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Profitability of Momentum Strategies: An Evaluation of Alternative Explanations

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ABSTRACT

This paper evaluates various explanations for the profitability of momentum strategies documented in Jegadeesh and Titman (1993). The evidence indicates that momentum profits have continued in the 1990s, suggesting that the original results were not a product of data snooping bias. The paper also examines the predictions of recent behavioral models that propose that momentum profits are due to delayed overreactions that are eventually reversed. Our evidence provides support for the behavioral models, but this support should be tempered with caution.

Many portfolio managers and stock analysts subscribe to the view that momentum strategies yield significant profits. Jegadeesh and Titman (1993) examine a variety of momentum strategies and document that strategies that buy stocks with high returns over the previous 3 to 12 months and sell stocks with poor returns over the same time period earn profits of about one percent per month for the following year.[1] Although these results have been well accepted, the source of the profits and the interpretation of the evidence are widely debated. Although some have argued that the results provide strong evidence of "market inefficiency," others have argued that the returns from these strategies are either compensation for risk, or alternatively, the product of data mining.

The criticism that observed empirical regularities arise because of data mining is typically the hardest to address because empirical research in nonexperimental settings is limited by data availability. Fortunately, with

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[1] Rouwenhorst (1998) reports that the momentum profits documented by Jegadeesh and Titman (1993) for the U.S. market also obtain in the European markets. Chui, Titman, and Wei (2000) document that with the notable exception of Japan and Korea, momentum profits also obtain in Asian markets. Moskowitz and Grinblatt (1999) and Grundy and Martin (2000) examine the industry and factor components of momentum profits. Asness (1997), Lee and Swaminathan (2000), and Hong, Lim, and Stein (2000) examine the relation between book-to-market ratios, trading volume and analyst coverage and momentum, and Chan, Jegadeesh, and Lakonishok (1996) examine the relation between earnings momentum and return momentum. See Haugen (1999) for additional discussion of the momentum effect.

the passage of time, we now have nine additional years of data that enable us to perform out-of-sample tests as well as to assess the extent to which investors may have learned from the earlier return patterns. Using the data over the 1990 to 1998 sample period, we find that Jegadeesh and Titman (1993) momentum strategies continue to be profitable and that past winners outperform past losers by about the same magnitude as in the earlier period. This is noteworthy given that other well-known anomalies such as the small firm effect documented by Banz (1981) and the superior performance of value stocks relative to growth stocks are not observed after the sample periods examined in the original studies.[2]

Given the persistence of this anomaly, it is important to understand its cause. A number of authors, for example, Barberis, Shleifer, and Vishny (1998), Daniel, Hirshleifer, and Subrahmanyam (1998), and Hong and Stein (1999), present behavioral models that are based on the idea that momentum profits arise because of inherent biases in the way that investors interpret information. Others, however, have argued that it is premature to reject the rational models and suggest that the profitability of momentum strategies may simply be compensation for risk. Most notably, Conrad and Kaul (1998) argue that the profitability of momentum strategies could be entirely due to *cross-sectional* variation in expected returns rather than to any predictable *time-series* variations in stock returns. Specifically, following Lo and MacKinlay (1990), Jegadeesh and Titman (1993), and others, they note that stocks with high (low) unconditional expected rates of return in adjacent time periods are expected to have high (low) realized rates of returns in both periods. Hence, under the Conrad and Kaul (1998) hypothesis, momentum strategies yield positive returns on average even if the expected returns on stocks are constant over time.

The behavioral models and Conrad and Kaul's arguments make diametrically opposed predictions about the returns of past winners and losers over the period following the initial holding period. The behavioral models imply that the holding period abnormal returns arise because of a delayed overreaction to information that pushes the prices of winners (losers) above (below) their long-term values. These models predict that in subsequent time periods, when the stock prices of the winners and losers revert to their fundamental values, the returns of losers should exceed the returns of winners. In contrast, Conrad and Kaul (1998) suggest that the higher returns of win-

[2] The average Fama-French size factor in the sample period 1965 to 1981 (which precedes the publication of Banz (1981)) is 0.53% per month with a t statistic of 2.34. However, in the 1982 to 1998 sample period, the average size factor is only -0.18% with a t statistic of -1.01. Similarly, the average book-to-market factor return in the 1990 to 1998 period (subsequent to the sample period in Fama and French (1993)) is 0.12% per month (t statistic of 0.47), which is not statistically different from zero. However, there are other out-of-sample results that support the value/growth phenomenon. For example, Fama and French (1998) and Davis, Fama, and French (2000) find that this is an international phenomenon and also that this phenomenon was observed in sample periods prior to that considered in the early studies.

ners in the holding period represent their unconditional expected rates of return and thus predict that the returns of the momentum portfolio will be positive on average in any postranking period.

To test the conflicting implications of these theories, we examine the returns of the winner and loser stocks in the 60 months following the formation date. Consistent with earlier work, we find that over the entire sample period of 1965 to 1998, the Jegadeesh and Titman (1993) momentum portfolio yields significant positive returns in the first 12 months following the formation period. In addition, the cumulative return in months 13 to 60 for the Jegadeesh and Titman (1993) momentum portfolio is *negative*, which is consistent with the behavioral theories but is inconsistent with the Conrad and Kaul hypothesis.[3]

Although the negative postholding period returns of the momentum portfolio appear to support the predictions of the behavioral models, further analysis suggests that this support should be interpreted with caution. First, we find strong evidence of return reversals for small firms, but the evidence is somewhat weak for large firms, particularly when we evaluate portfolio performance relative to the Fama and French (1993) benchmark. In addition, although we find strong evidence of return reversals in the 1965 to 1981 period, the evidence of return reversals is substantially weaker in the 1982 to 1998 period. This is noteworthy because there is no distinguishable difference between either the magnitude or the significance of the momentum profits in the two subperiods.

The remainder of the paper is organized as follows: Section I provides a brief description of our data and methodology and examines the profitability of momentum strategies in the 1990s, Section II provides an analysis of the longer horizon returns, and Section III concludes the paper.

I. Momentum Profits in the 1990s

This section examines whether the profitability of the momentum strategies documented by Jegadeesh and Titman (1993) can be attributed to data mining. The issue here is fairly straightforward. Stock return data are now widely available and computing power is fairly cheap. Because there are potentially large payoffs to any viable model that predicts stock returns (in terms of publications and/or money management revenues) many academics and practitioners have, no doubt, independently tested a wide variety of trading strategies. Therefore, it is difficult to assess the significance of individual studies that find that a particular trading strategy is profitable.

