Do momentum and reversals coexist?

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Keywords: *momentum, reversals, return predictability, firm size, volatility, underreaction, overreaction.*

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1. Introduction

There is a large body of literature on the cross-section prediction of stock returns based on past realized returns. Predictability has been found for various horizons and the direction of prediction seems to depend on the holding period. DeBondt and Thaler (1985) document long-term reversals over a period of three to five years while Lehmann (1990) and Jegadeesh (1990) document short-term reversals for horizons of one-week and one-month, respectively. Over the intermediate term−three to 12 months−return continuation or momentum is observed (Jegadeesh and Titman, 1993, 2001). Examining returns in weekly frequencies, Gutierrez Jr. and Kelly (2008) also find short-term reversals and medium-term momentum. The cross-section, return predictability appears to be prevalent in many markets (Rouwenhorst, 1998) and exists between and within industries (Maskowitz and Grinblatt, 1999; and Hameed, Huang and Mian, 2010). The occurrence of momentum and reversals over different horizons is exploited by Yu (2010) with a hybrid strategy.

All of the existing studies treat momentum and reversals as separate phenomena over different holding periods. No models or empirical studies exist that explore the simultaneous occurrence of momentum and reversals. Many studies have dissected momentum returns along various single dimensions and revealed that higher volatilities and smaller sizes deliver the largest momentum profits. A remarkably simple yet extremely important exercise is conspicuously missing in the literature: examining the return predictability along the two important dimensions (size and volatility) simultaneously.

The current study fills this gap. Performing sequential sorts on size, volatility and past returns, this study discovers that, over a holding period of up to six months, momentum and reversals coexist for large stocks. Specifically, large-cap/high-volatility stocks experience momentum while large-cap/low-volatility stocks exhibit reversals. For large-cap/low-volatility stocks, a statistically significant reversal, instead of a weaker momentum as suggested by previous findings, is observed. Meanwhile, all small stocks exhibit momentum regardless of the volatility level. The findings cannot be explained by the Fama-French systematic risk factors and the results are robust to a host of probes such as dividing the sample into subperiods, replacing the total volatility (as a

sorting variable) by idiosyncratic volatility or forward-looking implied volatility, removing January returns, and varying the cutoffs in size partitions. Moreover, the coexistence of momentum and reversals cannot be reproduced when return volatility as a sorting variable is replaced by any of the commonly known firm/stock characteristics (e.g., credit rating, institutional ownership, firm age, analyst coverage or following, earnings forecast dispersion, cash flow volatility, book to market ratio and leverage). Likewise, firm size as a sorting variable also beats out the alternative firm/stock characteristics.

To discuss the potential explanations for the new empirical finding and compare the current study with the existing ones, a brief literature review is in order. Various models and rationales have been put forward to explain the observed return momentum or reversals, but the search is still on for a convincing and encompassing theory. The explanations for the short-term reversal include market-microstructure considerations (Jegadeesh and Titman, 1995; and Conrad, Gultekin and Kaul, 1997), illiquidity (Avramov, Chordia and Goyal, 2006), and reversals in beliefs (Subrahmanyam 2005). The medium-term momentum and long-term reversals are rationalized largely along the behavioral avenue. Gradual information diffusion and/or investors underreaction leads to momentum (Chan, Jegadeesh and Lakonishok, 1996; and Hong, Lim and Stein, 2000) while overreaction coupled with or caused by psychological biases leads to long-term reversals (Barberis, Shleifer and Vishny, 1998; Daniel, Hirshleifer and Subrahmanyam, 1998; and Hong and Stein, 1999). In fact, authors who attempt to rationalize the long-term reversals (Barberis, Shleifer and Vishny, 1998; Daniel, Hirshleifer and Subrahmanyam, 1998; and Hong and Stein, 1999) design their framework such that the medium-term momentum can be explained at the same time. In all cases though, overreaction and underreaction can only occur sequentially in the market.

Some researchers have also tested or verified the role of psychological biases in rationalizing the phenomenon of return momentum or reversals. Jiang, Lee and Zhang (2005) and Zhang (2006) independently show that information uncertainty can intensify return continuations under the postulation that investors underreact more (due to overconfidence) when presented with vague information. Following this line of thinking, we should see a stronger momentum in securities with greater information uncertainty such as smaller stocks and stocks with higher volatility, a conjec-

ture the authors are able to verify. McLean (2010), on the other hand, examines the implications of limit to arbitrage in the context of return predictability. He argues and empirically shows that high idiosyncratic risk can prevent reversal profits from being arbitraged away, while its impact on momentum profits is minimal. In fact, McLean (2010) concludes that, contrary to the contention that momentum and reversals are part of the same phenomenon, momentum and reversal effects can each be stronger in different groups of stocks. The findings in the current paper reinforce this line of thinking.[1]

The only known study that explicitly examines return predictability in different subsets of stocks is Avramov, Choidia, Jostova and Philipov (2007). They show that momentum is strong among stocks of low-grade firms and is largely absent among stocks of higher-rated firms. Some studies attempt to associate momentum and reversals to firm characteristics, as part of robustness checks or for peripheral purposes. To begin, Jegadeesh and Titman (1993) examine momentum returns in three firm-size groups (Table III), and the large-firm group has the lowest, albeit still significant, momentum returns. That smaller/larger stocks generate higher/lower momentum returns is also found in other studies (e.g., Chan, Jegadeesh and Lakonishok, 1996; Hong, Lim and Stein, 2000; and Avramov, Choidia, Jostova and Philipov, 2007). Several studies, other than McLean (2010), also dissect the momentum results along the volatility dimension. Jiang, Lee and Zhang (2005) find momentum for all volatility terciles (Table 3), and the profit is smaller for the lowest volatility tercile. Zhang (2006) has a similar finding in volatility quintiles. The positive relation between momentum returns and volatility is also revealed in Table VI of Avramov, Chordia, Jostova and Philipov (2007) for the average- and low-grade firms. In contrast, Gutierrez Jr. and Kelly (2008) report (in Table VII) a stronger reversal in the high volatility group and a stronger momentum in the low volatility group. They themselves also realize (p434) the departure of their results from, e.g., Zhang (2006).

It is apparent that most researchers realize the importance of firm size and volatility in return

[1]Another study arriving at the same conclusion is by George and Hwang (2004) who use the distance to the 52-week high as a sorting variable and find a strong momentum effect over the usual 6-month holding period. However, they don't find return reversals over the long term. They therefore also conclude that momentum and reversals are largely separate phenomena and cannot be explained with one theory.

predictability. However, none of the existing studies dissect returns along the two dimensions simultaneously. As a result, the coexistence of momentum and reversals has eluded the literature until now. As for its rationality, none of the existing paradigms can fully explain the simultaneous existence of momentum and reversals. Thus, the results in this study poses a fresh challenge to the already challenged field: We barely have a consensus model which can explain the alternating nature of return predictability−reversals in the short run, continuation in the medium run, and reversals again in the long run−let alone a model that can explain the coexistence of momentum and reversals. There is hope, however. Section 6 of the paper proposes that introducing overreaction under low information uncertainty to the framework of Daniel, Hirshleifer and Subrahmanyam (1998) may hold promise.

The rest of the paper is organized as follows. Section 2 describes the data. Section 3 presents the main results. Further analyses and robustness checks are presented in Section 4. Section 5 delineates the alternative sorting variables and the characteristics of the large-cap/low-volatility stocks. Section 6 is a brief attempt to relate the findings to the existing paradigms such as overreaction/underreaction and information uncertainty. The paper is concluded in Section 7. Tables are relegated to the end.

2. Data and methodology

Daily records of common stocks (with a share code of 10 or 11) traded on the NYSE, AMEX and NASDAQ are obtained from CRSP for the period of January 1, 1964 to December 31, 2009. In accordance with prior studies (e.g., Jegadeesh and Titman, 2001; Zhang, 2006; and Avramov, Choidia, Jostova and Philipov, 2007), stocks with a price of $5 or lower on the portfolio formation day are excluded. The sample contains 19,880 stocks.

At the beginning of each month, realized returns and realized (annualized) volatilities are calculated for each stock for the past one, two, three, six and 12 months. One week (seven calendar days) prior to the beginning of each month is skipped to avoid biases due to microstructure issues (see, e.g., Jegadeesh and Titman, 1993; and Chan, Jegadeesh and Lakonishok, 1996). The methodology of Jegadeesh and Titamn (1993) is used to sort portfolios and calculate portfolio returns.

Specifically, at the beginning of each month, stocks are sorted into quintiles based on their realized past returns and equally-weighted portfolios are formed to be held for up to 12 months.[2] This sorting and portfolio formation procedure is performed each month, and the returns of the quintile portfolios and the winner-loser portfolio are equally-weighted averages of the monthly returns on the overlapping portfolios formed earlier. To correct for serial correlations in portfolio returns, the Newey-West adjustment is applied when calculating t-values. Since the longest evaluation and holding period is 12 months, the actual period within which momentum/reversal returns are available is from January 1965 to December 2008.

All combinations of evaluation and holding periods are examined, although most of the reported results revolve around evaluation periods of $J = 1, 2, 3, 6$ and holding periods of $K = 1, 2, 3, 4, 6$. On each portfolio formation day, an additional screening criterion is imposed: In order to be included in the sorting procedure, a stock must be traded on at least half of the trading days in the evaluation period. For instance, for a 2-month evaluation period, the number of valid price observations must be at least 22. This screening criterion is used to avoid thinly traded stocks which may not be traded at the time of liquidation. It turns out that the results are almost invariant to this additional screening.[3]

The general strategy is to perform three-way sorts on size, realized volatility and realized returns. As a base case, the sample is first divided into two equal halves by size (defined as the share price times the number of shares outstanding) and then a sequential 5×5 sort is performed on realized volatilities and returns for each size group. Results for independent sorts are similar, hence only sequential sorts are reported. The study mostly relies on sequential sorts to ensure a stable and equal size of quintile portfolios (in contrast, independent sorts on volatility and return may result in empty portfolios or portfolios with very few stocks).

[2]Since two-dimensional dissections are performed on the sample, quintiles instead of deciles are used to ensure a reasonable portfolio size. Notwithstanding, the results are robust to alternative sorting sizes.

[3]This could be due to the trade-off between two types of accuracies. When loosening this screening criterion, more stocks are included in the portfolios which may enhance the accuracy of the mean return calculations, but at the same time, the returns of some of the added stocks may not be accurate themselves due to, e.g., stale prices.

3. Momentum and reversals: the role of firm size and volatility

As a starting point, Table 1 presents results of single-dimension sorts. Two features stand out. First, although we do observe a monthly reversal, the magnitude is insignificant, in contrast to Jegadeesh (1990). The t-value for the return on the long-winner and short-loser portfolio ("momentum portfolio" hereafter) is only -0.345. For all other evaluation and holding period combinations, the momentum portfolio earns a positive return that is statistically significant (except for $J = 1$, $K = 2$ and $J = 2$, $K = 1$). Jegadeesh (1990) examines consecutive monthly returns without any skip. When the returns in Table 1 are recalculated without the one-week skip, a statistically significant, monthly reversal is found. Second, for short evaluation horizons ($J = 1, 2$), monotonicity in the returns of post-sorting quintile portfolios is the exception rather than the rule; for a 3-month evaluation period ($J = 3$), the returns for the middle three portfolios are very close to each other. The lack of monotonicity for short evaluation horizons are entirely neglected in the literature. In fact, it is precisely this feature that offers the critical clue leading to the key discovery of this study: The lack of monotonic ordering implies the existence of a hidden, counter force in returns, namely, reversals.

How do we sift out the reversals among the generally increasing returns from losers to winners? The existing empirical evidence already offers a clue. As reviewed earlier, momentum returns are lower for larger firms and low-volatility stocks when examined along either dimension alone. A simple yet crucial insight has eluded the literature: There might be some interaction effect between firm size and return volatility. Although it is generally known that large/small firms are associated with low/high return volatilities, some large firms may have a high return volatility, and some low-volatility stocks may actually belong to small firms. This realization suggests the necessity of a three-way sort on firm size, volatility and past returns.

Table 2 does exactly that. At the beginning of each month, the sample is first divided into equal halves at the size median, and then each of the size sample is sorted into volatility quintiles; finally, realized returns are sorted into quintiles for each of the volatility quintile, resulting in 25 portfolios for each size sample. Panel A reports the quintile portfolio returns as well as momentum

portfolio returns for selected cases with equal evaluation and holding periods, while Panel B reports the momentum portfolio returns for more combinations of holding and evaluation periods.

Several observations are in order. First and foremost, for large stocks with low volatility, there exists a statistically significant, return reversal in the momentum portfolios for evaluation and holding periods that sum to seven or eight months (e.g., when $J = 1$, reversals last until $K = 6$; when $J = 6$, reversals last until $K = 2$). What is more remarkable is the coexistence of momentum and reversals for large stocks, with the former being associated with high volatilities while the latter with low volatilities. When the evaluation period is one or two months ($J = 1, 2$), momentum and reversals coexist for a holding period of up to six months. This observation has never been made in the literature before. The obvious implication of this newly discovered empirical regularity is that all the existing theories concerning return predictability will have to be modified or refined to explain the simultaneous existence of momentum and reversals.

Additional remarks can be made regarding the horizons. The reversal intensity weakens as the holding period becomes longer, and eventually momentum prevails. For the widely studied case in the literature where $J = 6$ and $K = 6$, we do observe momentum for small stocks across all volatility levels; for large stocks, the momentum return is no longer significant for the lowest volatility quintile. Beyond the $J = 6$, $K = 6$ horizon, momentum prevails for all size-volatility combinations. In fact, calculations are also performed for longer holding periods (3−5 years) to see whether the commonly documented long-term reversals behave differently for size-volatility combinations. It turns out that reversals occur in both large and small stocks at all volatility levels, although they are stronger in high-volatility stocks.[4] Therefore the coexistence of momentum and reversals appears to prevail over only short horizons.

The higher reversal intensity for shorter horizons is also reflected in the wide range of volatilities within which this feature is exhibited. For instance, for the combinations of $(J, K) = (1, 1)$, $(1, 2)$ and $(2, 1)$, reversals occur in the first three volatility quintiles. Only the highest volatility quintile sees momentum.

Finally, consistent with the previous findings in the literature, overall, small stocks deliver

[4]Results are available from the author upon request.

the strongest momentum returns. Furthermore, aside from those volatility bins within which the momentum portfolio returns are not statistically different from zero, the holding-period returns under each volatility level are largely monotonic in both the reversal and the momentum cases.

Before performing robustness checks on the base case in Panel B of Table 2, a crucial question needs to be answered: Are the reversals beyond a holding period of one month mainly a manifestation of the previously documented monthly reversals (e.g., Jegadeesh, 1990)? Put differently, the monthly reversals for the large-cap/low-volatility stocks might be so strong that an overall reversal can still be observed for a holding period beyond one month even though a weak momentum already starts from the 2nd month after portfolio formation. This question is addressed in Table 3 that reports the month-by-month (as opposed to holding period) momentum portfolio returns since formation. The results clearly demonstrate that reversals prevail well beyond the first month. Granted that the significance of reversals mostly resides with a holding period of one or two months, for evaluation periods up to three months, momentum doesn't start until the 4th month after portfolio formation. Even for a holding period of six months, the 2nd month still sees a reversal (albeit insignificant), and a statistically significant momentum doesn't start until the 5th month. In sharp contrast, for the high volatility quintile, significant momentum is observed for all evaluation- and holding-period combinations save one: $J = 1, K = 4$.

