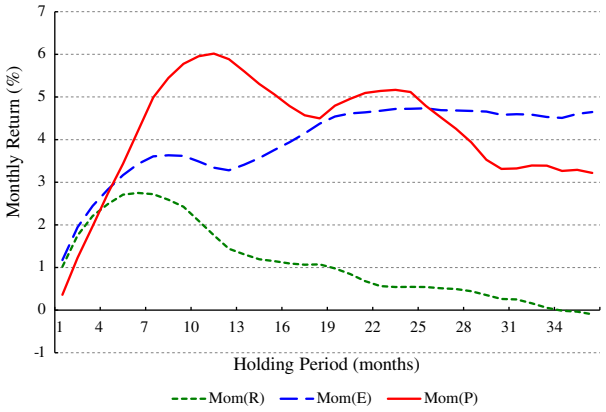

Fig. 1. Persistence of momentum effects. This figure shows the average cumulative returns of relative strength portfolios with respect to revenue surprises, earnings surprises, and prior price performance. The relative strength portfolio is buying stocks in highest quintile and selling stocks in lowest quintile on every formation date, and holding for 36 months. The cumulative returns are calculated by adding monthly returns from formation month t to month $t + i$.

significantly positive returns up to 36 months after the portfolio formation. Fig. 2D, on the other hand, shows that earnings momentum effects are both greater and longer-lasting for winner stocks than for loser stocks. The caveat on investment strategy is that earnings momentum returns are higher and more longer-lived when applied over stocks with superior price history in the past 6 months.

In Fig. 2E and F, price momentum strategies yield higher and more persistent returns for stocks with positive SUE or SURGE than for stocks with negative SUE or SURGE. A comparison of Fig. 2E and F also finds that high-SURGE serves as a more effective driver than high-SUE for stocks to exhibit greater and more persistent price momentum.

These observations on momentum persistence provide further support for our claim on momentum cross-contingencies. We find that the persistence of a momentum, just like the magnitude of the momentum returns, depends on the accompanying condition of another firm information. Such cross-contingencies are again not as strong in the relation between revenue momentum and SUE or between earnings momentum and SURGE, as shown in Fig. 2A and C. Results suggest that investors update their expectations based on the joint information of revenue surprises, earnings surprises, and prior price performance, and the speed of adjustment to firm fundamental information (SURGE or SUE) depends on the prevailing content of firm market information (prior returns), and vice versa.