We address the data mining issue in the context of the Jegadeesh and Titman (1993) six-month momentum strategy, which was previously shown to earn abnormal returns of about one percent per month with a t statistic of 3.07 over the 1965 to 1989 sample period. When this strategy is viewed as a

[3] In an independent paper, Lee and Swaminathan (2000) examine the relations between momentum, volume, and long horizon returns to test the predictions of behavioral models.

single experiment, standard statistical theory indicates that the probability of observing a t statistic at least as large as 3.07 under the hypothesis of market efficiency is less than 0.11 percent. Based on this, Jegadeesh and Titman (1993) conclude that the hypothesis of market efficiency can be rejected at even the most conservative levels of significance. This inference, however, ignores the fact that there were many other tests independently carried out by other researchers over the same sample period that were perhaps not profitable and hence were not reported. The fact that the evidence of momentum profits gained attention can be attributed to the fact that it yielded the highest test statistic among the many tests that were carried out collectively. Under this interpretation, the test statistic in Jegadeesh and Titman should be viewed as the highest order statistic across many tests rather than as a conventional test statistic from a single experiment. The distribution of this order statistic, of course, is not normal.

To formalize the statistical analysis, suppose that researchers collectively tested n independent trading strategies during the Jegadeesh and Titman (1993) sample period.[4] Also, suppose that the momentum strategy yielded the highest test statistic among these n strategies. The cumulative distribution of the largest order statistic is F^n, where F is the cumulative standard normal distribution.[5] As stated earlier, if the Jegadeesh and Titman (1993) test is viewed in isolation then $n = 1$ and the probability of observing a t statistic this large is 0.11 percent. However, if $n = 100$, for example, then the probability that the largest test statistic is at least 3.07 is about 10 percent. If $n = 650$, then the p value based on this test statistic drops below 50 percent. So the perception of how strong the Jegadeesh and Titman (1993) evidence is in rejecting the efficient market hypothesis depends on the readers' priors about how many other independent and unreported tests that failed to reject market efficiency had been carried out.

A. Portfolio Formation

The advantage of an out-of-sample test is that it significantly reduces the number of strategies that researchers can potentially search over, greatly reducing n, and thus increasing the informativeness of the tests. For this reason, we reexamine the Jegadeesh and Titman (1993) trading strategy in the time period subsequent to their analysis.

Our sample is constructed from all stocks traded on the New York Stock Exchange (NYSE), American Stock Exchange, and Nasdaq. We exclude all stocks priced below \$5 at the beginning of the holding period and all stocks with market capitalizations that would place them in the smallest NYSE decile. We exclude these stocks to ensure that the results are not driven

[4] The distribution of the highest order statistic will have to be numerically computed if the n trading strategies examined in this sample period are correlated.

[5] We are assuming here that the degrees of freedom for the t statistic are sufficiently large so that the t distribution can be approximated by the standard normal distribution.

Formation Period	Holding Period	Post-Holding Period
(Month –5 to Month 0)	(Month 1 to Month 6 or 12)	(Month 13 to Month 60)

Figure 1. Time line showing sample periods.

primarily by small and illiquid stocks or by bid-ask bounce.[6] Our sample differs from Jegadeesh and Titman (1993) because we include Nasdaq stocks but exclude small and low-priced stocks. The addition of Nasdaq stocks and the deletion of low-priced stocks, however, have very little effect on average returns over various horizons we consider, but they decrease standard errors and significantly lower the magnitude of the negative January returns.

Following Jegadeesh and Titman (1993), at the end of each month we rank the stocks in our sample based on their past six-month returns (Month −5 to Month 0) and then group the stocks into 10 equally weighted portfolios based on these ranks. Each portfolio is held for six months (Month 1 to Month 6) following the ranking month. The various periods we consider are presented in the time line in Figure 1, which also presents a postholding period (Month 13 to Month 60) that we consider in the next section.

To increase the power of our tests, we construct overlapping portfolios. In other words, a momentum decile portfolio in any particular month holds stocks ranked in that decile in any of the previous six ranking months. For instance, a December winner portfolio comprises 10 percent of the stocks with the highest returns over the previous June to November period, the previous May to October, and so on up to the previous January to June period. Each monthly cohort is assigned an equal weight in this portfolio.

B. Holding Period Returns

Table I presents average monthly returns for the 10 momentum portfolios. Portfolio P1 comprises stocks with the largest ranking period returns and P10 comprises stocks with the lowest ranking period returns. The table reveals a monotonic relation between returns and momentum ranks over the 1965 to 1989 sample period, confirming the results in Jegadeesh and Titman (1993). The difference between the P1 and P10 portfolio returns during this time period is 1.17 percent per month, which is reliably different from

[6] Conrad and Kaul (1993) point out that much of the evidence of long horizon mean reversion in DeBondt and Thaler (1985) is due to the inclusion of low-priced stocks. The results in this paper, however, are similar both with and without the $5 price screen except in Januaries. The low-priced stocks exhibit large return reversals in January and, as a result, the momentum strategies earn larger negative returns in January if these stocks are included. When all calendar months are considered, momentum profits are about one percent per month with or without the $5 price screen.

Table I

Momentum Portfolio Returns

This table reports the monthly returns for momentum portfolios formed based on past six-month returns and held for six months. P1 is the equal-weighted portfolio of 10 percent of the stocks with the highest returns over the previous six months, P2 is the equal-weighted portfolio of the 10 percent of the stocks with the next highest returns, and so on. The "All stocks" sample includes all stocks traded on the NYSE, AMEX, or Nasdaq excluding stocks priced less than $5 at the beginning of the holding period and stocks in the smallest market cap decile (NYSE size decile cutoff). The "Small Cap" and "Large Cap" subsamples comprise stocks in the "All Stocks" sample that are smaller and larger than the median market cap NYSE stock respectively. "EWI" is the returns on the equal-weighted index of stocks in each sample.

