Idiosyncratic Momentum and Option Markets

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Abstract

This study examines whether the idiosyncratic momentum strategy can generate excess returns following the emergence of traded options. Portfolios are formed based on past residuals of the Fama-French three factor model in idiosyncratic momentum, while those are formed based on past total returns in traditional momentum. We find that the idiosyncratic momentum profits show attenuation since options started trading in 1996. Our results show that momentum returns for stocks with options in idiosyncratic momentum are positive and significant for three, six, and twelve months following the formation date, while those for stocks with options in traditional momentum are insignificant or even turn to negative. We also find strong evidence that the enhanced information efficiency led by allowing short selling has more impact on traditional momentum returns than on idiosyncratic momentum returns. Overall, our results show that the idiosyncratic momentum strategy demonstrates an even bigger challenge to the conventional asset pricing literature.

Keywords: Traditional momentum, idiosyncratic momentum, stock option trading, short sale constraints

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1. Introduction

The relationship between risk and return is one of the core concerns in financial theory. The efficient market hypothesis, developed by Fama (1970), suggests that all valuable information is fully reflected in stock prices in an "ideal market" under the assumption that all investors are rational and that they are fully aware of all available information. That is, investors cannot obtain excess returns by trading on information in an efficient market.

However, anomalies such as momentum effects and contrarian effects challenge the principle of the efficient market hypothesis. Jegadeesh and Titman (1993) present momentum effects which stipulate that investors who take a long position on past winner portfolios and a short position on past loser portfolios can generate excess profits in the few months following the formation date. Subsequently, Jegadeesh and Titman (2001) confirm the evidence of momentum profits in the first year after formation date, but find return reversals in the 2 to 5 years following the first year.

Arena, Haggard and Yan (2008) document that stocks with higher idiosyncratic volatilities lead to higher momentum profits, confirming that momentum profits are more easily being arbitraged away for stocks with lower unsystematic risk. The result is statistically significant and robust when controlling for size, transaction cost and other variables. While the traditional momentum strategy that forms portfolios based on past total returns has challenged the efficient market hypothesis, the idiosyncratic momentum strategy that constructs portfolios based on past idiosyncratic returns delivers excess returns more stable and/or higher than the traditional momentum strategy.

The idiosyncratic momentum strategy is found to be profitable for years following the formation date by Gutierrez and Pirinsky (2007). Most recently, Blitz, Hanauer and Vidojevic (2018) form the portfolio based on idiosyncratic momentum instead of past total momentum and find that Idiosyncratic Volatilities (IVol) is a separate factor that cannot be considered an established asset pricing factor. Furthermore, they find that factors such as overconfidence or overreaction fail to explain the source of the idiosyncratic momentum profits in the U.S. stock market.

Blitz et al. (2018) show that the idiosyncratic momentum strategies are less affected by market dynamics and can generate positive profits in both bull and bear markets. They also argue that the idiosyncratic momentum strategy is better than the conventional momentum strategy in a way that the former can produce high short and long term returns, while the latter can only produce high short term returns and its returns turn to negative in one year after the formation date.

We build on this work to examine whether the idiosyncratic momentum strategies could attain consistent returns relative to the traditional momentum strategies in the U.S. stock markets following the introduction of option trading markets.

One candidate to study our question is option trading. Options give buyers the right but not the obligation to buy or sell underlying assets at a fixed price up until a fixed date in the future. As a result, options are used to hedge the losses that might incur from fluctuating future asset prices. Grossman (1988) argues that traded options can reflect an investor's future investment plans as well as stock price volatilities. As the number of stocks with traded options has increased dramatically since the appearance of traded options in 1996. However, the conventional momentum returns have been found to shrink in the U.S. market over the recent decades. Abhyankar, Filippou and Haykir (2018) demonstrate that factors like enhanced arbitrage capital flows and lower stock trading costs are all lead to the shrinkage of momentum returns. They also find that the expansion of stock option market is connected to the shrinkage in momentum returns, in the way of building up stock price informativeness and lessening short selling constraints.

If the idiosyncratic momentum profits are more stable and significantly positive than the traditional momentum profits following the emergence of traded options, then we confirm the finding of Blitz et al. (2018) that the idiosyncratic momentum strategy is better than the conventional momentum strategy, and that the idiosyncratic momentum might offer an even bigger anomaly of the asset pricing literature.

Our results show that the conventional momentum strategy generates an average monthly return of 0.288% when holding period of momentum portfolios is one month during the period 1996 - 2017, but the return is statistically insignificant. When we extend the holding period to three, six and twelve months, the conventional momentum returns keep declining and become significantly negative over the period from 1996 to 2017. More specifically, we find that the traditional momentum profits are smaller or more negative for stocks with options than those profits for stocks without options over the same period. Our results show that the average monthly idiosyncratic momentum profit is 0.02% during 1996 – 2017 when the holding period is one month, this return is insignificant and smaller than the traditional momentum return. However, as we extend holding periods to three, six and twelve months, the idiosyncratic momentum strategy generates positive and significant returns from 1996 to 2017. Furthermore, we find that the idiosyncratic momentum profits are insignificant for stocks with options when the holding period is one month, but the profits are positive and significant when holding periods are three, six, and twelve months, although they are smaller than profits for stocks without options.

Abhyankar et al. (2018) show that high short interest indicates lower mispricing power and hence lower momentum returns. They also show that the short interest of WML (Winner-Minus-Loser) spread for stocks with options is significantly negative, while that for stocks without options is negative but insignificant. That means stocks without options are more likely to generate higher momentum returns than stocks with options.

If the average short interest is lower in idiosyncratic momentum than in conventional momentum, then we confirm the findings in Blitz et al. (2018) that the idiosyncratic momentum strategy is more profitable than conventional one.

In this paper we find that the average short interests in WML spread portfolios for stocks with and without options are less negative in idiosyncratic momentum than in traditional momentum. We also find that the difference in WML spread portfolios between stocks with and without options are more negative for the traditional momentum strategy. That means the conventional momentum returns between stocks with and without options are more distinct than the idiosyncratic momentum returns. That is, option trading has more impact on the traditional momentum strategy than on the idiosyncratic momentum strategy.

In this paper, we support the findings of Blitz et al. (2018), that the idiosyncratic momentum strategy can generate more stable profits than the conventional momentum strategy could after the emergence of traded options. We find that enhanced information efficiency by incorporating option trading has less impacts on the profitability of the idiosyncratic momentum strategy. Our results are consistent with the findings in Gutierrez and Pirinsky (2007) that investors' overreaction attributes to traditional momentum, investors' underreaction attributes to idiosyncratic momentum. Our results show that the traditional momentum returns are generated from investors' underreaction to news when holding periods are one, three and six months. However, they are generated from investors' overreaction when holding period is twelve months. On the other hand, the idiosyncratic momentum returns are generated from investors' underreaction when holding periods are one, three, six and twelve months. In summary, our results show that the idiosyncratic momentum strategy presents an even bigger challenge to the conventional asset pricing literature.

2. Literature Review

2.1. Efficient Market Hypothesis

Kendall (1956) argues that the stock price performance is random and imperfect. Osborne (1959) discovers that the movement of stock prices is identical to a molecule's movement. Robert (1959) generates an irregular series of numbers which displays an indistinguishable pattern with the real stock prices. Fama (1970) presents the efficient market hypothesis (EMH), where an efficient market is defined as "a market in which firms can make production-investment decisions, and investors can choose among the securities that represent ownership of firms' activities under the assumption that security prices at any time 'fully reflect' all available information".(p. 383). The EMH asserts that an observed market price equals to the intrinsic fundamental value for a given information set with the assumption that all the investors are rational. Under the EMH, investors are unable to obtain excess returns by analyzing historical information or analyzing uncovered financial information. Jung and Shiller (2005) shows that the efficient market hypothesis prevails in single stocks rather than in whole stock market based on the U.S. stock market data since 1926.

Risk can be sorted into two categories: systematic risk and idiosyncratic risk, i.e. firm-specific risk. The Capital Asset Pricing Model (CAPM), which was developed by Sharpe (1964) and Lintner (1965), shows that only systematic risk matters in computing expected returns. While expected returns are positively related to systematic risk, unsystematic risk can be diversified away by forming a diversified portfolio. Furthermore, expected stock returns are only linearly related to systematic risk under CAPM. However, a large amount of empirical evidence illustrates that some other factors can explain stock returns as well. Fama and French (1992) demonstrate that two other factors also help explain stock returns: firm size and book-to-market ratio. Fama and French (1993) propose a three-factor model which explains variations in stock returns on portfolios or on individual stocks by market risk premium, firm size, and book-to-market ratio.

