THE JOURNAL OF FINANCE • VOL. XLVIII, NO. 1 • MARCH 1993

Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency

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ABSTRACT

This paper documents that strategies which buy stocks that have performed well in the past and sell stocks that have performed poorly in the past generate significant positive returns over 3- to 12-month holding periods. We find that the profitability of these strategies are not due to their systematic risk or to delayed stock price reactions to common factors. However, part of the abnormal returns generated in the first year after portfolio formation dissipates in the following two years. A similar pattern of returns around the earnings announcements of past winners and losers is also documented.

A POPULAR VIEW HELD by many journalists, psychologists, and economists is that individuals tend to overreact to information.[1] A direct extension of this view, suggested by De Bondt and Thaler (1985, 1987), is that stock prices also overreact to information, suggesting that contrarian strategies (buying past losers and selling past winners) achieve abnormal returns. De Bondt and Thaler (1985) show that over 3- to 5-year holding periods stocks that performed poorly over the previous 3 to 5 years achieve higher returns than stocks that performed well over the same period. However, the interpretation of the De Bondt and Thaler results are still being debated. Some have argued that the De Bondt and Thaler results can be explained by the systematic risk of their contrarian portfolios and the size effect.[2] In addition, since the long-term losers outperform the long-term winners only in Januaries, it is unclear whether their results can be attributed to overreaction.

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[1]See for example, the academic papers by Kahneman and Tversky (1982), De Bondt and Thaler (1985) and Shiller (1981).

[2]See for example, Chan (1988), Ball and Kothari (1989), and Zarowin (1990). For an alternate view, see the recent paper by Chopra, Lakonishok, and Ritter (1992).

More recent papers by Jegadeesh (1990) and Lehmann (1990) provide evidence of shorter-term return reversals. These papers show that contrarian strategies that select stocks based on their returns in the previous week or month generate significant abnormal returns. However, since these strategies are transaction intensive and are based on short-term price movements, their apparent success may reflect the presence of short-term price pressure or a lack of liquidity in the market rather than overreaction. Jegadeesh and Titman (1991) provide evidence on the relation between short-term return reversals and bid-ask spreads that supports this interpretation. In addition, Lo and MacKinlay (1990) argue that a large part of the abnormal returns documented by Jegadeesh and Lehmann is attributable to a delayed stock price reaction to common factors rather than to overreaction.

Although contrarian strategies have received a lot of attention in the recent academic literature, the early literature on market efficiency focused on relative strength strategies that buy past winners and sell past losers. Most notably, Levy (1967) claims that a trading rule that buys stocks with current prices that are substantially higher than their average prices over the past 27 weeks realizes significant abnormal returns. Jensen and Bennington (1970), however, point out that Levy had come up with his trading rule after examining 68 different trading rules in his dissertation and because of this express skepticism about his conclusions. Jensen and Bennington analyze the profitability of Levy's trading rule over a long time period that was, for the most part, outside Levy's original sample period. They find that in their sample period Levy's trading rule does not outperform a buy and hold strategy and hence attribute Levy's result to a selection bias.

Although the current academic debate has focused on contrarian rather than relative strength trading rules, a number of practitioners still use relative strength as one of their stock selection criteria. For example, a majority of the mutual funds examined by Grinblatt and Titman (1989, 1991) show a tendency to buy stocks that have increased in price over the previous quarter. In addition, the Value Line rankings are known to be based in large part on past relative strength. The success of many of the mutual funds in the Grinblatt and Titman sample and the predictive power of Value Line rankings (see Copeland and Mayers (1982) and Stickel (1985)) provide suggestive evidence that the relative strength strategies may generate abnormal returns.

How can we reconcile the success of Value Line rankings and the mutual funds that use relative strength rules with the current academic literature that suggests that the opposite strategy generates abnormal returns? One possibility is that the abnormal returns realized by these practitioners are either spurious or are unrelated to their tendencies to buy past winners. A second possibility is that the discrepancy is due to the difference between the time horizons used in the trading rules examined in the recent academic papers and those used in practice. For instance, the above cited evidence favoring contrarian strategies focuses on trading strategies based on either very short-term return reversals (1 week or 1 month), or very long-term return reversals (3 to 5 years). However, anecdotal evidence suggests that practitioners who use relative strength rules base their selections on price movements over the past 3 to 12 months.[3] This paper provides an analysis of relative strength trading strategies over 3- to 12-month horizons. Our analysis of NYSE and AMEX stocks documents significant profits in the 1965 to 1989 sample period for each of the relative strength strategies examined. We provide a decomposition of these profits into different sources and develop tests that allow us to evaluate their relative importance. The results of these tests indicate that the profits are not due to the systematic risk of the trading strategies. In addition, the evidence indicates that the profits cannot be attributed to a lead-lag effect resulting from delayed stock price reactions to information about a common factor similar to that proposed by Lo and MacKinlay (1990). The evidence is, however, consistent with delayed price reactions to firm-specific information.

Further tests suggest that part of the predictable price changes that occur during these 3- to 12-month holding periods may not be permanent. The stocks included in the relative strength portfolios experience negative abnormal returns starting around 12 months after the formation date and continuing up to the thirty-first month. For example, the portfolio formed on the basis of returns realized in the past 6 months generates an average cumulative return of 9.5% over the next 12 months but loses more than half of this return in the following 24 months.

Our analysis of stock returns around earnings announcement dates suggests a similar bias in market expectations. We find that past winners realize consistently higher returns around their earnings announcements in the 7 months following the portfolio formation date than do past losers. However, in each of the following 13 months past losers realize higher returns than past winners around earnings announcements.

The rest of this paper is organized as follows: Section I describes the trading strategies that we examine and Section II documents their excess returns. Section III provides a decomposition of the profits from relative strength strategies and evaluates the relative importance of the different components. Section IV documents these returns in subsamples stratified on the basis of ex ante beta and firm size and Section V measures these profits across calendar months and over 5-year subperiods. The longer term performance of the stocks included in the relative strength portfolios is examined in Section VI and Section VII back tests the strategy over the 1927 to 1964

[3]For instance, one of the inputs used by Value Line to assign a timeliness rank for each stock is a price momentum factor computed based on the stock's past 3- to 12-month returns. Value Line reports that the price momentum factor is computed by "dividing the stock's latest 10-week average relative price by its 52-week average relative price." These timeliness ranks, according to Value Line, are "designed to discriminate among stocks on the basis of relative price performance over the next 6 to 12 months" (see Bernard (1984), pp. 52–53).

period. Section VIII examines the returns of past winners and past losers around earnings announcement dates and Section IX concludes the paper.

I. Trading Strategies

If stock prices either overreact or underreact to information, then profitable trading strategies that select stocks based on their past returns will exist. This study investigates the efficiency of the stock market by examining the profitability of a number of these strategies. The strategies we consider select stocks based on their returns over the past 1, 2, 3, or 4 quarters. We also consider holding periods that vary from 1 to 4 quarters. This gives a total of 16 strategies. In addition, we examine a second set of 16 strategies that skip a week between the portfolio formation period and the holding period. By skipping a week, we avoid some of the bid-ask spread, price pressure, and lagged reaction effects that underlie the evidence documented in Jegadeesh (1990) and Lehmann (1990).

To increase the power of our tests, the strategies we examine include portfolios with overlapping holding periods. Therefore, in any given month t, the strategies hold a series of portfolios that are selected in the current month as well as in the previous $K - 1$ months, where K is the holding period. Specifically, a strategy that selects stocks on the basis of returns over the past J months and holds them for K months (we will refer to this as a J-month/K-month strategy) is constructed as follows: At the beginning of each month t the securities are ranked in ascending order on the basis of their returns in the past J months. Based on these rankings, ten decile portfolios are formed that equally weight the stocks contained in the top decile, the second decile, and so on. The top decile portfolio is called the "losers" decile and the bottom decile is called the "winners" decile. In each month t, the strategy buys the winner portfolio and sells the loser portfolio, holding this position for K months. In addition, the strategy closes out the position initiated in month $t - K$. Hence, under this trading strategy we revise the weights on $\frac{1}{K}$ of the securities in the entire portfolio in any given month and carry over the rest from the previous month.

The profits of the above strategies were calculated for both a series of buy and hold portfolios and a series of portfolios that were rebalanced monthly to maintain equal weights. Since the returns for these two strategies were very similar (the buy and hold strategies yielded slightly higher returns) we present only the rebalanced returns which are also used in the event study presented in Section VI.

II. The Returns of Relative Strength Portfolios

This section documents the returns of the portfolio strategies described in the last section over the 1965 to 1989 period using data from the CRSP daily returns file.[4] All stocks with available returns data in the J months preceding the portfolio formation date are included in the sample from which the buy and sell portfolios are constructed.