	All Stocks			Small Cap			Large Cap		
	1965–1998	1965–1989	1990–1998	1965–1998	1965–1989	1990–1998	1965–1998	1965–1989	1990–1998
P1 (Past winners)	1.65	1.63	1.69	1.70	1.69	1.73	1.56	1.52	1.66
P2	1.39	1.41	1.32	1.45	1.50	1.33	1.25	1.24	1.27
P3	1.28	1.30	1.21	1.37	1.42	1.23	1.12	1.10	1.19
P4	1.19	1.21	1.13	1.26	1.34	1.05	1.10	1.07	1.20
P5	1.17	1.18	1.12	1.26	1.33	1.06	1.05	1.00	1.19
P6	1.13	1.15	1.09	1.19	1.26	1.01	1.09	1.05	1.20
P7	1.11	1.12	1.09	1.14	1.20	0.99	1.09	1.04	1.23
P8	1.05	1.05	1.03	1.09	1.17	0.89	1.04	1.00	1.17
P9	0.90	0.94	0.77	0.84	0.95	0.54	1.00	0.96	1.09
P10 (Past losers)	0.42	0.46	0.30	0.28	0.35	0.08	0.70	0.68	0.78
P1–P10	1.23	1.17	1.39	1.42	1.34	1.65	0.86	0.85	0.88
t statistic	6.46	4.96	4.71	7.41	5.60	5.74	4.34	3.55	2.59
EWI	1.09	1.10	1.04	1.13	1.19	0.98	1.03	1.00	1.12

zero.[7] The table reveals that this return pattern continues in the more recent 1990 to 1998 period. In this period, past winners outperformed past losers by 1.39 percent per month, which is close to the corresponding returns in the original Jegadeesh and Titman (1993) sample period.

To put the results in perspective, Table I also presents the average equal-weighted returns for the stocks in the sample. Interestingly, the winners (P1 portfolio) outperform the equal-weighted index by 0.56 percent per month, whereas the losers (P10 portfolio) underperform the index by 0.67 percent per month. These results suggest that both winners and losers contribute about equally to momentum profits.

Table I also separately presents momentum returns generated by small and large stocks. Firms with market capitalizations above the median NYSE listed stock at the beginning of each holding period are classified as large stocks and the rest of the sample is classified as small stocks. We examine these subsamples separately for several reasons. First, because it is expensive to trade smaller capitalization stocks, it may not be possible to execute active trading strategies with these stocks. Therefore, from a practical standpoint, the evidence will be more convincing if we also find momentum profits for larger firms. Second, differences in the out-of-sample returns of momentum portfolios consisting of large and small stocks can potentially provide insights about the extent to which investors learn about the profitability of these momentum strategies and exploit them. Specifically, in the past decade, momentum strategies have become more popular among institutional investors, perhaps because of the dissemination of information relating to the performance of these strategies. One might expect that the trading activities of these institutions would eliminate the momentum effect, at least for the relatively large stocks that they can trade at low costs.

The results in Table I indicate that the momentum effect continues in the 1990s for large stocks as well as small stocks. The differences between winner and loser portfolio returns are about equal across the two subperiods for both the small and large firm subsamples. In all cases the returns are close to being monotonically related to past six-month returns. These results also indicate that the momentum profits come from the buy as well as the sell side of this strategy.[8]

Our findings relating to the profits from small versus large stocks and the long side versus the short side of our trading strategy are intriguing, given the conventional wisdom that, with learning, profit opportunities will be sustained longer when there are higher costs of implementing trading strat-

[7] The t statistic now is 4.96 compared with that of 3.07 reported by Jegadeesh and Titman (1993). Although the magnitude of momentum profits here is similar to that in Jegadeesh and Titman (1993), the variability is now smaller because of the exclusion of small stocks and stocks priced below $5.

[8] This observation should be contrasted with the observation in Hong, Lim, and Stein (2000), who suggest that most of the momentum profits come from the short side of the transaction. Their conclusions are perhaps driven by the fact that they form only three momentum portfolios as opposed to the decile portfolios formed here.

egies. The transaction costs explanation suggests that momentum profits will dissipate faster for large stocks, which are cheaper to trade, and that because of the costs of short-selling, the profits from trading past winners should be eliminated more quickly than the profits from trading past losers. These predictions are not supported by the data.

C. Seasonality

Jegadeesh and Titman (1993) find a striking seasonality in momentum profits. They document that the winners outperform losers in all months except January, but the losers significantly outperform the winners in January. This seasonality could potentially be a statistical fluke; January is one of twelve calendar months and it is possible that in any one calendar month momentum profits are negative. Here again, we can examine the out-of-sample performance of the strategy in January to examine whether this seasonality is real or whether it was the result of looking too closely at the data.

Our unreported analysis that replicates the momentum strategies using the sample selection criteria in Jegadeesh and Titman (1993) found results very similar to theirs for the 1990s, suggesting that the earlier finding was not a statistical fluke. Table II reports the momentum profits in January and non-January for our sample that excludes both stocks priced under $5 per share and stocks in the smallest size decile. The momentum profits in January for this sample are also negative in all subperiods but they are only marginally significant. This indicates that most of the previously reported negative returns in January are due to small and low-priced stocks, which are likely to be difficult to trade at the reported CRSP prices. The January momentum profits, however, are significantly smaller than the momentum profits in other calendar months in all sample periods.

D. Portfolio Characteristics and Abnormal Returns

This subsection examines the characteristics of the momentum portfolios and the risk-adjusted momentum portfolio returns. Table III presents the characteristics of the momentum portfolios. The size decile ranks in this table are computed using NYSE size decile cutoffs with the size rank of one being the smallest and the size rank of ten being the largest. Both winners and losers tend to be smaller firms than the average stock in the sample, because smaller firms have more volatile returns and are thus more likely to be in the extreme return sorted portfolios. The average size rank for the winner portfolio is larger than that for the loser portfolio.

Table III also presents the sensitivities of these portfolios to the three Fama-French factors. The results indicate that the market betas for winners and losers are virtually equal. However, the losers are somewhat more sensitive to the size factor than are the winners (the loadings for the losers is 0.55 versus 0.41 for the winners). Moreover, the winners have a loading of

Table II

Momentum Portfolio Returns in January and outside January

This table reports the average monthly momentum portfolio returns, the associated *t* statistics to test whether the returns are reliably different than zero, and the percentage of monthly momentum returns that are positive. The table reports returns for January as well as non-January months, and returns in the 1965–1989, Jegadeesh and Titman (1993) sample period, the 1990–1998 subsequent period, as well as the entire 1965–1998 period. The sample includes all stocks traded on the NYSE, AMEX, or Nasdaq, excluding stocks priced less than $5 at the beginning of the holding period and stocks in the smallest market cap decile (NYSE size decile cutoff). The momentum portfolios are formed based on past six-month returns and held for six months. P1 is the equal-weighted portfolio of 10 percent of the stocks with the highest past six-month returns and P10 is the equal-weighted portfolio of the 10 percent of the stocks with the lowest past six-month returns.

