# Delayed Price Discovery and Momentum Strategies: Evidence from Vietnam

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### Abstract

This paper investigates the effectiveness of momentum strategies for equities listed on the Vietnam Stock Exchange. It also investigates the roles of trading volume and price limits to examine the profitability of momentum strategies. Our paper finds evidence of significant momentum profits during the period 2000–2006 and our findings are robust to various tests, risk adjustments and market microstructure biases. We also show that trading volume is particularly important in generating momentum returns. We further document that price limits significantly hinder market liquidity. This fact, to a large extent, accounts for the strong price continuity of the Vietnam Stock Exchange.



JEL Classification: G11, G12, G15

**Keywords:** Momentum, Turnover Ratio, Past Returns, Price Limits, Vietnam

## I. Introduction

Anomalies are empirical results that are inconsistent with asset-pricing theories and indicate market inefficiency or inadequacies in the asset-pricing model (Schwert 2003). In a similar vein, Fama and French (2006) state that patterns in average returns that cannot be explained by the traditional Capital Asset Pricing Model (CAPM) are considered anomalies. They also state that the premier anomaly 'momentum' is left unexplained by the CAPM and the multifactor model of Fama and French (1993) and argue that the pervasiveness of anomaly returns is an important issue. In a more recent paper, Gutierrez and Pinsky (2007) document that momentum challenges the efficiency and rationality of financial markets. Naranjo and Porter (2004) document that although momentum strategies generate significant returns little has been published on the source of these profits.

This paper not only investigates the effectiveness of momentum strategies for one of the most dynamic markets in the Asia Pacific region – Vietnam- but also investigates the alternative sources of momentum profit in the spirit of Jegadeesh and Titman (1995). So, what is the momentum anomaly? In a landmark article, Jegadeesh and Titman (1993) document that strategies which include buying stocks that have performed well in the past and selling stocks that have performed poorly in the past generates an average return of 0.95 per month over the 1965-1989. In their 2001 paper Jegadeesh and Titman confirm this result for the 190-1998 period and reject the claim that their earlier findings were due to data snooping. Research also shows that stock returns exhibit serial correlation, and thus past stock returns predict future stock returns. For instance, Jegadeesh (1990) and Lehmann (1990) report significant profits from a contrarian strategy that buys "loser" stocks and sell "winner" stocks in investment horizons of from 1 to 6 months. This evidence was initially regarded as the overreaction of market price to information, due to speculative trading (see

Stiglitz, 1989 and Summers and Summers, 1989) or insufficient market liquidity (see Grossman and Miller, 1988).[1]

In a similar vein, DeBondt and Thaler (1985, 1987) report contrarian profits for longer investment horizons of 3 to 5 years. Jegadeesh and Titman (1993), however, report return continuity where winners continue to win and losers continue to lose in intermediate investment horizons of 3 to 12 months. They attribute this momentum phenomenon to the underreaction of market price to firm-specific news. Lee and Swaminathan (2000) find that trading volume appears to predict the magnitude and persistence of momentum strategies, and they suggest that past volume can provide a reconciliation between the "underreaction" of intermediate investment horizons and the "overreaction" of long-term investment horizons.

Momentum strategies have been documented to be internationally pervasive. For example, Rouwenhorst (1998) reports significant momentum returns using a sample of European countries; Rouwenhorst (1999) confirms the existence of momentum strategies in six out of 20 emerging markets and Hameed and Yuanto (2000) find statistically significant momentum profits in Asian stock markets. Kang et al. (2002) document statistically significant positive profits from both momentum and contrarian strategies across a range of formation and holding periods for Chinese equities.

Our paper is the first to investigate the effectiveness of momentum strategies for the Vietnam Stock Exchange (VSE). Further, we investigate the relationship between volume and momentum profits. We focus on the effectiveness of momentum strategies specifically in Vietnam for several reasons. From its establishment in July 2000 up to its recent surge, and despite its current status as one of the most exciting markets in Asia for 2006, the VSE has been little studied and awaits investigation.[2]

This lack of research is largely due to the small size of this market, the limited participation of international and institutional investors, and a relatively short history of trading. The VSE is now equal in value to more than 15 percent of national GDP and is thus an important venue for both domestic and international investors.

It is worth noting that individual investors account for almost 90 percent of trading on the VSE. Most of these traders do not possess fundamental knowledge and usually trade on rumours and chase trends. On the VSE, large waves of buying and selling chase each other when individual investors herd in and out of the market.[3] Furthermore, the VSE adheres to price fluctuation limits, which often results in imbalanced trading orders when the limit is reached. This interesting market setting warrants an empirical investigation on whether price continuity exists on the VSE. To study momentum strategies in Vietnam, we form and rebalance portfolios on a daily basis.

This paper pursues four objectives. First, while the majority of the literature on momentum and contrarian strategies is based on short term (1 to 3 month), intermediate term (3 to 6 month), and long term (3 to 5 year) stock returns, little if any, research has been published using daily returns. We investigate the effectiveness of momentum strategies using daily returns. Second, we examine whether trading volume can help predict momentum returns. Third, we study the role of price limits within the context of momentum strategies. Fourth, we investigate alternative sources of momentum profit in the context of Jegadeesh and Titman (1995).

We report that there are significant momentum profits for investment horizons of 1 to 20 days. These momentum profits are particularly strong among high volume stocks and the majority of the profits come from winners. We show that daily price limits significantly hinder trading liquidity and that this results in strong continuity of stock price in days subsequent to the limit being reached. Our decomposition of momentum profits indicates that underreaction to firm-specific information is the most significant determinant of momentum returns.

We also suggest that momentum trading may not be possible for individual investors who pay significant trading commissions, but that it is more significant for institutional investors who have greater capital and lower trading costs. However, as the trading volume is still relatively small on the VSE, we concede that momentum profits can be wiped away easily by a few large trades.

## II. Institutional Background

The Stock Trading Center of Vietnam (also known as Ho Chi Minh Securities Trading Centre) was officially inaugurated on July 20, 2000 in Ho Chi Minh City and trading commenced on July 28 2000. Initially, there were only two listed companies: Refrigeration Electrical Engineering Joint Stock Corporation (REE), and Saigon Cable and Telecommunication Material Joint Stock Company (SACOM). Prior to March 1, 2002, the market traded only on alternative days. By the end of 2006, over 100 firms were listed on the Ho Chi Minh Securities Trading Centre and the Hanoi Stock Securities Trading Center.[4] Both exchanges are operated and regulated by the State Securities Commission. The Vietnam Index is constituted only by stocks trading on the Ho Chi Minh Securities Trading Centre and our study also focuses on this exchange.[5]

Overall foreign ownership of equity was initially limited to 20 percent. In July 2003, the limit on foreign ownership was raised to 30% and subsequently to 49%. Although the VSE is the smallest stock exchange in Southeast Asia, it was the third best-performing exchange in the world in 2006. Figure 1 shows the market capitalisation and the number of listed firms in the VSE.

Trading on the Stock Trading Center of Vietnam is conducted via a call auction where trade price is determined at the level that maximizes trade execution. The Ho Chi Minh Securities Trading Centre also enforces a price limit of 5% on the previous day's closing price. The equivalent price limit for the Hanoi Securities Trading Centre is set at 10 percent. Trade settlement is centralized through a state-owned commercial bank.

## III. Data and methodology

### A. Data

The data for this study are from the Ho Chi Minh Securities Trading Centre for the period August 2000 to November 2006. The number of traded firms varied from 7 in 2000 to 63 in 2006.[6] Daily stock return is defined as the log of the current day's closing price over the previous day's closing price.

### A.1 Momentum Portfolios

For each day, we rank stocks based on the previous *F* (formation period) trading day returns (*F* ranges from 1 to 20 trading days). Based on this ranking, we form five portfolios where the portfolio with the top quintile of stock returns is the "winner" portfolio and the portfolio with the bottom quintile of stock returns is the "loser" portfolio. We then compute equal-weighted returns for each quintile for the next *H* (holding period) trading days (*H* ranges from 1 to 20 trading days).[7] We go "long" in

the winner portfolio and "short" the loser portfolio. Altogether, we have 20x20 momentum strategies. We present the results where *F* or *H* is equal to 1, 5, 10, 15, or 20 (this reduces to 5x5 momentum strategies). For a strategy where the holding period is *H* days, on each day *t*, we hold *H* momentum portfolios that were created from day *t*-*H* up to day *t*-1. At the end of day *t*, we liquidate and revise $\frac{1}{H}$ of this overall portfolio. To avoid potential bias from illiquidity and nonsynchronous trading, we consider strategies where one trading day is skipped between *F* and *H*.

## IV. Empirical results

### A.1 Profitability of momentum strategies

Table 1 reports the equal-weighted returns for portfolios from different formation/holding (*F*/*H*) periods. We normalise to weekly returns (equivalent to 5 trading days) so that the results can be compared across varying holding horizons. Panel A (B) presents the results for where there is 0 (1) day skipped between formation period *F* and holding period *H*.