2.2. Behavioral Finance

EMH has some theoretical challenges, because investors may not be fully rational in the real world. They may fail to identify relevant information and to deal with their portfolios accordingly. Black (1986) argues that noise can make the market inefficient because investors sometimes react to “noise” rather than information. Practitioners and academics in behavioral finance turn to investor psychology because investor behavior might affect stock returns as well. They associate market inefficiency with investors’ cognitive biases such as overconfidence, overreaction, or underreaction, because these biases are systematic and fail to be canceled out.

Presenting their pioneering work in behavioral finance. De Bondt and Thaler (1985) suggest that investors tend to show overreaction to unforeseen news, finding that past losers outperform past winners in the long-run. They also suggest that return reversals are the results of overreaction to unexpected news, and that the existence of momentum effects is evidence of market inefficiency. In a related study, Jegadeesh and Titman (1993) present momentum effects. They demonstrate that a long position on well-performing portfolios in the past and a short position on poorly-performing portfolios in the past generate significant excess returns over three to twelve holding months after the formation date in the U.S. market. In contrast, a trading strategy where an investor buys past losers and sells past winners is called a contrarian strategy. With respect to momentum effects, Fama and French (1996) show that the three-factor model fails to explain the momentum anomaly though it explained some other anomalies. Jegadeesh and Titman (1993) argue that the outperformance of momentum strategy is due to investors’ underreaction to news. Subsequently, Jegadeesh and Titman (2001) confirm the evidence of momentum profits in the first year after formation date, but find return reversals in the 2 to 5 years following the first year. Barberis, Shleifer and Vishny (1998) construct behavioral models and argue that the short-term momentum is attributed to underreaction to new information, and that the reversal is due to overreaction to new information.

Rouwenhorst (1998) finds that the momentum effect also exists in twelve European countries. Moskowitz and Grinblatt (1999) show that buying past winners industries' stocks and selling past losers industries' stocks also generate abnormal returns. Their finding indicates that the momentum effect not only exists among individual stocks, but also exists among industries. Jegadeesh and Titman (2001) suggest that the momentum portfolio generates negative returns during the holding periods of 13 to 60 months following the formation date. Conrad and Yavuz (2016) illustrate that short-term momentum and long-term reversal are not connected to each other by showing that the stocks which have momentum profits for the first six months do not experience reversals in one to two years following the formation date.

Ang, Hodrick, Xing and Zhang (2006) find that high idiosyncratic volatilities (high IVol) on stock returns has a negative effect on cross-sectional stock returns and such relation persists even after controlling for momentum effects. By analyzing the U.S. stock data from 1965 to 2002, Arena et al. (2008) find that portfolios with higher idiosyncratic volatilities have higher momentum profits but show quicker reversal than portfolios with lower idiosyncratic volatilities. This finding is statistically significant and robust after controlling for several factors. They argue that underreaction to firm-specific information is the reason for momentum returns. Pyo and Shin (2013) confirm that high idiosyncratic volatilities attribute to higher momentum returns in the

Korean stock market. Furthermore, they confirm that the Fama-French three factor model fails to explain momentum profits.

2.3. Idiosyncratic Momentum

The idiosyncratic momentum strategy is found to be profitable for years following the formation date by Gutierrez and Pirinsky (2007), while the total return momentum strategy reverses significantly. Blitz et al. (2018) demonstrate "idiosyncratic momentum is priced in the cross-section of stock returns and that it cannot be explained by the established asset pricing factors" (P.1) in the U.S. market. They also find that taking a long position on idiosyncratic momentum winners and a short position on conventional momentum losers generate long-term excess returns. Furthermore, their results are confirmed robust in Japan, Europe, Asia Pacific and emerging markets.

The idiosyncratic momentum strategy appears to be better than conventional momentum strategy in several ways. Blitz, Huji and Martens (2011) examine that idiosyncratic momentum strategy can double the Sharpe ratio by displaying half of the conventional momentum strategy's volatility. On the other hand, as discussed above, the idiosyncratic momentum strategy can realize long-term profits, while conventional momentum strategy reverses 12 months following the portfolio formation date. (Gutierrez & Pirinsky, 2007). Blitz et al. (2018) argue that investors can use idiosyncratic momentum to distinguish "high momentum stocks whose future returns reverse" from "those whose do not". They also illustrate that "unlike conventional momentum, momentum profits are positive following bull, as well as bear markets, and that they are substantially less affected by market dynamics", and that idiosyncratic momentum and total return momentum are distinct from each other - idiosyncratic momentum demonstrates a much larger violation to the asset pricing literature.

Extant evidence provides massive explanations of the sources of the momentum effects. Barberis et al. (1998) demonstrate that the "conservatism bias" attributes to momentum effect because investors who suffer from conservatism tend to stick to their previous portfolios and thus underreact to the new information they observe. Gutierrez and Pirinsky (2007) illustrate that idiosyncratic momentum also results from underreaction, while total return momentum results from overreaction, without eliminating the influences of other shock characteristics. Asem and Tian (2010) illustrate that conventional momentum is attributed to overreaction, while the idiosyncratic momentum is not. Blitz et al. (2018) support the hypothesis that underreaction attributes to idiosyncratic momentum even after controlling for other stock characteristics.

2.4. Momentum Strategy and the Option Markets

Grossman (1988) states that future trading motivations and price volatility can be displayed by traded options. By applying cross-sectional momentum anomaly as a candidate, Abhyankar et al. (2018) demonstrate that informational efficiency can be boosted in the stock market because of option market development. Stein (2009) states that momentum strategy allows arbitrageurs to make their decisions based on past returns rather than on an estimate of fundamental value. Hence, momentum strategy can be a good choice to study the role of information flows between traded options and stock profitability. Figlewski and Webb (1993) find that enhanced transactional and informational efficiency are attributed to traded options which reduce the effect of short selling constraints. Abhyankar et al. (2018) find that stocks without options have more momentum profits than those with options using U.S. data from 1972 to 2016.

Chordia, Subrahmanyam and Tong (2014) find that strategies to increase liquidity and alleviate trading costs help to enhance capital market efficiency and reduce many anomalies. Hanson and Sunderam (2014) indicate that the increment of capital investing in quantitative equity strategies, such as momentum, contributes to less strategy returns. McLean and Pontiff (2016) demonstrate that anomaly returns attenuate because investors pay much attention to an anomaly which was recently published in academic literature. After dividing their period 1996 - 2016 stock sample into two groups based on whether stocks have options or not, Abhyankar et al. (2018) find that stock option markets can provide more information about stocks and lower short-sale barriers. Since if the stocks in loser portfolios have put options traded on them, option market makers would hedge their potential loss by selling the underlying stocks. Therefore, it becomes a short sale in which investors bearing less constraints. Furthermore, Abhyankar et al. (2018) demonstrate that the increased profits of past loser stocks with options lead to the attenuation of momentum profits.

3. Hypothesis Development

Recall that when a stock has options traded on it, investors are provided with more information about future price movements. As options trading markets have developed in recent years, the conventional momentum strategy has become less profitable because of the enhanced information efficiency, as shown in Abhyankar et al. (2018). After dividing the whole period into two sub-periods, they find that the excess returns of conventional momentum trading over the 1972-2016 period in the U.S. stock market are positively and statistically significant. The momentum returns for the sub-period from 1972-1995 are also positively and statistically significant, while those of the latter period from 1996 to 2016 are insignificant. They find that an attenuation of momentum profits over the period from 1996 to 2016 is primarily led by large returns of the loser portfolios.

Gutierrez and Pirinsky (2007) document that idiosyncratic momentum returns sustain for years without reversing, while traditional momentum returns reverse after one year. Blitz et al. (2018) also illustrate that the idiosyncratic momentum strategy is more advantageous than conventional momentum strategy in that the former can generate positive returns in bull and bear markets. That is, the idiosyncratic momentum strategy could produce more stable returns than the traditional momentum strategy could. Following Blitz et al. (2018), if the idiosyncratic momentum strategy is superior to the conventional one, we should find that its profits are less volatile than conventional momentum profits in firms with options.

In this paper, we expect that idiosyncratic momentum profits have decreased since the emergence of options trading in 1996, but they are more stable than traditional momentum profits. That is, idiosyncratic momentum profits are less affected by option trading compared with the profits generated by the traditional momentum strategy.

Therefore, our first hypothesis is:

H1. Idiosyncratic momentum profits are less affected by the introduction of traded options than traditional momentum profits

To test Hypothesis 1, we hold momentum portfolios for one month in both traditional and idiosyncratic momentum. Furthermore, in order to examine whether our results are robust to various holding periods, we also consider three alternative momentum strategies with twelve months formation period (skipping the most recent month) combined with three, six and twelve months holding periods, respectively.