	P1	P10	P1-P10	*t* statistic	Percent Positive
1965–1989					
Jan	4.01	5.67	−1.67	−1.50	36
Feb–Dec	1.42	−0.01	1.43	6.20	69
All	1.63	0.46	1.17	4.96	66
1990–1998					
Jan	1.72	2.95	−1.24	−2.08	11
Feb–Dec	1.69	0.06	1.63	5.32	69
All	1.69	0.30	1.39	4.71	64
1965–1998					
Jan	3.40	4.95	−1.55	−1.87	29
Feb–Dec	1.49	0.01	1.48	7.89	69
All	1.65	0.42	1.23	6.46	66

−0.245 on the HML factor whereas the losers have a loading of −0.02. These results indicate that the losers are riskier than the winners because they are more sensitive to all three Fama-French factors.

Table IV reports the alphas of the various momentum portfolios estimated by regressing the monthly momentum returns (less the risk-free rate except for the zero investment P1–P10 portfolio) on the monthly returns of both the value-weighted index less the risk-free rate and the three Fama-French factors. The CAPM alpha for the winner minus loser portfolio is about the same as the raw return difference, as both winners and losers have about the same betas. Consistent with Fama and French (1996), the Fama-French alpha for this portfolio is also reliably positive. The Fama and French alpha for this portfolio is 1.36 percent, which is larger than the corresponding raw return of 1.23 percent. This difference arises because the losers are more sensitive to the Fama-French factors, as reported in Table III.

II. Postholding Period Returns of Momentum Portfolios

A number of hypotheses have been proposed in the literature to explain the profitability of momentum strategies. This section examines the per-

Table III

Portfolio Characteristics

This table reports the characteristics of momentum portfolios. The sample includes all stocks traded on the NYSE, AMEX, or Nasdaq, excluding stocks priced less than $5 at the beginning of the holding period and stocks in the smallest market cap decile (NYSE size cutoff). P1 is the equal-weighted portfolio of 10 percent of the stocks with the highest past six-month returns, P2 is the equal-weighted portfolio of the 10 percent of the stocks with the next highest past six-month returns, and so on. Average size decile rank is the average rank of the market capitalization of equity (based on NYSE size decile cutoffs) of the stocks in each portfolio at the beginning of the holding period. FF factor sensitivities are the slope coefficients in the Fama-French three-factor model time-series regressions. "Market" is the market factor (the value-weighted index minus the risk-free rate), "SMB" is the size factor (small stocks minus big stocks) and "HML" is the book-to-market factor (high minus low book-to-market stocks). The sample period is January 1965 to December 1998.

	Average Size Decile Rank	FF Factor Sensitivities		
		Market	SMB	HML
P1	4.81	1.08	0.41	−0.24
P2	5.32	1.03	0.23	0.00
P3	5.49	1.00	0.19	0.08
P4	5.51	0.99	0.17	0.14
P5	5.49	0.99	0.17	0.17
P6	5.41	0.99	0.19	0.19
P7	5.36	0.99	0.22	0.19
P8	5.26	1.01	0.24	0.16
P9	5.09	1.04	0.30	0.11
P10	4.56	1.12	0.55	−0.02
P1–P10	0.25	−0.04	−0.13	−0.22

formance of momentum portfolios over longer horizons to differentiate between these hypotheses. Specifically, we examine the returns of the portfolios in the periods following the holding periods considered in the previous section.

A. Market Underreaction

The null hypothesis of our postholding period tests is that the momentum profits arise because investors underreact to ranking period information, which is gradually incorporated into stock prices during the holding period. Barberis et al. (1998) discuss how a "conservatism bias" might lead investors to underreact to information in a way that is consistent with our null hypothesis. The conservatism bias, identified in experiments by Edwards (1968), suggests that individuals underweight new information in updating their priors. If investors act in this way, prices will tend to slowly adjust to information, but once the information is fully incorporated in prices, there is no further predictability in stock returns. This interpretation suggests that the postholding period returns will be zero.

Table IV

CAPM and Fama-French Alphas

This table reports the risk-adjusted returns of momentum portfolios. The sample comprises all stocks traded on the NYSE, AMEX, or Nasdaq, excluding stocks priced less than $5 at the beginning of the holding period and stocks in the smallest market cap decile (NYSE size decile cutoff). P1 is the equal-weighted portfolio of 10 percent of the stocks with the highest past six-month returns, P2 is the equal-weighted portfolio of the 10 percent of the stocks with the next highest past six-month returns, and so on. This table reports the intercepts from the market model regression (CAPM Alpha) and Fama-French three-factor regression (FF Alpha). The sample period is January 1965 to December 1998. The t statistics are reported in parentheses.

	CAPM Alpha	FF Alpha
P1	0.46	0.50
	(3.03)	(4.68)
P2	0.29	0.22
	(2.86)	(3.51)
P3	0.21	0.10
	(2.53)	(2.31)
P4	0.15	0.02
	(1.92)	(0.41)
P5	0.13	−0.02
	(1.70)	(−.43)
P6	0.10	−0.06
	(1.22)	(−1.37)
P7	0.07	−0.09
	(0.75)	(−1.70)
P8	−0.02	−0.16
	(−0.19)	(−2.50)
P9	−0.21	−0.33
	(−1.69)	(−4.01)
P10	−0.79	−0.85
	(−4.59)	(−7.54)
P1–P10	1.24	1.36
	(6.50)	(−7.04)

B. Behavioral Models

The recent behavioral literature is motivated in part by a body of evidence that suggests that the postholding period returns may in fact be negative. For example, Jegadeesh and Titman (1993) present some evidence that the postholding period average return of their momentum portfolio is negative, and DeBondt and Thaler (1985) provide stronger evidence of longer-term overreaction. In addition, the earlier mentioned evidence of return predictability based on book-to-market ratios is consistent with the existence of overreaction.

To explain the long-term overreaction as well as the shorter-term momentum, Barberis et al. (1998) present a model that combines the conservatism bias with what Tversky and Kahneman (1974) refer to as a "representative heuristic," which is the tendency of individuals to identify "an uncertain event, or a sample, by the degree to which it is similar to the parent population." In the context of stock prices, Barberis et al. (1998) argue that the representative heuristic may lead investors to mistakenly conclude that firms realizing extraordinary earnings growths will continue to experience similar extraordinary growth in the future. They argue that, although the conservatism bias in isolation leads to underreaction, this behavioral tendency in conjunction with the representative heuristic can lead to long horizon negative returns for stocks with consistently high returns in the past.[9]

Daniel et al. (1998) and Hong and Stein (1999) propose alternative models that are also consistent with short-term momentum and long-term reversals. Daniel et al. (1998) argue that informed traders suffer from a "self-attribution" bias. In their model, investors observe positive signals about a set of stocks, some of which perform well after the signal is received. Because of their cognitive biases, the informed traders attribute the performance of ex post winners to their stock selection skills and that of the ex post losers to bad luck. As a result, these investors become overconfident about their ability to pick winners and thereby overestimate the precision of their signals for these stocks. Based on their increased confidence in their signals, they push up the prices of the winners above their fundamental values. The delayed overreaction in this model leads to momentum profits that are eventually reversed as prices revert to their fundamentals.