Table I reports the average returns of the different buy and sell portfolios as well as the zero-cost, winners minus losers portfolio, for the 32 strategies described above. The returns of all the zero-cost portfolios (i.e., the returns per dollar long in this portfolio) are positive. All these returns are statistically significant except for the 3-month/3-month strategy that does not skip a week. Many of the individual t-statistics are sufficiently large to be significant even after considering the fact that we have conducted 32 separate tests. The probability of obtaining a single t-statistic as large as 4.28 (obtained with the 12-month/3-month strategy that skips a week) with 32 observations is less than 0.0006, as given by the Bonferroni inequality.[5]

The most successful zero-cost strategy selects stocks based on their returns over the previous 12 months and then holds the portfolio for 3 months. This strategy yields 1.31% per month (shown in Panel A) when there is no time lag between the portfolio formation period and the holding period and it yields 1.49% per month (shown in Panel B) when there is a 1-week lag between the formation period and the holding period.[6] The 6-month formation period produces returns of about 1% per month regardless of the holding period. These holding period returns are slightly higher when there is a 1-week lag between the formation period and the holding period (Panel B) than when the formation and holding periods are contiguous (Panel A).

Having established that the relative strength strategies are on average quite profitable, we now examine one specific strategy in detail, the 6-month/6-month strategy that does not skip a week between the portfolio formation period and the holding period. The results for this strategy are representative of the results for the other strategies.

III. Sources of Relative Strength Profits

This section presents two simple return-generating models that allow us to decompose the excess returns documented in the last section and identify the important sources of relative strength profits. The first model allows for factor-mimicking portfolio returns to be serially correlated but requires indi-

[4]The latest version of the CRSP daily returns file at the time this study was initiated covers the July 1962 to December 1989 period. Monthly returns were obtained by compounding the daily returns recorded in this data set. Since the 12-month/12-month strategy considered here requires lagged returns data over 23 months the first full calendar year for which we could examine portfolio returns is 1965.

[5]The Bonferroni inequality provides a bound for the probability of observing a t-statistic of a certain magnitude with N tests that are not necessarily independent.

[6]De Bondt and Thaler (1985) report 1-year holding period returns in their tables that are consistent with our findings here. However, they do not examine strategies based on 1-year horizons in any detail and based on their analysis of longer horizon strategies conclude that the market overreacts.

Table I

Returns of Relative Strength Portfolios

The relative strength portfolios are formed based on J-month lagged returns and held for K months. The values of J and K for the different strategies are indicated in the first column and row, respectively. The stocks are ranked in ascending order on the basis of J-month lagged returns and an equally weighted portfolio of stocks in the lowest past return decile is the *sell* portfolio and an equally weighted portfolio of the stocks in the highest return decile is the *buy* portfolio. The average monthly returns of these portfolios are presented in this table. The relative strength portfolios in Panel A are formed immediately after the lagged returns are measured for the purpose of portfolio formation. The relative strength portfolios in Panel B are formed 1 week after the lagged returns used for forming these portfolios are measured. The t-statistics are reported in parentheses. The sample period is January 1965 to December 1989.

		Panel A				Panel B			
	J	$K=$ 3	6	9	12	$K=$ 3	6	9	12
3	Sell	0.0108	0.0091	0.0092	0.0087	0.0083	0.0079	0.0084	0.0083
		(2.16)	(1.87)	(1.92)	(1.87)	(1.67)	(1.64)	(1.77)	(1.79)
3	Buy	0.0140	0.0149	0.0152	.0156	0.0156	0.0158	0.0158	0.0160
		(3.57)	(3.78)	(3.83)	(3.89)	(3.95)	(3.98)	(3.96)	(3.98)
3	Buy-sell	0.0032	0.0058	0.0061	0.0069	0.0073	0.0078	0.0074	0.0077
		(1.10)	(2.29)	(2.69)	(3.53)	(2.61)	(3.16)	(3.36)	(4.00)
6	Sell	0.0087	0.0079	0.0072	0.0080	0.0066	0.0068	0.0067	0.0076
		(1.67)	(1.56)	(1.48)	(1.66)	(1.28)	(1.35)	(1.38)	(1.58)
6	Buy	0.0171	0.0174	0.0174	0.0166	0.0179	0.0178	0.0175	0.0166
		(4.28)	(4.33)	(4.31)	(4.13)	(4.47)	(4.41)	(4.32)	(4.13)
6	Buy-sell	0.0084	0.0095	0.0102	0.0086	0.0114	0.0110	0.0108	0.0090
		(2.44)	(3.07)	(3.76)	(3.36)	(3.37)	(3.61)	(4.01)	(3.54)
9	Sell	0.0077	0.0065	0.0071	0.0082	0.0058	0.0058	0.0066	0.0078
		(1.47)	(1.29)	(1.43)	(1.66)	(1.13)	(1.15)	(1.34)	(1.59)
9	Buy	0.0186	0.0186	0.0176	0.0164	0.0193	0.0188	0.0176	0.0164
		(4.56)	(4.53)	(4.30)	(4.03)	(4.72)	(4.56)	(4.30)	(4.04)
9	Buy-sell	0.0109	0.0121	0.0105	0.0082	0.0135	0.0130	0.0109	0.0085
		(3.03)	(3.78)	(3.47)	(2.89)	(3.85)	(4.09)	(3.67)	(3.04)
12	Sell	0.0060	0.0065	0.0075	0.0087	0.0048	0.0058	0.0070	0.0085
		(1.17)	(1.29)	(1.48)	(1.74)	(0.93)	(1.15)	(1.40)	(1.71)
12	Buy	0.0192	0.0179	0.0168	0.0155	0.0196	0.0179	0.0167	0.0154
		(4.63)	(4.36)	(4.10)	(3.81)	(4.73)	(4.36)	(4.09)	(3.79)
12	Buy-sell	0.0131	0.0114	0.0093	0.0068	0.0149	0.0121	0.0096	0.0069
		(3.74)	(3.40)	(2.95)	(2.25)	(4.28)	(3.65)	(3.09)	(2.31)

vidual stocks to react instantaneously to factor realizations. This model is used to decompose relative strength profits into two components relating to systematic risk, which would exist in an efficient market, and a third component relating to firm-specific returns, which would contribute to relative strength profits only if the market were inefficient. The second return-generating model relaxes the assumption that stocks react instantaneously to the common factor. This model enables us to evaluate the possibility that the relative strength profits arise because of a lead-lag relationship in stock prices similar to that proposed by Lo and MacKinlay (1990) as a partial explanation for short horizon contrarian profits.

A. A Simple One-Factor Model

Consider the following one-factor model describing stock returns:[7]

$$\begin{aligned} r_{it} &= \mu_i + b_i f_t + e_{it}, \\ E(f_t) &= 0 \\ E(e_{it}) &= 0 \\ \mathrm{Cov}(e_{it}, f_t) &= 0, \qquad \forall i \\ \mathrm{Cov}(e_{it}, e_{jt-1}) &= 0, \qquad \forall i \neq j \end{aligned} \tag{1}$$

where μ_i is the unconditional expected return on security i, r_{it} is the return on security i, f_t is the unconditional unexpected return on a factor-mimicking portfolio, e_{it} is the firm-specific component of return at time t, and b_i is the factor sensitivity of security i. For the 6-month/6-month strategy that we consider in the rest of this paper the length of a period is 6 months.

The superior performance of the relative strength strategies documented in the last section implies that stocks that generate higher than average returns in one period also generate higher than average returns in the period that follows. In other words, these results imply that:

$$E(r_{it} - \bar{r}_t | r_{it-1} - \bar{r}_{t-1} > 0) > 0$$

and

$$E(r_{it} - \bar{r}_t | r_{it-1} - \bar{r}_{t-1} < 0) < 0,$$

where a bar above a variable denotes its cross-sectional average.

Therefore,

$$E\{(r_{it} - \bar{r}_t)(r_{it-1} - \bar{r}_{t-1})\} > 0. \tag{2}$$

The above cross-sectional covariance equals the expected profits from the zero-cost contrarian trading strategy examined by Lehmann (1990) and Lo and MacKinlay (1990) that weights stocks by their past returns less the past equally weighted index returns. This weighted relative strength strategy (WRSS) is closely related to our strategy. The WRSS yields a profit of 4.5% per dollar long semiannually (t-statistic = 2.99) and the correlation between the returns of this strategy and that of the trading strategy examined in the last section is 0.95. The equally weighted decile portfolios are used in most of our empirical tests since they provide relatively more information than the WRSS. However, as the following analysis demonstrates, the closely related WRSS provides a tractable framework for analytically examining the sources of relative strength profits and evaluating the relative importance of each of these sources.