4. Further analyses and robustness checks

4.1. Can momentum and reversals be explained by systematic risk?

Following the previous literature, the momentum portfolio returns are regressed on the market factor (Jegadeesh and Titman, 1993) and the other two Fama-French factors (Chan, Jegadeesh and Lakonishok, 1996; and Avramov, Chordia and Goyal, 2006).[5] If the observed reversals and return continuation across stocks simply reflect the hidden dynamics of returns in accordance to the factors' impact, then we should observe an intercept or alpha close to zero. An alpha statistically different from zero would be an excess return on the portfolio after accounting for systematic risks.

[5]Monthly series of the three factors are downloaded from Kenneth French's webpage: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/.

Table 4 reports the regression results.

Just as Jegadeesh and Titman (1993), Chan, Jegadeesh and Lakonishok (1996), and Avramov, Chordia and Goyal (2006) find alphas to be even higher than the raw return profits, the reversals here become even more manifest in alphas. Comparing Table 4 with Panel B of Table 2, we see not only more cases of reversals, but also a higher statistical significance. A case in point is the 6-month evaluation period. When the momentum profits are measured in raw returns (Panel B of Table 2), the lowest volatility quintile in large stocks sees significant reversals only for $K = 1$, 2. In contrast, when measured in alphas, significant reversals prevail for all holding periods. Unlike Jegadeesh and Titman (1993), Chan, Jegadeesh and Lakonishok (1996), and Avramov, Chordia and Goyal (2006), we see weakened, albeit still mostly significant, momentum returns for both small and large stocks. In fact, for small stocks, we also see reversals for the lowest volatility quintile. The upshot is: The role of volatility in cross-section return predictability cannot be explained away by the systematic risk factors.

4.2. Sorting on idiosyncratic volatilities

Since the work of Ang, Hodrick, Xing and Zhang (2006) who find a negative cross-sectional relationship between idiosyncratic volatility and returns over a monthly horizon, a great deal of research has been done to verify/explain the apparent puzzle. For instance, casting idiosyncratic volatility and returns in expected or ex ante forms, Fu (2006) finds a positive relationship. Huang, Liu, Rhee and Zhang (2010) confirm the positive relationship between expected idiosyncratic volatility and returns after correcting estimation biases in the former. Arena, Haggard and Yan (2008) investigate whether momentum returns are related to idiosyncratic risk. They find that stocks with a higher idiosyncratic risk deliver higher momentum returns and subsequently experience quicker and larger reversals. In their study, idiosyncratic volatilities are estimated using data over the past 12 months. McLean (2010) investigates whether idiosyncratic risk can explain, from the limit-to-arbitrage perspective, the persistence of reversals and momentum. In his study, the reversals are over a three-year period ($J = K = 36$) while the momentum over a six-month period ($J = 1, ..., 6$; $K = 6$); idiosyncractic volatilities are calculated over the past three years in all cases. He finds

that idiosyncratic volatility does have an impact on reversals, but not momentum, confirming the impact of limit to arbitrage. Moreover, he finds that stronger reversals and weaker momentum are associated with high idiosyncratic volatilities.

In contrast to Arena, Haggard and Yan (2008), and McLean (2010), idiosyncratic volatilities (with respect to the three Fama-French factors) in the current paper are calculated over each specific evaluation period. Once the idiosyncratic volatilities are in place, the sorting procedures in Panel B of Table 2 are repeated by replacing the total volatility with its idiosyncratic counterpart. Table 5 presents the results.

Overall, which volatility to use in the sorting procedures doesn't make much difference. In fact, in terms of occasions of momentum and reversals and their statistical significance, the results in Panel B of Table 2 and Table 5 are almost identical. The results shouldn't be too surprising since, for most stocks, total volatility is dominated by idiosyncratic volatility.

4.3. Potential impact of January effect

Jegadeesh and Titman (1993) investigate extensively the impact of the January effect on momentum portfolio returns. Consistent with their predictions, they find statistically significant, negative returns for momentum portfolios formed in January. No negative returns are found for other months and the non-January months collectively deliver positive momentum returns. The negative momentum returns (i.e., reversals) in January are significant for small firms, but not significant for large firms.

Similar investigations are also performed in the current paper. Momentum portfolio returns are calculated for the month of January and all other months combined and are reported in Table 6. To begin, the results are largely consistent with Jegadeesh and Titman (1993). For small firms, we see reversals in January (especially for low-volatility stocks) while momentum remains in other months of the year; for large firms, the reversals (for the low volatility quintile) are much stronger in January while the momentum (for the high volatility quintile) disappears. Do the reversals in large stocks disappear after January returns are removed? The answer is a resounding "No." Comparing with the whole sample, the t-values of the reversal returns for the non-January months are indeed

slightly lower, but the statistical significance remains for all cases save two ($J = 2$, $K = 6$ and $J = 6$, $K = 2$). In short, while reversals are confined to January for small stocks, they prevail in all months of the year for large-cap/low-volatility stocks. For large stocks, momentum and reversals coexist for non-January months.

4.4. Analysis for subperiods

A natural question at this point is: Are the results consistent and significant across sub-sample periods? The first part of the question is relatively easy to address while the second is not. If the signs and rough magnitude of the momentum portfolio returns are the same across subperiods, then consistency is established. As for significance, a critical trade-off must be considered. If the sample period is divided into too many subperiods, testing power will be lost (keep in mind that the momentum returns are time-series averages of monthly observations) and the statistical significance (or lack of it) is prone to chances; if the division is too rough, then consistency cannot be meaningfully investigated. In light of all the factors, the total sample period (within which complete momentum returns exist) is divided into three equal periods: 1965-1978, 1979-1993, and 1994-2008. To back-test the coexistence of momentum and reversals, calculations are repeated for the early period of 1926 to 1964. For shorter evaluation/holding periods, insignificant momentum portfolio returns are obtained, especially for large stocks. It turns out that the lack of power is mostly due to the smaller number of eligible stocks for the three-way sorts. For instance, the number of stocks for 1965 is 1,977 while it is only 567 for 1927 (resulting in only about 11 stocks per portfolio in the three-way sort). To ensure reasonable testing power, the starting year was set in 1951 so that the number of stocks to be used to form momentum portfolios in 1952 is 1005 (for all previous years, this number is lower than 1,000). Table 7 contains the results.

For small firms (Panel A), aside from the low volatility case for the subperiods of 1952-1964 and 1965-1978, results are more or less comparable across the subperiods. The t-values are generally smaller for the subperiods due to lower testing power. Similar observations can be made for large stocks too (Panel B), although we see some wider variations. It should be kept in mind that the period of 1952-1964 is both shorter and has fewer stocks compared with later periods. Nevertheless,

the results in Table 7 do show that the coexistence of momentum and reversals among large stocks generally prevails in the subperiods.

The occasional reversals in the early periods for small stocks deserve some additional discussions. Since the CRSP coverage of AMEX stocks only started in July 1962 (while that of NASDAQ stocks in December 1972), the early periods are mostly dominated by the NYSE stocks which are on average by far the largest among all stocks. During the sample period of 1965-2008, the median firm size is $769 million, $116 million and $71 million respectively for NYSE, NASDAQ and AMEX. Therefore, for the early years, all stocks are "large" since they are mostly from the NYSE. This is why we see reversals even for "smaller" stocks when the volatility is low. To shed further light on this, the calculations in Panel B of Table 2 are performed separately for the three exchanges: NYSE, NASDAQ and AMEX. Table 8 contains the results. As expected, for the NASDAQ and AMEX stocks the size-dichotomy has real implications while that for the NYSE stocks doesn't. The coexistence of momentum and reversals prevails for both the small and large NYSE stocks (though more manifest with the latter); for the NASDAQ and AMEX stocks, only the large ones see the coexistence of momentum and reversals. The "small" NYSE stocks in Table 8 are actually "large" stocks in the previous analyses where all stocks are lumped together. Table 8 offers the following insight: When it comes to momentum behavior along the lines of volatility, it is the absolute firm size (as opposed to the relative size) that matters.

4.5. Alternative cuts in size

The analyses so far are based on a simple dichotomy in size. Insofar as reversals only occur among large stocks, it is natural to wonder whether the reversals would become stronger when the sample is restricted to even larger firms. It should be realized though, that as we restrict the sample to larger and larger firms, testing power is also compromised since each quintile portfolio contains fewer and fewer stocks. To gain some insights nonetheless, three alternative constructions are examined. Specifically, from the size median, 10% of the sample is progressively cut away in each direction. For instance, for the first alternative, the small firms consist of those that are at or below the 40th percentile while the large firms consist of those at or above the 60th percentile. Table 9 reports the

results.

For small firms, casual observations reveal that for the one-month evaluation period, a sharper division actually weakens/reduces the momentum returns for high volatility stocks; for all other cases, slightly higher momentum returns are obtained as ever smaller stocks are considered. For large firms, no obvious patterns exist except that a significant reversal is eventually obtained as larger and larger stocks are retained in the sample for $J = 3$ and $K = 6$. In no cases do the reversals and the simultaneous momentum become weaker as the sample becomes progressively smaller. Insofar as testing power is compromised in smaller samples, the *preservation* of statistical significance indirectly confirms the negative association between size and the strength/magnitude of reversals. This is confirmed by simple regression analyses where firm size is positively related to the magnitude of the reversals under low volatilities.

4.6. Microstructure issues

It is tempting to think that the reversals in the large-cap/low-volatility stocks might be a mere manifestation of microstructure issues such as bid-ask bounces. This concern is addressed in three ways. First, as mentioned earlier, the screen on the number of trading days within the evaluation period doesn't have any material consequences. Second, as shown in the next section, the large-cap/low-volatility stocks actually have the lowest proportional bid-ask spread. In this sense, they enjoy the best liquidity. Besides, a calendar week separates the evaluation and holding periods. Third, lower-priced stocks are usual suspects of microstructure issues. This has been dealt with proactively by excluding stocks below \$5 as in Jegadeesh and Titman (2001), Zhang (2006), and Avramov, Choidia, Jostova and Philipov (2007). Unreported results show that, when the price threshold is lowered to \$2, the momentum in smaller stocks indeed weakens, but the coexistence of momentum and reversals for large stocks is not affected at all. This should not be surprising since lower-price stocks tend to belong to small firms anyway.

5. Alternative sorting variables and characteristics of the large-cap/low-volatility stocks

5.1. Alternative sorting variables

Although the choice of firm size and return volatility as sorting variables is based on the prominent empirical evidence as discussed earlier, one naturally wonders what if other sorting variables are used. In the absence of sound theoretical guidance, there are potentially a large number of permutations among the known firm/stock characteristics. To make the exercise manageable, the size dichotomy is retained while the second sorting variable, return volatility, is replaced by an alternative firm/stock characteristic. To this end, an almost exhaustive list of variables used in previous momentum studies is produced: credit rating (Avramov, Choidia, Jostova and Philipov, 2007), institutional ownership (Gutierrez Jr. and Kelly, 2008), book to market ratio (McLean, 2010), leverage (Avramov, Chordia and Goyal, 2006), and information uncertainty measures such as (Zhang, 2006) firm age, analyst coverage or following, earnings forecast dispersion, and cash flow volatility. To see whether forward-looking volatility makes any difference, the realized volatility is also replaced by option implied volatility. Before discussing the results, a brief description of the variable constructions is in order.

Cash flow volatility, leverage, and book-to-market ratio are constructed from Compustat for the period of 1965 to 2008. Cash flow volatility is calculated in exactly the same manner as Zhang (2006); leverage is book value of long-term debt over the sum of long-term debt and the market value of equity; book-to-market ratio is the book value divided by the market value of equity, where the former is common equity plus deferred taxes and investment tax credit minus the book value of preferred stock (Fama and French, 1993). All equity values are for the year-end. For the same sample period of 1965-2008, firm age is the number of years since the firm first appeared in CRSP.

Analyst following and forecast dispersion for the period of 1984 to 2008 are from IBES. Analyst following is simply the number of analysts covering the firm while earnings forecast dispersion (DISP) is the standard deviation of forecasts scaled by the stock price. Both measures are of almost monthly frequency since there are constant updates leading up to the announcements of quarterly earnings.

Institutional ownership, in quarterly frequency for the period of 1980 to 2008, is calculated from the Thomson Reuters Institutional Holdings (F13).

Credit rating (Standard and Poor's) for the period of 1986 to 2008 is retrieved from Compustat as in Avramov, Choidia, Jostova and Philipov (2007). Numerical values are assigned to ratings in the following sequence: AAA = 1, AA+ = 2, AA = 3, ..., D = 22.

Implied volatility for the period of 1996 to 2008 is retrieved from OptionMetrics. For each stock, on the day of momentum portfolio formation, all implied volatilities on options with a maturity between 7 and 90 days and a moneyness of 0.95 to 1.05 (defined as the exercise price over the stock price) are averaged to produce a forward-looking volatility forecast.

Each alternative sorting variable is merged with the previous return file and momentum return calculations are then carried out for the three-way sorts where the realized volatility is replaced by the alternative sorting variable in question. In cases where the frequency of the sorting variable is lower than monthly (e.g., book-to-market ratio), the last available data point is used. Table 10 contains the results. For brevity, only the results for large firms are reported. For comparison purposes, the coexistence of momentum and reversals for each sample period using the realized volatility as the sorting variable is presented first.

It is seen that, while most of the results conform to intuition (e.g., higher-rated firms or firms with low cash flow volatility experience reversals), none of the alternative sorting variables produces nearly as strong reversals as the realized volatility. The only exception is the implied volatility which has roughly the same potency as the realized volatility. But this exception is actually another piece of supporting evidence that it is the return volatility as opposed to any other sorting variable that can pick out the coexistence of momentum and reversals for large stocks.

Retaining the size dichotomy while only varying the second sorting variable may elicit objections from some readers. After all, some of the aforementioned alternative firm/stock characteristics, when combined with return volatility as sorting variables, may be more potent than firm size in detecting momentum and reversals. To address this issue, the main analysis presented in Table 2 is repeated by replacing firm size with each of the alternative firm/stock characteristics as the

first, dichotomic sorting variable. The results can be summarized as follows.[6] Some variables (e.g., leverage and book-to-market ratio) have no differentiation power whatsoever−reversals are associated with low-volatility stocks and momentum with high-volatility stocks regardless which half of the sample the stocks belong to. Earnings forecast dispersion fails to pick out a single significant reversal. As for rating, reversals are indeed observed for low-volatility stocks in the half sample of higher-rated firms (corresponding to large firms), but no corresponding momentum exists for high-volatility stocks. Cash flow volatility and implied volatility can each detect the coexistence of momentum and reversals, but the strength and magnitude are much weaker. For instance, when firm size is replaced by cash flow volatility as the first sorting variable, reversals occur for a holding period of up to only two months. The only sorting variables that produce comparable results as firm size are analyst following, firm age and institutional ownership. But again, the reversals and momentum are weaker in terms of either strength or magnitude, or both. The upshot is, firm size and return volatility, as two simultaneous sorting variables, lead to the sharpest results as far as identifying the coexistence of momentum and reversals is concerned.