Hong and Stein (1999) do not directly appeal to any behavioral biases on the part of investors, but they consider two groups of investors who trade based on different sets of information. The informed investors or the "news watchers" in their model obtain signals about future cash flows but ignore information in the past history of prices. The other investors in their model trade based on a limited history of prices and, in addition, do not observe fundamental information. The information obtained by the informed investors is transmitted with a delay and hence is only partially incorporated in the prices when first revealed to the market. This part of the model contributes to underreaction, resulting in momentum profits. The technical traders extrapolate based on past prices and tend to push prices of past winners above their fundamental values. Return reversals obtain when prices eventually revert to their fundamentals. Both groups of investors in this model act rationally in updating their expectations conditional on their information sets, but return predictability obtains due to the fact that each group uses only partial information in updating its expectation.

[9] The time horizon over which various biases come into play in the Barberis et al. (1998) (and in other behavioral models) is unspecified. One could argue that the six-month ranking period used in this paper may not be long enough for delayed overreaction due to the representative heuristic effect. In such an event we would only observe underreaction due to the conservatism bias.

C. The Conrad and Kaul Hypothesis

Conrad and Kaul (1998) start with the hypothesis that stock prices follow random walks with drifts, and the unconditional drifts vary across stocks. The Conrad and Kaul (1998) hypothesis suggests that the differences in unconditional drifts across stocks explain momentum profits. Because any predictability under the Conrad and Kaul (1998) hypothesis is due to differences in unconditional drifts across stocks and is not due to the random component of price changes in any particular period, the profits from a momentum strategy should be the same in *any* postranking period. In other words, this hypothesis predicts that the stocks on the long side of the momentum portfolio should continue to outperform stocks on the short side by the same magnitude in any postranking period.

D. The Postholding Period Evidence

Figure 2 summarizes (1) the underreaction, (2) the overreaction and price correction, and (3) the Conrad and Kaul (1998) hypotheses. Although all three hypotheses imply momentum profits in the holding period, the postholding period performance of the momentum portfolios differs sharply under the three hypotheses as discussed above.

To test these competing hypotheses, we examine the returns of the momentum portfolio following the initial formation date. The theoretical models do not offer any guidance regarding the length of the postholding period over which return reversals due to price corrections are expected to occur. Jegadeesh and Titman (1993) examine momentum portfolio returns up to three years after portfolio formation with the idea that even if markets are not fully efficient, the effect of any information will likely be impounded in prices within this time frame. Recent studies of initial public offerings and seasoned equity offerings, however, find evidence of underperformance even five years after the events.[10] Therefore we extend the postholding period to five years in this study.

Figure 3 presents cumulative momentum profits over a 60-month postformation period. Over the 1965 to 1998 sample period, the results reveal a dramatic reversal of returns in the second through fifth years. Cumulative momentum profits increase monotonically until they reach 12.17 percent at the end of Month 12. From Month 13 to Month 60 the momentum profits are on average negative. By the end of Month 60 the cumulative momentum profits decline to −0.44 percent. This evidence is clearly inconsistent with the Conrad and Kaul (1998) hypothesis and tends to support the behavioral hypotheses.[11]

[10] See Loughran and Ritter (1995) and Spiess and Affleck-Graves (1995), among others.

[11] Jegadeesh and Titman (2000) show that the main results in Conrad and Kaul (1998) are largely driven by small sample biases in their experiments.