[7]Our analysis in this subsection is similar to that in Jegadeesh (1987) and Lo and MacKinlay (1990).

Given the one-factor model defined in (1), the WRSS profits given in expression (2) can be decomposed into the following three terms:

$$E\{(r_{it} - \bar{r}_t)(r_{it-1} - \bar{r}_{t-1})\} = \sigma_\mu^2 + \sigma_b^2 \mathrm{Cov}(f_t, f_{t-1}) + \overline{\mathrm{Cov}}_i(e_{it}, e_{it-1}), \tag{3}$$

where σ_μ^2 and σ_b^2 are the cross-sectional variances of expected returns and factor sensitivities respectively.

The above decomposition suggests three potential sources of the relative strength profits. The first term in this expression is the cross-sectional dispersion in expected returns. Intuitively, since realized returns contain a component related to expected returns, securities that experience relatively high returns in one period can be expected to have higher than average returns in the following period. The second term is related to the potential to time the factor. If the factor portfolio returns exhibit positive serial correlation, the relative strength strategy will tend to pick stocks with high b's when the conditional expectation of the factor portfolio return is high. As the above expression demonstrates, the extent to which relative strength strategies generate profits because of the serial correlation of the factor portfolio return is a function of the cross-sectional variance of the b's. The last term in the above expression is the average serial covariance of the idiosyncratic components of security returns.

To assess whether the existence of relative strength profits imply market inefficiency, it is important to identify the sources of the profits. If the profits are due to either the first or the second term in expression (3) they may be attributed to compensation for bearing systematic risk and need not be an indication of market inefficiency. However, if the superior performance of the relative strength strategies is due to the third term, then the results would suggest market inefficiency.

B. The Average Size and Beta of Relative Strength Portfolios

This subsection considers the possibility that relative strength strategies systematically pick high-risk stocks and benefit from the first term in expression (3). Table II reports estimates of the two most common indicators of systematic risk, the post-ranking betas of the ten 6-month/6-month relative strength portfolios and the average capitalizations of the stocks in these portfolios. The betas of the extreme past returns portfolios are higher than the average beta for the full sample. In addition, since the beta of the portfolio of past losers is higher than the beta of the portfolio of past winners, the beta of the zero-cost winners minus losers portfolio is negative. The average capitalizations of the stocks in the different portfolios show that the highest and the lowest past returns portfolios consist of smaller than average stocks, with the stocks in the losers portfolios being smaller than the stocks in the winners portfolio. This evidence suggests that the observed relative strength profits are not due to the first source of profits in expression (3).

Table II

Betas and Market Capitalization of Relative Strength Portfolios

The relative strength portfolios are formed based on 6-month lagged returns and held for 6 months. The stocks are ranked in ascending order on the basis of 6-month lagged returns. The equally weighted portfolio of stocks in the lowest past return decile is portfolio P1, the equally weighted portfolio of stocks in the next decile is portfolio P2, and so on. The betas with respect to the value-weighted index and the average market capitalizations of the stocks included in these portfolios are reported here. The sample period is January 1965 to December 1989.

	Beta	Average Market Capitalization
P1	1.36	208.24
P2	1.19	480.07
P3	1.14	545.31
P4	1.11	618.85
P5	1.09	692.89
P6	1.08	702.51
P7	1.09	738.09
P8	1.12	758.87
P9	1.17	680.18
P10	1.28	495.13
P10–P1	−0.08	—

Additional evidence relating to the extent to which the dispersion in expected returns explains these profits is given in the next section.

C. The Serial Covariance of 6-Month Returns

This subsection examines the serial covariance of 6-month returns in order to assess the potential contribution of the second and third source of profits from our decomposition. Given the model expressed in (1), the serial covariance of an equally weighted portfolio of a large number of stocks is:[8]

$$\operatorname{cov}(\bar{r}_t, \bar{r}_{t-1}) = \bar{b}_i^2 \operatorname{Cov}(f_t, f_{t-1}). \tag{4}$$

If the source of relative strength profits is the serial covariance of factor-related returns then, from the above expression, the in-sample serial covariance of the equally weighted index returns is required to be positive. However, we find that the serial covariance of 6-month returns of the equally weighted index is negative (-0.0028) which, from the decomposition in expression (3), reduces the relative strength profits. This result indicates that the serial covariance of factor portfolio returns is unlikely to be the source of relative strength profits.

[8]The contribution of the serial covariances of e_{it} to the serial covariance of the equally weighted index becomes arbitrarily small as the number of stocks in the index becomes arbitrarily large.

The estimates of the serial covariance of market model residuals for individual stocks are on average positive (0.0012). This evidence suggests that the relative strength profits may arise from stocks underreacting to firm-specific information. However, this evidence is also potentially consistent with an alternative model in which some stocks react with a lag to factor realizations, and we address this possibility in the next subsection.

D. Lead-Lag Effects and Relative Strength Profits

This subsection examines whether the relative strength profits can arise from a lead-lag relationship in stock prices similar to that considered in Lo and MacKinlay (1990). In contrast to the model previously presented, the model in this subsection assumes that stocks can either overreact or underreact to the common factor but that the factor-mimicking portfolio returns are serially uncorrelated.

Consider the following return generating process:

$$r_{it} = \mu_i + b_{1i} f_t + b_{2i} f_{t-1} + e_{it}, \tag{5}$$

where b_{1i} and b_{2i} are sensitivities to the contemporaneous and lagged factor realizations. $b_{2i} > 0$ implies that stock i partly reacts to the factor with a lag as in Lo and MacKinlay and $b_{2i} < 0$ implies that the stock overreacts to contemporaneous factor realizations and this overreaction gets corrected in the subsequent period.

Given this model, the WRSS profits and the serial covariance of the equally weighted index are given by:

$$\mathrm{E}\{(r_{it} - \bar{r}_t)(r_{it-1} - \bar{r}_{t-1})\} = \sigma_\mu^2 + \delta\sigma_f^2 \tag{6}$$

and

$$\operatorname{cov}(\bar{r}_t, \bar{r}_{t-1}) = \bar{b}_1 \bar{b}_2 \sigma_f^2, \tag{7}$$

where $\bar{b}_1$ and $\bar{b}_2$ are cross-sectional averages of b_{1i} and b_{2i}, and,

$$\delta \equiv \frac{1}{N} \sum_{i=1}^{N} \left(b_{1i} - \bar{b}_1\right)\left(b_{2i} - \bar{b}_2\right).$$

From expression (6), when $\delta < 0$ the lead-lag relation has a negative effect on the profitability of the WRSS, or equivalently, a positive effect on contrarian profits as in Lo and MacKinlay. However, when $\delta > 0$, the lead-lag relation will generate positive relative strength profits. In addition, if $\bar{b}_2$ is positive (negative) then the equally weighted index returns will be positively (negatively) serially correlated. This parameter, however, does not affect the profitability of the WRSS.

If the lead-lag effect is an important source of relative strength profits, then the profit in any period will depend on the magnitude of factor portfolio return in the previous period. Formally, consider the expected WRSS profits conditional on the past factor portfolio return:

$$E\{(r_{it} - \bar{r}_t)(r_{it-1} - \bar{r}_{t-1})|f_{t-1}\} = \sigma_\mu^2 + \delta f_{t-1}^2. \tag{8}$$

In contrast, under model (1), the conditional expectation of the WRSS profits given in expression (3), assuming that the factor portfolio returns are normally distributed, is:

$$E\{(r_{it} - \bar{r}_t)(r_{it-1} - \bar{r}_{t-1})|f_{t-1}\} = \sigma_\mu^2 + \sigma_b^2 \rho f_{t-1}^2,$$

where ρ is the first order serial correlation of the factor portfolio returns.

Expression (8) implies that if the relative strength profits come entirely from the lead-lag effect in stock returns, then the magnitude of the profits should be positively related to the squared factor portfolio return in the previous period. Intuitively, if inefficient stock price reactions to factor realizations are important for the profitability of relative strength strategies, then large factor realizations should result in large WRSS profits. Alternatively, if the lead-lag effect does not contribute to the profits, then the observed negative serial covariance of the market index implies a negative relation between the magnitude of the WRSS profits and squared lagged factor portfolio returns.