Gutierrez and Pirinsky (2007) show that the idiosyncratic momentum strategy is profitable for years after the formation date, while they find that the conventional momentum strategy shows reversing one year after the formation date. Moreover, Blitz et al. (2018) confirm the findings of Gutierrez and Pirinsky (2007) that the idiosyncratic momentum strategy generates high short-term and long-term profits, but the traditional momentum strategy can only generate high short-term profits. Abhyankar et al. (2018) show insignificant momentum returns over period 1996 to 2016 when momentum portfolios are held for one month. We conjecture that the traditional momentum strategy stays unprofitable as the holding period is extended during the period from 1996 to 2017. We also expect that the idiosyncratic momentum strategy keeps generating positive profits in the same period when the holding month varies.

Therefore, our second hypothesis is:

H2. The Idiosyncratic momentum strategy can generate profits during 1996 to 2017, while the traditional momentum strategy cannot, when momentum portfolios are held for 3, 6, 12 months.

Abhyankar et al. (2018) partition all stocks into two groups, stocks with and without options over period from 1996 to 2016. They show that the traditional momentum strategy is more profitable for stocks without options, but not significant for stocks with options.

Grossman (1988) states that the existence of traded put options boosts the liquidity of information about the future price movements to investors. Hence, we expect that the momentum returns for stocks with options are lower than those for stocks without options in both traditional and idiosyncratic momentum and that the differences between the returns are more obvious in traditional momentum.

Therefore, out third hypothesis is:

H3. Momentum strategies are less profitable for stocks with options than those without options, and the decreased profitability is more obvious in the traditional momentum strategy.

Short interest represents the percentage of shares that sold short. It is a market sentiment indicator that tells whether or not investors are optimistic about future stock prices. Option market traders would lose money if their counterparties exercise put options when share prices go down in the future. To offset the potential losses, option traders would short sell stocks. Short sales allow traders to sell assets that they do not own. When short selling, traders borrow stocks from stockholders, sell them at a high price today, and eventually buy the shares back in the future at hopefully a lower price. By doing so, traders can hedge potential losses. Abhyankar et al. (2018) show that selling put options to counterparties would lead to short selling stocks by option market traders, and thus increase in short interest. Their results demonstrate that the average short interest for loser portfolios is much higher than that for winner portfolios because the information for stocks in loser portfolios are usually unfavorable, they also demonstrate that the short interest of WML spread for stocks with options is negative and significant, while that for stocks without options is negative but insignificant. That means stocks without options are more likely to generate higher momentum returns than stocks with options. By running Fama-Macbeth regressions (1973), Abhyankar et al. (2018) also find that the coefficient of short interest is negative, indicating that lower short interest results in higher mispricing and accordingly higher momentum profits.

If the average short interest is lower in idiosyncratic momentum than in conventional momentum, then we confirm the findings in Blitz et al. (2018) that idiosyncratic momentum strategy is more profitable than conventional one.

Thus, our fourth hypothesis is:

H4. The average short interest is smaller for the idiosyncratic momentum than for the conventional momentum strategy.

4. Data and Methodology

4.1. Data Sources

The data we used in this paper come from various databases. We obtain monthly stock returns data from the Center for Research in Security Prices (CRSP) from January 1969 to December 2017. Observations from January 1969 to December 1971 are used to construct 36-month rolling windows for observations from January 1972 to December 1974. We retain all common shares (i.e. CRSP share codes 10 and 11) that are traded on New York Stock Exchange

(NYSE), American Stock Exchange (AMEX), and NASDQA markets (i.e. exchange codes 1, 2, and 3). We exclude stocks with prices lower than $5 at the end of the month, and financial stocks (i.e. stocks with SIC codes between 6000 and 6900). We exclude missing returns as well. We also obtain the number of shares outstanding and other information to calculate variables such as market capitalization. We use Fama-French factor returns to construct idiosyncratic momentum score, and those returns are obtained from Kenneth R. French data library.

We download Supplemental Short Interest file from COMPUSTAT. We use the mid-month data and eliminate stocks that with short interest available after September 2007, to obtain a longer sample. For each stock, we calculate shares sold short as a percentage of the mid-month shares outstanding collected from CRSP daily stock file.

We obtain options data from Chicago Board Options Exchange (CBOE), our data is available from January 1998. We declare that a stock has options in a month if it has option trading information in that month on Equity Option Volume Archive. We do not use option trading data. Instead, we look into the existence of options on stocks. For example, if option information started in January 1998 and ended in March 1998, then the stock has options from January 1998 to March 1998.

4.2. Methodology

4.2.1. Traditional Momentum Construction.

Following the methodology in Blitz et .al (2018), we calculate total returns over the past 12-2 months period for each stock on each date (denoted by R (2, 12)). The traditional momentum decile portfolios are constructed based on sorting R (2, 12) of all stocks. We hold all decile portfolios for one month, three months, six months and twelve months after the formation date, respectively. P1 denotes loser portfolios, in which stocks have performed worst. P10 denotes winner portfolios, in which stocks have performed best. P10-P1 denotes Winner-Minus-Loser spread portfolios, and their returns stand for momentum returns generated by investors, who take a long position on winner portfolios and a short position on loser portfolios.

4.2.2. Idiosyncratic Momentum Construction.

We take multiple steps to compute idiosyncratic momentum. As conducted in Blitz et al. in 2018, we follow the methodologies in Gutierrez and Pirinsky (2017) and Blitz et al. (2011) to obtain idiosyncratic momentum.

First, we run model (1) over 36-month rolling windows for each stock i. We need the full 36 months past returns to estimate the model.

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{mkt,i} \cdot (R_{mkt,t} - R_{f,t}) + \beta_{hml,i} \cdot R_{hml,t} + \beta_{smb,i} \cdot R_{smb,t} + \varepsilon_{i,t}$$

(1),

where $(R_{i,t} - R_{f,t})$ is the excess return of stock *i* in month t over risk free rate in month t, $(R_{mkt,t} - R_{f,t})$ is market risk premium, and $R_{hml,t}$and $R_{smb,t}$are the factors of value stocks over growth stocks and small caps over big caps. α_i and βs are the parameters to be estimated. The reason we use 36-month rolling windows is to make sure we have adequate numbers of observations to acquire accurate estimates (Blitz et al., 2011). Therefore, the eligible stocks to run the above regression are those who have complete historical 36 monthly returns.

Second, the idiosyncratic returns are constructed as:

$$e_{i,t} = R_{i,t} - R_{f,t} - \widehat{\alpha}_i - \widehat{\beta}_{mkt,i} \cdot (R_{mkt,t} - R_{f,t}) - \widehat{\beta}_{hml,i} \cdot R_{hml,t} - \widehat{\beta}_{smb,i} \cdot R_{smb,t} \quad (2)$$

Finally, the idiosyncratic momentum score $imom_{i,t}$ is the previous 12-2 month idiosyncratic return adjusted by volatility:

$$Idiosyncratic\ \ Momentum = \frac{\sum_{t-12}^{t-2} e_{i,t}}{\sqrt{\sum_{t-12}^{t-2}(e_{i,t} - \bar{e_i})^2}} \quad (3),$$

where $\bar{e_i}$ denotes as the average residual returns.

Conventional momentum portfolios are sorted based on past 12-month total returns skipping the most recent month, while idiosyncratic momentum portfolios are sorted based on the total past 12-2 months idiosyncratic returns standardized by its standard deviation in the same period. Gutierrez and Pirinsky (2007) show that standardizing returns can improve the measure of returns derived from firm-specific information. By showing that the one-month momentum returns generated by non-standardized idiosyncratic returns have larger volatility and smaller Sharpe ratio, Blitz et al. (2011) find that standardizing idiosyncratic returns can make the idiosyncratic momentum strategy less risky. So we standardize returns to reduce the concerns of noisy information and improve the reliabilities of the idiosyncratic momentum return measurements.

We also hold all idiosyncratic momentum portfolios for one month, three months, six months and twelve months following the formation date, respectively. P1 represent loser portfolios, P10 represent winner portfolios. P10-P1 are momentum spread portfolios, and their returns stand for momentum returns generated by investors who buy winner portfolios and sell loser portfolios.

5. Empirical Results

5.1. Momentum Returns and Option Trading

Once we examine results for the entire period, we separate our full sample period 1972 to 2017 into two sub-periods; 1972 to 1995 and 1996 to 2017. These two sub-periods generally coincide with a period without options and a period with options, respectively. We start by presenting our conventional and idiosyncratic momentum returns produced by spread portfolios with holding period, K=1, 3, 6, 12 months after the formation date. Then we move on to present momentum returns for stocks with options and stocks without options over the second sub-period from 1998 to 2017, because our option data source from CBOE is available only from 1998. The momentum strategy portfolios are also held for one-month, three-month, six-month and twelve-month, respectively.