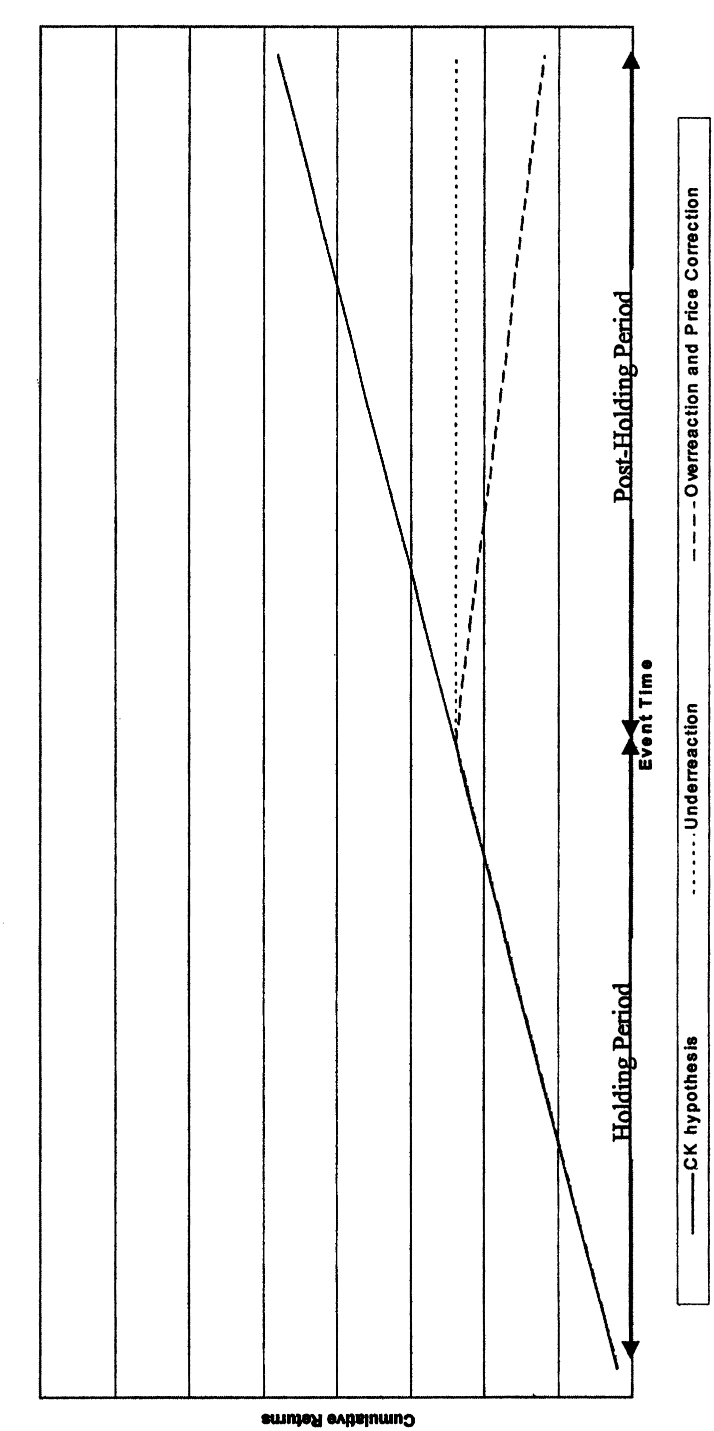

Figure 2. Long horizon momentum profits under different hypotheses. This figure presents the expected pattern of momentum portfolio returns under various hypotheses.

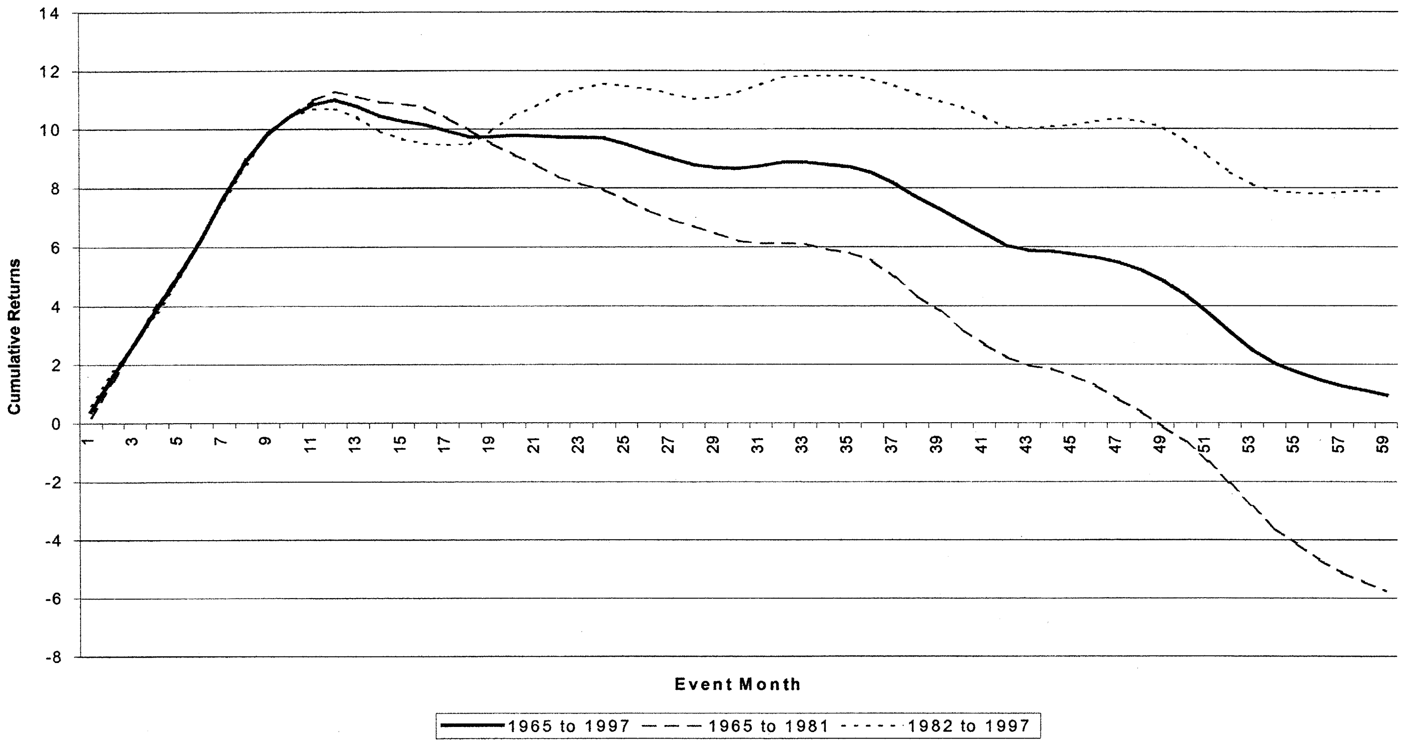

Figure 3. Cumulative momentum profits. This figure presents cumulative momentum portfolio returns with a sample of stocks traded on the NYSE, AMEX, or Nasdaq. The sample comprises all stocks that are larger than the smallest NYSE market cap decile at the beginning of the event period. Stocks priced less than $5 at the beginning of each event month are excluded from the sample. See Table I for a description of momentum portfolio construction.

Table V

Seasonality in Longer Horizon Momentum Profits and Fama and French Factors

Panel A presents the average monthly returns on the three Fama and French risk factors. "Market" is the market factor (value-weighted index minus risk-free rate), "SMB" is the size factor, and "HML" is the book-to-market factor. Panel B presents average monthly momentum portfolio (P1–P10) returns one, two, three, four, and five years after portfolio formation. See Table I for a description of portfolio construction. Panel C presents the intercepts from the Fama-French three-factor regressions fitted over all months in the sample period and separately within and outside January. The t statistics are reported in parentheses. The sample period is January 1965 to December 1998.

Panel A. Average Factors

Calendar Months	Fama-French Factors Market	SMB	HML
January	1.83	2.29	2.34
	(2.00)	(3.63)	(4.26)
Feb–Dec	0.39	−0.02	0.23
	(1.74)	(−.12)	(1.83)
All	0.51	0.17	0.41
	(2.32)	(1.21)	(3.18)

Panel B. Raw Returns

Calendar Months	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
January	−1.69	−2.87	−1.49	−0.48	−0.59	−1.36
	(−2.49)	(−5.46)	(−3.50)	(−1.35)	(−1.37)	(−5.12)
Feb–Dec	1.26	0.00	−0.15	−0.20	−0.28	−0.16
	(8.31)	(−0.04)	(−1.55)	(−2.31)	(−3.11)	(−3.01)
All	1.01	−0.24	−0.26	−0.23	−0.31	−0.26
	(6.52)	(−2.23)	(−2.70)	(−2.63)	(−3.40)	(−4.65)

Table V presents further details on the momentum portfolio returns in the first five years after portfolio formation. The average profit in the first 12 months of the holding period is 1.01 percent per month, the average profit is −0.24 percent per month in the second year, −0.26 percent in the third year, −0.23 percent per month in the fourth year, and −0.31 percent per month in the fifth year.[12] The average return of −0.26 percent over the second through fifth years is reliably less than zero, which is consistent with the behavioral models that predict that the momentum profits will eventually reverse.