To examine which of these predictions best explains the time-series variation in relative strength profits we estimate the following regression using the value-weighted index as a proxy for the factor portfolio:

$$r_{pt,6} = \alpha_i + \theta r_{mt,-6}^2 + u_{it},$$

where $r_{pt,6}$ is the 6-month return of the relative strength portfolio formed in month t based on 6-month lagged returns and $r_{mt,-6}$ is the demeaned return on the value-weighted index in the months $t-6$ through $t-1$. The estimates of θ and the corresponding autocorrelation-consistent t-statistic over the 1965 to 1989 sample period are -2.29 and -1.74 respectively. The estimates (t-statistic) of θ in the first and second half of this sample period are -2.55 (-2.65) and -1.83 (-2.52) respectively.[9] This reliably negative relation between the relative strength profits and lagged squared market returns is consistent with the model presented in the last subsection which assumed no lead-lag relationship and is inconsistent with the lead-lag model. This evidence indicates that the lead-lag effect is not an important source of relative strength profits and that the profitability of these strategies is therefore related to market underreaction to the firm-specific information.

[9] When this regression is fitted with the WRSS profits as the dependent variable, the estimate (t-statistic) of θ over 1965–1989 is -1.77 (-3.56) and the corresponding statistics in the two equal subperiods are -1.94 (-2.52) and -1.51 (-2.53).

IV. Profitability of Relative Strength Strategies Within Size- and Beta-Based Subsamples

In this section we examine the profitability of the 6-month/6-month strategy within subsamples stratified on the basis of firm size and ex ante estimates of betas. Specifically, we implement this strategy on three size-based subsamples (small, medium, and large), and three beta-based subsamples (low-beta, medium-beta, and high-beta stocks).

Measuring relative strength profits on size- and beta-based subsamples allows us to examine whether the profitability of the strategy is confined to any particular subsample of stocks. This analysis also provides additional evidence about the source of the observed relative strength profits. Since extant empirical evidence indicates that size and beta are related to both risk and expected returns,[10] the cross-sectional dispersion in expected returns should be less within these subsamples than in the full sample. Therefore, if the relative strength strategy profits are related to differences in expected returns, they will be less when they are implemented on stocks within each subsample rather than on all the stocks in the sample. The profits need not be reduced in these subsamples, however, if the profits of the strategies are due to serial covariances in idiosyncratic returns. In fact, if the profits are not factor-related, the strategies are likely to generate higher returns when they are implemented within the small-firm subsample that consists of less actively traded stocks and to generate lower returns when they are implemented within the large-firm subsample.

Table III presents the average returns of the 6-month/6-month strategy for each of the subsamples. The results in Panel A indicate that the observed abnormal returns are of approximately the same magnitude when the strategies are implemented on the various subsamples of stocks as when they are implemented on the entire sample. They do, however, appear to be somewhat related to firm size and beta; for the zero-cost, winners minus losers portfolio, the subsample with the largest firms generates lower abnormal returns than the other two subsamples and the returns in the subsamples segmented by beta are monotonically increasing in beta.[11] These findings indicate that the relative strength profits are not primarily due to the cross-sectional differences in the systematic risk of the stocks in the sample. This evidence suggests that the profits are due to the serial correlation in the firm-specific component of returns. Furthermore, these results indicate that the profitabil-

[10] See Fama and MacBeth (1973) and Banz (1981).

[11] One thing that is interesting to note here is that the average returns of low beta stocks are higher than the returns of the medium and high beta stocks. The average returns of stocks in the low, medium and high beta groups are 1.48%, 1.39%, and 1.16% respectively. These results, obtained with daily betas, should be contrasted with earlier findings of positive relations between monthly betas and average returns (e.g., Fama and MacBeth (1973)). The difference between our results using daily betas and the earlier results using monthly betas is due to the lower correlation between firm size and daily betas. Jegadeesh (1992) and Fama and French (1992) document that there is no reliable relation between monthly betas and average returns after controlling for firm size.

ity of the relative strength strategies is not confined to any particular subsample of stocks.

As a further test Panel B of Table III presents the risk-adjusted returns of the relative strength strategies implemented within the size- and beta-based subsamples. The risk-adjusted returns are estimated as the intercepts from the following market model regression:

$$r_{pt} - r_{ft} = \alpha_p + \beta_p(r_{mt} - r_{ft}) + e_{it}, \tag{9}$$

where r_{pt} is the return on the portfolio p, r_{mt} is the return on the value-weighted index, and r_{ft} is the interest rate on 1-month Treasury Bill. Consistent with the negative betas of the zero-cost strategies, the abnormal returns of the relative strength strategies estimated from these regressions slightly exceed the raw returns given in Table III (Panel A). With the exception of the F-statistics becoming somewhat more significant, the findings in Table III (Panel B) are virtually the same as those reported in Table III (Panel A).

An additional implication of the results in Table III (Panel B) is that the abnormal performance of the zero-cost portfolio is due to the buy side of the transaction rather than the sell side. The portfolio of past winners achieves significant positive abnormal return when the value-weighted index is used as the benchmark, while the abnormal return of the portfolio of past losers is not statistically significant with this benchmark. However, in unreported regressions that used the equally weighted index as the benchmark, the positive and the negative abnormal returns of the winners and losers portfolios were both statistically significant. The magnitude and statistical significance of the abnormal returns of the zero-cost, winners minus losers, portfolio (0.0115 with a t-statistic of 3.84) was slightly higher when the equally weighted index was used in place of the value-weighted index as the benchmark.

From a practical investment perspective, it is important to assess whether the relative strength strategies will be profitable after accounting for transaction costs. On average, the relative strength trading rule results in a turnover of 84.8% semiannually.[12] The risk-adjusted return of the relative strength trading rule after considering a 0.5% one-way transaction cost[13] is 9.29% per year, which is reliably different from zero. The risk-adjusted returns after transaction costs are also significantly positive in each of the three size-based subsamples.

[12] The average turnovers for the buy and sell sides of the zero-cost portfolio are 86.6% and 83.1% respectively. These percentages are significantly less than the 90% turnover that would be expected if the transition probabilities are equal across the return decile portfolios.

[13] Berkowitz, Logue, and Noser (1988) estimate one way transaction costs of 23 basis points for institutional investors, suggesting that the assumed transaction cost of 0.5% per trade is conservative.

V. Subperiod Analysis

A. Seasonal Patterns in Relative Strength Portfolio Returns

This section tests for possible seasonal effects in the performance of the relative strength portfolios. Based on earlier papers, e.g., Roll (1983), we have reason to expect that the relative strength strategies will not be successful in the month of January. Table IV reports the average returns of the zero-cost portfolio in each calendar month and the results here support this conjecture.

Table III

Returns of Size-Based and Beta-Based Relative Strength Portfolios

The relative strength portfolios are formed based on 6-month lagged returns and held for 6 months. The stocks are ranked in ascending order on the basis of 6-month lagged returns and the equally weighted portfolio of stocks in the lowest past return decile is portfolio P1, the equally weighted portfolio of stocks in the next decile is portfolio P2, and so on. Average monthly returns and excess returns of these portfolios and the returns of the relative strength portfolios formed using size-based and beta-based subsamples of securities are reported here. The subsample S1 contains the smallest firms, S2 contains the medium-sized firms, and S3 contains the largest firms. The subsamples β_1, β_2, and β_3 contain the firms with the smallest, medium, and the largest Scholes-Williams betas estimated from the returns data in the calendar year prior to portfolio formation. The sample period is January 1965 to December 1989.

Panel A: Average Monthly Returns							
	All	S1	S2	S3	β_1	β_2	β_3
P1	0.0079	0.0083	0.0047	0.0082	0.0129	0.0097	0.0052
	(1.56)	(1.35)	(0.99)	(2.22)	(2.92)	(2.01)	(0.95)
P2	0.0112	0.0117	0.0102	0.0098	0.0140	0.0128	0.0086
	(2.78)	(2.29)	(2.54)	(3.08)	(4.38)	(3.37)	(1.83)
P3	0.0125	0.0152	0.0125	0.0105	0.0132	0.0133	0.0102
	(3.40)	(3.23)	(3.34)	(3.53)	(4.59)	(3.77)	(2.28)
P4	0.0124	0.0163	0.0130	0.0105	0.0134	0.0128	0.0110
	(3.59)	(3.59)	(3.58)	(3.66)	(5.02)	(3.82)	(2.50)
P5	0.0128	0.0164	0.0134	0.0109	0.0135	0.0135	0.0121
	(3.87)	(3.74)	(3.83)	(3.85)	(5.14)	(4.15)	(2.86)
P6	0.0134	0.0174	0.0146	0.0102	0.0135	0.0142	0.0122
	(4.14)	(4.08)	(4.22)	(3.66)	(5.23)	(4.38)	(2.92)
P7	0.0136	0.0175	0.0143	0.0109	0.0136	0.0142	0.0126
	(4.19)	(4.13)	(4.12)	(3.90)	(5.09)	(4.43)	(3.01)
P8	0.0143	0.0174	0.0148	0.0111	0.0143	0.0146	0.0132
	(4.30)	(4.11)	(4.16)	(3.86)	(5.12)	(4.44)	(3.15)
P9	0.0153	0.0183	0.0154	0.0126	0.0165	0.0156	0.0141
	(4.36)	(4.28)	(4.11)	(4.17)	(5.34)	(4.56)	(3.28)
P10	0.0174	0.0182	0.0173	0.0157	0.0191	0.0176	0.0160
	(4.33)	(3.99)	(4.11)	(4.41)	(5.17)	(4.53)	(3.50)
P10–P1	0.0095	0.0099	0.0126	0.0075	0.0062	0.0079	0.0108
	(3.07)	(2.77)	(4.57)	(3.03)	(2.05)	(2.64)	(3.35)
F-Statistics[a]	2.83	2.65	4.51	4.38	2.51	1.99	1.69
p-Value	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.04)	(0.09)