5.2. Characteristics of the large-cap/low-volatility stocks

While it has been firmly established by now that among large-cap stocks, low-volatility and high-volatility stocks exhibit opposite momentum returns, one last question remains: What are the key differences between these two groups of stocks? More pointedly, what are the characteristics of the large-cap/low-volatility stocks (that exhibit reversals) in contrast with all other stocks? This question is addressed in Table 11 that presents the average value, within each quintile, of each firm/stock characteristic examined in Table 10 plus two more: share turnover and proportional bid-ask spread, both of which are based on data from CRSP. Turnover (available for the period of 1983 to 2008) is simply the average daily turnover in the past three months calculated on each portfolio formation day; proportional bid-ask spread (available for the period of 1993 to 2008) is the daily spread averaged over the past three months where daily spread is the difference between the ask and bid prices divided by their average.

[6]The resulting tables are omitted to conserve space. However, they are available from the author upon request.

To preserve space, full results are reported only for firm size and realized volatility; for all other characteristics, average values are reported only for the volatility quintile portfolios (without separate averages along the return-sorting dimension). Several observations are in order. First, while there is not much dispersion in firm size in the "small firm" group, the size difference is large across volatility quintiles in the "large firm" group. Lower volatility firms tend to be larger and vice versa. Nevertheless, even the smallest (the highest volatility quintile) in the "large firm" group is about ten times larger than the largest in the "small firm" group. Meantime, Panel B reveals that, while the highest volatility for large firms is not the highest in the whole sample (it is actually comparable to the second highest in the "small firm" group), the lowest (less than 20%) is surely the lowest in the whole sample. In other words, the stocks exhibiting reversals are indeed the largest in market capitalization with the lowest return volatility.[7]

As for other characteristics, the large-cap/low-volatility stocks don't differ much from the rest in terms of turnover, institutional ownership, analyst following, book-to-market ratio and leverage. However, they do stand out in other aspects. Aside from the obvious−the implied volatility is the lowest, the large-cap/low-volatility stocks 1) have the best credit rating, 2) have the lowest proportional bid-ask spread (which clearly rules out the possibility that reversals are caused by microstructural effects), 3) are the oldest and most mature, 4) experience the smallest earnings forecast dispersion, and 5) have the lowest cash flow volatility. The findings here have direct implications for the potential reasons why momentum and reversals tend to coexist for large stocks.

6. Potential explanations for the coexistence of momentum and reversals

Now that the coexistence of momentum and reversals among large stocks has been established, the next task is to come up with plausible explanations. As argued below, the newly discovered phenomenon cannot be fully rationalized with any of the existing theories although some plausible avenues for developing a more encompassing model do seem to exist.

[7]For "large firms," the close association between size (Panel A) and realized volatility (Panel B) suggests that the two might be the two sides of the same coin. They are not. When the large firms are further sorted into size quintiles, not a single reversal is observed for the largest-size quintile (seemingly corresponding to the lowest-volatility quintile). Results are available from the author upon resquest.

To begin, explanations along the lines of microstructure issues (e.g., bid-ask bounces) have already been ruled out in Section 4. A calendar week is being skipped between evaluation and holding periods to avoid artificial return predictability due to bid-ask bounces. Eliminating stocks with prices below five dollars further alleviates micro-structure issues, if any. Besides, the coexistence of momentum and reversals extends to a holding period of up to six months (when the evaluation period is one or two months), a period long enough for any impact of microstructure issues to completely diminish. The obvious risk-based arguments can also be safely ruled out, since the robustness checks reveal even stronger reversals when momentum portfolio profits are measured in alphas.

The illiquidity-based explanation can also be ruled out. Avramov, Chordia and Goyal (2006) find that short-term reversals are highly correlated with illiquidity, even after controlling for volume. Insofar as smaller stocks generally have poorer liquidity, it would have made perfect sense had the reversals been observed in small stocks. Yet, reversals are found to occur in large-cap stocks with the best liquidity in terms of proportional bid-ask spreads.

A plausible avenue appears to be behavioral-based explanations. While the modeling strategies and frameworks vary among the studies in this area (Barberis, Shleifer and Vishny, 1998; Daniel, Hirshleifer and Subrahmanyam, 1998; and Hong and Stein, 1999), the common thread is investors underreaction and overreaction to news. In Barberis, Shleifer and Vishny (1998) and Daniel, Hirshleifer and Subrahmanyam (1998), a single representative agent suffers from cognitive biases and as a result under- or over-shoots in his/her actions. In Barberis, Shleifer and Vishny (1998), the agent initially suffers from the conservatism bias when presented with the so-called "low-strength news" such as regular earnings announcements, and suffers from the representativeness bias after encountering "high-strength" information such as a series of encouraging earnings announcements. This framework can potentially explain the intermediate-term momentum (due to underreaction) and the long-term reversals (due to overreactions). In order for this framework to successfully explain the coexistence of momentum and reversals, we need to assume that sub-categories of same-sized stocks simultaneously deliver different types of news in a systematic fashion. Specifically, large-cap/low-volatility stocks need to deliver "high-strength" information while at the same time,

large-cap/high-volatility stocks need to deliver "low-strength" news. Putting aside the fact that all stocks deliver "low-strength" news such as earnings announcements, large-cap/low-volatility stocks are the least plausible candidate to consistently deliver "high-strength" information. In fact, small-cap/high-volatility stocks fit the bill the best as far as revealing high-impact news is concerned, yet they have the strongest momentum instead of reversals.

Daniel, Hirshleifer and Subrahmanyam (1998) design their framework such that underreaction and overreaction stem from self-attribution bias and overconfidence. Overconfidence causes the investor to overestimate the precision of his/her private signal, hence overreact. This overreaction is eventually corrected as more and more public information is revealed to confirm/contradict the private signal, leading to long-term reversals. In the intermediate term, the self-attribution bias prompts the investor to interpret public information in his/her own favor. For instance, a confirmation of the private signal by public information enhances the investor's self-perceived prophecy while an invalidation tends to be brushed off. This type of behavior exacerbates the price overreaction, leading to medium-term momentum. Clearly, this particular sequential nature, i.e., momentum first and reversals later, flies in the face of what is being observed in large-cap/low-volatility stocks: reversals first and momentum later (Panel B of Table 2).

The framework in Hong and Stein (1999) encounters the same challenge when used to explain the coexistence of momentum and reversals. They model two groups of traders: "newswatchers" who are incapable of fully inferring other newswatchers' information from prices and "momentum traders" who ride on the waves created by newswatchers. Under the assumption that information diffuses gradually, newswatchers initially underreact, causing momentum in returns. Once momentum is detected by "momentum traders," they jump in, hoping to profit from the continuation in returns, which amounts to overreaction and eventual return reversals.

Several authors have attempted to enrich and verify the thesis of mis-reaction in the context of return predictability. For instance, building on the framework of Daniel, Hirshleifer and Subrahmanyam (1998), Jiang, Lee and Zhang (2005) and Zhang (2006) hypothesize that information uncertainty should intensify the extent to which investors underreact. They argue that the greater the uncertainty about the firm's value, the more room for investors to be overconfident in their pri-

vate judgment, leading to underreaction to public information. Using such information-uncertainty proxies as firm size, return volatility, firm age and cash flow volatility, both studies demonstrate a stronger momentum effect (in prices as well as earnings) under greater information uncertainty. Their argument and findings are consistent, in part, with the findings in the current paper−for both small and large firms, stronger momentum effects are observed under higher volatilities (see e.g., Panel B of Table 2). However, neither study addresses short-term reversals. According to their thesis, large-cap/low-volatility stocks should have the least information uncertainty−at least within the confinement of the size and volatility proxies. If investors underreact more when faced with greater information uncertainty, they should underreact less when information uncertainty is low. This line of thinking implies a weaker, or the absence of, momentum in large-cap/low-volatility stocks. An additional, yet to be devised channel or mechanism is needed to explain the observed reversals.

Clearly, none of the existing behavioral-based models/explanations can fully rationalize the evidence presented in this paper. Any future, more encompassing models must possess, at the minimum, the following features: 1) heterogenous firms that exhibit different traits in terms of information revelation and precision, and 2) heterogenous investors who, separately, suffer from different types of cognitive biases. So far, none of the existing models contains either of the two features, let alone combined.

The characteristics of the large-cap/low-volatility stocks uncovered in the previous section offer some useful clues to the necessary mechanism to be built in a more encompassing model. To begin, we need two groups of investors, with one group underacting to news from large-cap/high-volatility stocks while the other overreacting to news from large-cap/low-volatility stocks. Alternatively, we could have one representative investor or homogeneous investors who trade different stocks and who simultaneously underreact and overreact to different news. Regardless, they need to behave in a similar fashion toward smaller stocks. This behavior dichotomy by firm-size creates an uncomfortable logical void since size in and of itself doesn't convey much meaning, which prompts us to the next element−information uncertainty.

It seems promising to use information uncertainty as the common thread. Section 5 reveals that

stocks/firms that experience return reversals have the following characteristics: old and mature, largest in size, least volatile, best rated, most liquid, and having the lowest cash flow volatility and earnings forecast dispersion. Collectively these traits point to low information uncertainty. Therefore, it suffices to say that investors underreact to news from stocks/firms with high information uncertainty (due to overconfidence) while *overreact* to news from stocks/firms with low information uncertainty. The second part of the above statement is a leap in faith and needs rigorous modelling. As discussed earlier, the framework of Daniel, Hirshleifer and Subrahmanyam (1998) only allows us to legitimately deduce that momentum should be weak or absent in low-information-uncertainty stocks. The findings in the current paper seem to suggest that there exists a tipping point or threshold in information uncertainty below which investors' mentality switches gears. This conjecture calls for rigorous modelling and empirical testing, both of which are beyond the scope of the current paper.

All said, none of the existing behavioral-based models can fully rationalize the coexistence of momentum and reversals.

7. Conclusion

It is well known in the literature that return predictability, be it in the form of momentum or reversals, is more manifest in small stocks or stocks with high volatility. A natural question arises: How would the predictability turn out if it is dissected under size and volatility simultaneously? The current study performs this three-way dissection (size, volatility and momentum returns) and reveals intriguing results not previously known in the literature. Among small stocks, no reversals are observed, and the momentum effects are stronger when volatilities are higher. Among large stocks, depending on the volatility level, reversals and momentum coexist for a holding period of up to six months; specifically, reversals prevail in low-volatility stocks while momentum occurs in high-volatility stocks. Beyond a holding period of six months (but within 12 months), all stocks exhibit momentum. The intriguing coexistence of momentum and reversals in large-cap stocks is not due to systematic risks, persists in subperiods, remains unchanged when total volatility is replaced by idiosyncratic volatility or forward-looking implied volatility as a sorting variable, and is robust to

removing January returns. When replacing volatility by other commonly known firm/stock characteristics as a sorting variable (e.g., credit rating, institutional ownership, firm age, analyst coverage or following, earnings forecast dispersion, cash flow volatility, book to market ratio and leverage), the coexistence of momentum and reversals either becomes very weak or disappears altogether. By the same token, firm size also dominates each of the alternative firm/stock characteristics as a sorting variable.

The simultaneous existence of momentum and reversals in large stocks cannot be fully rationalized by either risk-based or behavioral-based explanations. Although some of the behavioral-based paradigms appear to be successful in rationalizing the sequential medium-term momentum and long-term reversals, none of them in their current forms can fully explain the coexistence of the opposing return behaviors. The existing paradigms need to be expanded in several dimensions in order to accommodate the newly observed phenomenon, in addition to the already existing regularities. Introducing overreaction under low information uncertainty in the framework of Daniel, Hirshleifer and Subrahmanyam (1998) appears to be a promising avenue. So, while the current study has provided a positive answer to the question posed in the title, an even more challenging question arises: Why do momentum and reversals coexist?

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Table 1. Returns of quintile portfolios

This table shows the average monthly returns of quintile portfolios formed by sorting past realized returns each month following the procedure in Jegadeesh and Titman (1993). Five evaluation periods (J = 1, 2, 3, 6, and 12 months) and seven holding periods (K = 1, 2, 3, 4, 5, 6, and 12 months). The quintile portfolios are denoted by P1 (loser), P2, P3, P4 and P5 (winner). The return on the momentum portfolio (a zero-investment portfolio by buying the winner portfolio and shorting the loser portfolio), denoted by (P5–P1) is also shown. Its *t*-value is corrected for autocorrelation by the Newey-West adjustment. Bolded *t*-values correspond to a significance level of 5% or higher. The sample contains all common stocks traded on the NYSE, AMEX and NASDAQ, covering the period from January 1, 1964 to December 31, 2009. At the time of sorting and portfolio formation, stocks with a share price of $5 or lower are deleted.