As Table III reports, the loser portfolios have larger sensitivities to the Fama and French size and book-to-market factors. The negative returns observed in the postholding period may therefore represent compensation for

[12] Momentum profits are negative in four of the five years from Year 6 thorough Year 10, but they are not reliably different from zero.

Table V—*Continued*

Panel C. Fama-French Three-factor Alphas						
Calendar Months	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
			Winner Portfolio (P1)			
January	−0.06	−0.11	0.29	0.07	0.18	0.11
	(−0.11)	(−0.33)	(1.13)	(0.29)	(0.56)	(0.66)
Feb–Dec	0.42	−0.21	−0.18	−0.14	−0.18	−0.18
	(4.82)	(−3.24)	(−2.84)	(−2.37)	(−3.04)	(−3.93)
All	0.37	−0.23	−0.16	−0.12	−0.16	−0.17
	(4.11)	(−3.48)	(−2.57)	(−2.10)	(−2.75)	(−3.83)
			Loser Portfolio (P10)			
January	0.42	1.02	0.38	0.38	0.22	0.50
	(1.18)	(3.73)	(1.36)	(1.14)	(0.74)	(2.76)
Feb–Dec	−0.88	−0.29	−0.10	0.02	0.09	−0.07
	(−9.22)	(−4.35)	(−1.58)	(0.31)	(1.60)	(−1.58)
All	−0.80	−0.20	−0.06	0.03	0.10	−0.03
	(−8.54)	(−2.97)	(−0.96)	(0.54)	(1.71)	(−0.74)
			Momentum Portfolio (P1–P10)			
January	−0.48	−1.13	−0.09	−0.31	−0.04	−0.39
	(−0.57)	(−2.20)	(−0.21)	(−0.69)	(−0.06)	(−1.72)
Feb–Dec	1.30	0.08	−0.08	−0.16	−0.28	−0.11
	(8.60)	(0.87)	(−0.90)	(−1.91)	(−3.14)	(−2.69)
All	1.17	−0.03	−0.10	−0.16	−0.26	−0.14
	(7.57)	(−0.31)	(−1.11)	(−1.84)	(−2.94)	(−3.26)

factor risks. Furthermore, the Fama-French factors exhibit a January seasonal. In our sample period, the Fama-French size factor has an average return of 2.29 percent in January compared with −0.02 percent outside January, whereas the book-to-market factor has an average return of 2.34 percent in January and 0.23 percent outside January. If the negative returns for the momentum portfolio are due to their exposures to the Fama-French factors, then we would expect that a large portion of these negative returns will also be concentrated in January.

Table V (Panel B) presents the momentum profits in January and outside January over various horizons. The average postholding period momentum profit is negative each year and is significantly negative in each January. The momentum profits outside January are close to zero in the second and third years following formation but are reliably negative in the fourth and fifth years.

Panel C of Table V presents the Fama-French three-factor alphas for the zero cost momentum portfolio for both the winner's and loser's portfolios. The table reveals that the alpha of the zero cost momentum portfolio is approximately half the size of the raw returns in Month 13 to Month 60. The alphas are significantly negative only in years four and five. Our separate analysis of winners and losers indicates that the return reversals observed for the zero cost momentum portfolio is entirely due to the negative alphas of the winners. Indeed, the evidence here indicates that the losers as well as winners experience negative abnormal returns in years two through five (see Table V, Panel C). This evidence is inconsistent with the idea that the momentum in loser returns is generated as a result of positive feedback trading that is later reversed.

E. Subperiod Evidence

To investigate the robustness of long horizon return reversals we examine the performance of momentum portfolios in two separate time periods, the 1965 to 1981 and 1982 to 1998 subperiods. In addition to being the half-way point, 1981 represents somewhat of a break point for the Fama and French factor returns. The Fama-French SMB and HML factors have higher returns in the pre-1981 period (the monthly returns of the SMB and HML factors average 0.53 percent and 0.48 percent, respectively; see Table VI) than in the post-1981 period (the monthly returns of the SMB and HML factors average −0.18 percent and 0.33 percent, respectively).

The evidence in Table VI and Figure 3 indicates that the momentum strategy is significantly profitable, and quite similar in both subperiods in the first 12 months following the formation date. The returns in the postholding periods, however, are quite different in the two subperiods. In the 1965 to 1981 subperiod, the cumulative momentum profit declines from 12.10 percent at the end of Month 12 to 5.25 percent at the end of Month 36 and then declines further to −6.29 percent at the end of Month 60. In fact, we found that the momentum profit is negative in each event month after Month 12 in this subperiod. In the 1982 to 1998 subperiod, the cumulative profit decreases from 12.24 percent at the end of month 12 to 6.68 percent at the end of Month 36 and then stays at about the same level for the next 24 months.

Tables VII and VIII replicate Tables V and VI on the large- and small-firm subsamples. For the large firms we find strong evidence of return reversals when we examine raw returns. However, the Fama-French alpha in Month 13 to Month 60 is only −0.07 percent per month, which is not statistically significant. Furthermore, evidence of return reversals is observed only in the first subperiod and the average postholding period abnormal return in the second subperiod is only −0.01 percent per month.

For the small stocks, we find somewhat stronger evidence of postholding period return reversals. Here again, the evidence of return reversals is considerably stronger in the first half of the sample, although as before, the

Table VI

Longer Horizons Momentum Profits and Fama and French Factors—Subperiod Results

This table presents momentum profits and Fama-French factors within two subperiods. Panel A presents the average monthly returns on the three Fama and French risk factors. "Market" is the market factor (the value-weighted index minus the risk-free rate), "SMB" is the size factor (small stocks minus big stocks), and "HML" is the book-to-market factor (high minus low book-to-market stocks). Panel B presents average monthly momentum portfolio (P1–P10) returns one, two, three, four, and five years after portfolio formation. See Table I for a description of portfolio construction. Panel C presents the intercepts from the Fama-French three-factor regressions fitted within each subperiod. The t statistics are reported in parentheses.