Table III—*Continued*

Panel B: Excess Returns Using the CRSP Value-Weighted Index as the Market Proxy

	All	S1	S2	S3	β_1	β_2	β_3
P1	−0.0030	−0.0029	−0.0062	−0.0020	0.0031	−0.0009	−0.0062
	(−0.89)	(−0.60)	(−2.11)	(−1.17)	(0.94)	(−0.28)	(−1.71)
P2	0.0011	0.0012	−0.0001	0.0000	0.0051	0.0029	−0.0024
	(0.43)	(0.31)	(−0.03)	(0.03)	(2.36)	(1.26)	(−0.87)
P3	0.0026	0.0051	0.0024	0.0009	0.0045	0.0035	−0.0007
	(1.24)	(1.46)	(1.18)	(0.93)	(2.45)	(1.83)	(−0.29)
P4	0.0026	0.0062	0.0030	0.0011	0.0048	0.0031	0.0000
	(1.48)	(1.90)	(1.57)	(1.24)	(2.98)	(1.83)	(0.01)
P5	0.0031	0.0064	0.0036	0.0014	0.0049	0.0038	0.0012
	(1.96)	(2.06)	(1.98)	(1.84)	(3.21)	(2.55)	(0.58)
P6	0.0037	0.0075	0.0048	0.0008	0.0048	0.0045	0.0013
	(2.55)	(2.51)	(2.74)	(1.13)	(3.46)	(3.12)	(0.69)
P7	0.0039	0.0075	0.0044	0.0015	0.0049	0.0045	0.0017
	(2.70)	(2.57)	(2.61)	(2.15)	(3.29)	(3.25)	(0.90)
P8	0.0045	0.0074	0.0048	0.0016	0.0054	0.0049	0.0023
	(3.01)	(2.56)	(2.76)	(2.12)	(3.53)	(3.29)	(1.19)
P9	0.0053	0.0082	0.0052	0.0029	0.0074	0.0057	0.0031
	(3.20)	(2.89)	(2.76)	(3.23)	(4.10)	(3.60)	(1.54)
P10	0.0070	0.0077	0.0067	0.0056	0.0094	0.0074	0.0048
	(3.24)	(2.56)	(2.91)	(3.50)	(4.10)	(3.47)	(2.02)
P10–P1	0.0100	0.0106	0.0129	0.0076	0.0063	0.0083	0.0111
	(3.23)	(2.97)	(4.69)	(3.08)	(2.09)	(2.76)	(3.42)
F-Statistics[b]	5.2910	5.4401	8.3713	4.7386	3.6045	4.0171	2.5872

[a]The *F*-statistics are computed under the hypothesis that the returns on portfolios P1 through P10 are jointly equal.

[b]The *F*-statistics are computed under the hypothesis that the abnormal returns on portfolios P1 through P10 are jointly equal to zero. All *F*-statistics are significant at the 1 percent level.

The relative strength strategy loses about 7% on average in each January but achieves positive abnormal returns in each of the other months.[14] The relative strength strategy realizes positive returns in 67% of the months, and 71% of the months when January is excluded (see Table V). The average return in non-January months is 1.66% per month.[15] Consistent with earlier papers, we find the magnitude of the negative January performance of the relative strength strategy to be inversely related to firm size. The negative

[14]It is possible that at least part of the negative January returns of the relative strength strategy is due to a tendency of past winners to trade at the ask prices and past losers to sell at the bid prices at the close of the last trading day in the year. See Keim (1989) for a discussion of bid-ask spread biases and the January effect.

[15]If we were to use our priors about the performance of relative strength strategies in January and reverse the buy and sell portfolios in that calendar month (taking a long position in the past losers and a short position in the past winners in January only), then the abnormal returns would be even larger. Such a strategy generates close to 25% per year in abnormal returns, and loses money (about −0.7%) only in 1 year out of the 25 years in the sample period.

Table IV

Returns on Size-Based Relative Strength Portfolios (P10–P1) by Calendar Months

The relative strength portfolios are formed based on 6-month lagged returns and held for 6 months. The stocks are ranked in ascending order on the basis of 6-month lagged returns and the equally weighted portfolio of stocks in the lowest past return decile is the *sell* portfolio and the equally weighted portfolio of stocks in the highest past return decile is the *buy* portfolio. This table reports the average monthly returns of the zero-cost, buy minus sell, portfolio in each calendar month. The average returns of the zero-cost portfolios formed using size-based subsamples of securities are also reported. The subsample S1 contains the smallest firms, S2 contains the medium-sized firms, and S3 contains the largest firms. The sample period is January 1965 to December 1989.

	All	S1	S2	S3
Jan.	−0.0686	−0.0797	−0.0347	−0.0161
	(−3.52)	(−3.36)	(−2.14)	(−1.28)
Feb.	0.0063	0.0089	0.0149	0.0099
	(0.85)	(0.81)	(2.44)	(1.35)
Mar.	0.0105	0.0196	0.0103	0.0108
	(1.37)	(2.08)	(1.49)	(1.49)
Apr.	0.0333	0.0323	0.0368	0.0215
	(7.39)	(5.35)	(7.29)	(4.91)
May	0.0102	0.0046	0.0091	0.0079
	(1.32)	(0.56)	(1.18)	(1.19)
June	0.0238	0.0237	0.0231	0.0185
	(3.86)	(3.50)	(3.23)	(2.59)
July	0.0075	0.0112	0.0084	0.0035
	(0.96)	(1.44)	(0.96)	(0.41)
Aug.	0.0027	0.0079	−0.0011	−0.0058
	(0.35)	(0.97)	(−0.14)	(−0.71)
Sept.	0.0116	0.0126	0.0137	0.0053
	(1.10)	(1.20)	(1.27)	(0.60)
Oct.	0.0137	0.0160	0.0151	0.0025
	(1.30)	(1.40)	(1.44)	(0.22)
Nov.	0.0372	0.0352	0.0331	0.0248
	(5.31)	(5.01)	(4.12)	(2.78)
Dec.	0.0264	0.0265	0.0224	0.0070
	(2.61)	(2.13)	(2.86)	(0.99)
Feb.–Dec.	0.0166	0.0181	0.0169	0.0096
	(6.67)	(6.47)	(6.83)	(4.00)
F-Statistics[a]	7.90	7.14	4.11	1.81
p-Value	(0.00)	(0.00)	(0.00)	(0.51)
F-Statistics[b]	2.04	1.23	1.91	1.28
p-Value	(0.03)	(0.27)	(0.04)	(0.24)

[a] The F-statistics are computed under the hypothesis that the returns on the zero-cost portfolio are jointly equal in all calendar months.

[b] The F-statistics are computed under the hypothesis that the returns on the zero-cost portfolios are jointly equal in the calendar months February through December.

Table V

Proportion of Positive Returns of Relative Strength Portfolios by Calendar Months

The relative strength portfolios are formed based on 6-month lagged returns and held for 6 months. The stocks are ranked in ascending order on the basis of 6-month lagged returns and the equally weighted portfolio of stocks in the lowest past return decile is the *sell* portfolio and the equally weighted portfolio of stocks in the highest past return decile is the *buy* portfolio. This table reports the proportion of months when the average return of the zero-cost, buy minus sell, portfolio is positive. This proportion for the zero-cost portfolio formed within each size-based subsample of securities is also reported. The subsample S1 contains the smallest firms, S2 contains the medium-sized firms, and S3 contains the largest firms. The sample period is January 1965 to December 1989.