5.1.1. Returns for Momentum Portfolios with One-month Holding Period.

Following the approach adopted in Blitz et al. (2018), we form traditional momentum decile portfolios based on the past twelve to two months total returns of stocks and hold the portfolios for one month. Table 1 reports average excess returns of each decile portfolio, where all returns are monthly and value-weighted. The spread portfolio returns represent those generated by investors, who take a long position in winner portfolios and a short position in loser portfolios and then hold the spread portfolio for one month. Table 1 also reports CAPM alphas and Fama-French three-factor model alphas for each decile portfolio and spread portfolio over the three sample periods. We confirm the finding of Abhyankar et al. (2018) for conventional momentum strategy with one month holding period. As shown in Table 1, WML spread portfolios generate high and statistically significant monthly average momentum returns of 79.2 bps (basis points) over the entire sample period from January 1972 to December 2017. Spread portfolios attain even higher momentum returns over the first sub-period from January 1972 to December 1995, around 125.3 bps. However, WML momentum strategies become much less profitable during the second sub-period from January 1996 to December 2017, with a statistically insignificant average monthly momentum return of 28.8 bps, falling by around 96.5 bps per month compared with momentum returns in the first sub-period.

Table 2 presents descriptive statistics of the performance of idiosyncratic momentum portfolios that are held for one month. Following the methodologies in Gutierrez and Pirinsky (2007) and Blitz et al. (2011), we construct idiosyncratic momentum portfolios by univariate sorts on previous twelve months volatility-scaled idiosyncratic returns after skipping the most recent month. In Table 2, we report average monthly excess returns for each decile portfolio, and the momentum returns produced by the idiosyncratic momentum strategy of investing past winner portfolios and selling past loser portfolios. We also report CAPM and Fama-French three-factor model alphas for each decile portfolio as well as for WML portfolios. Over the entire sample time period from 1972 to 2017, the WML portfolios generate a positive momentum return of around 50.3 bps per month and the return is economically and statistically significant. Over the period from 1972 to 1995, the idiosyncratic momentum strategy provides even much higher monthly return of 78.0 bps which is also positively significant. However, the average momentum return drops dramatically to 2.0 bps per month and becomes no longer significant during period 1996 to 2017. Examining closely the three short legs and three long legs in this table, we find that the least momentum return over the second time period is mainly driven by the highest return in the short leg and the lowest return in the long leg. For CAMP alphas and Fama-French three-factor alphas, they show patterns similar to average excess returns: with highest WML returns over period from 1972 to 1995 and with lowest and insignificant WML returns over period from 1996 to 2017.

We find that the idiosyncratic momentum strategy has become less profitable ever since the appearance of options market in 1996. However, if we compare Table 1 with Table 2, although returns in the traditional momentum strategy are numerically larger than those in idiosyncratic momentum strategy over period 1996 to 2017, the returns in the latter case are less insignificant than those in the former case. We confirm H1 that the idiosyncratic momentum strategy is less affected by traded options than the traditional momentum strategy is, although it has become less profitable since 1996.

5.1.2. Growth of Stocks with Traded Options.

Table 3 displays the numbers and percentages of stocks with and without options for every year over our sample period from 1998 to 2017. The table presents the number and the percentage of stocks with traded options increase significantly during this period. More specifically, we find that the increasing percentage is not only attributable to the increasing number of stocks with options, but also attributable to the decreasing numbers of total listed stocks. We note that only 20.6% listed stocks had options traded on them at the beginning of our sample period in 1998. The percentage grows to 82.1 by the end of our sample period in 2017.

5.1.3. Returns for Momentum Portfolios with Holding Periods K=3, 6, 12 months.

The results reported above are based on a twelve-month formation period (after skipping the most recent month) and a one-month holding period. In order to examine whether our results are affected by different holding periods, we consider three more alternative momentum strategies for both conventional momentum and idiosyncratic momentum, those strategies are combining twelve-month formation period (after skipping the most recent month) with three-month, six-month and twelve-month holding periods, respectively.

In Table 4, we report the monthly average returns for P1, P5 and P10, where holding period K equals to 3, 6, 12 months in traditional momentum and idiosyncratic momentum. We also report WML spread portfolio momentum returns over the three holding periods.

Panel A presents the performance of traditional momentum decile portfolios with the three holding periods. We find that, when holding period is 3-month, the WML momentum portfolios generate a positively significant average excess return of 56.3 bps per month over the entire sample period, and that the return becomes even higher over the first sub-period from 1972 to 1995, increasing to 94.8 bps per month. However, the average momentum return drops dramatically and becomes insignificant (13.8 bps per month) during 1996 - 2017. The traditional momentum investing strategy delivers an average return of 23.5 bps per month over period 1972 – 2017, when the holding period extends to six months, but the result is not significantly different from zero. The difference between winner and loser portfolio returns rises to approximately 70.4 bps per month during the period from 1972 to 2017, which is significantly different from zero. However, the momentum return goes down to -28.8 bps per month and becomes insignificant since options started trading in 1996. Past winner portfolios underperform past loser portfolios by 20.2 bps per month over period 1972 to 2017, when portfolios are held for 12 months after formation date. However, Panel A shows that past winner portfolios outperform past loser portfolios by 9.2 bps per month over the first sub-period from 1972 to 1995 when K=12 months. During the second sub-period, the monthly average momentum return becomes negative again at around -53.8 bps. WML momentum returns for the entire period and the second sub-period are significantly negative when portfolios are held for twelve months, but insignificant during the first sub-period.

In Panel B, we display the performance of idiosyncratic momentum decile portfolios with various holding periods. We find that when holding portfolios for three months, the idiosyncratic momentum strategy generates an average monthly abnormal return of 61.1 bps, which is significantly different from zero during 1972 - 2017. The return continues to be high over the first sub-period from 1972 to 1995 at around 75.1 bps per month, but attenuates in the second sub-period at around 45.8 bps per month. The return patterns do not change when holding momentum portfolios for six and twelve months. That is, momentum returns reach the highest during the first sub-period and drop to the lowest during the second sub-period. All of the WML spread portfolio returns from the idiosyncratic momentum strategy are positively significant with holding period K=3, 6, and 12 months.

Focusing on the momentum returns during period 1972 - 2017 only, we find that the average monthly returns are 79.2, 56.3, 23.5 and -20.2 bps in traditional momentum strategies when holding periods are one-month, three-month, six-month and twelve-month, respectively. In contrast, the average monthly returns are 50.3, 61.1, 56.5 and 42.7 bps in idiosyncratic momentum strategies when holding portfolios for one month, three months, six months and twelve months, respectively. Our results are consistent with the findings in Blitz et al. (2018) that traditional momentum strategies generate high short term returns, but the returns become insignificant very soon, and then turn to negative around the 12 months following the formation date. On the other hand, idiosyncratic momentum strategies generate excess returns for various holding periods. Our results are also consistent with the findings of Gutierrez and Pirinsky (2007) that traditional momentum reverses and is attributable to investors' overreaction to news, and idiosyncratic momentum persists and is attributable to investors' underreaction to news.

In Table 4, we find that the idiosyncratic momentum strategies can still generate positive average monthly returns over the period 1996 - 2017 although those returns attenuate slightly compared with those over the period 1972 – 1995. However, traditional momentum strategies become non-profitable over 1996 to 2017. We show that idiosyncratic momentum profits attenuate following the availability of equity options trading. Furthermore, we validate our second hypothesis that idiosyncratic momentum strategies can generate more profits than conventional momentum strategies can in time period with trading options.

5.1.4. Momentum Portfolios with One-month Holding Period.

Following Abhyankar et al. (2018), we partition our sample in an entire period from 1998 to 2017 into two groups: stocks with options and stocks without options. In Table 5, we present the value-weighted average monthly excess returns of each decile as well as those of spread portfolios. We also report CAPM alphas and Fama-French alphas for each decile portfolio and WML portfolios for both stocks with options and stocks without options. Our results show that the average spread portfolio return is 43.5 bps with t-statistics as 0.79 among stocks with options. Consistent with Abhyankar et al. (2018)'s results, we find that WML spread portfolios generate positive and significant momentum returns (approximately 63.6 bps on average), and the return is around 20.1 bps higher than that for stocks with options. The CAPM and Fama-French three-factor model alphas show the similar patterns with average excess returns. We confirm the findings in Abhyankar et al. (2018) that stocks with options attribute to the attenuation of momentum profits following the appearance of traded options in 1996.