[INSERT TABLE 1 ABOUT HERE]

Table 1, Panel A shows that there is strong continuity of stock returns in those holding periods where a loser portfolio continues to lose and winner portfolio continues to win. The momentum return when *F*=1 and *H*=1 is strikingly large at 2.99 percent and is significant at the 5 percent level. We find that profits decrease when the holding period is increased from 5 to 20 days. Thus, we propose that the momentum anomaly is rather short-lived and would best be limited to 5 trading days. The results are presented graphically in Figures 2 to 5.

In Table 1, Panel B, when 1 trading day is skipped between *F* and *H*, the momentum profits decline significantly. For example, when *F*=1 and *H*=1, the momentum profit is 1.17 percent and this is 2.5 times lower than the profit from Panel A. However, the magnitude of all momentum profits is still economically large and consistently significant at the 1 percent level. Again, momentum portfolios should best be limited to a 5–trading-day holding. In both Panels A and B, the dominance of momentum profits arises from the buying of winner portfolios. For subsequent tests, we use momentum portfolios in Panel B where 1 trading day is skipped between *F* and *H* so that the momentum profits are robust to market microstructure biases.

**A.2 Trading volume and momentum profits**

Lee and Swaminathan (2000) report the very important phenomenon that trading volume can predict the magnitude and persistence of momentum profits. Specifically, they find that the momentum phenomenon is more pronounced and short-lived for high volume stocks and vice versa for low volume stocks. They therefore show that part of the momentum effect manifests as long-horizon overreaction due to rapid reversal of momentum profits for high volume stocks in the long run.

To examine the role of trading volume, we implement volume-based momentum strategies by means of a two-way sort of price- and trading-volume. We form 5 portfolios based on price performance over *F* trading days and then independently form 3 portfolios based on average daily turnover, also over *F* trading days.[8] The V1 portfolio has stocks with the lowest average turnover and the V3 portfolio has stocks with the highest average turnover.

Table 2 reports the results of volume-based momentum strategies when *F* is equal to *H*. First, conditional on past return, high-volume winners outperform low-volume winners up to 15 holding days. For example, when *F*=5 and *H*=5, high-volume

winners outperform low-volume winners by 0.54 percent, significant at the 5% level. V3-V1 for winner stocks only becomes negative after the holding period exceeds 20 days, but the difference is small and insignificant. A reverse phenomenon is observed for loser stocks. At holding periods of 5 to 20 days, high-volume losers generally underperform low-volume losers. For example, when *F*=1 and *H*=10, V3−V1 for losers is -0.97 percent, significant at the 1 percent level. These results suggest that the momentum effect is most pronounced for high volume stocks. The momentum portfolio that goes long winners and short losers consistently gives the highest return for the V3 portfolio across all momentum strategies. We also find that when *F*=10 and *H*=10, the momentum return for V3 is 1.4 percent higher that that of V1, or an annualized 69%.[9] We report that, controlling for volume, momentum portfolios consistently produce positive returns only at medium and high volume levels (V2 and V3).

[INSERT TABLE 2 ABOUT HERE]

It is generally agreed that low-volume stocks tend to earn higher expected returns as a compensation for their relative illiquidity (Datar et al., 1998; Pastor and Stambaugh, 2003). In our sample, this hypothesis appears to be consistent with the momentum pattern of loser stocks but fails to explain the momentum pattern of winner stocks and the large return of the momentum portfolio for high volume stocks (WV3-LV3). The empirical results are more consistent with the fact that incomplete reaction, together with strong trading volume, translates to larger continuation of price performance.

### A.3 Momentum profits and daily price limits

While daily price limits were initially adopted to prevent wild daily swings in stock prices, research results regarding the effectiveness of price limits are mixed and inconclusive. Ma et al. (1989) find overreaction in stock price, as evidenced by price reversal after limits are hit. Other studies raise the concern that price limits can translate into volatility spillover, delayed price discovery, and trading interference (see Kyle, 1988, Fama, 1989, Lehmann, 1989 and Kuhn et al., 1991). In an important study, Kim and Rhee (1997) conclude that abnormal volatility, price continuity and increases in trading activity are observed after price limits are reached. We conjecture that price continuity is particularly strong for stocks that reach price limits, since these stocks represent the most extreme performance within momentum portfolios.

Table 3 presents the results for portfolios that hit their daily price limits. In this analysis, momentum portfolios are formed based on the previous one-day price performance, where winner stocks increase by 5 percent and loser stocks decrease by 5 percent. Out of the total of 1426 days, there are 591 days where at least one stock hits the price limit. This ensures that price limit momentum portfolios can be formed on a reasonably frequent basis (an average of one portfolio for every 2.4 trading days). In Panel A, price continuity is striking; winner stocks go up by 1.18% and loser stocks go down by -0.43% on the trading day immediately succeeding the day on which the price limit is reached. This strong and statistically significant continuity lasts up to day 2 for winner stocks, while it subsides relatively quickly for loser stocks. The momentum strategy earns an average of 2.7 percent within 5 days after formation and 60 percent of this return is realized on day 1.[10] When looking at the return pattern of stocks that do not experience price limits, we find no continuity.

[INSERT TABLE 3 ABOUT HERE]

Panel B of Table 3 presents the 5-day percentage change in turnover for winner and loser stocks that reach their price limits. Both winner and loser stocks exhibit substantial increases in trading activity on day 1 and decreases in trading activity thereafter. Since the price limit interferes with trading activity, traders must wait until the subsequent day to continue to lock in their positions. These results indicate that there is a significant imbalance in trading orders when a price limit is reached, and this drastically hinders liquidity. Investors must buy and sell at unfavourable prices on the day after stock prices reach their price limits.

**A.4 Calendar month, year and momentum profits**

Several studies have shown that stock returns exhibit seasonal patterns, both in the US and in international markets. For example, there is a tendency of the stock market to rise between December 31 and the end of the first week in January (see Roll, 1983; Thaler, 1987; Jones et al., 1987, among others). Jegadeesh and Titman (1993) report that the strong January effect in the US works against their momentum strategies as most of these strategies produce negative returns in this month.

We investigate whether daily momentum strategies in Vietnam are influenced by seasonality effects. A momentum portfolio is determined to belong to a calendar month if the end of the holding period *H* is within that calendar month.[11] Table 4 shows average momentum returns and the proportion of the momentum portfolio that generates positive returns in each calendar month. Across all strategies, momentum profits are most pronounced in January and February. For example, when *F*=1 and *H*=1, the return is 2.65 percent in February, with 65 percent of momentum portfolios showing positive gain. When *F*=20 and *H*=20, the return is 1.6 percent in January, with 78 percent of momentum portfolios showing positive gain. Since these two months normally occur during the period of the Lunar New Year in Vietnam, investors' positive mood may translate into strong performance for momentum

portfolios, especially for winner stocks. While some strategies may not work in certain months, there seems to be no particular month that is consistently bad for momentum strategies.

[INSERT TABLE 4 ABOUT HERE]

Table 5 presents the profitability of momentum strategies using sub-period analysis. The returns of momentum portfolios from different formation and holding periods are stronger in the sub-period 2000–2003 than 2004-2006. A careful analysis of the results reveals that this phenomenon is due to the inconsistent performance of loser portfolios. While all loser portfolios show negative returns in the period 2000–2003, they all show positive returns in the period 2004–2006. It is our conjecture that this result is, to a large extent, due to the strong performance of the VSE.[12] The results for winner portfolios are more consistent between the two sub-periods. We therefore conclude that the strong momentum effect is most pronounced in winner stocks.

[INSERT TABLE 5 ABOUT HERE]

**A.5 Risk and the sources of momentum profits**

Momentum strategies clearly show strong and consistent profits for various formation/holding periods. A possible explanation is that winner and loser portfolios are differently related to several common factors. Chan (1988) shows that losers tend to be more risky and winners tend to be less risky within the holding period of a contrarian strategy. Jegadeesh and Titman (1993) show that winner portfolios have lower beta than loser portfolios when momentum strategies are implemented using monthly returns for the US market. Based on a weekly formation/holding horizon, Kang et al. (2002) find no significant difference in the betas of winner and loser

portfolios for the Chinese market. Thus, we ask whether the time-varying market risk can account for large momentum profits.

$$r_{Wt} - r_{ft} = \alpha + \beta(r_{Mt} - r_{ft}) + \varepsilon_t \quad (1a)$$

$$r_{Lt} - r_{ft} = \alpha + \beta(r_{Mt} - r_{ft}) + \varepsilon_t \quad (1b)$$

$$r_{(W-L)t} = \alpha + \beta(r_{Mt} - r_{ft}) + \varepsilon_t \quad (2),$$

where $r_{Wt}$, $r_{Lt}$, and $r_{(W-L)t}$ are the returns for the winner portfolio, the loser portfolio and the momentum portfolio, respectively, that goes long the winner stocks and shorts loser stocks on day t; $r_{ft}$ is the risk-free rate and $r_{Mt}$ is the market return on day t. Theoretically, by construction, each momentum strategy creates a hedged position whereby the market risk should be offset between winners and losers to approach zero. If the $\beta$ for the momentum portfolio is significantly different from zero, it can be said that the momentum portfolio is no longer market neutral due to the time-varying risk of winners and losers in the holding period.