A. Fama-French Factors

	Market	SMB	HML
1965–1981	0.13	0.53	0.48
	(0.42)	(2.33)	(2.60)
1982–1998	0.89	−0.18	0.33
	(2.95)	(−1.01)	(1.88)

B. Raw Returns

	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
1965–1981	1.01	−0.30	−0.26	−0.48	−0.50	−0.38
	(3.99)	(−1.80)	(−1.84)	(−3.78)	(−3.58)	(−4.45)
1982–1998	1.02	−0.19	−0.26	0.03	−0.11	−0.13
	(5.62)	(−1.34)	(−1.99)	(0.22)	(−1.00)	(−1.93)

C. Fama-French Three-Factor Alphas

	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
1965–1981	1.26	0.01	−0.03	−0.37	−0.36	−0.19
	(5.09)	(0.04)	(−0.28)	(−2.94)	(−2.63)	(−3.11)
1982–1998	1.12	−0.05	−0.12	0.06	−0.19	−0.08
	(5.95)	(−0.42)	(−0.99)	(0.56)	(−1.70)	(−1.34)

magnitude of the momentum profits in the holding period is similar in the two sample periods.

In unreported tests, we separately examined the performance of momentum portfolios consisting of high-priced and low-priced stocks over different horizons. Our analysis was motivated by the fact that past losers tend to be priced lower than past winners. The results for both high-price and low-price subsamples were quite similar to the results in Tables VII and VIII for large and small firm subsamples. Specifically, both subsamples exhibit momentum profits over the 12-month holding period and similar patterns of reversals over the following four years.

Table VII

Long Horizon Momentum Profits for Large Firms

This table presents the momentum portfolio (winners minus losers) returns for large firms. The large firm sample in this table comprises all stocks traded on the NYSE, AMEX, or Nasdaq with market capitalizations larger than the median market capitalization of NYSE stocks. All stocks priced less than $5 at the beginning of the holding period are excluded from the sample. Panel A presents average monthly raw returns and Panel B presents abnormal returns adjusted for Fama-French factors.

Sample Period	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
Panel A. Raw Returns						
1965–1998	0.78	−0.21	−0.18	−0.19	−0.25	−0.21
	(4.66)	(−1.64)	(−1.67)	(−1.97)	(−2.46)	(−3.39)
1965–1981	0.82	−0.28	−0.23	−0.45	−0.32	−0.32
	(3.15)	(−1.49)	(−1.52)	(−3.37)	(−2.32)	(−3.85)
1982–1998	0.74	−0.14	−0.14	0.07	−0.18	−0.10
	(3.52)	(−0.80)	(−0.86)	(0.50)	(−1.21)	(−1.08)
Panel B. Fama-French Alpha						
1965–1998	0.96	0.05	0.00	−0.11	−0.22	−0.07
	(5.78)	(0.41)	(−0.03)	(−1.17)	(−2.18)	(−1.57)
1965–1981	1.07	0.03	0.00	−0.34	−0.21	−0.13
	(4.17)	(0.16)	(0.03)	(−2.53)	(−1.52)	(−2.23)
1982–1998	0.89	0.07	0.03	0.10	−0.25	−0.01
	(4.15)	(0.44)	(0.17)	(0.75)	(−1.63)	(−0.16)

III. Conclusions

This paper evaluates various explanations for the momentum profits documented previously by Jegadeesh and Titman (1993). We first document that the momentum profits in the eight years subsequent to the Jegadeesh and Titman (1993) sample period are remarkably similar to the profits found in the earlier time period. This evidence provides some assurance that the momentum profits are not entirely due to data snooping biases. Moreover, our results suggest that market participants have not altered their investment strategies in a way that would eliminate this source of return predictability.

To learn more about the source of momentum profits, we examine the returns of the momentum portfolios in the postholding period. By examining the postholding period performance, we address issues that were raised recently by Conrad and Kaul (1998), who argue that momentum profits arise because of cross-sectional differences in expected returns rather than because of time-series return patterns, and Barberis et al. (1998), Daniel et al. (1998), and Hong and Stein (1999), who present behavioral models that suggest that the postholding period returns of the momentum portfolio should be negative.

Table VIII

Long Horizon Momentum Profits for Small Firms

This table presents the momentum portfolio (winners minus losers) returns for small firms. The small firm sample in this table comprises all stocks traded on the NYSE, AMEX, or Nasdaq with market capitalizations smaller than the median market capitalization of NYSE stocks. All stocks priced less than $5 at the beginning of the holding period and stocks in the smallest market cap decile (NYSE size decile cutoff) are excluded from the sample. Panel A presents average monthly raw returns and Panel B presents abnormal returns adjusted for Fama-French factors.

Sample Period	Months 1 to 12	Months 13 to 24	Months 25 to 36	Months 37 to 48	Months 49 to 60	Months 13 to 60
			Panel A. Raw Returns			
1965–1998	1.11	−0.31	−0.32	−0.21	−0.33	−0.29
	(7.28)	(−2.87)	(−3.24)	(−2.41)	(−3.69)	(−5.29)
1965–1981	1.07	−0.38	−0.29	−0.47	−0.55	−0.42
	(4.33)	(−2.33)	(−1.93)	(−3.58)	(−3.91)	(−4.77)
1982–1998	1.16	−0.23	−0.35	0.04	−0.10	−0.16
	(6.41)	(−1.70)	(−2.72)	(0.36)	(−0.97)	(−2.50)
			Panel B. Fama-French Alpha			
1965–1998	1.27	−0.12	−0.17	−0.15	−0.29	−0.18
	(8.31)	(−1.30)	(−1.87)	(−1.66)	(−3.26)	(−4.07)
1965–1981	1.35	−0.10	−0.07	−0.38	−0.44	−0.25
	(5.58)	(−0.70)	(−0.51)	(−2.90)	(−3.16)	(−3.51)
1982–1998	1.22	−0.13	−0.23	0.08	−0.19	−0.12
	(6.47)	(−0.96)	(−1.84)	(0.70)	(−1.87)	(−2.16)

Our evidence suggests that the performance of the momentum portfolio in the 13 to 60 months following the portfolio formation month is negative. Although this evidence clearly rejects the Conrad and Kaul (1998) hypothesis, and is consistent with the behavioral models, for a variety of reasons our evidence in support of the behavioral models should be tempered with caution. In particular, although our evidence of momentum profits in the year following the formation period is extremely robust, evidence of negative postholding period returns tends to depend on the composition of the sample, the sample period, and, in some instances, whether the postholding period returns are risk adjusted. In other words, positive momentum returns are sometimes associated with postholding period reversals and sometimes are not, suggesting that the behavioral models provide at best a partial explanation for the momentum anomaly.

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