We move on to analyze idiosyncratic momentum returns. We divide the sample stocks over period 1998 to 2017 into two groups: stocks with options and without options. For each group, we calculate the monthly value-weighted returns of each decile portfolio and the average WML momentum strategy returns. We then compute their corresponding CAPM and Fama-French three-factor model alphas. Table 6 presents descriptive statistics on average monthly returns for stocks with and without options in idiosyncratic momentum portfolios that are held for one month. We observe that the average idiosyncratic momentum return for stocks with options is low at around 27.8 bps per month and is statistically insignificant, while the average return for stocks without options is much higher at around 44.9 bps per month and is significantly different from zero. Furthermore, CAPM alphas and Fama and French (1993) alphas generated by the WML momentum strategy show much higher and significantly positive for stocks without options, while these measures are lower and statistically insignificant for stocks with options. Based on the results above, it appears that the reduction in profits for the idiosyncratic momentum strategy over the period from 1998 to 2017 is mainly driven by stocks with options, when those portfolios are held for one month. We confirm our third hypothesis that the idiosyncratic momentum strategy is less profitable for stocks with options. However, we cannot confirm the lower profitability for stocks with options is obvious for traditional momentum, as both results are not different from zero when the portfolios are held for one month.

5.1.5. Momentum Portfolios with Holding Periods K=3, 6, and 12 months.

Following the analysis with one-month holding period, we divide the entire sample into stocks with options and stocks without options over the period from 1998 to 2017, because our options data from CBOE is available since 1998. Table 7 displays the value-weighted monthly returns of P1, P5 and P10 for stocks with and without options when the holding period is 3-month, 6-month and 12-month, respectively. Table 7 also presents the WML spread portfolio monthly returns and their corresponding t statistics in conventional and idiosyncratic momentum returns.

Panel A shows return performance for stocks with and without options in traditional momentum. When momentum portfolios are held for three months, spread portfolio strategies for stocks without options generate an average monthly return of 42.3 bps that is significantly different from zero, while for stocks with options, the strategies deliver an insignificant average return at around 23.2 bps per month. The average momentum returns are -24.9 bps and 12.6 bps per month for stocks with options and stocks without options, respectively, when momentum decile portfolios being held for six months, while both returns are not significant, the negative return (-24.9 bps) is relatively more significant than the positive return (12.6 bps). Past winner portfolios underperform past loser portfolios in both cases, when the holding period is 12-month, leading to negative momentum returns for spread portfolios strategies. Stocks with options deliver a more negative and statistically significant average momentum return at around -51.1 bps per month, while stocks without options have a lesser negatively significant average momentum return around -29.3 bps per month.

Panel B shows stock price performance for stocks with and without options in idiosyncratic momentum. We find that the WML momentum returns for various holding periods display patterns similar to cases in traditional momentum. That is, lower returns are delivered from stocks with options and higher returns from stocks without options. The results are positively different from zero, but with less significance for the former case in each holding period.

Table 7 shows that the momentum profits shrink and become negative in traditional momentum when the holding periods are extended. The changes are more pronounced for stock with options. However, momentum profits stay positive and significant in idiosyncratic momentum for both stocks with and stocks without options, although the profits decrease slightly as holding period extends. In Table 7, we illustrate that the idiosyncratic momentum strategy can generate more stable returns than the traditional momentum strategy can. Our findings support the third hypothesis that both momentum strategies from stocks with options deliver lower profits than those from stocks without options, when holding periods K=3, 6 and 12. The lower profitability for stocks with options is more pronounced in the traditional momentum strategy.

5.2. Short Interest and Momentum Portfolios

We follow the approach by Abhyankar et al. (2018). Table 8 reports the monthly time-series in average short interests for each decile portfolio as well as the differences between winners and losers portfolios in traditional momentum over the period from 1998 to 2017 because our options data from CBOE is available since 1998. We find that the average short interest is higher for stocks with options (around 6.7%) than that for stocks without options at around 4.1% in panel A. In panel B, we find that the short interest in loser portfolios for stocks with options is very high at around 10.5%, resulting in a significantly negative average short interest for WML spread portfolios at around -2.3%. In contrast, the difference in average short interest between loser portfolios and winner portfolios is much smaller at around -1.5% for stocks without options. We also conduct tests to examine whether or not the difference between the average short interests of the two WML spread portfolios is different from zero. Our results show that the average short interest of WML portfolio for stocks with options is statistically more negative than that for stocks without options. This result is consistent with the finding in Abhyankar et al. (2018).

In Table 9, we present the monthly time-series in average short interests for each decile portfolio as well as the differences in between winner and loser portfolios in idiosyncratic momentum over the same period. Panel A shows that the average monthly short interest is about 6.2% for stocks with options, which is 4.3% for stocks without options. The results are consistent with our previous findings that idiosyncratic momentum profits for stocks with options are lower than those for stocks without options, as the higher short interest ratio indicates the lower mispricing power and hence the lower momentum returns (Abhyankar et al., 2018). Panel B shows that the average monthly short interest in loser portfolio for stocks with options is very high at around 7.4%, leading to a very negative average short interest for WML spread portfolios at around -1.6%. In contrast, average short interest is around 5.0% for loser portfolios and 3.9% for winner portfolios, resulting in a smaller difference for stocks without options at around -1.1%. We also examine whether the difference between the average short interests of the two WML spread portfolios is statistically significant. Our results show that the two average short interests are different from zero. That is, the short interest becomes more negative for the case of stocks with options.

Comparing Table 8 with Table 9, we find that the average short interest ratios of stocks with and without options portfolios is higher for traditional momentum than those for idiosyncratic momentum, resulting in a lower mispricing and therefore lower returns for the traditional momentum strategy (Abhyankar et al., 2018). The results support the fourth hypothesis that the average short interest for idiosyncratic momentum is smaller than that for conventional momentum. Furthermore, we find that the difference of WML spread portfolios between stocks with and without options for idiosyncratic momentum are smaller than that for tradition momentum. The results indicate that the impact of option trading markets on traditional momentum strategy is bigger than it on idiosyncratic momentum strategy.

Table 10 shows the summary of our main findings. Panel A shows the comparison of momentum return performances between the traditional momentum strategy and the idiosyncratic momentum strategy during the period from 1996 to 2017. Panel B shows the comparison of momentum return performances between the traditional momentum strategy and the idiosyncratic momentum strategy for stock with options. The idiosyncratic momentum strategy consistently generates excess returns with or without available stock options, while the traditional momentum strategy cannot provide excess returns with available stock options.

5.3. Future Research

Future research can extend the related research in three ways. First, the sources of idiosyncratic momentum profits can be fruitful in understanding the advantages of the idiosyncratic momentum over the traditional momentum. Arena et al. (2008) report that the traditional momentum profits mainly come from idiosyncratic volatilities. The idiosyncratic momentum profits might weaken the source in idiosyncratic volatilities and open venues to new source. Second, the idiosyncratic momentum score can be constructed by using the Carhart four-factor model (Carhart, 1997) as well as the Fama-French five-factor model (Fama & French, 2015). Third, the holding periods can be extended into 2 to 5 years, to examine whether the superiority of the idiosyncratic momentum strategy to the traditional momentum strategy in the option trading markets sustains in the long run.

6. Conclusion

The momentum effect is one of the most well-known anomalies documented in the financial literature. An investor who takes a long position on past winner portfolios and a short position on past loser portfolios can realize excess returns over the next few months. Some other anomalies have disappeared ever since they were discovered, while the momentum strategy is still profitable since it was presented by Jegadeesh and Titman (1993). However, the momentum profits show attenuation after the emergence of traded options in 1996. Abhyankar et al. (2018) find that traditional momentum monthly return becomes insignificant over the period 1996 to 2016, and argue that the attenuation is mainly due to stocks with options. While the traditional momentum strategy forms portfolios based on past total returns, the idiosyncratic momentum strategy constructs portfolios based on past idiosyncratic returns adjusted by volatilities.

We construct idiosyncratic momentum by adopting the methodologies in Gutierrez and Pirinsky (2007) and Blitz et al (2011). We follow the approach in Abhyankar et al. (2018) and hold both idiosyncratic and traditional momentum portfolios for one, three, six and twelve months, respectively. We find that idiosyncratic momentum returns are still positive and significant during 1996 – 2017, although they attenuate compared with those during 1972 – 1995 when holding periods are three, six and twelve months, while traditional momentum returns become insignificant and even turn to negative during the same period. However, idiosyncratic momentum returns are insignificant when portfolios are held for one month, but they are less insignificant than traditional returns.

When we divide our sample stocks into two groups based on stocks with and stocks without options, we find that the traditional momentum returns for stocks with options are insignificant or more negative than stocks without options when holding periods are one, three, six and twelve months. However, idiosyncratic momentum returns for stocks with options are significantly positive, although they are smaller than those for stocks without options when holding periods are three, six, and twelve months.