		K = 1	K = 2	K = 3	K = 4	K = 5	K = 6	K = 12
	P1 (loser)	1.053	0.913	0.826	0.835	0.823	0.821	0.848
	P2	1.186	1.164	1.131	1.139	1.125	1.115	1.088
J = 1	P3	1.173	1.170	1.179	1.173	1.163	1.165	1.159
	P4	1.077	1.088	1.111	1.110	1.114	1.128	1.164
	P5 (winner)	0.997	1.044	1.103	1.089	1.097	1.124	1.178
	P5 − P1	-0.056	0.131	0.277	0.254	0.275	0.303	0.330
	t-value	-0.345	0.967	**2.555**	**2.661**	**3.066**	**3.657**	**5.432**
	P1 (loser)	0.916	0.785	0.741	0.753	0.738	0.729	0.785
	P2	1.171	1.121	1.116	1.108	1.091	1.085	1.064
J = 2	P3	1.114	1.134	1.154	1.152	1.148	1.154	1.155
	P4	1.096	1.106	1.111	1.124	1.136	1.150	1.189
	P5 (winner)	1.190	1.233	1.227	1.209	1.211	1.238	1.250
	P5 − P1	0.274	0.448	0.486	0.456	0.473	0.509	0.466
	t-value	1.416	**2.727**	**3.497**	**3.572**	**3.921**	**4.510**	**5.438**
	P1 (loser)	0.797	0.718	0.682	0.679	0.662	0.672	0.751
	P2	1.052	1.079	1.074	1.071	1.052	1.047	1.043
J = 3	P3	1.102	1.115	1.138	1.146	1.140	1.147	1.152
	P4	1.122	1.112	1.128	1.145	1.163	1.177	1.211
	P5 (winner)	1.407	1.350	1.327	1.305	1.313	1.320	1.294
	P5 − P1	0.610	0.632	0.645	0.626	0.651	0.648	0.543
	t-value	**3.176**	**3.697**	**4.155**	**4.323**	**4.737**	**4.976**	**5.427**
	P1 (loser)	0.627	0.532	0.520	0.528	0.532	0.545	0.713
	P2	0.965	0.973	0.981	0.982	0.975	0.969	1.022
J = 6	P3	1.058	1.081	1.087	1.100	1.093	1.102	1.140
	P4	1.215	1.209	1.214	1.222	1.229	1.245	1.242
	P5 (winner)	1.608	1.581	1.554	1.531	1.521	1.523	1.358
	P5 − P1	0.980	1.049	1.034	1.003	0.989	0.978	0.645
	t-value	**4.983**	**5.632**	**5.804**	**5.866**	**6.053**	**6.256**	**4.911**
	P1 (loser)	0.404	0.388	0.416	0.467	0.498	0.542	0.819
	P2	0.861	0.878	0.898	0.912	0.925	0.947	1.037
J = 12	P3	1.104	1.119	1.126	1.131	1.135	1.145	1.158
	P4	1.342	1.322	1.311	1.308	1.296	1.287	1.227
	P5 (winner)	1.792	1.713	1.651	1.594	1.545	1.512	1.278
	P5 − P1	1.389	1.325	1.235	1.127	1.046	0.970	0.459
	t-value	**7.026**	**7.000**	**6.687**	**6.181**	**5.808**	**5.485**	**2.919**

Table 2. Returns of quintile and momentum portfolios based on three-way sorts

This table shows the per-month, holding-period quintile-portfolio returns (in percentage) and returns of momentum portfolios which are zero-investment portfolios by buying the winner portfolios and shorting the loser portfolios. Loser and winner portfolios are identified by monthly sequential sorts along the following three dimensions: firm size at the time of portfolio formation (small versus large, divided at the median of the sample), realized volatility in the evaluation period (sorted into quintiles), and the realized return in the evaluation period (sorted into quintiles). Portfolio return calculations follow the same procedure as in Jegadeesh and Titman (1993). Panel A contains the quintile portfolio returns denoted by P1 (loser), P2, P3, P4 and P5 (winner). The return on the momentum portfolio is denoted by (P5–P1). Panel B only reports the momentum portfolio returns and their *t*-values for various combinations of evaluation and holding periods. All *t*-values are corrected for autocorrelation by the Newey-West adjustment. Bolded *t*-values correspond to a significance level of 5% or higher. The sample contains all common stocks traded on the NYSE, AMEX and NASDAQ, covering the period from January 1, 1964 to December 31, 2009. At the time of sorting and portfolio formation, stocks with a share price of $5 or lower are deleted.

Panel A. Quintile portfolio returns sorted by size and volatility for equal formation and holding periods

	volatility quintiles					volatility quintiles				
	1 (low)	2	3	4	5 (high)	1 (low)	2	3	4	5 (high)
	$J = 1, K = 1$, small firms					$J = 1, K = 1$, large firms				
P1 (loser)	0.851	0.980	0.707	0.362	-0.655	1.648	1.817	1.998	2.041	2.020
P2	0.827	0.973	0.852	0.589	-0.370	1.368	1.556	1.847	1.941	2.142
P3	1.057	1.032	0.860	0.561	-0.358	1.191	1.348	1.585	1.998	2.098
P4	1.145	0.866	0.685	0.488	-0.369	1.023	1.133	1.334	1.720	2.148
P5 (winner)	1.038	0.645	0.379	0.173	-0.209	0.794	1.009	1.311	1.925	2.792
P5 − P1	0.188	-0.335	-0.327	-0.189	0.446	-0.854	-0.808	-0.687	-0.117	0.772
t-value	1.584	**-2.560**	**-2.016**	-1.040	1.959	**-7.892**	**-7.714**	**-5.162**	-0.666	**2.764**
	$J = 2, K = 2$, small firms					$J = 2, K = 2$, large firms				
P1 (loser)	1.042	1.033	0.677	0.215	-0.503	1.359	1.395	1.302	1.284	0.928
P2	1.063	1.154	0.974	0.634	-0.006	1.227	1.310	1.290	1.464	1.301
P3	1.218	1.179	1.088	0.861	0.167	1.112	1.221	1.282	1.439	1.397
P4	1.209	1.221	1.103	1.028	0.355	0.952	1.085	1.203	1.497	1.575
P5 (winner)	1.128	1.078	1.200	1.148	0.748	0.875	1.113	1.369	1.781	1.992
P5 − P1	0.086	0.046	0.524	0.933	1.251	-0.484	-0.281	0.067	0.497	1.064
t-value	0.826	0.428	**4.082**	**5.782**	**6.535**	**-5.449**	**-2.757**	0.527	**2.964**	**4.652**
	$J = 3, K = 3$, small firms					$J = 3, K = 3$, large firms				
P1 (loser)	1.020	0.911	0.610	0.258	-0.359	1.245	1.211	1.158	1.055	0.654
P2	1.119	1.187	1.005	0.671	0.172	1.142	1.245	1.246	1.192	0.931
P3	1.211	1.238	1.157	0.949	0.316	1.067	1.091	1.248	1.289	1.265
P4	1.300	1.296	1.268	1.020	0.708	0.975	1.129	1.161	1.418	1.355
P5 (winner)	1.202	1.327	1.464	1.438	1.029	0.896	1.151	1.338	1.679	1.777
P5 − P1	0.182	0.416	0.853	1.180	1.387	-0.350	-0.060	0.181	0.623	1.123
t-value	**2.022**	**4.327**	**6.830**	**7.932**	**7.619**	**-4.207**	-0.589	1.443	**3.951**	**5.207**
	$J = 6, K = 6$, small firms					$J = 6, K = 6$, large firms				
P1 (loser)	0.905	0.777	0.508	0.317	0.036	1.023	0.960	0.887	0.764	0.362
P2	1.134	1.146	0.985	0.778	0.386	1.052	1.072	1.098	0.992	0.662
P3	1.244	1.294	1.180	1.010	0.684	1.031	1.085	1.159	1.129	0.967
P4	1.321	1.393	1.377	1.219	1.032	1.009	1.124	1.251	1.325	1.222
P5 (winner)	1.381	1.616	1.632	1.676	1.333	1.095	1.329	1.469	1.675	1.640
P5 − P1	0.476	0.839	1.124	1.360	1.297	0.072	0.369	0.582	0.911	1.278
t-value	**5.135**	**8.442**	**10.269**	**9.339**	**6.553**	0.795	**3.517**	**4.376**	**5.618**	**5.352**

Table 2. Returns of quintile and momentum portfolios based on three-way sorts (continued)

Panel B. Momentum returns sorted by size and volatility for various formation and holding periods

		small firms					large firms				
		volatility quintiles					volatility quintiles				
J =	*K* =	1 (low)	2	3	4	5 (high)	1 (low)	2	3	4	5 (high)
1	1	0.188	-0.335	-0.327	-0.189	0.446	-0.854	-0.808	-0.687	-0.117	0.772
		1.584	**-2.560**	**-2.016**	-1.040	1.959	**-7.892**	**-7.714**	**-5.162**	-0.666	**2.764**
1	2	0.102	-0.070	0.035	0.386	0.682	-0.554	-0.399	-0.239	0.255	0.734
		1.114	-0.668	0.286	**2.788**	**4.043**	**-6.732**	**-4.597**	**-2.267**	1.860	**3.315**
1	3	0.178	0.108	0.304	0.654	0.794	-0.367	-0.197	-0.041	0.360	0.752
		2.293	1.218	**2.978**	**5.533**	**5.678**	**-5.617**	**-2.743**	-0.468	**3.055**	**4.284**
1	4	**0.183**	**0.142**	**0.317**	**0.702**	**0.711**	-0.338	-0.156	-0.027	**0.348**	**0.625**
		2.680	1.833	**3.492**	**6.629**	**5.546**	**-5.874**	**-2.410**	-0.343	**3.370**	**3.964**
1	6	0.194	0.231	0.396	0.692	0.691	-0.173	-0.049	0.077	0.425	0.569
		3.228	**3.436**	**5.342**	**7.488**	**5.943**	**-3.772**	-0.855	1.117	**4.476**	**4.199**
1	12	0.235	0.286	0.373	0.541	0.534	-0.012	0.089	0.206	0.422	0.530
		4.727	**4.856**	**5.872**	**7.722**	**5.980**	-0.330	**1.980**	**3.766**	**5.747**	**5.231**
2	1	0.043	-0.340	0.044	0.528	1.177	-0.815	-0.637	-0.326	0.224	0.998
		0.345	**-2.483**	0.270	**2.679**	**5.046**	**-7.225**	**-5.140**	**-2.293**	1.116	**3.535**
2	2	0.086	0.046	0.524	0.933	1.251	-0.484	-0.281	0.067	0.497	1.064
		0.826	0.428	**4.082**	**5.782**	**6.535**	**-5.449**	**-2.757**	0.527	**2.964**	**4.652**
2	3	0.151	0.189	0.694	1.053	1.143	-0.344	-0.176	0.155	0.519	0.986
		1.741	**2.135**	**5.933**	**7.482**	**6.837**	**-4.602**	-1.959	1.362	**3.676**	**4.957**
2	4	0.147	0.251	0.704	0.969	1.066	-0.293	-0.102	0.174	0.500	0.905
		1.896	**3.151**	**6.754**	**7.724**	**6.786**	**-4.338**	-1.223	1.632	**3.837**	**4.980**
2	6	0.208	0.376	0.740	0.934	0.973	-0.136	0.040	0.256	0.523	0.806
		2.895	**5.632**	**8.213**	**8.707**	**6.814**	**-2.387**	0.549	**2.769**	**4.327**	**4.900**
2	12	0.261	0.398	0.582	0.664	0.685	0.053	0.172	0.323	0.530	0.669
		4.790	**6.852**	**7.830**	**8.143**	**5.723**	1.198	**2.949**	**4.498**	**5.665**	**4.918**
3	1	0.128	0.067	0.401	1.060	1.500	-0.710	-0.454	-0.087	0.432	1.229
		1.051	0.517	**2.535**	**5.242**	**6.542**	**-6.554**	**-3.571**	-0.592	**2.138**	**4.593**
3	2	0.125	0.307	0.757	1.239	1.442	-0.478	-0.176	0.138	0.544	1.192
		1.227	**2.893**	**5.386**	**7.795**	**7.303**	**-5.130**	-1.605	1.038	**3.101**	**5.114**
3	3	0.182	0.416	0.853	1.180	1.387	-0.350	-0.060	0.181	0.623	1.123
		2.022	**4.327**	**6.830**	**7.932**	**7.619**	**-4.207**	-0.589	1.443	**3.951**	**5.207**
3	4	0.229	0.473	0.854	1.106	1.293	-0.249	0.028	0.219	0.634	1.083
		2.672	**5.625**	**7.402**	**8.262**	**7.304**	**-3.195**	0.296	1.839	**4.281**	**5.291**
3	6	0.295	0.565	0.831	1.091	1.121	-0.111	0.130	0.305	0.609	0.974
		3.729	**7.445**	**8.523**	**9.408**	**6.777**	-1.578	**1.522**	**2.838**	**4.476**	**5.053**
3	12	0.325	0.532	0.637	0.764	0.699	0.091	0.235	0.384	0.604	0.742
		5.514	**8.120**	**8.276**	**8.136**	**5.064**	1.669	**3.470**	**4.384**	**5.541**	**4.674**
6	1	0.127	0.447	0.937	1.346	1.751	-0.424	0.047	0.138	0.739	1.469
		1.132	**3.299**	**6.163**	**7.171**	**6.877**	**-3.731**	0.355	0.858	**3.665**	**5.590**
6	2	0.254	0.688	1.171	1.513	1.737	-0.237	0.210	0.336	0.879	1.508
		2.340	**5.683**	**8.529**	**8.679**	**7.404**	**-2.243**	**1.682**	**2.209**	**4.617**	**5.933**
6	3	0.330	0.775	1.221	1.506	1.560	-0.139	0.277	0.404	0.881	1.460
		3.159	**6.796**	**9.375**	**9.233**	**7.080**	-1.334	**2.311**	**2.708**	**4.824**	**5.858**
6	4	0.387	0.806	1.190	1.430	1.426	-0.062	0.323	0.470	0.895	1.376
		3.833	**7.399**	**9.671**	**9.105**	**6.804**	-0.624	**2.792**	**3.294**	**5.016**	**5.596**
6	6	0.476	0.839	1.124	1.360	1.297	0.072	0.369	0.582	0.911	1.278
		5.135	**8.442**	**10.269**	**9.339**	**6.553**	0.795	**3.517**	**4.376**	**5.618**	**5.352**
6	12	0.445	0.697	0.761	0.776	0.599	0.179	0.340	0.504	0.693	0.783
		6.324	**8.310**	**8.321**	**6.174**	**3.610**	**2.447**	**3.765**	**4.303**	**4.796**	**4.000**

Table 3. Month-by-month returns of momentum portfolios based on three-way sorts

This table shows the month-by-month returns (in percentage) of momentum portfolios which are zero-investment portfolios by buying the winner portfolios and shorting the loser portfolios. Loser and winner portfolios are identified by monthly sequential sorts along the following three dimensions: firm size at the time of portfolio formation (small versus large, divided at the median of the sample), realized volatility in the evaluation period (sorted into quintiles), and the realized return in the evaluation period (sorted into quintiles). Instead of holding period returns as in Panel B of Table 2, this table reports the returns for each subsequent month (M = 1, 2, 3, 4, 5) after the portfolio formation. All t-values are corrected for autocorrelation by the Newey-West adjustment. Bolded t-values correspond to a significance level of 5% or higher. The sample contains all common stocks traded on the NYSE, AMEX and NASDAQ, covering the period from January 1, 1964 to December 31, 2009. At the time of sorting and portfolio formation, stocks with a share price of $5 or lower are deleted.