	All	S1	S2	S3
Jan.	0.24	0.16	0.20	0.44
Feb.	0.60	0.60	0.76	0.60
Mar.	0.80	0.76	0.72	0.72
Apr.	0.96	0.92	0.96	0.80
May	0.68	0.68	0.72	0.56
June	0.76	0.64	0.76	0.72
July	0.56	0.68	0.56	0.52
Aug.	0.52	0.60	0.48	0.48
Sept.	0.80	0.72	0.80	0.68
Oct.	0.64	0.60	0.64	0.56
Nov.	0.84	0.84	0.84	0.68
Dec.	0.68	0.76	0.68	0.44
Feb.–Dec.	0.71	0.71	0.72	0.61
All	0.67	0.66	0.68	0.60

average relative strength return in January is not statistically significant for the subsample of large firms.

The findings in Table IV suggest that there is also a seasonal pattern outside January. For example, the returns are fairly low in August and are particularly high in April, November, and December. The F-statistics reported in this table indicate that these monthly differences outside January are statistically significant for the whole sample as well as for the sample of medium-size firms.

One of the interesting findings documented in this table is that the relative strength strategy produces positive returns in 96% (24 out of 25) of the Aprils. The large (3.33%) and consistently positive April returns may be related to the fact that corporations must transfer money to their pension funds prior to April 15 if the funds are to qualify for a tax deduction in the previous year. If these pension fund assets are primarily invested by portfolio managers who follow relative strength rules, then the winners portfolio may benefit from additional price pressure in this month. Similarly, the larger than average returns in November and December may in part be due to price pressure arising from portfolio managers selling their losers in these months for tax or window dressing reasons.

Table VI

Returns of Size-Based Relative Strength Portfolios: Subperiod Analysis

The relative strength portfolios are formed based on 6-month lagged returns and held for 6 months. The stocks are ranked in ascending order on the basis of 6-month lagged returns and the equally weighted portfolio of stocks in the lowest past return decile is the *sell* portfolio and the equally weighted portfolio of stocks in the highest past return decile is the *buy* portfolio. This table reports the average monthly returns of the zero-cost, buy minus sell, portfolio within 5-year subperiods. The average returns of the zero-cost portfolios formed using size-based subsamples of securities within subperiods are also reported. The subsample S1 contains the smallest firms, S2 contains the medium-sized firms, and S3 contains the largest firms. The sample period is January 1965 to December 1989.

Sample	Months	65–69	70–74	75–79	80–84	85–89
	All	0.0123	0.0109	−0.0044	0.0127	0.0162
		(1.94)	(1.23)	(−0.51)	(2.67)	(3.42)
All	Jan.	−0.0524	−0.1070	−0.1017	−0.0253	−0.0569
		(−1.28)	(−2.54)	(−1.31)	(−1.38)	(−2.76)
	Feb.–Dec.	0.0182	0.0217	0.0044	0.0161	0.0229
		(3.36)	(2.88)	(0.78)	(3.44)	(6.09)
	All	0.0082	0.0128	−0.0064	0.0153	0.0197
		(1.14)	(1.63)	(−0.58)	(2.61)	(2.89)
S1	Jan.	−0.0838	−0.0853	−0.1107	−0.0124	−0.1064
		(−1.60)	(−2.29)	(−1.09)	(−0.62)	(−4.45)
	Feb.–Dec.	0.0165	0.0217	0.0031	0.0179	0.0311
		(3.19)	(3.18)	(0.41)	(2.94)	(6.59)
	All	0.0177	0.0115	0.0018	0.0172	0.0146
		(3.08)	(1.57)	(0.24)	(3.38)	(3.40)
S2	Jan.	−0.0264	−0.0465	−0.0795	−0.0100	−0.0112
		(−1.05)	(−1.81)	(−1.16)	(−0.46)	(−0.48)
	Feb.–Dec.	0.0217	0.0168	0.0092	0.0197	0.0170
		(3.86)	(2.29)	(1.87)	(3.83)	(4.08)
	All	0.0129	0.0115	0.0018	0.0076	0.0035
		(2.71)	(1.62)	(0.35)	(1.41)	(0.73)
S3	Jan.	−0.0073	−0.0154	−0.0335	−0.0094	−0.0147
		(−0.32)	(−0.48)	(−0.77)	(−0.33)	(−0.78)
	Feb.–Dec.	0.0148	0.0139	0.0050	0.0092	0.0052
		(3.08)	(1.95)	(1.21)	(1.70)	(1.04)

B. Portfolio Returns Over 5-Year Subperiods

This section documents the returns of the 6-month/6-month zero-cost strategy in each of the five 5-year subperiods in the 1965 to 1989 sample period. The evidence in Table VI indicates that the returns of the strategy, when implemented on the entire sample of stocks, produces average returns that are positive in all but one time period (1975 to 1979). An analysis of this strategy applied to size-based subsamples indicates that the negative returns in the 1975 to 1979 time period is due primarily to the January returns of the small firms. The strategy yields positive profits in each of the 5-year time periods when it is implemented on the subsamples of large- and medium-size firms. In addition, the returns are positive in each of the 5-year periods as well as in each size-based subsample when the month of January is excluded.

VI. Performance of Relative Strength Portfolios in Event Time

In this section we examine the returns of the relative strength portfolio in event time. We track the average portfolio returns in each of the 36 months following the portfolio formation date.

This event study analysis provides both additional insights about the riskiness of the strategy and about whether the profits are due to overreaction or underreaction. Significant positive returns in months beyond the holding period would indicate that the zero-cost portfolio systematically selects stocks that have higher than average unconditional returns either because of their risk or for other reasons such as differential tax exposures. Significant negative returns of the zero-cost portfolio in the months following the holding period would suggest that the price changes during the holding period are at least partially temporary.

Table VII presents the average monthly and cumulative returns of the zero-cost portfolio in event time in the 36 months after the formation date.[16] With the exception of month 1, the average return in each month is positive in the first year. The average return is negative in each month in year 2 as well as in the first half of year 3 and virtually zero thereafter. The cumulative returns reach a maximum of 9.5% at the end of 12 months but decline to about 4% by the end of month 36.

The negative returns beyond month 12 indicate that the relative strength strategy does not tend to pick stocks that have high unconditional expected returns. The observed pattern of initially positive and then negative returns of the zero-cost portfolio also suggests that the observed price changes in the first 12 months after the formation period may not be permanent. Unfortunately, estimates of expected returns over 2-year periods are not very precise. As a result, the negative returns for the zero-cost portfolio in years 2 and 3 are not statistically significant (t-statistic of -1.27). Similarly, since the abnormal return over the entire 36-month period is not statistically different from zero, we cannot rule out the possibility that the positive returns over the first 12 months is entirely temporary.[17]

[16] Since overlapping returns are used to calculate the cumulative returns in event time, the autocorrelation-consistent Newey-West standard errors are used to compute the t-statistics for the cumulative returns (see Newey and West (1987)).

[17] Another reason why we find this evidence hard to interpret is that the entire negative return over this holding period occurs in Januaries. The returns beyond the first year are close to zero in non-January months.

Table VII

Performance of Relative Strength Portfolios in Event Time

The relative strength portfolios are formed based on 6-month lagged returns. The stocks are ranked in ascending order on the basis of 6-month lagged returns. The equally weighted portfolio of stocks in the lowest past return decile is the *sell* portfolio and the equally weighted portfolio of stocks in the highest past return decile is the *buy* portfolio. This table reports the average returns of the zero-cost, buy minus sell, portfolio in each month following the formation period. t is the month after portfolio formation. The sample period is January 1965 to December 1989. Autocorrelation-consistent estimates of standard errors are used to compute the t-statistics for cumulative returns.