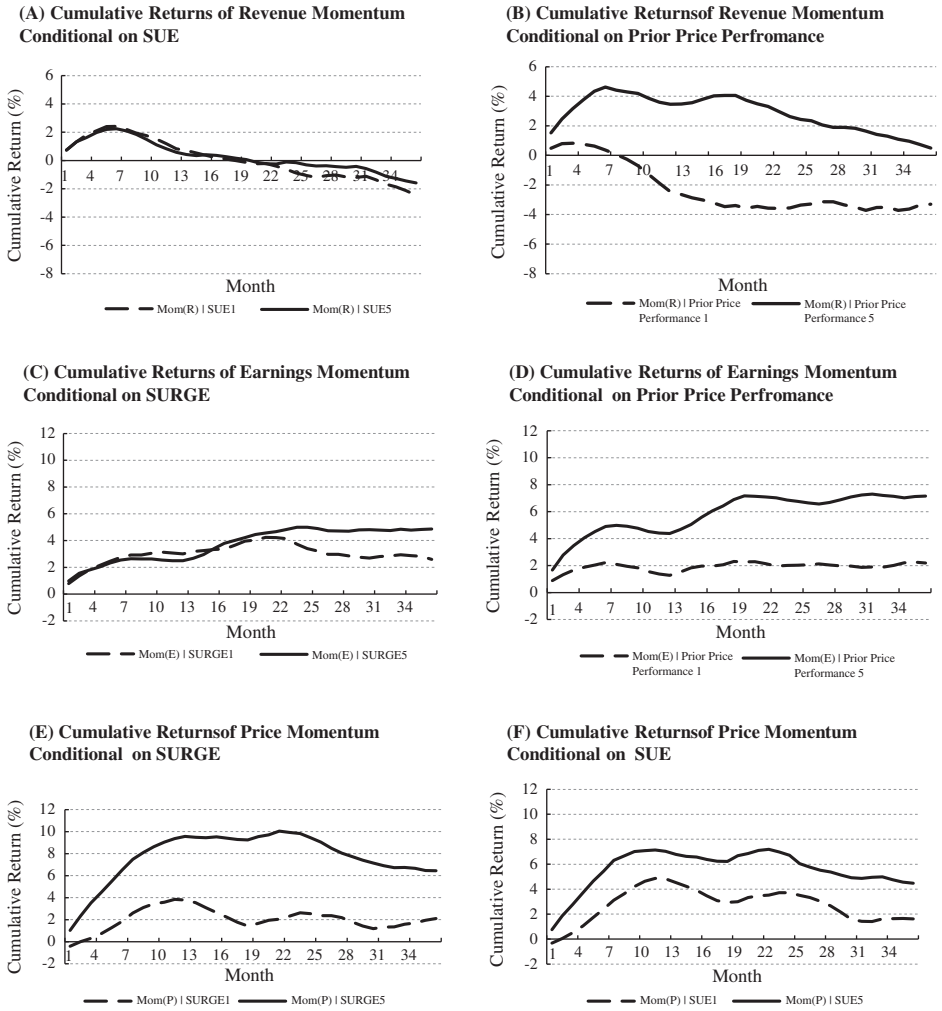

Fig. 2. Cumulative returns of momentum effect conditional on performance measure. These figures show the average cumulative returns of relative strength portfolio with respect to revenue surprises, earnings surprises, and prior price performance conditional on one another. The holding period is up to 36 months. The cumulative profits are calculated by adding monthly returns from formation month t to month $t + i$.

Table 11
Returns of momentum strategies in January and Non-January Months.

Momentum strategies	All months	Jan.	February–December	*F*-statistic	*p*-Value
Mom(R)	0.0047***	−0.0061	0.0057***	31.66	<0.01
	(4.42)	(−1.59)	(5.19)		
Mom(E)	0.0058***	0.0026	0.0061***	6.12	0.01
	(8.17)	(0.72)	(8.67)		
Mom(P)	0.0072***	−0.0134	0.0090***	28.28	<0.01
	(3.36)	(−1.32)	(4.25)		
Mom(R + E)	0.0081***	−0.0062	0.0094***	37.42	<0.01
	(6.25)	(−1.09)	(7.22)		
Mom(R + P)	0.0109***	−0.0164	0.0134***	40.05	<0.01
	(4.53)	(−1.44)	(5.62)		
Mom(E + P)	0.0118***	−0.0082	0.0136***	26.18	<0.01
	(5.47)	(−0.73)	(6.48)		
Mom(R + E + P)	0.0144***	−0.0131	0.0169***	41.72	<0.01
	(6.06)	(−1.11)	(7.26)		

This table presents average monthly returns and the associated *t*-statistics for the returns obtained from single momentum strategies, two-way sorted combined momentum strategies, and two-way sorted combined momentum strategies for all calendar months, for January, and for non-January months. The *F*-statistics and *p*-values are computed under the hypothesis that the returns to momentum strategies are equal in January and non-January months.
*** Indicate statistical significance at 1% respectively.

6.2. Seasonality

Jegadeesh and Titman (1993), Heston and Sadka (2008), Asness et al. (2013), Novy-Marx (2012), and Yao (2012) find that prior return winners outperform losers in all months except January, leading to positive profits for a price momentum strategy in all months except January but negative profits for that strategy in January. Chordia and Shivakumar (2006) also find significant seasonality effects in returns to the earnings momentum strategy. Do a revenue momentum strategy and combined momentum strategies exhibit similar seasonalities?