		small firms					large firms				
		volatility quintiles					volatility quintiles				
J =	M =	1 (low)	2	3	4	5 (high)	1 (low)	2	3	4	5 (high)
1	1	0.188	-0.335	-0.327	-0.189	0.446	-0.854	-0.808	-0.687	-0.117	0.772
		1.584	**-2.560**	**-2.016**	-1.040	1.959	**-7.892**	**-7.714**	**-5.162**	-0.666	**2.764**
1	2	0.006	0.191	0.393	0.948	0.921	-0.253	0.008	0.206	0.628	0.695
		0.057	1.573	**2.753**	**6.241**	**5.020**	**-2.763**	0.079	1.628	3.858	**3.237**
1	3	0.339	0.480	0.834	1.191	1.010	0.023	0.211	0.353	0.563	0.777
		3.683	**4.052**	**6.846**	**8.342**	**5.874**	0.236	**2.032**	**3.211**	**3.782**	**4.366**
1	4	0.199	0.231	0.342	0.829	0.468	-0.253	-0.063	-0.028	0.267	0.200
		1.842	**2.187**	**2.816**	**5.893**	**2.885**	**-2.806**	-0.623	-0.245	**2.003**	0.973
1	5	0.148	0.152	0.581	0.616	0.714	0.065	0.069	0.167	0.489	0.405
		1.476	1.295	**5.073**	**4.041**	**3.470**	0.655	0.629	1.260	**3.106**	**2.023**
2	1	0.043	-0.340	0.044	0.528	1.177	-0.815	-0.637	-0.326	0.224	0.998
		0.345	**-2.483**	0.270	**2.679**	**5.046**	**-7.225**	**-5.140**	**-2.293**	1.116	**3.535**
2	2	0.130	0.417	1.007	1.330	1.307	-0.145	0.073	0.458	0.746	1.106
		1.144	**3.574**	**6.916**	**7.929**	**6.585**	-1.566	0.672	**3.298**	**4.390**	**5.201**
2	3	0.300	0.476	1.042	1.306	0.898	-0.056	0.036	0.324	0.535	0.790
		3.048	**4.071**	**7.366**	**8.725**	**4.753**	-0.578	0.327	**2.433**	**3.514**	**3.567**
2	4	0.127	0.420	0.703	0.699	0.821	-0.146	0.089	0.188	0.396	0.604
		1.215	**3.934**	**5.241**	**4.749**	**4.077**	-1.437	0.760	1.322	**2.537**	**2.717**
2	5	0.217	0.512	0.831	0.779	0.784	0.224	0.326	0.273	0.528	0.577
		2.054	**4.278**	**6.148**	**4.397**	**3.423**	**2.048**	**2.980**	**1.897**	**3.147**	**2.541**
3	1	0.128	0.067	0.401	1.060	1.500	-0.710	-0.454	-0.087	0.432	1.229
		1.051	0.517	**2.535**	**5.242**	**6.542**	**-6.554**	**-3.571**	-0.592	**2.138**	**4.593**
3	2	0.118	0.536	1.110	1.410	1.361	-0.241	0.094	0.348	0.622	1.117
		1.131	**4.429**	**7.080**	**8.922**	**6.363**	**-2.484**	0.835	**2.399**	**3.603**	**4.893**
3	3	0.304	0.636	1.047	1.074	1.243	-0.085	0.183	0.255	0.760	0.939
		2.766	**5.540**	**7.648**	**6.230**	**6.090**	-0.830	1.517	1.713	**4.534**	**3.816**
3	4	0.344	0.616	0.839	0.840	0.986	0.039	0.279	0.293	0.613	0.904
		3.040	**5.831**	**6.292**	**5.338**	**4.498**	0.375	**2.470**	**2.014**	**3.746**	**3.807**
3	5	0.387	0.695	0.896	1.139	0.692	0.143	0.328	0.460	0.503	0.826
		3.631	**5.762**	**5.972**	**6.829**	**2.938**	1.345	**2.742**	**3.259**	**2.741**	**3.665**
6	1	0.127	0.447	0.937	1.346	1.751	-0.424	0.047	0.138	0.739	1.469
		1.132	**3.299**	**6.163**	**7.171**	**6.877**	**-3.731**	0.355	0.858	**3.665**	**5.590**
6	2	0.384	0.921	1.393	1.679	1.702	-0.047	0.366	0.523	0.992	1.513
		3.327	**7.411**	**9.572**	**9.258**	**7.167**	-0.431	**2.870**	**3.332**	**5.023**	**5.647**
6	3	0.488	0.954	1.302	1.521	1.179	0.069	0.421	0.535	0.863	1.325
		4.330	**7.654**	**8.975**	**8.792**	**5.287**	0.601	**3.396**	**3.453**	**4.628**	**4.913**
6	4	0.540	0.863	1.063	1.198	1.014	0.160	0.463	0.630	0.891	1.109
		4.993	**7.043**	**7.397**	**6.892**	**4.527**	1.490	**3.837**	**4.249**	**4.688**	**4.265**
6	5	0.596	0.782	1.043	1.235	0.860	0.330	0.408	0.723	0.850	1.106
		5.320	**6.467**	**6.943**	**6.616**	**3.219**	**2.873**	**3.300**	**4.731**	**4.713**	**4.209**

Table 4. Alphas of momentum portfolios based on three-way sorts

This table shows the per-month alphas (in percentage) of momentum portfolios which are zero-investment portfolios by buying the winner portfolios and shorting the loser portfolios. Loser and winner portfolios are identified by monthly sequential sorts along the following three dimensions: firm size at the time of portfolio formation (small versus large, divided at the median of the sample), realized volatility in the evaluation period (sorted into quintiles), and the realized return in the evaluation period (sorted into quintiles). Portfolio return calculations follow the same procedure as in Jegadeesh and Titman (1993). Alphas are the intercepts from regressions of the monthly momentum portfolio returns on the three Fama-French factors. Below each alpha is its *t*-value. Bolded *t*-values correspond to a significance level of 5% or higher. The sample contains all common stocks traded on the NYSE, AMEX and NASDAQ, covering the period from January 1, 1964 to December 31, 2009. At the time of sorting and portfolio formation, stocks with a share price of $5 or lower are deleted.

		small firms					large firms				
		volatility quintiles					volatility quintiles				
J =	*K* =	1 (low)	2	3	4	5 (high)	1 (low)	2	3	4	5 (high)
1	1	-0.113	-0.620	-0.620	-0.522	0.177	-1.189	-1.115	-0.987	-0.436	0.478
		-1.202	**-5.355**	**-4.306**	**-3.115**	0.801	**-12.277**	**-10.599**	**-7.074**	**-2.407**	1.914
1	2	-0.217	-0.398	-0.302	0.006	0.349	-0.918	-0.729	-0.561	-0.075	0.408
		-3.062	**-4.479**	**-2.733**	0.048	**2.060**	**-11.765**	**-8.560**	**-5.291**	-0.544	**2.062**
1	3	-0.165	-0.245	-0.046	0.278	0.409	-0.746	-0.537	-0.376	0.008	0.409
		-2.743	**-3.119**	-0.480	**2.368**	**2.755**	**-11.437**	**-7.237**	**-4.018**	0.063	**2.383**
1	6	-0.181	-0.137	0.019	0.292	0.305	-0.579	-0.431	-0.298	0.043	0.194
		-3.696	**-2.254**	0.262	**3.177**	**2.590**	**-12.443**	**-7.404**	**-4.037**	0.440	1.442
1	12	-0.154	-0.099	-0.011	0.128	0.156	-0.424	-0.295	-0.174	0.051	0.158
		-4.016	**-1.982**	-0.181	1.874	1.821	**-11.422**	**-6.353**	**-3.032**	0.666	1.639
2	1	-0.244	-0.624	-0.224	0.224	0.846	-1.154	-0.908	-0.607	-0.034	0.731
		-2.453	**-5.080**	-1.454	1.240	**3.786**	**-10.626**	**-7.407**	**-4.290**	-0.176	**2.627**
2	2	-0.236	-0.273	0.209	0.591	0.874	-0.853	-0.589	-0.214	0.212	0.776
		-2.788	**-2.732**	1.657	**3.781**	**4.388**	**-9.292**	**-5.398**	-1.712	1.243	**3.305**
2	3	-0.204	-0.145	0.357	0.688	0.756	-0.731	-0.505	-0.133	0.214	0.668
		-2.807	-1.682	**3.144**	**4.918**	**4.217**	**-9.347**	**-5.218**	-1.155	1.429	**3.176**
2	6	-0.159	0.019	0.381	0.576	0.600	-0.548	-0.338	-0.086	0.188	0.450
		-2.724	0.274	**4.251**	**5.258**	**3.999**	**-9.423**	**-4.513**	-0.901	1.518	**2.642**
2	12	-0.125	0.033	0.214	0.289	0.338	-0.350	-0.202	-0.017	0.197	0.334
		-2.741	0.574	**2.957**	**3.561**	**2.923**	**-7.611**	**-3.396**	-0.236	**2.091**	**2.621**
3	1	-0.186	-0.197	0.145	0.723	1.167	-1.056	-0.733	-0.324	0.218	0.931
		-1.801	-1.603	0.942	**3.890**	**4.939**	**-9.656**	**-5.568**	**-2.100**	1.083	**3.317**
3	2	-0.208	-0.007	0.455	0.866	1.084	-0.854	-0.490	-0.137	0.301	0.859
		-2.308	-0.061	**3.350**	**5.417**	**5.046**	**-8.835**	**-4.190**	-0.971	**1.669**	**3.481**
3	3	-0.163	0.090	0.534	0.818	1.016	-0.739	-0.386	-0.110	0.361	0.784
		-1.997	0.917	**4.406**	**5.476**	**5.118**	**-8.658**	**-3.575**	-0.834	**2.180**	**3.438**
3	6	-0.064	0.217	0.484	0.742	0.762	-0.525	-0.241	-0.041	0.299	0.627
		-0.935	**2.755**	**4.841**	**6.203**	**4.356**	**-7.585**	**-2.728**	-0.361	**2.110**	**3.239**
3	12	-0.060	0.180	0.284	0.416	0.371	-0.312	-0.134	0.056	0.290	0.437
		-1.138	**2.769**	**3.675**	**4.450**	**2.820**	**-5.676**	-1.919	0.648	**2.731**	**2.953**
6	1	-0.203	0.184	0.685	1.004	1.440	-0.796	-0.278	-0.111	0.531	1.164
		-1.874	1.405	**4.413**	**5.427**	**5.644**	**-6.983**	**-2.006**	-0.657	**2.425**	**4.231**
6	2	-0.094	0.399	0.870	1.165	1.391	-0.630	-0.131	0.075	0.636	1.176
		-0.929	**3.345**	**6.040**	**6.770**	**5.748**	**-5.828**	-0.997	0.467	**3.075**	**4.447**
6	3	-0.022	0.472	0.914	1.160	1.205	-0.543	-0.068	0.123	0.610	1.114
		-0.230	**4.160**	**6.703**	**7.160**	**5.185**	**-5.235**	-0.540	0.784	**3.046**	**4.327**
6	6	0.109	0.506	0.805	1.033	0.937	-0.329	0.026	0.274	0.608	0.937
		1.302	**5.067**	**6.882**	**6.954**	**4.471**	**-3.558**	0.233	1.956	**3.455**	**3.998**
6	12	0.065	0.361	0.444	0.480	0.301	-0.198	0.017	0.228	0.437	0.526
		0.991	**4.370**	**4.683**	**4.020**	**1.880**	**-2.694**	0.197	**2.096**	**3.213**	**2.885**

Table 5. Returns of momentum portfolios based on three-way sorts and idiosyncratic volatility

This table is a counterpart of Panel B of Table 2 with the total realized volatility replaced by the realized idiosyncratic volatility with respect to the three-factor Fama-French model. Portfolio return calculations follow the same procedure as in Jegadeesh and Titman (1993). Below each return is its *t*-value. Bolded *t*-values correspond to a significance level of 5% or higher. The sample contains all common stocks traded on the NYSE, AMEX and NASDAQ, covering the period from January 1, 1964 to December 31, 2009. At the time of sorting and portfolio formation, stocks with a share price of $5 or lower are deleted.

		small firms					large firms				
		idiosyncratic volatility quintiles					idiosyncratic volatility quintiles				
J =	*K* =	1 (low)	2	3	4	5 (high)	1 (low)	2	3	4	5 (high)
1	1	0.166	-0.288	-0.217	-0.135	0.337	-0.805	-0.718	-0.689	-0.188	0.717
		1.331	**-2.015**	-1.285	-0.702	1.460	**-7.364**	**-6.183**	**-4.858**	-1.034	**2.511**
1	2	0.081	-0.101	0.160	0.351	0.632	-0.530	-0.357	-0.168	0.146	0.709
		0.818	-0.928	1.265	**2.499**	**3.712**	**-6.489**	**-3.747**	-1.548	0.993	**3.178**
1	3	0.126	0.113	0.331	0.622	0.766	-0.341	-0.214	-0.004	0.325	0.744
		1.571	1.270	**3.084**	**5.359**	**5.437**	**-5.082**	**-2.843**	-0.049	**2.571**	**4.197**
1	4	0.151	0.153	0.354	0.649	0.668	-0.314	-0.164	-0.030	0.305	0.605
		2.172	1.935	**3.755**	**6.231**	**5.118**	**-5.372**	**-2.414**	-0.374	**2.780**	**3.816**
1	6	0.163	0.249	0.420	0.652	0.662	-0.183	-0.053	0.077	0.383	0.569
		2.647	**3.676**	**5.380**	**7.156**	**5.740**	**-3.868**	-0.914	1.103	**3.973**	**4.217**
1	12	0.225	0.278	0.382	0.559	0.499	-0.026	0.105	0.189	0.431	0.506
		4.391	**4.667**	**5.832**	**8.006**	**5.741**	-0.675	**2.256**	**3.555**	**5.809**	**5.029**
2	1	0.035	-0.325	0.043	0.560	1.158	-0.739	-0.607	-0.339	0.062	1.043
		0.268	**-2.231**	0.253	**2.834**	**4.944**	**-6.294**	**-4.729**	**-2.195**	0.294	**3.700**
2	2	0.066	0.094	0.498	0.876	1.226	-0.483	-0.251	0.048	0.454	1.076
		0.622	0.872	**3.665**	**5.339**	**6.227**	**-5.140**	**-2.302**	0.364	**2.489**	**4.676**
2	3	0.131	0.225	0.632	1.028	1.155	-0.332	-0.165	0.117	0.526	1.006
		1.489	**2.430**	**5.213**	**7.162**	**6.826**	**-4.226**	-1.714	0.998	**3.455**	**5.075**
2	4	0.142	0.277	0.643	0.968	1.058	-0.273	-0.106	0.125	0.509	0.929
		1.810	**3.402**	**5.877**	**7.452**	**6.663**	**-3.878**	-1.201	1.126	**3.646**	**5.156**
2	6	0.200	0.399	0.686	0.959	0.963	-0.124	0.056	0.217	0.518	0.821
		2.768	**5.673**	**7.505**	**8.488**	**6.709**	**-2.116**	0.733	**2.285**	**4.105**	**5.000**
2	12	0.261	0.404	0.562	0.675	0.672	0.051	0.182	0.311	0.512	0.687
		4.700	**6.810**	**7.572**	**7.889**	**5.722**	1.110	**2.946**	**4.176**	**5.168**	**5.130**
3	1	0.089	0.086	0.437	1.066	1.483	-0.689	-0.334	-0.155	0.433	1.196
		0.708	0.635	**2.567**	**5.292**	**6.439**	**-6.106**	**-2.538**	-1.013	**2.025**	**4.465**
3	2	0.084	0.302	0.782	1.277	1.404	-0.460	-0.138	0.117	0.577	1.194
		0.789	**2.689**	**5.418**	**7.854**	**7.042**	**-4.773**	-1.198	0.853	**3.141**	**5.060**
3	3	0.145	0.395	0.884	1.256	1.358	-0.315	-0.038	0.162	0.634	1.129
		1.548	**3.899**	**6.830**	**8.428**	**7.427**	**-3.705**	-0.357	1.269	**3.873**	**5.196**
3	4	0.194	0.447	0.863	1.186	1.258	-0.213	0.026	0.223	0.622	1.070
		2.198	**4.892**	**7.324**	**8.836**	**7.107**	**-2.699**	0.263	1.852	**4.095**	**5.202**
3	6	0.275	0.540	0.842	1.137	1.085	-0.072	0.125	0.292	0.617	0.962
		3.395	**6.643**	**8.530**	**9.615**	**6.556**	-1.010	1.387	**2.694**	**4.423**	**4.993**
3	12	0.321	0.507	0.640	0.780	0.672	0.100	0.243	0.368	0.629	0.730
		5.383	**7.469**	**8.107**	**8.152**	**4.894**	1.782	**3.354**	**4.167**	**5.661**	**4.618**
6	1	0.115	0.435	1.045	1.258	1.760	-0.369	0.013	0.249	0.689	1.463
		0.973	**3.278**	**6.331**	**6.326**	**6.855**	**-3.226**	0.096	1.512	**3.237**	**5.510**
6	2	0.250	0.666	1.246	1.439	1.771	-0.184	0.182	0.431	0.894	1.514
		2.215	**5.417**	**8.555**	**7.933**	**7.639**	-1.706	1.380	**2.798**	**4.492**	**5.931**
6	3	0.329	0.748	1.266	1.460	1.609	-0.081	0.251	0.483	0.913	1.445
		3.030	**6.500**	**9.213**	**8.755**	**7.381**	-0.773	**1.973**	**3.265**	**4.758**	**5.791**
6	4	0.389	0.781	1.233	1.408	1.475	-0.012	0.314	0.516	0.917	1.359
		3.776	**7.105**	**9.502**	**8.812**	**7.048**	-0.116	**2.563**	**3.614**	**4.945**	**5.514**
6	6	0.464	0.809	1.169	1.335	1.345	0.112	0.401	0.608	0.951	1.258
		4.913	**7.995**	**10.103**	**8.984**	**6.824**	1.217	**3.596**	**4.559**	**5.624**	**5.281**
6	12	0.433	0.687	0.788	0.767	0.601	0.197	0.355	0.488	0.715	0.772
		6.038	**8.128**	**7.971**	**6.053**	**3.644**	**2.585**	**3.632**	**4.049**	**4.681**	**4.009**