Furthermore, we calculate average short interests for stocks with and without options. Short interest can reflect the information efficiency because if stocks have put options traded on them, the option traders will hedge their risk by short selling. Hence, mispricing power has been reduced and so have momentum returns. Our results show that the average short interests for idiosyncratic momentum portfolios are lower than that for traditional momentum portfolios. In addition, the average short interests for WML spread portfolios in the idiosyncratic momentum strategy are smaller than that in the traditional momentum strategy. The difference of WML spread portfolios between stocks with and without options for idiosyncratic momentum are smaller than that for traditional momentum. The results suggest that the impact of options trading markets on traditional momentum strategy is bigger than it on idiosyncratic momentum strategy.

In summary, our results show that the idiosyncratic momentum strategy can produce positive and more significant returns following the emergence of traded options, while the conventional momentum strategy cannot. That is, the enhanced information efficiency available with options trading has less impact on the profitability of the idiosyncratic momentum strategy.

We support the findings by Blitz et al. (2018) that the idiosyncratic momentum strategy delivers stable excess returns better than the traditional momentum strategy.

Reference

Abhyankar, A., Filippou, I., Garcia-Ares, P. & Haykir, O. (2018) Overcoming Arbitrage Limits: Option Trading and Momentum Returns. *Working Paper*. Retrieved from SSRN: https://ssrn.com/abstract=3206873 or http://dx.doi.org/10.2139/ssrn.3206873

Asem, E., & Tian, G. Y. (2010) Market dynamics and momentum profits. *Journal of Financial and Quantitative Analysis,* 45 (6), 1549–1562.

Ang, A., Hodrick, R.J., Xing, Y., & Zhang, X. (2006). The cross-section of volatility and expected returns, *Journal of Finance,* 61, 259–299

Arena, M.P., Haggard, K.S. & Yan, X. (2008). Price momentum and idiosyncratic volatility, *Financial Review,* 43, 159-190.

Bai, J., Philippon, T. & Savov, A. (2016). Have financial markets become more informative? *Journal of Financial Economics,* 122 (3), 625-654.

Barberis, N., Shleifer, A. & Vishny, R. (1998). A model of investor sentiment, *Journal of Financial Economics,* 49, 307–343

Black, F. (1986). Noise, *Journal of Finance,* 41 (3), 528-543.

Blitz, D., Huij, J. & Martens, M. (2011) Residual momentum. *Journal of Empirical Finance,* 18 (3), 506–521.

Blitz, D., Hanauer, M. X., & Vidojevic, M. (2018). The idiosyncratic momentum anomaly. *Working Paper*. Retrieved From SSRN: https://ssrn.com/abstract=2947044

Carhart, M, M. (1997). On Persistence in Mutual Fund Performance. Journal of Finance, 52 (1), 57-82.

Chordia, T., Subrahmanyam, A. & Tong, Q. (2014). Have Capital Market Anomalies Attenuated in the Recent Era of High Liquidity and Trading Activity? Journal of Accounting and Economics, 58 (1), 41-58.

Chu, Y., Hirshleifer, D. A. & Ma, L (2016). The Causal Effect of Limits to Arbitrage on Asset Pricing Anomalies. *Working Paper*. Retrieved From SSRN: https://ssrn.com/abstract=2696672or http://dx.doi.org/10.2139/ssrn.2696672

Conrad, J., & Yavuz, M. D. (2016). Momentum and Reversal: Does What Goes Up Always Come Down? *Review of Finance*, 21 (2), 555–581.

De Bondt, W.F.M., & Thaler, R. (1985). Does the Stock Market Overreact? *Journal of Finance 40,* 793–805.

Fama, E. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance,* 25 (2), 383-417.

Fama, E.F., & French, K.R. (1993). Common Risk Factors in the Returns on Stocks and Bonds, *Journal of Financial Economics,* 33, 3–56.

Fama, E.F., & French, K.R. (1996). Multifactor explanations of asset pricing anomalies, *Journal of Finance,* 51, 55–84.

Fama, E.F., & French, K.R. (2015). A Five-factor Asset Pricing Model, *Journal of Financial Economics,* 116, 1-22.

Figlewski, S. & Webb, G. P. (1993). Options, Short Sales, and Market Completeness. *Journal of Finance,* 761-777.

Frijns, B., Indriawan, I., Tourani-Rad, A. & and Tse, Y. (2015) Macroeconomic News Announcements and Price Discovery: Evidence from Canadian-U.S. Crosslisted Firms. *Journal of Empirical Finance*, 32, 35-48

Gravelle, T., & Moessner, F. (2001). Reactions of Canadian Interest Rates to Macroeconomic Announcements: Implications for Monetary Policy Transparency. *Bank of Canada Working paper Series* Vol.5.

Grossman, S. J. (1988). An Analysis of the Implications for Stocks and Futures Price Volatility of Program Trading and Dynamic Hedging Strategies. *The Journal of Business,* 61 (3), 275-298

Gutierrez, R. C., & Pirinsky, C. A. (2007). Momentum, Reversal, and the Trading Behaviors of Institutions. *Journal of Financial Markets,* 10 (1):48–75.

Hanson, S. G. & Sunderam, A. (2014). The Growth and Limits of Arbitrage: Evidence from Short Interest. *The Review of Financial Studies,* 27 (4), 1238-1286.

Jegadeesh, N. & Titman, S. (1993). Returns to Buying Winners and Selling Losers - Implications for Stock Market Efficiency, *Journal of Finance,* 48, 65-91.

Jegadeesh, N, & Titman, S. (2001). Profitability of Momentum Strategies: An Evaluation of Alternative Explanations, *Journal of Finance,* 56, 699-720.

Jung, J., & Shiller, R. J., (2005). Samuelson's Dictum and the Stock Market. *Economic Inquiry,* 43 (2), 221-228.

Kendall, D. G. (1956). Deterministic and Stochastic Epidemics in Closed Populations. *Proceedings of the Third Berkeley Symposium on Mathematical Statistics and Probability,* 4, 149—165.

L'Her, J., Masmoudi, T. & Suret, J. (2004). Evidence to Support the Four-Factor Pricing Model from the Canadian Stock Market. *Journal of International Financial Markets Institutions and Money*, 14 (4), 313-328.

Lintner, J. (1965). The Valuation of Risk Assets and the Selection of Risky Investments in Stocks Portfolios and Capital Budgets. *The Review of Economics and Statistics,* 47 (1), 13-37.

McLean, R. D. & Pontiff, J. (2016). Does Academic Research Destroy Stock Return Predictability? *The Journal of Finance,* 71 (1), 5-32.

Moskowitz, T. J., & Grinblatt, M. (1999). Do Industries Explain Momentum? *Journal of Finance,* 54, 1249-1290.

Nowak, S., Andritzky, J. & Tamirisa, N. (2011). Macroeconomic Fundamentals, Price Discovery, and Volatility Dynamics in Emerging Bond Markets. *Journal of Banking and Finance,* 35, 2584-2597.

Osborne, M. F. M (1959). Brownian Motions in Stock Market. *Operations Research,* 145-173.

Pyo, U., & Shin. Y. J. (2013). Momentum Profits and Idiosyncratic Volatility: the Korean evidence, *Review of Accounting and Finance,* 12 (2), 180-200.

Roberts, H. V. (1959). Stock-market “Patterns” and Financial Analysis: Methodological Suggestions, *Journal of Finance,* 14 (1), 1-10.

Rouwenhorst, K.G., 1998. International Momentum Strategies, *Journal of Finance*, 53, 267–284.

Sharpe, W. F. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *Journal of Finance,* 19 (3), 425-442.

Singh, S. (2014). Idiosyncratic Risk Pricing in Canada. Journal of Applied Business and Economics, 16, 110-127.

Stein, J. C. (2009). Presidential Address: Sophisticated Investors and Market Efficiency. The Journal of Finance, 64 (4), 1517-1548.

Switzer, L. N., & Picard, A. (2015). Idiosyncratic Volatility, Momentum, Liquidity, and Expected Stock Returns in Developed and Emerging Markets. *Multinational Finance Journal,* 19 (3). 169-221.