Table 11 presents results for tests of seasonal patterns in returns to univariate momentum strategies and combined momentum strategies. For all types of momentum strategies, momentum profits in January are either negative or insignificantly different from zero. *F*-tests reject the hypothesis that the returns to momentum strategies are equal in January and non-January months. We therefore conclude that, as in finding elsewhere, there is seasonality in momentum strategies, and revenue surprises, earnings, surprises, and prior returns all yield significantly positive returns only in non-January months.

7. Conclusions

This paper focuses on the three firm performance information that receive most attentions from investors – revenue, earnings and price. We attempt to understand how investors incorporate those information variables altogether in stock prices. Multivariate momentums are therefore used as a venue in the exploration. We provide new evidence that a revenue momentum strategy yields an average monthly return of 0.61%, and remain significant after adjustment for market factor and FF-3 factors. Compared to the results of price momentum and earnings momentum, revenue momentum is less profitable and relatively short-lived.

Dominance tests show that none of the three momentum strategies generate returns that can be fully captured by the information driving an alternative strategy. This finding answers our first research question, and suggests that revenue surprises, earnings surprises, and prior returns each carry some unpriced information that is exclusive to itself. In particular, the information conveyed by revenue surprises and/or earnings surprises only makes a limited contribution to price momentum. The overall evidence indicates that while revenue serves as a base for a firm's earnings and stock valuation, revenue momentum neither drives nor rides earnings or price momentum.

Our second research question inquires how investors process the joint implications of multiple firm performance information. The results from double sorted portfolios find that next-period returns increase monotonically with each information variable, and the highest (lowest) abnormal return occurs for stocks receiving the best (worst) news in both variables. We further observe cross-contingencies of momentum profits in that momentum returns driven by fundamental performance information (SUE or SURGE) are positively associated with the accompanying market performance information (prior returns), and the reverse holds as well. For example, earnings/revenue momentum strategies with winner stocks yield higher returns than with loser stocks; a price momentum strategy with stocks with higher SURGE/SUE yields higher returns than with lower SURGE/SUE stocks. This pattern would mean that investors are subject to a conservatism bias that is asymmetric with respect to good news vis-à-vis bad news. The above findings are consistent with the claim that investors underestimate the joint implications of revenue surprises, earnings surprises, and prior returns, particularly when they point in the same direction. The speed of adjustment to firm fundamental information also depends on the accompanying market information, and vice versa.

The persistence of profitability also varies amongst the three momentums and exhibits inter-dependency. An earnings momentum strategy is found to present the strongest persistence, while the revenue momentum strategy is the shortest-lived among the three, except when the strategy is executed over price winner stocks. In general, the speed of adjustment to firm fundamental information also depends on the accompanying market information, and vice versa. Exploiting sources of momentums from three information variables altogether, a combined momentum strategy using independent sorts yields a monthly return of 1.44%, amounting to an annual return as high as 17.28%. The net contribution from prior return information is the greatest, followed by earnings surprises, and then revenue surprises.

Revenue, earnings, and historical prices are the most readily available firm performance information that investors use for stock evaluation. The pricing effect from investors' joint consideration of revenue, earnings, and prior returns is yet well explored in the finance literature. Our results are serving as useful guidance for asset managers identifying profitable investment strategies and for

financial economists understanding the source of momentums in future research.

Appendix A. Measures of earnings and revenue surprises

The literature provides a variety of measures to estimate earnings and revenue surprises. There are generally two approaches to building the measures; one is based on historical earnings/revenue data and the other on analysts' forecasts.

The empirical literature demonstrates consistent post-earnings-announcement drift, whichever method is used to measure the earnings surprises. For example, Foster et al. (1984) and Bernard and Thomas (1989) assume that the differences in quarterly earnings per share follow an AR(1) process, and find that firms with highly unexpected earnings outperform firms with poor unexpected earnings. Chan et al. (1996) analyze earnings momentum effects by applying three different earnings surprise measures built upon a seasonal random walk model, cumulative abnormal stock returns around the announcement date, and changes in analyst earnings forecasts. Jegadeesh and Livnat (2006a) use a seasonal random walk model with a drift and an analysts' forecast model to estimate earnings surprises, and find both approaches can capture the drift following earnings surprises.