Table 6 presents the parameters estimated from (1a), (1b) and (2) for all momentum strategies. If the holding period *H* is equal to 1 trading day, none of the momentum portfolio shows significant $\beta$. However, as the holding period increases to 20 trading days, momentum portfolios begin to exhibit significant market risk. Thus, for longer holding periods, winner portfolios tend to be more risky than loser portfolios. This fact, nonetheless, cannot fully explain the economically large and statistically significant $\alpha$ of most momentum strategies.

[INSERT TABLE 6 ABOUT HERE]

**A.6 Decomposition of momentum profits**

In this section, we decompose momentum profits by source, as suggested by Jegadeesh and Titman (1995) so that we can evaluate each source's relative importance. We estimate the sensitivities of individual stock returns to contemporaneous and lagged common factors by a one-factor model as follows:

$$r_{i,t} = \alpha + \beta_{0,} f_t + \beta_{1,i} f_{t-1} + \varepsilon_{i,t}, \qquad (3)$$

where $r_{i,t}$ is the time t return of stock i, , $f_t$ and $f_{t-1}$ are the unexpected common factors realised at time t and time t–1 (we use the value-weighted market index return as a proxy for this factor). $\alpha$ is the unconditional expected return for stock I; $\beta_0$ and $\beta_1$ are the contemporaneous and lagged betas, respectively. In this study, we consider the momentum strategy that buys winners and sells losers at time t–1 and that holds the portfolio up to time t. If every stock in the momentum portfolio has a weight equal to its excess return over the average market return at time t–1, we can decompose the expected momentum profits as proposed by Lo and MacKinlay (1990):

$$w_{i,t} = \frac{1}{N}\left(r_{i,t-1} - r_{i,t}\right) \qquad (4)$$

$$E(\pi_{momentum}) = E(\sum_{i}^{N} w_{i,t} \times r_{i,t}) = E\left(\frac{1}{N}\sum_{i=1}^{N}\left(r_{i,t-1} - \overline{r_{i,t-1}}\right) \times r_{i,t}\right) \qquad (5)$$

$$E(\pi_{momentum}) = \sigma_{\alpha}^2 + \Omega + \delta\sigma_f^2 \qquad (6),$$

where

$$\sigma_{\alpha}^2 = \frac{1}{N}\sum_{i=1}^{N}\left(\alpha_i - \overline{\alpha}\right)^2 \qquad (7)$$

$$\Omega = \frac{1}{N}\sum_{i=1}^{N}\mathrm{cov}(\varepsilon_{t},\varepsilon_{t-1}) \tag{8}$$

$$\delta = \frac{1}{N}\sum_{i=1}^{N}(\beta_{0,i} - \overline{\beta_0})(\beta_{1,i} - \overline{\beta_1}), \qquad \delta \equiv E(\delta) \tag{9}$$

$$\sigma_f^2 = \frac{1}{T}\sum_{t=1}^{T}(f_t - \overline{f})^2 \tag{10}$$

$\overline{\beta_0}$ and $\overline{\beta_1}$ are the cross-sectional averages of $\beta_0$ and $\beta_1$ from equation (3).

Equation (6) decomposes momentum profits into three components. The first component, $\sigma_\alpha^2$, is the cross-sectional average of unconditional expected returns. Stocks with higher unconditional expected returns tend to have higher average returns in both formation and holding periods, and this will therefore increase momentum profits. The second component, $\Omega$, is the cross-sectional average of serial covariance of the idiosyncratic component of returns. This is determined by the stock price reaction to firm-specific information. If stock prices on average under-react to firm-specific information, there will be continuation of stock price reaction in the following period and $\Omega$ will be positive. Hence, it will increase momentum profits. On the other hand, if stock prices overreact to firm-specific information, a correction of overreaction (opposite-direction stock price reaction) will be observed in the following period. $\Omega$ will then be negative and this will decrease momentum profits. The last component, $\delta\sigma_f^2$, shows the lead–lag structure or the timeliness of stock price reaction to common factors. If the cross-serial covariance between contemporaneous and lagged beta is positive ($\delta > 0$), there is a delay in stock price reaction to common factors and this will increase momentum profits. The reverse is true if there is an overreaction to common factors ($\delta < 0$).

Table 7 reports estimates for the three components of momentum strategy where the formation period *F* is equal to holding period *H*. Most importantly, among the three components, the second component ($\Omega$, or the cross-sectional average of serial covariance of the idiosyncratic component of returns) is the most dominant source of momentum profits (more than 80 percent of the expected momentum profits in all strategies). The importance of the second component indicates that stock prices underreact to firm-specific information on a daily basis in Vietnam. We advance herd behaviour of individual investors as a plausible explanation. This fact, augmented by the small number of trades and the daily price limit, can translate to strong continuity of the idiosyncratic component of daily stock returns. The first component (the cross-sectional variance of unconditional expected returns) contributes anywhere from 6.4% (*F*=5 and *H*=5) up to 24.5% (*F*=1 and *H*=1) to overall momentum profits. The third component (the lead–lag structure to common factors) is negative when *F*=1 and *H*=1 and positive for the remaining momentum strategies, but its magnitude is relatively negligible compared to the overall momentum profits.

[INSERT TABLE 7 ABOUT HERE]

**B. Other possible causes**

**B.1 Measurement error**

Several studies have implicated bid–ask spread as the cause of short-term contrarian profit (see Lehman 1990 and Conrad, et al. 1997). In our study, buying winners (selling losers) are executed at the ask (bid) and selling winners (buying losers) are executed at bid (ask). If the bid–ask spread plays a significant role, this should reduce the profits of momentum strategies. Most importantly, trading prices on the VSE are determined in a batch market where trades take place three times a day from aggregated buy and sell orders. Hence, stock prices are neither at bid nor ask, but are instead at a point that best clears the market. Second, we adopt the skipping

of one trading day between the formation period *F* and the holding period *H*, as shown in Panel B of Table 1, to avoid any potential microstructure biases.

**B.2 Implementation of momentum strategies**

Past research has found that most returns to momentum strategies are due to short rather than long positions. For example, Hong et al. (2000) find that more than 70 percent of the momentum returns in the US come from loser portfolios (see also Jegadeesh and Titman, 2001 and Lesmond et al., 2004). The results from our study suggest that most of the daily momentum profits in Vietnam come from winner stocks. Short selling is not yet allowed on the VSE. Hence, for practical implementation of our strategies on the VSE, we can focus only on winner stocks. The consistently large and statistically significant returns for winner portfolios, as documented in Table 5, suggest that positioning in winner stocks alone can be of significant importance to investors.[13] We compute the weekly Sharpe ratios for winner portfolios (not tabulated) and the results are as follows: 0.125, 0.101, 0.079, 0.084, and 0.067 when *F*=1 and *H*=1, *F*=5 and *H*=5, *F*=10 and *H*=10, *F*=15 and *H*=15, and *F*=20 and *H*=20, respectively. The corresponding Sharpe ratio for the value-weighted index is 0.069. Unhedged winner-based strategies at 1, 5, 10 and 15 days significantly and clearly outperform the market.[14]

**B.3 Trading costs**

Total transaction costs are derived from several sources, such as bid–ask spread, commission, price impact costs, taxes and short selling cost. As previously discussed, bid–ask spread can be largely ignored. Short selling is not yet applicable on the VSE and our winner-based strategies completely avoid short positions. Note that there is no tax on securities trading in Vietnam.[15] As daily momentum strategies require frequent portfolio rebalancing, commission cost is potentially a challenge to momentum profits. From correspondence with several brokerage houses and the

VSE, we document that commission fee ranges from 0.2 percent to 0.4 percent per trade value for individual investors. To be conservative, we assume a two-way cost of 0.8 percent. This large trading cost appears to gobble up most of the profits from momentum strategies, and this may explain why the phenomenon is not arbitraged away. However, broker firms and institutional investors have access to a much lower trading cost (0.05% per deal paid to the stock exchange by every broker firm) and this should not discourage arbitrage activities.[16]

Illiquidity is not likely to be the single factor that accounts for the price continuation of winner stocks. The average trading value for winner portfolios is around 6.8 billion VND daily (slightly more than 400,000 US dollars) compared to 3.1 billion VND daily for other portfolios. If a fund attempts to pursue winner stocks only, a buy trade of 200,000 US dollars or above can create a positive price impact. This trade value, however, is still too small for international hedge funds with USD billions of assets to generate any significant profits.[17]

## V. Conclusions

We find strong evidence of momentum profits when portfolios are formed on a daily basis on the VSE. This profit is most dominant among high-volume stocks. These results are consistent with the notion that stock prices in Vietnam significantly underreact to firm-specific news. This phenomenon, to a large extent, is the result of price limits hindering liquidity and delaying price discovery. Excessive underreaction is also likely due to the dominance of individual investors who chase trends and speculate on rumours, the lack of participation from large institutional investors, and the limited supply of reliable information on firms and trading activities. It would therefore be interesting to revisit this phenomenon in the near future as market

liquidity in Vietnam will be fundamentally improved by continuous trading and active participation of institutional investors.