t	Monthly Return	Cumulative Return	t	Monthly Return	Cumulative Return	t	Monthly Return	Cumulative Return
1	−0.0025	−0.0025	13	−0.0036	0.0915	25	−0.0035	0.0521
	(−0.59)	(−0.59)		(−1.12)	(3.35)		(−1.36)	(1.41)
2	0.0124	0.0099	14	−0.0039	0.0876	26	−0.0030	0.0492
	(3.29)	(1.37)		(−1.34)	(3.07)		(−1.14)	(1.22)
3	0.0116	0.0216	15	−0.0034	0.0842	27	−0.0024	0.0467
	(3.18)	(2.20)		(−1.21)	(2.89)		(−0.98)	(1.10)
4	0.0110	0.0326	16	−0.0038	0.0804	28	−0.0032	0.0435
	(3.19)	(2.67)		(−1.41)	(2.76)		(−1.33)	(0.98)
5	0.0093	0.0419	17	−0.0047	0.0757	29	−0.0032	0.0403
	(2.82)	(2.79)		(−1.74)	(2.70)		(−1.38)	(0.87)
6	0.0091	0.0510	18	−0.0056	0.0701	30	−0.0030	0.0373
	(2.94)	(2.92)		(−2.19)	(2.68)		(−1.31)	(0.77)
7	0.0134	0.0644	19	−0.0026	0.0675	31	−0.0001	0.0372
	(4.98)	(3.32)		(−1.14)	(2.75)		(−0.06)	(0.74)
8	0.0115	0.0759	20	−0.0032	0.0642	32	0.0008	0.0380
	(4.16)	(3.60)		(−1.35)	(2.73)		(0.41)	(0.73)
9	0.0085	0.0844	21	−0.0032	0.0611	33	0.0013	0.0394
	(3.07)	(3.73)		(−1.32)	(2.55)		(0.62)	(0.73)
10	0.0048	0.0892	22	−0.0034	0.0577	34	0.0008	0.0402
	(1.69)	(3.74)		(−1.39)	(2.21)		(0.36)	(0.71)
11	0.0045	0.0938	23	−0.0011	0.0566	35	0.0010	0.0412
	(1.55)	(3.77)		(−0.45)	(1.93)		(0.45)	(0.71)
12	0.0013	0.0951	24	−0.0010	0.0556	36	−0.0005	0.0406
	(0.43)	(3.67)		(−0.40)	(1.69)		(−0.24)	(0.67)

One possible explanation of the inverted U shape in the cumulative returns is that the risk of the strategy changes over event time. Perhaps, the strategy picks stocks that are initially very risky and the risk then diminishes with time. To assess this possibility we estimate the betas in each event month with respect to the value-weighted index and the equally weighted index. The beta of the zero-cost portfolio with respect to the value-weighted (equally weighted) index is initially −0.20 (−0.41) and then it steadily increases to 0.02 (−0.08). Although these results indicate that the risk of the zero-cost portfolio does change over time, the direction of change in risk goes counter to what would be required to explain the change in average returns.

VII. Back-Testing the Strategy

This section examines the extent to which the relative strength profits reported in the previous sections existed prior to 1965. Specifically, we replicate the test in Table VII, which tracks the performance of the 6-month relative strength portfolio in event time for both the 1927 to 1940 time period and the 1941 to 1964 time period. As Fama and French (1988) and others have noted, the market was extremely volatile and experienced a significant degree of mean reversion in the 1927 to 1940 period. In contrast, the market's volatility in the 1941 to 1964 period was similar to the volatility in the 1965 to 1989 period and the market index did not exhibit mean reversion in the post-1940 period.

Table VIII (Panel A) reports the returns of the 6-month relative strength strategy in the 36 event months over the 1927 to 1940 time period. The returns in this time period are significantly lower than the returns in the 1965 to 1989 period, but the patterns of returns across event months is somewhat similar. The month 1 returns are strongly negative on average (about -5%). The returns in months 2 through 10 are statistically insignificant, but the returns in the later months are substantially lower. The cumulative excess return equals -40.81% in month 36.

These negative cumulative returns are likely to be due to two factors: First, because of the greater volatility in this period, many of the firms in the loser's decile were close to bankruptcy and thus had very high betas over the holding periods. The beta of the zero-cost 6-month/6-month strategy is about -0.5 in this period and it is substantially higher following periods of market declines. The second factor relates to the market's mean reversion in this time period. As the decomposition in Subsection III.*A* and the regression results in Subsection III.*B* indicate, negative serial correlation in the market and large market movements will reduce the profits from relative strength strategies. This is because the relative strength strategy tends to select high- (low-) beta stocks following a market increase (decrease) and hence tends to perform poorly during market reversals. For example, following a 40% decline in the equally weighted index over the previous 6 months, the index rebounded with a 43% increase in July 1932. In this month the 6-month/6-month relative strength portfolio experienced a negative 40% return. In the following month the equally weighted index increased an additional 66% and the 6-month/6-month strategy lost 68%. In the 1930s there were four other months in which the 6-month/6-month strategy lost over 40%. Each occurred when the market increased substantially.

Panel B of Table VIII reports the returns in the 36 event months for the 1941 to 1964 period. The relative strength strategy returns over this time period are very similar to the returns in the more recent time period reported earlier. As in the 1965 to 1989 time period, the average return is slightly negative in month 1, significantly positive in month 2 through month 8, and negative in month 12 and beyond. In contrast to the findings for the 1965 to

1989 period, the positive cumulative return over the first 12 months dissipates almost entirely by month 24.

VIII. Stock Returns Around Earnings Announcement Dates

This section examines the returns of past winners and losers around their quarterly earnings announcement dates. By analyzing stock returns within a short window around the dissemination of important firm-specific information we have a sharp test that directly assesses the potential biases in market expectations. Consider, for example, the possibility that stock prices system-

Table VIII

Back-Testing the Strategy: Performance of Relative Strength Portfolios Prior to 1965

The relative strength portfolios are formed based on 6-month lagged returns. The stocks are ranked in ascending order on the basis of 6-month lagged returns. The equally weighted portfolio of stocks in the lowest past return decile is the *sell* portfolio and the equally weighted portfolio of stocks in the highest past return decile is the *buy* portfolio. This table reports the average returns of the zero-cost, buy minus sell, portfolio in each month following the formation period. t is the month after portfolio formation. Autocorrelation consistent estimates of standard errors are used to compute the t-statistics for cumulative returns.

Panel A: 1927–1940								
t	Monthly Return	Cumulative Return	t	Monthly Return	Cumulative Return	t	Monthly Return	Cumulative Return
1	-0.0495	-0.0495	13	-0.0245	-0.1257	25	-0.0118	-0.3359
	(-3.72)	(-3.72)		(-2.60)	(-1.50)		(-1.41)	(-2.48)
2	-0.0143	-0.0639	14	-0.0166	-0.1423	26	-0.0067	-0.3427
	(-1.32)	(-2.21)		(-2.08)	(-1.69)		(-1.01)	(-2.53)
3	-0.0088	-0.0726	15	-0.0164	-0.1587	27	-0.0135	-0.3562
	(-0.87)	(-1.78)		(-1.87)	(-1.83)		(-1.82)	(-2.52)
4	-0.0048	-0.0775	16	-0.0200	-0.1787	28	-0.0082	-0.3644
	(-0.45)	(-1.60)		(-2.20)	(-2.01)		(-1.06)	(-2.47)
5	0.0061	-0.0713	17	-0.0131	-0.1919	29	-0.0125	-0.3769
	(0.60)	(-1.40)		(-1.80)	(-2.12)		(-1.37)	(-2.39)
6	0.0057	-0.0656	18	-0.0166	-0.2085	30	-0.0107	-0.3876
	(0.55)	(-1.22)		(-2.11)	(-2.07)		(-1.20)	(-2.29)
7	0.0092	-0.0564	19	-0.0161	-0.2245	31	-0.0018	-0.3894
	(0.83)	(-1.05)		(-1.90)	(-2.01)		(-0.20)	(-2.18)
8	0.0054	-0.0511	20	-0.0224	-0.2469	32	-0.0022	-0.3916
	(0.52)	(-0.92)		(-2.28)	(-2.03)		(-0.26)	(-2.07)
9	-0.0029	-0.0539	21	-0.0178	-0.2647	33	0.0008	-0.3908
	(-0.34)	(-0.94)		(-1.92)	(-2.04)		(0.11)	(-1.99)
10	-0.0065	-0.0604	22	-0.0213	-0.2860	34	-0.0025	-0.3933
	(-0.68)	(-0.90)		(-2.08)	(-2.14)		(-0.41)	(-1.97)
11	-0.0183	-0.0787	23	-0.0183	-0.3043	35	-0.0050	-0.3983
	(-1.74)	(-1.04)		(-1.74)	(-2.23)		(-0.89)	(-1.97)
12	-0.0225	-0.1012	24	-0.0198	-0.3241	36	-0.0098	-0.4081
	(-2.35)	(-1.27)		(-1.94)	(-2.41)		(-1.47)	(-2.01)