Table 6. January and non-January returns of momentum portfolios

This table is a break-down version of Panel B of Table 2. Momentum portfolio returns are separated between January and all other months of the year. For brevity, only returns for the two extreme volatility quintiles are reported. Below each return is its *t*-value. Bolded *t*-values correspond to a significance level of 5% or higher. Please refer to Table 2 for calculation procedures and sample specifications.

		small firms						large firms					
		All		Jan.		Feb. - Dec.		All		Jan.		Feb. - Dec.	
J =	*K* =	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)
1	1	0.188	0.446	-1.682	-2.504	0.358	0.715	-0.854	0.772	-2.417	-0.761	-0.712	0.911
		1.584	1.959	**-3.273**	**-2.859**	**3.175**	**3.127**	**-7.892**	**2.764**	**-6.882**	-1.065	**-6.621**	**3.084**
1	2	0.102	0.682	-1.675	-1.719	0.260	0.895	-0.554	0.734	-1.629	-0.153	-0.458	0.813
		1.114	**4.043**	**-3.666**	**-2.233**	**2.993**	**5.239**	**-6.732**	**3.315**	**-5.384**	-0.212	**-5.637**	**3.433**
1	3	0.178	0.794	-1.470	-1.354	0.324	0.985	-0.367	0.752	-1.349	-0.095	-0.279	0.827
		2.293	**5.678**	**-4.132**	**-1.964**	**4.447**	**6.804**	**-5.617**	**4.284**	**-5.869**	-0.149	**-4.316**	**4.354**
1	4	0.183	0.711	-1.437	-1.091	0.327	0.872	-0.338	0.625	-1.286	-0.478	-0.253	0.724
		2.680	**5.546**	**-4.955**	-1.932	**5.059**	**6.668**	**-5.874**	**3.964**	**-5.805**	-0.846	**-4.545**	**4.310**
1	6	0.194	0.691	-1.282	-0.865	0.326	0.830	-0.173	0.569	-0.932	-0.364	-0.105	0.652
		3.228	**5.943**	**-5.444**	-1.560	**5.853**	**7.205**	**-3.772**	**4.199**	**-4.956**	-0.728	**-2.394**	**4.704**
1	12	0.235	0.534	-0.915	-0.765	0.339	0.652	-0.012	0.530	-0.607	-0.128	0.042	0.589
		4.727	**5.980**	**-4.758**	-1.895	**7.095**	**7.431**	-0.330	**5.231**	**-4.227**	-0.426	1.128	**5.727**
2	1	0.043	1.177	-2.464	-1.017	0.270	1.376	-0.815	0.998	-2.081	-0.366	-0.700	1.122
		0.345	**5.046**	**-3.549**	-1.207	**2.313**	**5.681**	**-7.225**	**3.535**	**-4.058**	-0.457	**-6.410**	**3.672**
2	2	0.086	1.251	-2.228	-0.950	0.292	1.447	-0.484	1.064	-1.407	0.034	-0.402	1.155
		0.826	**6.535**	**-3.946**	-1.173	**2.936**	**7.122**	**-5.449**	**4.652**	**-3.871**	0.045	**-4.564**	**4.664**
2	3	0.151	1.143	-1.775	-0.991	0.322	1.333	-0.344	0.986	-1.352	-0.248	-0.254	1.096
		1.741	**6.837**	**-4.472**	-1.340	**3.825**	**7.530**	**-4.602**	**4.957**	**-4.529**	-0.351	**-3.481**	**5.084**
2	4	0.147	1.066	-1.771	-1.012	0.318	1.251	-0.293	0.905	-1.230	-0.409	-0.209	1.022
		1.896	**6.786**	**-4.966**	-1.381	**4.330**	**7.765**	**-4.338**	**4.980**	**-4.088**	-0.617	**-3.277**	**5.311**
2	6	0.208	0.973	-1.546	-0.983	0.365	1.148	-0.136	0.806	-0.904	-0.273	-0.067	0.903
		2.895	**6.814**	**-4.792**	-1.420	**5.501**	**8.020**	**-2.387**	**4.900**	**-3.696**	-0.482	-1.239	**5.358**
2	12	0.261	0.685	-1.192	-1.158	0.393	0.853	0.053	0.669	-0.597	-0.299	0.112	0.757
		4.790	**5.723**	**-3.977**	-1.958	**7.618**	**7.348**	1.198	**4.918**	**-3.119**	-0.753	**2.573**	**5.477**
3	1	0.128	1.500	-2.252	-1.110	0.344	1.738	-0.710	1.229	-1.954	0.020	-0.597	1.339
		1.051	**6.542**	**-4.386**	-1.237	**2.849**	**7.571**	**-6.554**	**4.593**	**-4.298**	0.024	**-5.650**	**4.557**
3	2	0.125	1.442	-2.223	-1.039	0.334	1.662	-0.478	1.192	-1.653	-0.056	-0.374	1.303
		1.227	**7.303**	**-4.860**	-1.309	**3.316**	**8.010**	**-5.130**	**5.114**	**-4.307**	-0.072	**-4.049**	**5.156**
3	3	0.182	1.387	-2.048	-0.982	0.381	1.598	-0.350	1.123	-1.452	-0.305	-0.251	1.250
		2.022	**7.619**	**-5.392**	-1.221	**4.376**	**8.467**	**-4.207**	**5.207**	**-4.301**	-0.386	**-3.098**	**5.485**
3	4	0.229	1.293	-1.870	-1.023	0.417	1.500	-0.249	1.083	-1.312	-0.451	-0.154	1.220
		2.672	**7.304**	**-5.256**	-1.226	**5.076**	**8.391**	**-3.195**	**5.291**	**-3.796**	-0.636	**-2.073**	**5.769**
3	6	0.295	1.121	-1.617	-1.259	0.466	1.334	-0.111	0.974	-1.036	-0.387	-0.029	1.096
		3.729	**6.777**	**-4.271**	-1.607	**6.328**	**8.194**	-1.578	**5.053**	**-3.566**	-0.608	-0.423	**5.582**
3	12	0.325	0.699	-1.298	-1.581	0.473	0.905	0.091	0.742	-0.657	-0.639	0.159	0.868
		5.514	**5.064**	**-4.183**	**-2.202**	**8.302**	**6.936**	1.669	**4.674**	**-2.815**	-1.270	**2.971**	**5.372**
6	1	0.127	1.751	-2.387	-1.051	0.356	2.006	-0.424	1.469	-2.090	-0.713	-0.273	1.667
		1.132	**6.877**	**-3.892**	-0.994	**3.238**	**7.580**	**-3.731**	**5.590**	**-4.104**	-0.766	**-2.495**	**6.389**
6	2	0.254	1.737	-2.270	-0.796	0.478	1.962	-0.237	1.508	-1.560	-0.528	-0.120	1.689
		2.340	**7.404**	**-4.169**	-0.810	**4.648**	**7.901**	**-2.243**	**5.933**	**-3.410**	-0.585	-1.137	**6.615**
6	3	0.330	1.560	-1.943	-1.159	0.533	1.803	-0.139	1.460	-1.331	-0.541	-0.033	1.638
		3.159	**7.080**	**-3.766**	-1.147	**5.408**	**7.915**	-1.334	**5.858**	**-3.096**	-0.615	-0.319	**6.525**
6	4	0.387	1.426	-1.794	-1.340	0.582	1.673	-0.062	1.376	-1.183	-0.654	0.038	1.557
		3.833	**6.804**	**-3.494**	-1.281	**6.120**	**7.883**	-0.624	**5.596**	**-2.746**	-0.779	0.393	**6.321**
6	6	0.476	1.297	-1.547	-1.382	0.657	1.537	0.072	1.278	-0.996	-0.526	0.168	1.440
		5.135	**6.553**	**-3.229**	-1.295	**7.541**	**7.961**	0.795	**5.352**	**-2.468**	-0.698	1.908	**5.915**
6	12	0.445	0.599	-1.401	-2.052	0.612	0.840	0.179	0.783	-0.853	-1.469	0.273	0.987
		6.324	**3.610**	**-3.785**	**-2.404**	**8.811**	**5.211**	**2.447**	**4.000**	**-2.528**	**-2.198**	**3.773**	**4.921**

Table 7. Returns of momentum portfolios based on three-way sorts for different sub-sample periods

This table is a break-down version of Panel B of Table 2 while omitting the 12-month holding period (for brevity). The sample is broken into three equal periods: 1965-1978, 1979-1993, and 1994-2008 (note that, only the period of January 1, 1965 to December 31, 2008 contains momentum portfolio returns for all combinations of evaluation and holding periods). For completeness, the results for 1965-2008 are duplicated in the first two columns. For brevity, only returns for the two extreme volatility quintiles are reported. An earlier period of 1952 to 1964 is also added. Panel A is for small firms and Panel B for larger firms. Below each return is its *t*-value. Bolded *t*-values correspond to a significance level of 5% or higher. Please refer to Table 2 for calculation procedures.

Panel A. Momentum returns by size and volatility for various formation and holding periods - small firms											
		1965 - 2008		1952 - 1964		1965 - 1978		1979 - 1993		1994 - 2008	
J =	*K* =	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)
1	1	0.188	0.446	-0.369	0.097	-0.658	-0.571	0.821	0.726	0.343	1.116
		1.584	1.959	**-2.074**	0.308	**-3.216**	-1.438	**4.750**	**2.321**	**1.976**	**2.637**
1	2	0.102	0.682	-0.183	0.446	-0.566	0.403	0.569	1.013	0.292	0.660
		1.114	**4.043**	-1.492	1.862	**-3.504**	1.558	**3.933**	**4.241**	**2.454**	1.868
1	3	0.178	0.794	0.000	0.652	-0.300	0.645	0.502	1.171	0.335	0.605
		2.293	**5.678**	-0.005	**3.228**	**-2.138**	**2.957**	**3.816**	**6.363**	**3.364**	**2.062**
1	4	0.183	0.711	0.093	0.651	-0.141	0.588	0.432	1.059	0.274	0.529
		2.680	**5.546**	0.983	**3.715**	-1.144	**2.951**	**3.521**	**6.481**	**3.022**	1.906
1	6	0.194	0.691	0.222	0.700	-0.086	0.464	0.402	1.050	0.275	0.591
		3.228	**5.943**	**3.256**	**4.680**	-0.786	**2.476**	**3.675**	**6.997**	**3.512**	**2.379**
2	1	0.043	1.177	-0.626	0.465	-0.776	0.463	0.532	1.386	0.317	1.633
		0.345	**5.046**	**-3.371**	1.392	**-3.284**	1.328	**3.021**	**4.586**	1.819	**3.238**
2	2	0.086	1.251	-0.124	0.729	-0.492	0.917	0.380	1.745	0.362	1.134
		0.826	**6.535**	-0.837	**2.604**	**-2.344**	**3.563**	**2.366**	**7.143**	**2.666**	**2.628**
2	3	0.151	1.143	0.096	0.905	-0.211	0.891	0.341	1.664	0.326	0.910
		1.741	**6.837**	0.733	**4.070**	-1.302	**3.940**	**2.235**	**8.226**	**2.736**	**2.381**
2	4	0.147	1.066	0.161	0.921	-0.110	0.809	0.294	1.536	0.283	0.898
		1.896	**6.786**	1.296	**4.534**	-0.722	**3.714**	**2.111**	**8.378**	**2.874**	**2.458**
2	6	0.208	0.973	0.255	0.882	-0.027	0.622	0.370	1.427	0.298	0.896
		2.895	**6.814**	**2.962**	**4.980**	-0.192	**2.849**	**2.852**	**8.311**	**3.256**	**2.813**
3	1	0.128	1.500	-0.203	0.896	-0.518	0.924	0.470	1.889	0.389	1.650
		1.051	**6.542**	-1.156	**2.780**	**-2.266**	**2.368**	**2.274**	**5.849**	**2.395**	**3.662**
3	2	0.125	1.442	0.156	1.065	-0.236	1.164	0.287	1.984	0.340	1.218
		1.227	**7.303**	1.140	**3.779**	-1.262	**3.749**	1.531	**8.122**	**2.396**	**2.878**
3	3	0.182	1.387	0.267	1.197	-0.007	1.124	0.242	1.878	0.325	1.199
		2.022	**7.619**	**2.111**	**4.797**	-0.041	**3.973**	1.417	**8.208**	**2.842**	**3.031**
3	4	0.229	1.293	0.334	1.197	0.109	1.006	0.302	1.780	0.313	1.151
		2.672	**7.304**	**2.941**	**4.965**	0.623	**3.601**	1.879	**7.964**	**3.019**	**2.990**
3	6	0.295	1.121	0.331	1.054	0.098	0.768	0.449	1.507	0.361	1.125
		3.729	**6.777**	**3.517**	**4.975**	0.578	**2.870**	**3.240**	**7.339**	**3.812**	**3.099**
6	1	0.127	1.751	0.032	1.292	-0.280	0.837	0.354	2.430	0.280	1.925
		1.132	**6.877**	0.192	**3.670**	-1.317	1.917	1.644	**7.154**	**2.115**	**3.874**
6	2	0.254	1.737	0.293	1.369	-0.031	0.927	0.405	2.394	0.395	1.892
		2.340	**7.404**	**2.092**	**4.197**	-0.146	**2.375**	**1.962**	**7.936**	**3.228**	**4.005**
6	3	0.330	1.560	0.343	1.334	0.090	0.857	0.477	2.166	0.433	1.679
		3.159	**7.080**	**2.797**	**4.266**	0.434	**2.270**	**2.359**	**7.820**	**3.630**	**3.765**
6	4	0.387	1.426	0.337	1.254	0.165	0.739	0.562	2.041	0.472	1.555
		3.833	**6.804**	**2.715**	**4.315**	0.815	**2.047**	**2.925**	**7.912**	**4.043**	**3.626**
6	6	0.476	1.297	0.289	1.168	0.193	0.734	0.744	1.948	0.508	1.271
		5.135	**6.553**	**2.450**	**4.554**	1.046	**2.194**	**4.336**	**7.946**	**4.419**	**3.058**