[1] Mun et al. (1999) and Bacmann and Dubois (1998) suggest that overreaction to firm specific information is the main reason for abnormal returns from short-term contrarian strategies.
[2]According to the Stock Trading Center in Vietnam, our study is the first and foremost academic research that has ever been done in a Vietnamese setting.
[3] For example, in mid 2006, after a significant decline, the average market PE in the market was around 11 and the Exchange CEO remarked that the market was largely undervalued. This average surged to almost 40 in six months towards the end of 2006.
[4] The value of these two exchanges at the end of 2006 is more than 11 billion dollars, which is 20 percent of the national GDP.
[5] In this study, Vietnam Stock Exchange (VSE) refers to the Ho Chi Minh Securities Trading Centre. We do not include the Hanoi Securities Trading Centre as this is a small exchange with limited history of trading data.
[6] We exclude the days where we cannot form five portfolios due to lack of relevant data and the sample therefore starts from 4th August, 2000.
[7] There are cases where both winners and losers generated negative returns during the formation period as the market was going down. We choose not to form portfolios of winner and loser stocks if the returns for all the stocks in the market are non-positive during the formation period.
[8] Daily turnover is the ratio of the numbers of shares traded in a day scaled by the total number of outstanding shares. See Campbell et al. (1993) and Lee and Swaminathan (2000) for details.
[9] The average number of yearly trading days in Vietnam is around 245 days or 49 weeks.
[10] If we apply the conservative assumption that momentum portfolio is formed on day 1 (the day after price limit is reached) and held until day 6, this would still result in more than 1 percent profit in a 5-day holding period.
[11] For example, a $F$=20, $H$=20 momentum portfolio is said to be in February if the liquidation of this portfolio is carried out in February although the formation period is based on January stock price performance.
[12] Loser stocks are relative losers to the market performance in the formation period and therefore they do not necessarily produce negative returns. When the market is very strong, we can have loser portfolios with positive performance in both formation and holding periods.
[13] Korajczyk and Sadka (2004) suggest that strategies that invest in winner stocks only are conservative relative to simultaneous long/short positions before trading costs, and since loser stocks are less liquid they should induce significant trading costs.
[14] These results, together with the results in Table 1 show that increasing holding periods does not add to momentum returns, but significantly increases the volatility of the strategies.
[15] The government, however, proposes to charge a 25% tax on profits from securities trading on the stock exchange in the coming years and this could significantly affect the profits of momentum trading strategies.
[16] Only broker firms can trade on the Vietnam stock exchange. While commissions are the main source of income, some firms also trade for themselves. Apart from a few local investment banks who have their own broker divisions, most institutional investors (both international and local) trade via an account with a broker firm. They are also offered lower trading costs as a result of large deals.
[17] In addition to the relatively small trade values on the VSE that deters participation by international investment funds, foreign ownership cannot exceed 49 percent.

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**Figure1: Market value and number of firms over time on the Vietnam Stock Exchange**