Tables Table 1. Performance of Traditional Momentum Portfolios for 1-month Holding Period

Holding Period K=1									
	January 1972 - December 2017			January 1972 - December 1995			January 1996 - December 2017		
Decile	Avg Ret	CAPM Alpha	FF3 Alpha	Avg Ret	CAPM Alpha	FF3 Alpha	Avg Ret	CAPM Alpha	FF3 Alpha
Losers	0.816	0.451	0.440	0.634	0.435	0.433	1.016	0.414	0.439
2	0.873	0.761	0.777	0.823	0.712	0.692	0.927	0.780	0.831
3	0.887	0.611	0.604	0.793	0.608	0.574	0.864	0.587	0.605
4	0.845	0.663	0.655	0.827	0.677	0.617	0.864	0.619	0.660
5	0.910	0.720	0.764	1.017	0.765	0.752	0.793	0.641	0.717
6	0.967	0.758	0.794	1.163	0.965	1.001	0.752	0.499	0.562
7	1.160	0.987	1.054	1.366	1.237	1.272	0.934	0.686	0.778
8	1.103	1.000	1.037	1.363	1.285	1.322	0.818	0.673	0.717
9	1.374	1.279	1.339	1.687	1.596	1.628	1.031	0.914	1.003
Winners	1.609	1.483	1.543	1.887	1.969	1.993	1.303	0.919	1.034
WML	0.792	1.032	1.103	1.253	1.534	1.560	0.288	0.504	0.594
T-stat	2.73	2.98	3.14	3.79	3.95	3.90	0.59	0.86	1.00

Decile portfolios are formed every month from January 1972 to December 2017. Traditional momentum portfolios are formed by sorting stocks based on past 12-2 month total stock returns. Winner portfolio denotes decile 10, loser portfolio denotes decile 1, WML denotes winner-minus-loser portfolio. K is the number of months in holding period. The table reports the value weighted average excess monthly returns for every decile portfolio as well as the corresponding alphas of the CAPM and Fama-French (1993) three-factor model. The last two rows show the differences in monthly returns and the differences in alphas between winners and losers portfolios with their associated t-statistics (t-stat) in traditional momentum sorted portfolios. Average returns and risk-adjusted returns are given in percentage terms. The samples cover January 1972 to December 2017, January 1972 to December 1995 and January 1996 to December 2017, respectively.

Table 2. Performance of Idiosyncratic Momentum Portfolios for 1-month Holding Period

Holding Period K=1									
	January 1972 – December 2017			January 1972 - December 1995			January 1996 – December 2017		
Decile	Avg Ret	CAPM Alpha	FF3 Alpha	Avg Ret	CAPM Alpha	FF3 Alpha	Avg Ret	CAPM Alpha	FF3 Alpha
Losers	0.740	0.468	0.475	0.652	0.477	0.387	0.836	0.432	0.486
2	0.676	0.581	0.617	0.771	0.682	0.657	0.555	0.433	0.483
3	0.881	0.678	0.726	0.851	0.649	0.651	0.920	0.698	0.763
4	1.008	0.812	0.834	0.969	0.701	0.676	1.043	0.910	0.949
5	0.977	0.729	0.742	1.063	0.773	0.768	0.885	0.643	0.679
6	0.949	0.721	0.779	1.113	0.976	0.987	0.758	0.407	0.503
7	1.108	0.963	0.986	1.214	1.007	1.014	0.987	0.887	0.944
8	1.054	0.926	0.963	1.251	1.101	1.107	0.837	0.716	0.775
9	1.152	0.993	1.030	1.361	1.241	1.268	0.906	0.693	0.770
Winners	1.243	1.072	1.115	1.420	1.313	1.344	1.036	0.775	0.846
WML	0.503	0.604	0.640	0.780	0.835	0.956	0.020	0.342	0.360
T-stat	2.59	2.75	2.86	3.28	2.96	3.30	0.64	1.00	1.04

Decile portfolios are formed every month from January 1972 to December 2017. Idiosyncratic momentum portfolios are formed based on past 12-2 month volatility-scaled idiosyncratic returns estimated over past 36-month rolling windows using Fama-French (1993) three-factor model. Winner portfolio denotes decile 10, loser portfolio denotes decile 1, WML denotes winner-minus-loser portfolio. K is the number of months in holding period. The table reports the value weighted average excess monthly returns for every decile portfolio as well as the corresponding alphas of the CAPM and Fama-French (1993) three-factor model. The last two rows show the differences in monthly returns and the differences in alphas between winners and losers portfolios with their associated HAC adjusted t-statistics (t-stat) in idiosyncratic momentum sorted portfolios. Average returns and risk-adjusted returns are given in percentage terms. The samples cover January 1972 to December 2017, January 1972 to December 1995 and January 1996 to December 2017, respectively.

Table 3. Stocks with and without Options

Year	Total Number of Stocks	Number of Stocks with Options	% Stocks with Options	Number of Stocks without Options	% Stocks without Options
1998	4971	1022	0.206	3949	0.794
1999	4851	1066	0.220	4785	0.780
2000	4829	1374	0.285	3455	0.715
2001	3687	1394	0.378	2293	0.622
2002	3214	1477	0.460	1737	0.540
2003	3187	1477	0.463	1710	0.537
2004	3419	1619	0.474	1800	0.526
2005	3353	1666	0.497	1687	0.503
2006	3396	1769	0.521	1627	0.479
2007	3335	1934	0.580	1401	0.420
2008	2891	2095	0.725	796	0.275
2009	2499	1944	0.778	555	0.222
2010	2697	2042	0.757	655	0.243
2011	2692	2025	0.752	667	0.248
2012	2543	1987	0.781	556	0.219
2013	2641	2131	0.807	510	0.193
2014	2792	2163	0.775	629	0.225
2015	2757	2250	0.816	507	0.184
2016	2662	2098	0.788	564	0.212
2017	2684	2204	0.821	480	0.179

This table presents the numbers and percentage of stocks with and without options in our sample period from 1998 to 2017. We define a stock with options if it has option traded volume on CBOE. Due to the availability of data on CBOE, we only consider the time period from 1998 to 2017.

Table 4. Returns for Momentum Portfolios with Holding Periods of 3-month, 6-month and 12-month

		K=3			K=6			K=12		
		Whole period	Sub-period 1	Sub-period 2	Whole period	Sub-period 1	Sub-period 2	Whole period	Sub-period 1	Sub-period 2
Panel A										
Traditional Momentum	P1	0.393	0.358	0.431	0.446	0.383	0.517	0.620	0.628	0.612
	P5	0.698	0.822	0.562	0.662	0.816	0.490	0.650	0.794	0.484
	P10	0.956	1.307	0.569	0.682	1.088	0.229	0.418	0.720	0.073
	WML	0.563	0.948	0.138	0.235	0.704	-0.288	-0.202	0.092	-0.538
	T-stat	3.20	4.90	0.46	1.85	5.67	-1.27	-2.17	1.11	-3.11
Panel B										
Idiosyncratic Momentum	P1	0.377	0.398	0.349	0.296	0.320	0.269	0.349	0.382	0.310
	P5	0.772	0.889	0.638	0.696	0.837	0.539	0.656	0.822	0.467
	P10	0.988	1.145	0.807	0.861	1.018	0.684	0.776	0.944	0.582
	WML	0.611	0.751	0.458	0.565	0.699	0.415	0.427	0.562	0.272
	T-stat	6.09	5.73	2.98	8.94	8.78	4.18	9.38	10.28	3.68

Decile portfolios are formed every month from January 1972 to December 2017. Panel A shows the results of traditional momentum, Panel B shows the results of idiosyncratic momentum results. Traditional momentum portfolios are formed by sorting stocks based on past 12-2 months total stock returns and idiosyncratic momentum portfolios are formed based on past 12-2 months volatility-scaled idiosyncratic returns estimated over past 36-month rolling windows using Fama-French (1993) three-factor model. Winner portfolio is denoted by P10, loser portfolio is denoted P1, P5 denotes the fifth decile, WML denotes winner-minus-loser portfolio. K is the number of months in holding period. The table reports the value weighted average excess monthly returns for loser, decile 5 and winner portfolios as well as the differences in monthly returns between winners and losers portfolios with their corresponding HAC adjusted t-statistics (t-stat) in traditional momentum and idiosyncratic momentum sorted portfolios. The returns are given in percentage terms. The samples cover January 1972 to December 2017 (represented by whole period), January 1972 to December 1995 (represented by sub-period 1) and January 1996 to December 2017 (represented by sub-period 2), respectively.