Empirical research however finds inconsistent results as to whether revenues or expenses provide added information content over earnings, mostly thanks to the different measures being applied (e.g., see Hopwood and McKeown, 1985; Swaminathan and Weintrop, 1991; Ertimur et al., 2003; Rees and Sivamakrishnan, 2001; Jegadeesh and Livnat, 2006b). There are particular advantages and disadvantages when it comes to estimating expected earnings/revenues according to historical data or analyst forecast data. Considering that Compustat reports only restated accounting data, historical data on earnings/revenues might suffer a look-ahead bias to the extent that some input data are not available at the time we calculate earnings and revenue surprises. The analyst forecast approach has the advantage that it does not suffer from a potential look-ahead bias problem, and allows us to include in our sample young firms that do not have the accounting data required by the historical data approach. Its major disadvantage is that a sample will be limited to firms with analyst forecast data available.

Our study requires not only earnings forecast data but also revenue forecast data, which are not available from IBES until 1996, although even after 1996 many IBES sample firms still lack revenue forecasts. With such a restriction, the empirical results might be biased and lose their generality. Weighing the pros and cons, we elect to borrow the approach of Jegadeesh and Livnat (2006a, 2006b) and measure earnings surprises and revenue surprises on the basis of historical earnings and revenues.

Specifically, we follow Jegadeesh and Livnat (2006b) and assume that quarterly earnings per share follow a seasonal random walk with a drift. We use the earnings per share in the same quarter of the previous year, instead of earnings per share in the previous quarter, to proxy for the earnings expectation; this approach takes into account the seasonality of earnings. We also accommodate a possible trend in earnings growth by including a drift term in the expected earnings. The drift term, $\delta^E_{i,t}$, is calculated from the average growth of previous eight quarters. Expected quarterly earnings per share for firm i and quarter t are estimated by

$$E\left(Q^E_{i,t}\right) = Q^E_{i,t-4} + \delta^E_{i,t}, \tag{A.1}$$

and

$$\delta^E_{i,t} = \frac{\sum_{j=1}^{8}\left(Q^E_{i,t-j} - Q^E_{i,t-j-4}\right)}{8}. \tag{A.2}$$

The estimator for the standard deviation of quarterly earnings growth, $\sigma^E_{i,t}$, for computing earnings surprises is

$$\sigma^E_{i,t} = \frac{1}{7}\sqrt{\sum_{j=1}^{8}\left[Q^E_{i,t-j} - E\left(Q^E_{i,t-j}\right)\right]^2}. \tag{A.3}$$

We therefore define our measure of SUE for i in quarter t as Eq. (1) in the text:

$$SUE_{i,t} = \frac{Q^E_{i,t} - E\left(Q^E_{i,t}\right)}{\sigma^E_{i,t}}. \tag{1}$$

The same method is applied to measure revenue surprises. To deal with possible seasonal effects and trend effects in quarterly revenues, we again assume the quarterly revenue follows a seasonal random walk with a drift. That is, the expected quarterly revenue per share and the drift term are estimated as:

$$E\left(Q^R_{i,t}\right) = Q^R_{i,t-4} + \delta^R_{i,t} \tag{A.4}$$

and

$$\delta^R_{i,t} = \frac{\sum_{t=1}^{8}\left(Q^R_{i,t-j} - Q^R_{i,t-j-4}\right)}{8}. \tag{A.5}$$

For computing revenue surprises, the standard deviation of quarterly revenue growth is estimated by the year-to-year growth of revenue for the prior eight quarters:

$$\sigma^R_{i,t} = \frac{1}{7}\sqrt{\sum_{j=1}^{8}\left[Q^R_{i,t-j} - E\left(Q^R_{i,t-j}\right)\right]^2}. \tag{A.6}$$

Therefore the measure of revenue surprises is defined as Eq. (2) in the text:

$$SURGE_{i,t} = \frac{Q^R_{i,t} - E\left(Q^R_{i,t}\right)}{\sigma^R_{i,t}}. \tag{2}$$

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