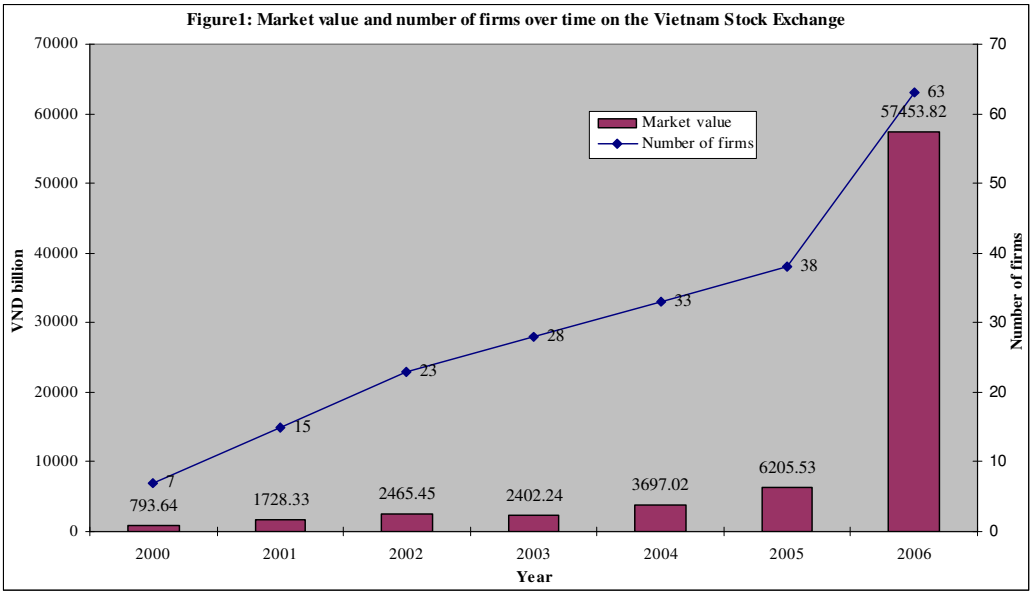


Figure 2: Momentum porfolios based on F=1

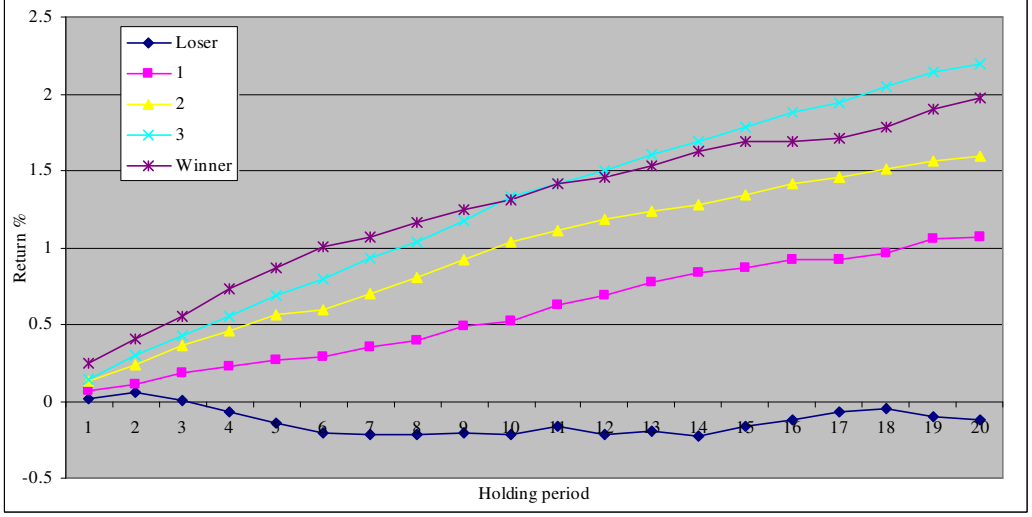

Figure 3: Momentum portfolios based on F=5

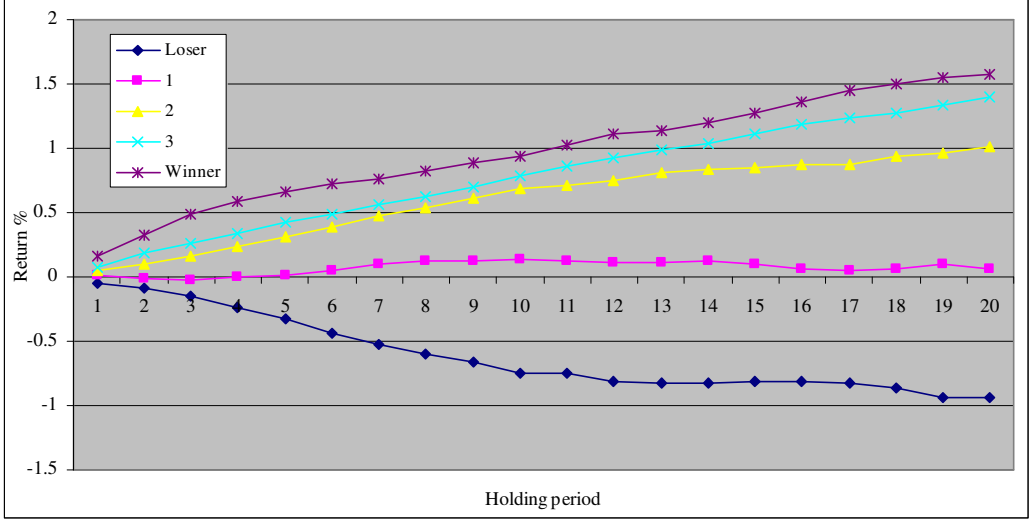


Figure 4: Momentum portfolios based F=10

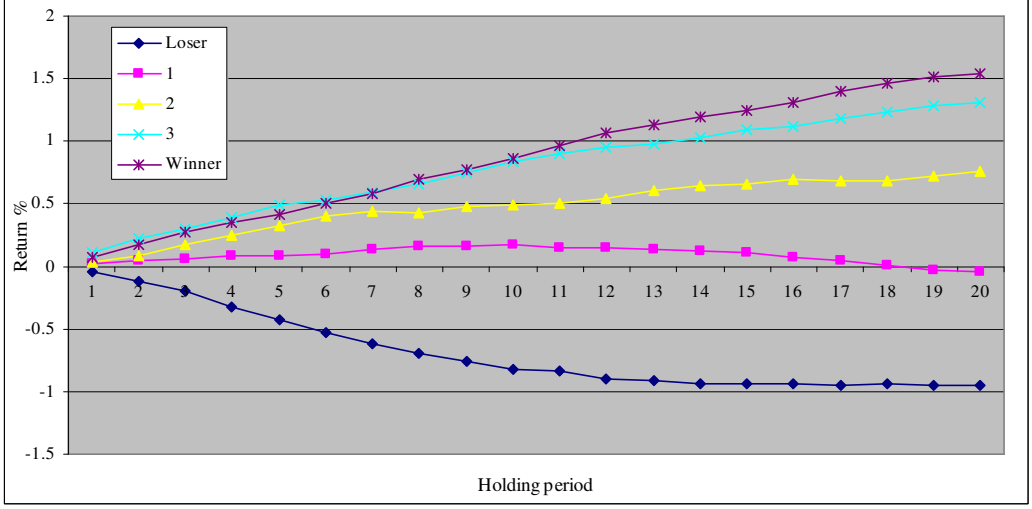

Figure 4: Momentum portfolios based on F=15

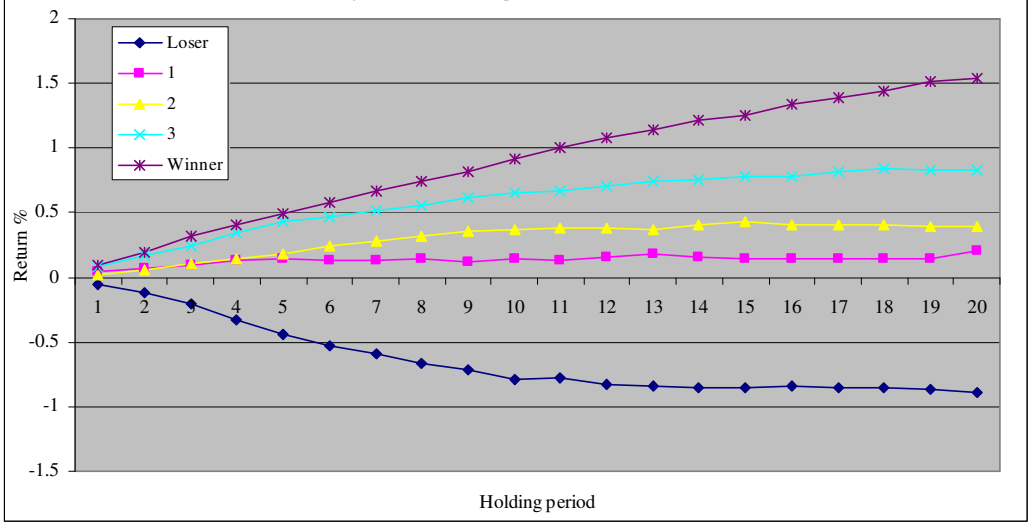


Figure 5: Momentum portfolios based on F=20

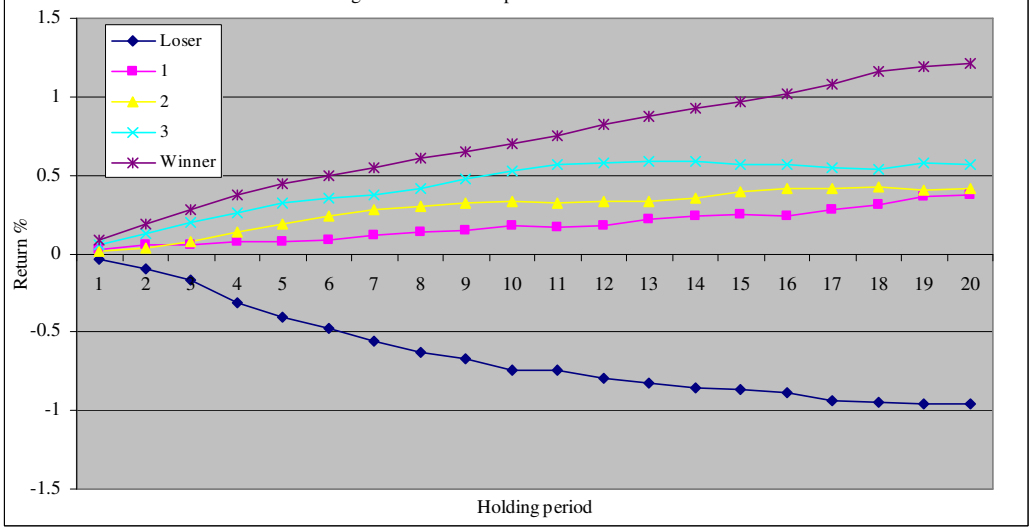

Table 1: Profitability of momentum strategies based on trading days

This table presents the profitability of momentum strategies based on trading day price performance. The quintile portfolios are formed based on the previous F trading days (F ranges from 1 to 20 trading days and the results presented are based on F=1, 5, 10, 15 and 20 respectively). The loser portfolio (L) is the quintile with the lowest stock returns in the formation period. The winner portfolio (W) is the quintile with the highest stock returns in the formation period. An equal-weighted return for each portfolio is calculated for the next H trading days (H ranges from 1 to 20 trading days and the results presented are based on H=1, 5, 10, 15, 20 trading days respectively). Returns are normalised to weekly returns (equivalent to 5 trading days) and in percentage term. (W-L) is the momentum strategies that goes long the winner portfolio and short the loser portfolio for the next H trading days. Panel A presents the momentum portfolios with no skipping between the formation period F and the holding period H. Panel B presents the momentum portfolios with 1 day skipped between the formation period F and the holding period H. The t-statistic is in parenthesis. ** indicates significance at 1% level, and * indicates significance at 5% level.

Panel A: Momentum portfolios with no skipping between F and H

| | Quintile | H=1 | | H=5 | | H=15 | | H=20 | |
|---|---|---|---|---|---|---|---|---|---|
| Momentum portfolios formed based on F=1 trading day | L | -0.533 | | -0.195 | | -0.132 | | -0.087 | |
| | | (-1.88) | * | (-1.33) | | (-1.20) | | (-0.84) | |
| | 2 | -0.100 | | 0.216 | | 0.300 | | 0.259 | |
| | | (-0.37) | | (1.45) | | (2.67) | ** | (2.49) | ** |
| | 3 | 0.636 | | 0.636 | | 0.499 | | 0.442 | |
| | | (2.33) | ** | (4.13) | ** | (4.19) | ** | (4.02) | ** |
| | 4 | 0.882 | | 0.704 | | 0.577 | | 0.532 | |
| | | (3.09) | ** | (3.90) | ** | (4.51) | ** | (4.55) | ** |
| | W | 2.457 | | 1.199 | | 0.673 | | 0.561 | |
| | | (8.64) | ** | (6.66) | ** | (5.60) | ** | (4.95) | ** |
| | W-L | 2.990 | | 1.387 | | 0.794 | | 0.650 | |
| | | (9.53) | ** | (7.97) | ** | (8.02) | ** | (7.02) | ** |

| | Quintile | H=1 | | H=5 | | H=15 | | H=20 | |
|---|---|---|---|---|---|---|---|---|---|
| Momentum portfolios formed based on F=5 trading days | L | -0.095 | | -0.238 | | -0.267 | | -0.218 | |
| | | (-0.41) | | (-1.94) | * | (-2.74) | ** | (-2.46) | ** |
| | 2 | 0.163 | | 0.021 | | 0.047 | | 0.022 | |
| | | (0.68) | | (0.17) | | (0.50) | | (0.26) | |
| | 3 | 0.226 | | 0.287 | | 0.247 | | 0.219 | |