Table 7. Returns of momentum portfolios based on three-way sorts for different sub-sample periods (continued)

Panel B. Momentum returns by size and volatility for various formation and holding periods - big firms											
		1965 - 2008		1952 - 1964		1965 - 1978		1979 - 1993		1994 - 2008	
J =	*K* =	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)
1	1	-0.854	0.772	-0.783	0.565	-0.408	1.320	-0.911	1.107	-0.611	0.845
		-7.892	**2.764**	**-4.604**	**2.298**	**-1.971**	**2.963**	**-4.422**	**3.849**	**-3.226**	1.226
1	2	-0.554	0.734	-0.396	0.417	-0.173	1.205	-0.489	0.914	-0.479	0.904
		-6.732	**3.315**	**-3.896**	**2.007**	-0.902	**2.753**	**-3.172**	**4.232**	**-3.200**	1.608
1	3	-0.367	0.752	-0.137	0.586	-0.059	1.201	-0.384	0.985	-0.300	0.718
		-5.617	**4.284**	-1.622	**3.707**	-0.308	**2.874**	**-3.175**	**5.566**	**-2.602**	1.611
1	4	-0.338	0.625	-0.081	0.557	-0.062	1.150	-0.352	0.911	-0.330	0.512
		-5.874	**3.964**	-1.008	**4.124**	-0.335	**2.833**	**-3.376**	**5.460**	**-3.197**	1.296
1	6	-0.173	0.569	0.059	0.530	-0.031	1.105	-0.158	0.760	-0.182	0.491
		-3.772	**4.199**	0.803	**4.453**	-0.178	**2.893**	-1.819	**5.173**	**-2.457**	1.466
2	1	-0.815	0.998	-0.851	0.679	-1.011	0.486	-0.736	1.105	-0.712	1.371
		-7.225	**3.535**	**-4.832**	**2.366**	**-5.403**	1.407	**-3.534**	**3.284**	**-3.831**	**2.011**
2	2	-0.484	1.064	-0.327	0.933	-0.640	0.698	-0.429	1.193	-0.380	1.308
		-5.449	**4.652**	**-2.539**	**3.971**	**-4.359**	**2.369**	**-2.732**	**4.626**	**-2.464**	**2.359**
2	3	-0.344	0.986	-0.111	1.018	-0.387	0.758	-0.354	1.193	-0.300	1.025
		-4.602	**4.957**	-1.096	**5.696**	**-3.020**	**2.880**	**-2.690**	**5.010**	**-2.309**	**2.154**
2	4	-0.293	0.905	-0.011	0.896	-0.295	0.808	-0.306	1.117	-0.282	0.834
		-4.338	**4.980**	-0.122	**5.304**	**-2.423**	**3.347**	**-2.579**	**4.895**	**-2.469**	1.934
2	6	-0.136	0.806	0.100	0.899	-0.159	0.690	-0.105	1.047	-0.142	0.750
		-2.387	**4.900**	1.153	**6.002**	-1.398	**3.075**	-1.043	**5.153**	-1.654	1.918
3	1	-0.710	1.229	-0.440	1.218	-0.886	0.894	-0.708	1.419	-0.549	1.352
		-6.554	**4.593**	**-2.747**	**4.151**	**-4.788**	**2.390**	**-3.740**	**4.439**	**-2.978**	**2.160**
3	2	-0.478	1.192	-0.175	1.307	-0.496	0.922	-0.510	1.489	-0.417	1.197
		-5.130	**5.114**	-1.315	**5.951**	**-3.000**	**2.733**	**-3.107**	**5.540**	**-2.668**	**2.199**
3	3	-0.350	1.123	-0.025	1.266	-0.282	0.973	-0.447	1.390	-0.331	1.039
		-4.207	**5.207**	-0.223	**6.687**	-1.877	**3.002**	**-3.027**	**5.466**	**-2.441**	**2.090**
3	4	-0.249	1.083	0.056	1.256	-0.178	0.972	-0.318	1.328	-0.242	1.021
		-3.195	**5.291**	0.558	**6.463**	-1.218	**3.179**	**-2.261**	**5.289**	**-1.992**	**2.173**
3	6	-0.111	0.974	0.168	1.171	-0.107	0.832	-0.122	1.227	-0.102	0.950
		-1.578	**5.053**	1.791	**6.799**	-0.736	**2.831**	-0.956	**5.605**	-1.038	**2.104**
6	1	-0.424	1.469	-0.027	1.832	-0.408	1.320	-0.592	1.727	-0.272	1.349
		-3.731	**5.590**	-0.178	**7.136**	**-1.971**	**2.963**	**-2.890**	**4.928**	-1.543	**2.482**
6	2	-0.237	1.508	0.164	1.798	-0.173	1.205	-0.367	1.783	-0.153	1.589
		-2.243	**5.933**	1.156	**7.092**	-0.902	**2.753**	-1.869	**5.903**	-0.950	**2.927**
6	3	-0.139	1.460	0.277	1.722	-0.059	1.201	-0.300	1.679	-0.058	1.565
		-1.334	**5.858**	**2.069**	**6.905**	-0.308	**2.874**	-1.526	**5.879**	-0.375	**2.843**
6	4	-0.062	1.376	0.310	1.587	-0.062	1.150	-0.135	1.627	0.028	1.441
		-0.624	**5.596**	**2.469**	**6.611**	-0.335	**2.833**	-0.709	**5.794**	0.200	**2.612**
6	6	0.072	1.278	0.347	1.494	-0.031	1.105	0.091	1.579	0.170	1.264
		0.795	**5.352**	**3.034**	**7.185**	-0.178	**2.893**	0.530	**5.920**	1.286	**2.297**

Table 8. Returns of momentum portfolios based on three-way sorts for stocks on NYSE, NASDAQ and AMEX

This table is a break-down version of Panel B of Table 2 while omitting the 12-month holding period (for brevity). The three-way sorting is performed separately for stocks on each of the three exchanges. For brevity, only returns for the two extreme volatility quintiles are reported. Below each return is its *t*-value. Bolded *t*-values correspond to a significance level of 5% or higher. Please refer to Table 2 for calculation procedures and sample specifications. The median firm size (over the entire sample) is $769 million, $116 million and $71 million respectively for NYSE, NASDAQ and AMEX.

		small firms						big firms					
		NYSE		NASDAQ		AMEX		NYSE		NASDAQ		AMEX	
J =	*K* =	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)
1	1	-0.728	0.244	0.972	0.517	0.364	0.192	-0.667	0.282	-0.883	0.887	-0.749	0.905
		-5.211	1.049	**6.781**	1.820	**2.010**	0.530	**-5.649**	1.114	**-6.851**	**2.390**	**-4.370**	**2.426**
1	2	-0.448	0.394	0.621	0.679	0.187	0.646	-0.431	0.320	-0.443	1.002	-0.449	0.969
		-4.336	**2.425**	**5.185**	**3.200**	1.372	**2.640**	**-4.592**	1.670	**-4.505**	**3.567**	**-3.629**	**3.556**
1	3	-0.237	0.514	**0.525**	**0.796**	**0.262**	0.767	-0.285	0.269	-0.285	0.954	-0.285	0.806
		-2.829	**3.703**	**5.062**	**4.444**	**2.509**	**3.725**	**-3.922**	1.837	**-3.458**	**3.995**	**-2.620**	**3.392**
1	4	-0.185	0.453	0.422	0.704	0.277	0.626	-0.258	0.263	-0.259	0.779	-0.206	0.895
		-2.620	**3.496**	**4.605**	**4.491**	**2.857**	**3.318**	**-4.084**	**2.041**	**-3.562**	**3.586**	**-2.294**	**3.880**
1	6	-0.060	0.447	0.373	0.773	0.300	0.675	-0.153	0.291	-0.155	0.728	-0.018	0.760
		-0.960	**3.806**	**4.901**	**5.745**	**3.736**	**4.218**	**-2.960**	**2.654**	**-2.640**	**4.055**	-0.237	**4.009**
2	1	-0.755	0.646	0.742	1.340	-0.044	0.949	-0.672	0.256	-0.718	1.202	-0.963	1.346
		-5.825	**2.769**	**4.836**	**4.665**	-0.230	**2.538**	**-5.300**	0.968	**-4.911**	**3.123**	**-5.274**	**3.083**
2	2	-0.421	0.809	0.527	1.281	0.060	1.285	-0.416	0.524	-0.343	1.270	-0.554	1.357
		-3.892	**4.214**	**4.009**	**5.235**	0.396	**4.531**	**-4.127**	**2.451**	**-2.837**	**4.328**	**-4.233**	**3.879**
2	3	-0.306	0.809	0.404	1.215	0.222	1.168	-0.331	0.458	-0.235	1.120	-0.357	1.125
		-3.391	**4.597**	**3.598**	**5.743**	1.746	**4.924**	**-3.896**	**2.566**	**-2.316**	**4.290**	**-3.427**	**3.844**
2	4	-0.239	0.759	0.324	1.126	0.228	1.118	-0.286	0.448	-0.233	1.009	-0.180	1.096
		-2.917	**4.628**	**3.213**	**5.732**	1.947	**5.129**	**-3.726**	**2.731**	**-2.625**	**4.371**	**-1.961**	**4.302**
2	6	-0.127	0.780	0.367	1.069	0.337	1.021	-0.171	0.460	-0.110	0.853	0.008	1.010
		-1.820	**5.408**	**4.332**	**6.294**	**3.279**	**5.549**	**-2.668**	**3.047**	-1.512	**4.043**	0.096	**4.529**
3	1	-0.419	0.911	0.622	1.467	0.036	1.941	-0.484	0.468	-0.636	1.056	-0.857	1.535
		-2.979	**3.886**	**4.294**	**4.997**	0.203	**5.422**	**-3.862**	1.906	**-4.380**	**2.892**	**-5.006**	**3.756**
3	2	-0.254	1.000	0.417	1.386	0.038	1.585	-0.403	0.485	-0.373	1.225	-0.414	1.376
		-2.060	**4.733**	**3.271**	**5.492**	0.265	**5.676**	**-3.791**	**2.159**	**-3.020**	**4.023**	**-3.058**	**4.056**
3	3	-0.159	0.950	0.292	1.389	0.224	1.432	-0.315	0.491	-0.261	1.060	-0.155	1.370
		-1.511	**4.840**	**2.572**	**5.944**	1.835	**5.767**	**-3.172**	**2.390**	**-2.407**	**3.776**	-1.265	**4.315**
3	4	-0.074	0.901	0.311	1.297	0.282	1.334	-0.238	0.508	-0.197	0.992	0.030	1.383
		-0.780	**4.880**	**2.938**	**5.874**	**2.332**	**5.859**	**-2.578**	**2.610**	**-1.999**	**3.869**	0.266	**4.971**
3	6	0.007	0.826	0.363	1.176	0.364	1.187	-0.161	0.500	-0.081	0.924	0.200	1.316
		0.089	**4.994**	**3.790**	**6.186**	**3.299**	**6.050**	**-1.979**	**2.727**	-0.963	**3.816**	**2.024**	**5.271**
6	1	-0.185	1.607	0.432	2.050	0.409	2.359	-0.465	0.586	-0.504	1.267	-0.004	2.000
		-1.288	**6.349**	**2.998**	**6.376**	**2.289**	**6.024**	**-3.489**	**2.075**	**-3.765**	**3.444**	-0.020	**4.816**
6	2	-0.037	1.622	0.373	1.974	0.341	2.179	-0.313	0.766	-0.272	1.424	0.284	1.806
		-0.286	**6.788**	**2.822**	**6.860**	**2.133**	**6.859**	**-2.526**	**2.879**	**-2.289**	**4.249**	1.861	**4.910**
6	3	0.063	1.462	0.405	1.732	0.449	2.103	-0.202	0.718	-0.148	1.280	0.426	1.767
		0.503	**6.362**	**3.209**	**6.579**	**2.865**	**7.371**	-1.696	**2.748**	-1.295	**4.085**	**3.018**	**5.110**
6	4	0.126	1.346	0.447	1.592	0.536	1.865	-0.155	0.758	-0.047	1.249	0.499	1.620
		1.067	**6.060**	**3.683**	**6.423**	**3.479**	**6.880**	-1.370	**2.981**	-0.445	**4.102**	**3.616**	**4.982**
6	6	0.237	1.202	0.533	1.450	0.592	1.614	-0.026	0.781	0.095	1.198	0.552	1.481
		2.253	**5.827**	**4.644**	**6.339**	**4.223**	**6.616**	-0.260	**3.295**	1.036	**4.092**	**4.143**	**4.833**

Table 9. Returns of momentum portfolios based on three-way sorts with alternative firm size cuts

This table repeats the calculations in Panel B of Table 2 with alternative cuts of firm size while omitting the 6-month evaluation period and the 12-month holding period (for brevity). The first alternative cut entails small firms at the 40th percentile or lower (denoted by "40th % & below") and large firms at the 60th percentile or higher (denoted by "60th % & up"). The other two cuts are done in a similar fashion. For completeness, the results for the case of equal-half division are duplicated in the first two columns. To conserve space, only returns for the two extreme volatility quintiles are reported. Below each return is its *t*-value. Bolded *t*-values correspond to a significance level of 5% or higher. Please refer to Table 2 for calculation procedures. The sample contains all common stocks traded on the NYSE, AMEX and NASDAQ, covering the period from January 1, 1964 to December 31, 2009. At the time of sorting and portfolio formation, stocks with a share price of $5 or lower are deleted.