Table VIII—*Continued*

Panel B: 1941–1964								
t	Monthly Return	Cumulative Return	*t*	Monthly Return	Cumulative Return	*t*	Monthly Return	Cumulative Return
1	−0.0035	−0.0035	13	−0.0068	0.0515	25	−0.0035	0.0014
	(−1.04)	(−1.04)		(−2.14)	(2.57)		(−1.32)	(0.04)
2	0.0069	0.0034	14	−0.0085	0.0429	26	−0.0027	−0.0013
	(2.32)	(0.59)		(−3.07)	(1.90)		(−1.08)	(−0.03)
3	0.0109	0.0143	15	−0.0059	0.0371	27	−0.0015	−0.0028
	(4.15)	(2.20)		(−2.40)	(1.54)		(−0.69)	(−0.07)
4	0.0098	0.0241	16	−0.0063	0.0308	28	−0.0003	−0.0030
	(3.81)	(3.15)		(−2.80)	(1.21)		(−0.14)	(−0.08)
5	0.0075	0.0316	17	−0.0080	0.0228	29	−0.0009	−0.0039
	(3.09)	(3.40)		(−3.70)	(0.86)		(−0.51)	(−0.11)
6	0.0049	0.0365	18	−0.0074	0.0153	30	−0.0001	−0.0040
	(1.97)	(3.42)		(−3.63)	(0.56)		(−0.03)	(−0.12)
7	0.0079	0.0444	19	−0.0033	0.0120	31	0.0017	−0.0023
	(3.24)	(3.82)		(−1.61)	(0.43)		(0.98)	(−0.08)
8	0.0062	0.0507	20	−0.0012	0.0108	32	0.0011	−0.0012
	(2.52)	(4.00)		(−0.61)	(0.38)		(0.69)	(−0.05)
9	0.0039	0.0546	21	−0.0016	0.0092	33	−0.0005	−0.0017
	(1.63)	(3.91)		(−0.81)	(0.31)		(−0.32)	(−0.10)
10	0.0022	0.0568	22	−0.0021	0.0071	34	−0.0006	−0.0023
	(0.96)	(3.73)		(−1.04)	(0.22)		(−0.37)	(−0.17)
11	0.0024	0.0592	23	−0.0008	0.0063	35	−0.0004	−0.0027
	(1.00)	(3.70)		(−0.35)	(0.19)		(−0.24)	(−0.20)
12	−0.0009	0.0583	24	−0.0014	0.0050	36	−0.0004	−0.0030
	(−0.34)	(3.40)		(−0.60)	(0.14)		(−0.28)	(−0.20)

atically underreact to information about future earnings. In this case, the stock returns for past winners, which presumably had favorable information revealed in the past, should realize positive returns around the time when their earnings are actually announced. Similarly, past losers should realize negative returns around the time their earnings are announced.[18] The quarterly earnings announcement dates used in this analysis are obtained from the COMPUSTAT quarterly industrial database. The sample period for this part of the study is 1980 to 1989, the period covered by the 1990 COMPUSTAT quarterly file. On average, there are 429.2 available quarterly earnings announcements per month with matched stock return data.

Our tests again separate firms into deciles based on their prior 6-month returns. The 3-day returns (days −2 to 0) of the individual stocks in these groups are then calculated around each of their quarterly earnings announcements that occur within 36 months of the date at which the stocks are ranked according to their past returns. Table IX reports the differences between the

[18] Chopra, Lakonishok, and Ritter (1992) use a similar approach to evaluate the evidence of long horizon overreaction documented by De Bondt and Thaler (1985). See also Bernard and Thomas (1990).

Table IX

Quarterly Earnings Announcement Date Returns

The stocks are ranked in ascending order on the basis of 6-month lagged returns. The stocks in the lowest past return decile are called the *losers* group and the stocks in the highest past return decile is called the *winners* group. The differences between the 3-day returns (returns on days −2 to 0) around quarterly earnings announcements for stocks in the winners group and the losers group are reported here ($r_t^w - r_t^l$). t is the month after the ranking date. The sample period is January 1980 to December 1989.

t	$r_t^w - r_t^l$	t	$r_t^w - r_t^l$	t	$r_t^w - r_t^l$
1	0.0055	13	−0.0055	25	−0.0002
	(2.75)		(−2.56)		(−0.11)
2	0.0082	14	−0.0080	26	−0.0021
	(4.41)		(−3.89)		(−1.02)
3	0.0082	15	−0.0071	27	−0.0032
	(4.36)		(−4.04)		(−1.68)
4	0.0090	16	−0.0097	28	−0.0028
	(4.88)		(−5.75)		(−1.31)
5	0.0059	17	−0.0062	29	−0.0015
	(3.16)		(−2.90)		(−0.62)
6	0.0058	18	−0.0060	30	−0.0021
	(3.14)		(−2.96)		(−1.10)
7	0.0013	19	−0.0031	31	−0.0027
	(0.62)		(−1.63)		(−1.52)
8	0.0000	20	−0.0017	32	−0.0021
	(−0.02)		(−0.82)		(−1.13)
9	−0.0020	21	0.0006	33	−0.0020
	(−1.07)		(0.27)		(−1.05)
10	−0.0031	22	−0.0005	34	−0.0017
	(−1.60)		(−0.29)		(−0.91)
11	−0.0039	23	−0.0001	35	−0.0022
	(−2.23)		(−0.05)		(−1.29)
12	−0.0053	24	0.0012	36	−0.0059
	(−2.75)		(0.63)		(−2.91)

average announcement period returns for the winners and losers deciles in each of the 36 months following the ranking date. The pattern of announcement date returns presented in this table is consistent with the pattern of the zero-cost portfolio returns reported in Table VII. For the first 6 months the announcement date returns of the past winners exceed the announcement date returns of the past losers by over 0.7% on average, and is statistically significant in each of these 6 months. Since there are on average 2 quarterly earnings announcements per firm within a 6-month period, the returns around the earnings announcements represents about 25% of the zero-cost portfolio returns over this holding period.

The negative announcement period returns in later months are consistent with the negative relative strength portfolio returns beyond month 12 documented earlier (see Table VII). From months 8 through 20 the differences in announcement date returns are negative and are generally statistically significant. The announcement period returns are especially significant in months 11 through 18 where they average about -0.7%. In the later months the differences between the announcement period returns of the winners and losers are generally negative but are close to zero.

The predictability of stock returns around quarterly earnings announcements documented in Table IX is similar to the recent findings of Bernard and Thomas (1990). Bernard and Thomas find that average returns around quarterly earnings announcement dates are significantly positive following a favorable earnings surprise in the previous quarter. This is consistent with the positive announcement returns we see in the first 7 months in Table IX. Bernard and Thomas also find that the average return around earnings announcement dates is significantly negative 4 quarters after a positive earnings surprise. The significant negative returns around earnings announcement dates in months 11 through 18 are consistent with this finding.

IX. Conclusions

Trading strategies that buy past winners and sell past losers realize significant abnormal returns over the 1965 to 1989 period. For example, the strategy we examine in most detail, which selects stocks based on their past 6-month returns and holds them for 6 months, realizes a compounded excess return of 12.01% per year on average. Additional evidence indicates that the profitability of the relative strength strategies are not due to their systematic risk. The results of our tests also indicate that the relative strength profits cannot be attributed to lead-lag effects that result from delayed stock price reactions to common factors. The evidence is, however, consistent with delayed price reactions to firm-specific information.

The returns of the zero-cost winners minus losers portfolio were examined in each of the 36 months following the portfolio formation date. With the exception of the first month, this portfolio realizes positive returns in each of the 12 months after the formation date. However, the longer-term performances of these past winners and losers reveal that half of their excess returns in the year following the portfolio formation date dissipate within the following 2 years.

The returns of the stocks in the winners and losers portfolios around their earnings announcements in the 36 months following the formation period were also examined and a similar pattern was found. Specifically, stocks in the winners portfolio realize significantly higher returns than the stocks in the losers portfolio around the quarterly earnings announcements that are made in the first few months following the formation date. However, the announcement date returns in the 8 to 20 months following the formation date are significantly higher for the stocks in the losers portfolio than for the stocks in the winners portfolio.

The evidence of initial positive and later negative relative strength returns suggests that common interpretations of return reversals as evidence of overreaction and return persistence (i.e., past winners achieving positive returns in the future) as evidence of underreaction are probably overly simplistic. A more sophisticated model of investor behavior is needed to explain the observed pattern of returns. One interpretation of our results is that transactions by investors who buy past winners and sell past losers move prices away from their long-run values temporarily and thereby cause prices to overreact. This interpretation is consistent with the analysis of DeLong, Shleifer, Summers, and Waldman (1990) who explore the implications of what they call "positive feedback traders" on market price. Alternatively, it is possible that the market underreacts to information about the short-term prospects of firms but overreacts to information about their long-term prospects. This is plausible given that the nature of the information available about a firm's short-term prospects, such as earnings forecasts, is different from the nature of the more ambiguous information that is used by investors to assess a firm's longer-term prospects.

The evidence in this paper does not allow us to distinguish between these two hypotheses about investor behavior. In addition, there are probably other explanations for these results. Given that our results suggest that investor expectations are systematically biased, further research that attempts to identify explanations for these empirical regularities would be of interest.

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