Panel B: Momentum portfolios with 1 day skipping between F and H

| Quintile | H=1 | | H=5 | | H=10 | | H=15 | | H=20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| L | 0.061 | | -0.140 | | -0.106 | | -0.053 | | -0.030 | |
| | (0.23) | | (-0.98) | | (-0.85) | | (-0.47) | | (-0.30) | |
| 2 | 0.356 | | 0.272 | | 0.262 | | 0.290 | | 0.268 | |
| | (1.29) | | (1.83) | * | (2.08) | * | (2.57) | ** | (2.62) | ** |
| 3 | 0.640 | | 0.559 | | 0.517 | | 0.448 | | 0.398 | |
| | (2.33) | ** | (3.44) | ** | (3.75) | ** | (3.70) | ** | (3.60) | ** |
| 4 | 0.735 | | 0.695 | | 0.668 | | 0.595 | | 0.549 | |
| | (2.37) | ** | (3.92) | ** | (4.75) | ** | (4.80) | ** | (4.89) | ** |
| W | 1.232 | | 0.870 | | 0.653 | | 0.563 | | 0.494 | |
| | (4.35) | ** | (4.93) | ** | (4.57) | ** | (4.69) | ** | (4.40) | ** |
| W-L | 1.171 | | 1.010 | | 0.759 | | 0.616 | | 0.525 | |
| | (4.15) | ** | (6.19) | ** | (6.33) | ** | (6.16) | ** | (5.72) | ** |

| Quintile | H=1 | | H=5 | | H=10 | | H=15 | | H=20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| L | -0.246 | | -0.331 | | -0.372 | | -0.273 | | -0.234 | |
| | (-1.05) | | (-2.55) | ** | (-3.28) | ** | (-2.79) | ** | (-2.64) | ** |
| 2 | 0.058 | | 0.009 | | 0.071 | | 0.033 | | 0.017 | |
| | (0.25) | | (0.07) | | (0.67) | | (0.35) | | (0.19) | |
| 3 | 0.265 | | 0.312 | | 0.344 | | 0.281 | | 0.253 | |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (1.01) | | (2.17) | * | (2.54) | ** | (2.39) | ** | | | (1.18) | | (2.29) | * | (3.21) | ** | (2.92) | ** | (2.80) | ** |
| | 4 | 0.303 | | 0.377 | | 0.376 | | 0.343 | | | 4 | 0.358 | | 0.424 | | 0.392 | | 0.373 | | 0.350 | |
| | | (1.24) | | (2.60) | ** | (3.80) | ** | (3.78) | ** | | | (1.43) | | (3.05) | ** | (3.49) | ** | (3.74) | ** | (3.81) | ** |
| | W | 0.690 | | 0.687 | | 0.450 | | 0.430 | | | W | 0.799 | | 0.665 | | 0.470 | | 0.426 | | 0.395 | |
| | | (2.80) | ** | (4.61) | ** | (4.39) | ** | (4.50) | ** | | | (3.37) | ** | (4.48) | ** | (4.13) | ** | (4.16) | ** | (4.11) | ** |
| | W-L | 0.786 | | 0.925 | | 0.717 | | 0.648 | | | W-L | 1.045 | | 0.989 | | 0.836 | | 0.692 | | 0.622 | |
| | | (2.99) | ** | (6.78) | ** | (7.98) | ** | (8.18) | ** | | | (4.24) | ** | (7.02) | ** | (7.48) | ** | (7.62) | ** | (7.96) | ** |

| | Quintile | H=1 | | H=5 | | H=15 | | H=20 | | Quintile | H=1 | | H=5 | | H=10 | | H=15 | | H=20 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | -0.075 | | -0.343 | | -0.284 | | -0.231 | | L | -0.248 | | -0.430 | | -0.410 | | -0.314 | | -0.238 | |
| | | (-0.32) | | (-2.59) | ** | (-2.93) | ** | (-2.64) | ** | | (-1.11) | | (-3.09) | ** | (-3.51) | ** | (-3.16) | ** | (-2.70) | ** |
| | 2 | 0.209 | | 0.150 | | 0.069 | | 0.035 | | 2 | 0.088 | | 0.088 | | 0.087 | | 0.035 | | -0.012 | |
| | | (0.90) | | (1.14) | | (0.70) | | (0.39) | | | (0.38) | | (0.67) | | (0.80) | | (0.36) | | (-0.14) | |
| Momentum portfolios formed based on F=10 trading days | 3 | 0.081 | | 0.287 | | 0.200 | | 0.184 | | 3 | 0.175 | | 0.324 | | 0.245 | | 0.218 | | 0.190 | |
| | | (0.32) | | (2.17) | * | (2.06) | * | (2.03) | * | | (0.68) | | (2.41) | ** | (2.24) | * | (2.23) | * | (2.10) | * |
| | 4 | 0.368 | | 0.358 | | 0.308 | | 0.265 | | 4 | 0.553 | | 0.487 | | 0.417 | | 0.366 | | 0.328 | |
| | | (1.62) | | (2.62) | ** | (3.22) | ** | (3.07) | ** | | (2.53) | ** | (3.77) | ** | (4.00) | ** | (3.90) | ** | (3.77) | ** |
| | W | 0.405 | | 0.458 | | 0.438 | | 0.409 | | W | 0.388 | | 0.418 | | 0.432 | | 0.417 | | 0.386 | |
| | | (1.68) | * | (3.08) | ** | (4.11) | ** | (4.05) | ** | | (1.58) | | (2.82) | ** | (3.64) | ** | (3.94) | ** | (3.86) | ** |
| | W-L | 0.480 | | 0.801 | | 0.722 | | 0.640 | | W-L | 0.636 | | 0.849 | | 0.842 | | 0.731 | | 0.625 | |
| | | (1.92) | * | (5.80) | ** | (7.63) | ** | (7.57) | ** | | (2.63) | ** | (6.00) | ** | (7.11) | ** | (7.75) | ** | (7.50) | ** |

| | Quintile | H=1 | | H=5 | | H=15 | | H=20 | | Quintile | H=1 | | H=5 | | H=10 | | H=15 | | H=20 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | -0.099 | | -0.305 | | -0.269 | | -0.213 | | L | -0.281 | | -0.441 | | -0.393 | | -0.284 | | -0.224 | |
| | | (-0.43) | | (-2.30) | * | (-2.79) | ** | (-2.47) | ** | | (-1.23) | | (-3.17) | ** | (-3.39) | ** | (-2.89) | ** | (-2.55) | ** |
| | 2 | 0.262 | | 0.140 | | 0.069 | | 0.072 | | 2 | 0.246 | | 0.141 | | 0.074 | | 0.046 | | 0.053 | |
| | | (1.14) | | (1.07) | | (0.72) | | (0.83) | | | (1.08) | | (1.06) | | (0.70) | | (0.48) | | (0.62) | |
| Momentum portfolios formed based on F=15 trading days | 3 | 0.094 | | 0.127 | | 0.138 | | 0.106 | | 3 | 0.127 | | 0.178 | | 0.185 | | 0.142 | | 0.100 | |
| | | (0.37) | | (0.92) | | (1.40) | | (1.16) | | | (0.49) | | (1.30) | | (1.68) | * | (1.42) | | (1.08) | |
| | 4 | 0.468 | | 0.437 | | 0.290 | | 0.219 | | 4 | 0.423 | | 0.431 | | 0.327 | | 0.259 | | 0.206 | |
| | | (2.09) | * | (3.24) | ** | (3.12) | ** | (2.47) | ** | | (1.89) | * | (3.24) | ** | (3.04) | ** | (2.75) | ** | (2.33) | ** |
| | W | 0.315 | | 0.437 | | 0.355 | | 0.337 | | W | 0.450 | | 0.490 | | 0.460 | | 0.419 | | 0.384 | |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (1.28) | | (3.02) | ** | (3.26) | ** | (3.37) | ** | | | (1.85) | * | (3.47) | ** | (3.99) | ** | (3.98) | ** | (3.91) | ** |
| | W-L | 0.413 | | 0.742 | | 0.624 | | 0.550 | | | W-L | 0.731 | | 0.931 | | 0.852 | | 0.703 | | 0.608 | |
| | | (1.66) | * | (5.30) | ** | (6.77) | ** | (6.55) | ** | | | (2.93) | ** | (6.30) | ** | (7.17) | ** | (7.38) | ** | (7.05) | ** |