		small firms								large firms							
		50th % & below		40th % & below		30th % & below		20th % & below		50th % & up		60th % & up		70th % & up		80th % & up	
J =	*K* =	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)
1	1	0.188	0.446	0.353	0.400	0.640	0.223	0.757	0.005	-0.854	0.772	-0.870	0.851	-0.894	0.856	-0.755	0.976
		1.584	**1.959**	**2.906**	1.728	**4.918**	0.878	**5.465**	0.018	**-7.892**	**2.764**	**-8.512**	**3.075**	**-8.323**	**3.213**	**-6.430**	**3.493**
1	2	0.102	0.682	0.233	0.650	0.460	0.573	0.499	0.396	-0.554	0.734	-0.556	0.741	-0.547	0.743	-0.487	0.922
		1.114	**4.043**	**2.468**	**3.821**	**4.368**	**3.082**	**4.260**	**2.088**	**-6.732**	**3.315**	**-7.100**	**3.432**	**-6.454**	**3.547**	**-5.353**	**4.058**
1	3	0.178	0.794	0.291	0.799	0.463	0.725	0.517	0.615	-0.367	0.752	-0.375	0.762	-0.369	0.732	-0.362	0.768
		2.293	**5.678**	**3.621**	**5.730**	**5.162**	**4.645**	**5.460**	**3.831**	**-5.617**	**4.284**	**-5.787**	**4.440**	**-5.208**	**4.350**	**-5.101**	**4.356**
1	4	0.183	0.711	0.275	0.701	0.417	0.635	0.508	0.563	-0.338	0.625	-0.335	0.635	-0.319	0.596	-0.317	0.655
		2.680	**5.546**	**3.810**	**5.593**	**5.262**	**4.805**	**6.072**	**4.154**	**-5.874**	**3.964**	**-5.885**	**4.194**	**-5.154**	**4.067**	**-5.127**	**4.139**
1	6	0.194	0.691	0.279	0.689	0.373	0.656	0.447	0.628	-0.173	0.569	-0.177	0.594	-0.181	0.535	-0.184	0.547
		3.228	**5.943**	**4.330**	**6.121**	**5.499**	**5.781**	**6.038**	**5.387**	**-3.772**	**4.199**	**-3.846**	**4.454**	**-3.734**	**4.245**	**-3.592**	**3.985**
2	1	0.043	1.177	0.265	1.303	0.492	1.235	0.683	1.242	-0.815	0.998	-0.777	0.979	-0.757	1.002	-0.756	0.913
		0.345	**5.046**	**1.964**	**5.688**	**3.495**	**5.101**	**4.274**	**4.872**	**-7.225**	**3.535**	**-6.824**	**3.152**	**-6.574**	**3.334**	**-6.087**	**2.966**
2	2	0.086	1.251	0.226	1.337	0.371	1.309	0.408	1.245	-0.484	1.064	-0.479	1.061	-0.454	1.065	-0.502	1.021
		0.826	**6.535**	**2.037**	**7.149**	**3.253**	**6.927**	**3.096**	**6.283**	**-5.449**	**4.652**	**-5.314**	**4.333**	**-4.880**	**4.405**	**-5.017**	**4.014**
2	3	0.151	1.143	0.247	1.246	0.375	1.226	0.429	1.208	-0.344	0.986	-0.342	0.966	-0.324	0.927	-0.410	0.855
		1.741	**6.837**	**2.630**	**7.633**	**3.786**	**7.592**	**3.901**	**7.092**	**-4.602**	**4.957**	**-4.519**	**4.555**	**-4.101**	**4.578**	**-4.762**	**4.012**
2	4	0.147	1.066	0.242	1.143	0.341	1.147	0.403	1.180	-0.293	0.905	-0.289	0.888	-0.287	0.803	-0.358	0.757
		1.896	**6.786**	**2.946**	**7.327**	**3.859**	**7.521**	**4.205**	**7.458**	**-4.338**	**4.980**	**-4.193**	**4.714**	**-3.939**	**4.387**	**-4.529**	**3.942**
2	6	0.208	0.973	0.305	1.031	0.365	1.068	0.422	1.071	-0.136	0.806	-0.135	0.817	-0.133	0.720	-0.218	0.656
		2.895	**6.814**	**3.991**	**7.348**	**4.515**	**7.909**	**4.713**	**7.631**	**-2.387**	**4.900**	**-2.300**	**4.829**	**-2.177**	**4.381**	**-3.305**	**3.907**
3	1	0.128	1.500	0.295	1.506	0.458	1.801	0.560	1.793	-0.710	1.229	-0.703	1.107	-0.590	1.222	-0.559	1.259
		1.051	**6.542**	**2.366**	**6.510**	**3.478**	**7.192**	**3.377**	**7.038**	**-6.554**	**4.593**	**-6.307**	**4.121**	**-5.172**	**4.282**	**-4.471**	**3.909**
3	2	0.125	1.442	0.246	1.462	0.399	1.572	0.463	1.503	-0.478	1.192	-0.469	1.092	-0.444	1.075	-0.486	1.044
		1.227	**7.303**	**2.308**	**7.424**	**3.694**	**7.771**	**3.689**	**7.153**	**-5.130**	**5.114**	**-4.916**	**4.697**	**-4.464**	**4.427**	**-4.637**	**3.988**
3	3	0.182	1.387	0.269	1.398	0.419	1.412	0.446	1.434	-0.350	1.123	-0.345	1.025	-0.333	0.965	-0.380	0.944
		2.022	**7.619**	**2.894**	**7.672**	**4.341**	**7.487**	**4.298**	**7.505**	**-4.207**	**5.207**	**-4.056**	**4.768**	**-3.658**	**4.447**	**-3.957**	**4.050**
3	4	0.229	1.293	0.315	1.304	0.450	1.329	0.455	1.331	-0.249	1.083	-0.245	0.988	-0.243	0.888	-0.292	0.881
		2.672	**7.304**	**3.594**	**7.391**	**4.932**	**7.389**	**4.694**	**7.208**	**-3.195**	**5.291**	**-3.123**	**4.874**	**-2.903**	**4.341**	**-3.329**	**4.057**
3	6	0.295	1.121	0.365	1.130	0.470	1.170	0.458	1.167	-0.111	0.974	-0.113	0.919	-0.099	0.815	-0.180	0.833
		3.729	**6.777**	**4.468**	**7.106**	**5.599**	**7.331**	**5.061**	**7.238**	-1.578	**5.053**	-1.617	**4.726**	-1.336	**4.180**	**-2.291**	**4.138**

Table 10. Returns of momentum portfolios for large firms based on three-way sorts by replacing volatility with other firm characteristics

This table shows the per-month returns (in percentage) of large-stock momentum portfolios which are zero-investment portfolios by buying the winner portfolios and shorting the loser portfolios. Loser and winner portfolios are identified by monthly sequential sorts along the following three dimensions: firm size at the time of portfolio formation (small versus large, divided at the median of the sample), Characteristic X in the evaluation period (sorted into quintiles), and the realized return in the evaluation period (sorted into quintiles). Characteristic X includes cash flow volatility, implied volatility, firm age, rating, institutional ownership, analyst following, earnings forecast dispersion, book-to-equity ratio and leverage. See Section 5 for the calculation/construction of these characteristics. Essentially, we repeat the calculation in Panel B of Table 2 by replacing the sorting variable (return volatility) with one of the alternative firm characteristics. For brevity, only the returns for the two extreme volatility quintiles are reported. Please see Table 2 for calculation procedures. Below each return is its *t*-value. Bolded *t*-values correspond to a significance level of 5% or higher. The sample period is dictated by the data availability for each firm characteristic. For comparison, momentum returns based on return volatility are also reported for each corresponding sample.

		Panel A. sample period: 1965-2008									
		volatility		cash flow volatility		leveage		book-to-market		age	
J =	*K* =	1 (low)	5 (high)	1 (low)	5 (high)	1 (low)	5 (high)	5 (high)	1 (low)	5 (long)	1 (short)
3	1	-0.710	1.229	-0.496	0.786	0.039	0.349	0.008	0.652	-0.194	0.711
		-6.554	**4.593**	**-2.731**	**2.604**	0.167	1.754	0.042	**2.321**	-1.223	**2.802**
3	2	-0.478	1.192	-0.311	0.786	0.194	0.243	0.004	0.730	-0.168	0.847
		-5.130	**5.114**	**-1.998**	**3.028**	0.942	1.349	0.026	**2.980**	-1.169	**3.867**
3	3	-0.350	1.123	-0.210	0.718	0.315	0.252	0.091	0.773	-0.082	0.794
		-4.207	**5.207**	-1.522	**3.162**	1.699	1.484	0.604	**3.503**	-0.607	**3.988**
3	4	-0.249	1.083	-0.111	0.680	0.350	0.274	0.130	0.789	-0.029	0.728
		-3.195	**5.291**	-0.886	**3.360**	**2.042**	1.721	0.929	**3.829**	-0.228	**3.925**
3	6	-0.111	0.974	0.037	0.716	0.401	0.334	0.228	0.812	0.090	0.697
		-1.578	**5.053**	0.329	**3.914**	**2.581**	**2.353**	1.824	**4.271**	0.818	**4.074**

		Panel B. sample period: 1984-2008						Panel C. sample period: 1980-2008			
		volatility		# of analysts		DISP		volatility		inst. ownership	
J =	*K* =	1 (low)	5 (high)	5 (high)	1 (low)	1 (low)	5 (high)	1 (low)	5 (high)	5 (high)	1 (low)
3	1	-0.549	1.352	0.444	0.583	0.390	0.847	-0.592	1.398	0.104	0.595
		-2.978	**2.160**	1.391	1.280	1.019	1.855	**-4.392**	**3.870**	0.368	1.612
3	2	-0.417	1.197	0.376	0.386	0.359	0.846	-0.451	1.331	0.220	0.486
		-2.668	**2.199**	1.231	1.114	1.078	**2.236**	**-3.892**	**4.261**	0.853	1.511
3	3	-0.331	1.039	0.292	0.418	0.429	0.747	-0.389	1.182	0.226	0.441
		-2.441	**2.090**	1.016	1.424	1.468	**2.197**	**-3.739**	**4.103**	0.946	1.573
3	4	-0.242	1.021	0.297	0.347	0.445	0.654	-0.279	1.141	0.250	0.505
		-1.992	**2.173**	1.086	1.317	1.684	**2.074**	**-2.989**	**4.159**	1.106	**2.054**
3	6	-0.102	0.950	0.401	0.409	0.533	0.612	-0.091	1.051	0.318	0.657
		-1.038	**2.104**	1.579	1.907	**2.330**	**2.116**	-1.142	4.082	1.584	**3.007**

		Panel D. sample period: 1986-2008				Panel E. sample period: 1996-2008			
		volatility		rating		volatility		implied volatility	
J =	*K* =	1 (low)	5 (high)	5 (high)	1 (low)	1 (low)	5 (high)	1 (low)	5 (high)
3	1	-0.464	1.377	-0.413	0.853	-0.609	1.450	-0.525	1.360
		-3.153	**3.187**	-1.853	1.741	**-2.409**	1.834	**-2.258**	1.687
3	2	-0.379	1.261	-0.437	0.830	-0.514	1.220	-0.425	1.211
		-2.989	**3.369**	**-2.105**	1.941	**-2.546**	1.876	**-2.228**	1.825
3	3	-0.353	1.078	-0.373	0.627	-0.381	0.998	-0.370	0.909
		-3.039	**3.123**	-1.911	1.533	**-2.117**	1.762	**-2.170**	1.569
3	4	-0.308	0.998	-0.316	0.514	-0.294	1.021	-0.281	1.080
		-2.860	**3.032**	-1.763	1.305	-1.817	1.855	-1.683	1.945
3	6	-0.159	0.915	-0.097	0.578	-0.131	1.073	-0.101	1.094
		-1.730	**2.918**	-0.627	1.578	-0.843	1.937	-0.680	1.955

Table 11. Stock characteristics for quintile portfolios

This table shows the characteristics of the quintile portfolios produced by the three-way sort: firm size at the time of portfolio formation (small versus large, divided at the median of the sample), realized volatility in the 3-month evaluation period (sorted into quintiles), and the realized return in the 3-month evaluation period (sorted into quintiles). The characteristics being examined include firm size, realized volatility, cash flow volatility, implied volatility, firm age, rating, institutional ownership, analyst following, earnings forecast dispersion, book-to-equity ratio and leverage. See Section 5 for the calculation/construction of these characteristics. The sample period is dictated by the data availability for each firm characteristic as shown in Table 10. Implied volatilities are from options with maturities ranging from 7 to 90 days at the time of portfolio formation. All the other characteristics are applicable to the three months (or longer period) prior to the portfolio formation. The average value of each characteristic variable is calculated at the beginning of each month for the quintile portfolio and is then averaged over the sample period. For brevity, except for firm size and realized volatility, only the average value for each size-volatility quintile (with the row entry "All portfolios") is reported.

	volatility quintiles					volatility quintiles				
	1 (low)	2	3	4	5 (high)	1 (low)	2	3	4	5 (high)
	small firms					large firms				
	Panel A. Firm size (in 1,000 dollars)									
P1 (loser)	55,678	64,660	67,087	67,573	64,588	4,264,659	3,053,574	2,070,113	1,350,449	722,922
P2	54,209	63,370	65,184	65,190	59,682	4,360,572	3,228,333	2,183,018	1,416,646	828,061
P3	54,350	63,287	64,560	63,593	58,917	4,367,284	3,390,413	2,109,963	1,333,508	888,989
P4	57,383	66,762	66,744	66,365	60,163	4,705,501	3,488,928	2,207,531	1,448,427	889,084
P5 (winner)	62,673	70,964	72,831	71,988	61,637	4,598,927	3,360,066	2,118,892	1,342,987	800,733
	Panel B. Annualized realized volatility in the past three months									
P1 (loser)	0.214	0.336	0.437	0.554	0.802	0.188	0.262	0.330	0.421	0.636
P2	0.195	0.333	0.434	0.550	0.764	0.179	0.260	0.328	0.417	0.592
P3	0.190	0.331	0.434	0.550	0.770	0.178	0.260	0.327	0.416	0.587
P4	0.196	0.332	0.434	0.551	0.788	0.181	0.261	0.328	0.416	0.597
P5 (winner)	0.217	0.337	0.438	0.556	0.905	0.189	0.263	0.331	0.422	0.674
	Panel C. Short-term implied volatility (over maturities of 7 to 90 days)									
All portfolios	0.367	0.463	0.552	0.647	0.777	0.255	0.307	0.357	0.426	0.584
	Panel D. S&P rating (AAA=1, AA+=2, AA=3, etc)									
All portfolios	8.336	9.717	10.805	11.877	12.990	5.958	6.020	6.586	7.254	9.063
	Panel E. Turnover (daily volume over shares outstanding)									
All portfolios	0.0016	0.0026	0.0037	0.0050	0.0084	0.0029	0.0039	0.0052	0.0074	0.0128
	Panel F. Proportional bid-ask spread (spread over mid-point of bid and ask)									
All portfolios	0.0223	0.0263	0.0279	0.0290	0.0346	0.0082	0.0094	0.0107	0.0109	0.0109
	Panel G. Instituional ownership (shares owned over total number of shares outstanding)									
All portfolios	0.170	0.211	0.222	0.215	0.176	0.368	0.434	0.432	0.410	0.352
	Panel H. Frim age in years									
All portfolios	20.85	20.59	19.69	18.46	17.02	39.70	37.20	32.86	27.85	22.39
	Panel I. Analyst following (# of analysts)									
All portfolios	1.341	1.712	1.920	2.043	1.932	6.021	6.692	6.369	6.106	5.707
	Panel J. Earnings forecast dispersion (standard deviation of forecasts scaled by price)									
All portfolios	0.0025	0.0054	0.0076	0.0095	0.0147	0.0012	0.0017	0.0025	0.0041	0.0072
	Panel K. Book-to-market ratio									
All portfolios	0.987	0.946	0.924	0.845	0.778	0.736	0.681	0.668	0.648	0.597
	Panel L. Leverage									
All portfolios	0.266	0.248	0.234	0.217	0.199	0.261	0.221	0.208	0.198	0.187
	Panel M. Cash flow volatility									
All portfolios	0.060	0.072	0.085	0.101	0.120	0.035	0.042	0.050	0.077	0.111