Momentum portfolios formed based on F=20 trading days

| Quintile | H=1 | | H=5 | | H=15 | | H=20 | |
|---|---|---|---|---|---|---|---|---|
| L | -0.128 | | -0.325 | | -0.287 | | -0.233 | |
| | (-0.56) | | (-2.38) | ** | (-2.99) | ** | (-2.70) | ** |
| 2 | 0.186 | | 0.085 | | 0.106 | | 0.098 | |
| | (0.78) | | (0.65) | | (1.16) | | (1.16) | |
| 3 | 0.231 | | 0.167 | | 0.105 | | 0.084 | |
| | (1.00) | | (1.28) | | (1.12) | | (0.98) | |
| 4 | 0.156 | | 0.296 | | 0.202 | | 0.162 | |
| | (0.61) | | (2.13) | * | (2.03) | * | (1.75) | * |
| W | 0.363 | | 0.415 | | 0.298 | | 0.276 | |
| | (1.50) | | (2.83) | ** | (2.73) | ** | (2.68) | ** |
| W-L | 0.491 | | 0.740 | | 0.585 | | 0.509 | |
| | (2.02) | * | (5.21) | ** | (6.57) | ** | (6.03) | ** |

| Quintile | H=1 | | H=5 | | H=10 | | H=15 | | H=20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| L | -0.181 | | -0.403 | | -0.369 | | -0.290 | | -0.240 | |
| | (-0.80) | | (-2.95) | ** | (-3.22) | ** | (-3.02) | ** | (-2.78) | ** |
| 2 | 0.149 | | 0.072 | | 0.089 | | 0.084 | | 0.092 | |
| | (0.63) | | (0.53) | | (0.85) | | (0.91) | | (1.08) | |
| 3 | 0.098 | | 0.190 | | 0.168 | | 0.131 | | 0.104 | |
| | (0.41) | | (1.47) | | (1.57) | | (1.38) | | (1.20) | |
| 4 | 0.277 | | 0.321 | | 0.261 | | 0.188 | | 0.143 | |
| | (1.10) | | (2.37) | ** | (2.45) | ** | (1.94) | * | (1.57) | |
| W | 0.444 | | 0.446 | | 0.351 | | 0.322 | | 0.302 | |
| | (1.86) | * | (3.08) | ** | (2.86) | ** | (2.95) | ** | (2.94) | ** |
| W-L | 0.625 | | 0.849 | | 0.719 | | 0.612 | | 0.543 | |
| | (2.61) | ** | (6.04) | ** | (6.91) | ** | (6.95) | ** | (6.48) | ** |

Table 2: Trading volume and momentum profitability

This table presents momentum profits based on two-way sort of price performance and trading volume. Quintile portfolios are formed based on price performance from the previous F trading days. Tercile portfolios are formed based on the average turnover from the previous F trading days. The loser portfolio (L) is the quintile with the lowest stock returns in the formation period. The winner portfolio (W) is the quintile with the highest stock returns in the formation period. V1 is the portfolio with the lowest trading volume and V3 is the portfolio with the highest trading volume. An equal-weighted return for each portfolio is calculated for the next H trading days. Returns are normalised to weekly return (equivalent to 5 trading days). (W-L) is the momentum strategies that goes long the winner portfolio and short the loser portfolio for the next H trading days. The t-statistic is in parenthesis. ** indicates significance at 1% level, and * indicates significance at 5% level.

| | | V1 | | V2 | | V3 | | V3-V1 | |
|---|---|---|---|---|---|---|---|---|---|
| F=1 H=1 | W | 0.464 | | 1.169 | | 1.232 | | 0.768 | |
| | | (1.33) | | (3.39) | ** | (3.20) | ** | (1.48) | |
| | L | -0.049 | | 0.351 | | 0.391 | | 0.440 | |
| | | (-0.14) | | (1.03) | | (1.12) | | (0.88) | |
| | W-L | 0.513 | | 0.818 | | 0.840 | | 0.327 | |
| | | (1.03) | | (1.69) | * | (1.61) | | (1.29) | |
| F=5 H=5 | W | 0.014 | | 0.678 | | 0.555 | | 0.541 | |
| | | (0.08) | | (3.98) | ** | (3.08) | ** | (2.21) | * |
| | L | 0.140 | | 0.111 | | -0.383 | | -0.523 | |
| | | (0.97) | | (0.76) | | (-2.43) | ** | (-2.45) | ** |
| | W-L | -0.126 | | 0.567 | | 0.938 | | 1.064 | |
| | | (-0.57) | | (2.53) | ** | (3.92) | ** | (2.58) | ** |
| F=10 H=10 | W | -0.273 | | 0.485 | | 0.178 | | 0.451 | |
| | | (-2.37) | ** | (3.37) | ** | (1.33) | | (2.56) | ** |
| | L | 0.285 | | 0.097 | | -0.686 | | -0.972 | |
| | | (2.51) | ** | (0.82) | | (-4.67) | ** | (-5.23) | ** |
| | W-L | -0.558 | | 0.388 | | 0.865 | | 1.423 | |
| | | (-3.45) | ** | (2.09) | * | (4.36) | ** | (2.46) | ** |
| F=15 H=15 | W | -0.064 | | 0.477 | | 0.137 | | 0.202 | |
| | | (-0.58) | | (4.01) | ** | (1.14) | | (1.23) | |
| | L | 0.280 | | 0.211 | | -0.673 | | -0.952 | |
| | | (2.93) | ** | (2.04) | * | (-5.69) | ** | (-6.27) | ** |
| | W-L | -0.344 | | 0.266 | | 0.810 | | 1.154 | |
| | | (-2.36) | ** | (1.69) | * | (4.79) | ** | (2.79) | ** |
| F=20 H=20 | W | 0.268 | | 0.249 | | 0.236 | | -0.032 | |
| | | (2.53) | ** | (2.37) | ** | (2.10) | * | (-0.21) | |
| | L | 0.220 | | 0.287 | | -0.518 | | -0.739 | |
| | | (2.61) | ** | (3.12) | ** | (-4.94) | ** | (-5.49) | ** |
| | W-L | 0.048 | | -0.039 | | 0.754 | | 0.706 | |
| | | (0.35) | | (-0.28) | | (4.90) | ** | (2.56) | ** |

Table 3: Delayed price discovery and trading interference of winner and loser stock that reach price limit

This table presents 5 day return and trading activity of winner (W) and loser (L) stocks that reach price limit. Day 1 to 5 are 5 trading days after the stocks reach the price limit. (W-L) is the momentum strategy that goes long the winner portfolio and short the loser portfolio. Cumulative (W-L) is the cumulative return of this momentum strategy over 5 days. Trading activity is defined as the percentage change in daily turnover over the previous day turnover. The t-statistic is in parenthesis. ** indicates significance at 1% level, and * indicates significance at 5% level.

Panel A: 5 day return of winner and loser stocks that reach price limit

| Day | W | | L | | W-L | | Cumulative(W-L) |
|---|---|---|---|---|---|---|---|
| 1 | 1.181 | | -0.431 | | 1.612 | | 1.612 |
| | (5.80) | ** | (-2.76) | ** | (4.28) | ** | |
| 2 | 0.390 | | 0.043 | | 0.347 | | 1.959 |
| | (2.28) | * | (0.28) | | (1.28) | | |
| 3 | 0.196 | | -0.014 | | 0.209 | | 2.169 |
| | (1.19) | | (-0.09) | | (0.64) | | |
| 4 | 0.124 | | -0.149 | | 0.273 | | 2.441 |
| | (0.79) | | (-0.99) | | (0.89) | | |
| 5 | 0.130 | | -0.131 | | 0.260 | | 2.701 |
| | (0.61) | | (-0.92) | | (0.76) | | |

Panel B: 5 day percentage change in turnover of winner and loser stocks that reach price limit

| Day | W | L |
|---|---|---|
| 1 | 11.945 | 2.061 |
| 2 | -10.071 | -5.292 |
| 3 | -6.599 | -3.232 |
| 4 | -2.728 | -7.890 |
| 5 | -5.579 | -6.144 |

Table 4: Calendar moth and momentum profits

This table presents momentum profits based on calendar months. Column W-L shows the average returns for momentum portfolio that goes long winner stocks and short loser stocks for each month. Column (W-L)>0 shows the proportion of momentum portfolios with positive returns for each month. We present the results for five momentum strategies where the formation period F is equal the holding period H.

| | F=1 H=1 | | F=5 H=5 | | F=10 H=10 | | F=15 H=15 | | F=20 H=20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | W-L | (W-L)>0 | W-L | (W-L)>0 | W-L | (W-L)>0 | W-L | (W-L)>0 | W-L | (W-L)>0 |
| January | 1.152 | 0.547 | 0.989 | 0.586 | 1.399 | 0.632 | 1.671 | 0.701 | 1.599 | 0.782 |
| | (1.79) * | | (2.66) ** | | (3.66) ** | | (5.58) ** | | (8.29) ** | |
| February | 2.654 | 0.677 | 3.040 | 0.723 | 2.519 | 0.705 | 2.847 | 0.733 | 1.912 | 0.633 |
| | (3.27) ** | | (6.65) ** | | (5.68) ** | | (7.08) ** | | (6.48) ** | |
| March | 1.224 | 0.525 | 1.307 | 0.607 | 0.222 | 0.467 | 0.390 | 0.437 | 1.263 | 0.634 |
| | (1.56) | | (3.30) ** | | (0.73) | | (1.25) | | (4.16) ** | |
| April | 2.087 | 0.535 | 1.400 | 0.546 | 0.381 | 0.483 | 0.362 | 0.517 | 0.231 | 0.471 |
| | (2.51) ** | | (3.52) ** | | (1.22) | | (1.54) | | (1.13) | |
| May | 1.500 | 0.558 | 0.974 | 0.577 | 1.307 | 0.712 | 1.134 | 0.640 | 1.106 | 0.679 |
| | (1.90) * | | (2.88) ** | | (3.68) ** | | (3.00) ** | | (2.76) ** | |
| June | 0.594 | 0.511 | 0.407 | 0.442 | 0.903 | 0.450 | 0.813 | 0.517 | 0.705 | 0.583 |
| | (0.43) | | (0.67) | | (1.73) * | | (2.22) * | | (2.49) ** | |
| July | 1.363 | 0.556 | -0.807 | 0.476 | -0.830 | 0.444 | -0.562 | 0.476 | -0.279 | 0.653 |
| | (1.02) | | (-2.53) ** | | (-2.60) ** | | (-2.19) * | | (-0.92) | |
| August | 2.274 | 0.533 | 1.028 | 0.484 | 0.418 | 0.520 | 1.039 | 0.573 | -0.137 | 0.508 |
| | (1.87) * | | (1.41) | | (1.37) | | (3.27) ** | | (-0.65) | |
| September | -1.391 | 0.519 | 0.754 | 0.531 | 1.076 | 0.602 | 0.379 | 0.536 | 0.896 | 0.571 |
| | (-1.23) | | (1.52) | | (2.68) ** | | (1.39) | | (3.07) ** | |
| October | 0.677 | 0.532 | 0.618 | 0.540 | 0.034 | 0.508 | -0.093 | 0.569 | -0.203 | 0.556 |
| | (0.88) | | (1.68) * | | (0.14) | | (-0.45) | | (-1.21) | |
| November | 1.489 | 0.600 | 1.182 | 0.557 | 0.893 | 0.584 | 0.121 | 0.469 | -0.488 | 0.464 |
| | (2.01) * | | (3.16) ** | | (3.15) ** | | (0.60) | | (-1.92) * | |
| December | 0.309 | 0.453 | 1.706 | 0.643 | 2.771 | 0.620 | 1.369 | 0.549 | 0.654 | 0.569 |
| | (0.52) | | (2.60) ** | | (3.58) ** | | (2.43) ** | | (1.60) | |

Table 5: Profitability of momentum strategies in sub-periods

This table presents momentum profits based on sub periods. We split our whole sample into 2000-2003 and 2004-2006. We present the results for winner portfolio, loser portfolio and momentum portfolio that goes long winner portfolio and short loser portfolio when the formation period F is equal to the holding period H. The t-statistic is in parenthesis. ** indicates significance at 1% level, and * indicates significance at 5% level.

| | | 2000-2003 | | 2004-2006 | |
|---|---|---|---|---|---|
| F=1 H=1 | W | 1.868 | | 0.816 | |
| | | (3.90) | ** | (2.34) | ** |
| | L | -0.524 | | 0.365 | |
| | | (-1.15) | | (1.15) | |
| | W-L | 2.392 | | 0.452 | |
| | | (4.17) | ** | (1.64) | * |
| F=5 H=5 | W | 0.795 | | 0.566 | |
| | | (3.23) | ** | (2.90) | ** |
| | L | -0.985 | | 0.347 | |
| | | (-4.68) | ** | (2.37) | ** |
| | W-L | 1.767 | | 0.219 | |
| | | (6.49) | ** | (1.59) | |
| F=10 H=10 | W | 0.447 | | 0.461 | |
| | | (2.20) | * | (3.16) | ** |
| | L | -1.021 | | 0.233 | |
| | | (-5.24) | ** | (1.91) | * |
| | W-L | 1.468 | | 0.228 | |
| | | (6.35) | ** | (2.25) | * |
| F=15 H=15 | W | 0.402 | | 0.459 | |
| | | (2.25) | * | (3.55) | ** |
| | L | -0.796 | | 0.270 | |
| | | (-4.82) | ** | (2.52) | ** |
| | W-L | 1.198 | | 0.189 | |
| | | (6.65) | ** | (2.17) | * |
| F=20 H=20 | W | 0.035 | | 0.630 | |
| | | (0.19) | | (5.33) | ** |
| | L | -0.821 | | 0.317 | |
| | | (5.72) | ** | (3.27) | ** |
| | W-L | 0.857 | | 0.313 | |
| | | (5.26) | ** | (4.29) | ** |

Table 6: Time-varying risk of momentum strategies

This table presents the time-varying risk of momentum strategies. Capital asset pricing model i equation (1a and 1b) is used to estimate the parameters for winner and loser portfolios. Equation (2) i used to estimate parameters for the momentum strategy that goes long winner portfolio and short lose portfolio. There is always one trading day skipped between the formation period F and the holdin period H. The t-statistic, corrected for heteroskedasticity using the White correction, is in parenthesis ** indicates significance at 1% level, and * indicates significance at 5% level.

| | | α | β | $R^2$ |
|---|---|---|---|---|
| F=1 H=1 | W | 1.276 ** | 0.682 ** | 0.395 |
| | | (5.97) | (12.64) | |
| | L | -0.860 ** | 0.752 ** | 0.485 |
| | | (-5.54) | (21.43) | |
| | W-L | 2.136 ** | -0.070 | 0.003 |
| | | (7.61) | (-0.97) | |
| F=5 H=5 | W | 0.359 * | 0.826 ** | 0.508 |
| | | (2.11) | (12.81) | |
| | L | -0.641 ** | 0.693 ** | 0.490 |
| | | (-6.98) | (15.13) | |
| | W-L | 1.000 ** | 0.134 | 0.015 |
| | | (5.86) | (1.49) | |
| F=10 H=10 | W | 0.053 | 0.907 ** | 0.626 |
| | | (-0.47) | (24.35) | |
| | L | -0.780 ** | 0.793 ** | 0.501 |
| | | (-9.57) | (16.94) | |
| | W-L | 0.833 ** | 0.114 * | 0.010 |
| | | (6.25) | (1.66) | |
| F=15 H=15 | W | 0.075 | 0.932 ** | 0.647 |
| | | (-0.26) | (22.57) | |
| | L | -0.601 ** | 0.815 ** | 0.577 |
| | | (-10.07) | (19.35) | |
| | W-L | 0.676 ** | 0.116 * | 0.013 |
| | | (6.52) | (1.73) | |
| F=20 H=20 | W | -0.020 * | 1.038 ** | 0.726 |
| | | (-2.12) | (29.69) | |
| | L | -0.506 ** | 0.778 ** | 0.587 |
| | | (-9.87) | (18.22) | |
| | W-L | 0.486 ** | 0.260 ** | 0.068 |
| | | (5.29) | (4.26) | |

Table 7: Three components of momentum profits

This table presents the estimates for the three components of momentum strategies. The expected momentum profits are decomposed using one factor model where the value-weighted market index serves as the common factor. $\sigma_\alpha^2$ is the cross-sectional average of unconditional expected returns. $\sigma_\alpha^2 = \frac{1}{N}\sum_{i=1}^{N}\left(\alpha_i - \overline{\alpha}\right)^2$. $\Omega$, is the cross-sectional average of serial covariance of the idiosyncratic component of returns. $\Omega = \frac{1}{N}\sum_{i=1}^{N}\mathrm{cov}(\varepsilon_{t,}\varepsilon_{t-1})$. $\delta\sigma_f^2$ shows the lead-lag structure or the timeliness of stock price reaction to common factors. $\delta\sigma_f^2 = \left(\frac{1}{N}\sum_{i=1}^{N}(\beta_{0,i} - \overline{\beta_0})(\beta_{1,i} - \overline{\beta_1})\right)\left(\frac{1}{T}\sum_{t=1}^{T}(f_t - \overline{f})^2\right)$. The number in parenthesis represents the relative contribution of each component to the overall momentum profits. We present the results for momentum strategies where the formation period (F) is equal to the holding period (H) and there is one day skipped between F and H.

| Momentum strategy | $\sigma_\alpha^2$ | | $\Omega$ | | $\delta\sigma_f^2$ | |
|---|---|---|---|---|---|---|
| F=1 H=1 | 0.00017008 | (0.245) | 0.00099588 | (1.433) | -0.00047101 | (-0.678) |
| F=5 H=5 | 0.00011361 | (0.064) | 0.00160555 | (0.903) | 0.00005976 | (0.034) |
| F=10 H=10 | 0.00008680 | (0.087) | 0.00087283 | (0.876) | 0.00003728 | (0.037) |
| F=15 H=15 | 0.00007239 | (0.112) | 0.00056730 | (0.881) | 0.00000405 | (0.006) |
| F=20 H=20 | 0.00007672 | (0.160) | 0.00039686 | (0.828) | 0.00000570 | (0.012) |