Table 5. Returns for Stocks with and without Options in Traditional Momentum Portfolios with 1-month Holding Period

Holding Period K=1						
	Stocks with Options			Stocks without Options		
Decile	Avg Ret	CAPM Alpha	FF3 Alpha	Avg Ret	CAPM Alpha	FF3 Alpha
Losers	0.872	0.271	0.314	1.025	0.694	0.670
2	0.850	0.707	0.766	0.920	0.783	0.786
3	0.830	0.560	0.577	0.837	0.656	0.651
4	0.760	0.525	0.587	0.901	0.746	0.698
5	0.636	0.471	0.542	1.087	0.930	0.966
6	0.530	0.305	0.382	1.171	0.956	0.972
7	0.767	0.456	0.535	1.203	1.074	1.080
8	0.703	0.500	0.533	1.131	1.078	1.107
9	0.825	0.691	0.787	1.567	1.474	1.530
Winners	1.307	0.825	1.142	1.661	1.647	1.684
WML	0.435	0.554	0.658	0.636	0.953	1.013
t-stat	0.79	0.84	0.99	2.11	2.58	2.69

Decile portfolios are formed every month from January 1998 to December 2017. Traditional momentum portfolios are formed by sorting stocks based on past 12-2 month total stock returns. Winner portfolio denotes decile 10, loser portfolio denotes decile 1, WML denotes winner-minus-loser portfolio. K is the number of months in holding period. The table reports the value weighted average excess monthly returns for every decile portfolio as well as the corresponding alphas of the CAPM and Fama-French (1993) three-factor model. The last two rows show the differences in monthly returns and the differences in alphas between winners and losers portfolios with their associated HAC adjusted t-statistics (t-stat) in traditional momentum sorted portfolios. Average returns and risk-adjusted returns are given in percentage terms. The samples are categorized into two groups, one is stocks with options another is stocks without options.

Table 6. Returns for Stocks with and without Options in Idiosyncratic Momentum Portfolios with 1-month Holding Period

Holding Period K=1						
	Stocks with Options			Stocks without Options		
Decile	Avg Ret	CAPM Alpha	FF3 Alpha	Avg Ret	CAPM Alpha	FF3 Alpha
Losers	0.746	0.400	0.428	0.825	0.553	0.560
2	0.407	0.294	0.289	0.728	0.639	0.630
3	0.864	0.592	0.666	0.925	0.793	0.796
4	0.928	0.803	0.840	0.988	0.774	0.753
5	0.825	0.526	0.551	1.042	0.791	0.789
6	0.668	0.261	0.363	1.013	0.851	0.850
7	0.863	0.699	0.756	1.218	1.120	0.119
8	0.758	0.635	0.672	1.141	1.005	1.022
9	0.709	0.440	0.534	1.193	1.052	1.081
Winners	1.024	0.671	0.770	1.275	1.187	1.216
WML	0.278	0.270	0.341	0.449	0.633	0.656
t-stat	0.77	0.67	0.84	2.11	2.64	2.69

Decile portfolios are formed every month from January 1998 to December 2017. Idiosyncratic momentum portfolios are formed based on past 12-2 month volatility-scaled idiosyncratic returns estimated over past 36-month rolling windows using Fama-French (1993) three-factor model. Winner portfolio denotes decile 10, loser portfolio denotes decile 1, WML denotes winner-minus-loser portfolio. K is the number of months in holding period. The table reports the value weighted average excess monthly returns for every decile portfolio as well as the corresponding alphas of the CAPM and Fama-French (1993) three-factor model. The last two rows show the differences in monthly returns and the differences in alphas between winners and losers portfolios with their associated HAC adjusted t-statistics (t-stat) in idiosyncratic momentum sorted portfolios. Average returns and risk-adjusted returns are given in percentage terms. The samples are categorized into two groups, one is stocks with options another is stocks without options.

Table 7. Returns for Stocks with and without Options in Momentum Portfolios with Holding Period of 3-month, 6-month and 12-month

		K=3		K=6		K=12	
		With Options	without Options	With Options	Without Options	With Options	Without Options
Panel A							
Traditional Momentum	P1	0.282	0.547	0.441	0.551	0.575	0.701
	P5	0.368	0.833	0.297	0.823	0.340	0.740
	P10	0.514	0.970	0.192	0.677	0.063	0.409
	WML	0.232	0.423	-0.249	0.126	-0.511	-0.293
	T-stat	0.68	2.25	-1.00	0.88	-2.67	-2.86
Panel B							
Idiosyncratic Momentum	P1	0.214	0.442	0.187	0.329	0.213	0.363
	P5	0.622	0.767	0.486	0.726	0.362	0.746
	P10	0.694	0.981	0.555	0.819	0.476	0.715
	WML	0.480	0.539	0.368	0.490	0.263	0.352
	T-stat	2.69	4.51	3.23	6.11	3.20	5.58

Decile portfolios are formed every month from January 1998 to December 2017. Panel A shows the results of traditional momentum, Panel B shows the results of idiosyncratic momentum results. Traditional momentum portfolios are formed by sorting stocks based on past 12-2 month total stock returns and idiosyncratic momentum portfolios are formed based on past 12-2 month volatility-scaled idiosyncratic returns estimated over past 36-month rolling windows using Fama-French (1993) three-factor model. Winner portfolio is denoted by P10, loser portfolio is denoted by P1, P5 denotes decile 5, WML denotes winner-minus-loser portfolio. K is the number of months in holding period. The table reports the value weighted average excess monthly returns for loser, decile 5 and winner portfolios as well as the differences in monthly returns between winners and losers portfolios with their corresponding HAC adjusted t-statistics (t-stat) in traditional momentum and idiosyncratic momentum sorted portfolios. The returns are given in percentage terms. The samples are categorized into two groups, one is stocks with options another is stocks without options.

Table 8. Short Interest of Traditional Momentum Portfolios

Panel A: All Firms			
Decile	All stocks	Stocks with Options	Stocks without Options
Average	0.058	0.067	0.041
t-stat	455.46	409.90	218.91

Panel B: Momentum Portfolios			
Decile	All stocks	Stocks with Options	Stocks without Options
Losers	0.088	0.105	0.056
2	0.067	0.078	0.045
3	0.058	0.067	0.042
4	0.053	0.060	0.039
5	0.049	0.055	0.036
6	0.047	0.053	0.036
7	0.048	0.054	0.036
8	0.050	0.056	0.037
9	0.054	0.062	0.038
Winners	0.066	0.081	0.041
WML	-0.021	-0.023	-0.015
t-stat	-32.05	-26.81	-17.99
	Difference in WML= -0.008	t-stat= -5.94	

Decile portfolios are formed every month from January 1998 to December 2017. Traditional momentum portfolios are formed by sorting stocks based on past 12-2 month total stock returns. Winner portfolio denotes decile 10, loser portfolio denotes decile 1, WML denotes winner-minus-loser portfolio. The table reports the time-series average of short interest and the differences in between winners and losers portfolios with their associated HAC adjusted t-statistics (t-stat).This table also represents the difference in spread portfolios between stocks with options and stocks without options as well as its corresponding t-statistics.

Table 9. Short Interest of Idiosyncratic Momentum Portfolios

Panel A: All Firms			
Decile	All stocks	Stocks with Options	Stocks without Options
Average	0.056	0.062	0.043
t-stat	380.11	341.33	176.98

Panel B: Momentum Portfolios			
Decile	All stocks	Stocks with Options	Stocks without Options
Losers	0.067	0.074	0.050
2	0.061	0.067	0.047
3	0.059	0.064	0.045
4	0.057	0.063	0.044
5	0.055	0.061	0.041
6	0.054	0.061	0.041
7	0.053	0.058	0.042
8	0.053	0.059	0.041
9	0.051	0.057	0.038
Winners	0.052	0.058	0.039
WML	-0.015	-0.016	-0.011
t-stat	-22.03	-20.06	-10.26
	Difference in WML=-0.005	t-stat= -3.71	

Decile portfolios are formed every month from January 1998 to December 2017. Idiosyncratic momentum portfolios are formed based on past 12-2 month volatility-scaled idiosyncratic returns estimated over past 36-month rolling windows using Fama-French (1993) three-factor model**.** Winner portfolio denotes decile 10, loser portfolio denotes decile 1, WML denotes winner-minus-loser portfolio. The table reports the time-series average of short interest and the differences in between winners and losers portfolios with their associated HAC adjusted t-statistics (t-stat).This table also represents the difference in spread portfolios between stocks with options and stocks without options as well as its corresponding t-statistics.

Table 10. Summary of Results

Panel A. Performances of returns during the period of 1996 to 2017				
Holding Months	**Traditional Momentum**		**Idiosyncratic Momentum**	
K=1	Positive	More insignificant	Positive	Less insignificant
K=3	Positive	Insignificant	Positive	Significant
K=6	Negative	Insignificant	Positive	Significant
K=12	Negative	Significant	Positive	Significant
Panel B. Performances stocks with options during the period of 1996 to 2017				
Holding Months	**Traditional Momentum**		**Idiosyncratic Momentum**	
K=1	Positive	Insignificant	Positive	Insignificant
K=3	Positive	Insignificant	Positive	Significant
K=6	Negative	Insignificant	Positive	Significant
K=12	Negative	Significant	Positive	Significant

This table shows the summary of results. Panel A shows the comparison of momentum return performances between the traditional momentum strategy and the idiosyncratic momentum strategy during the period from 1996 to 2017. Panel B shows the comparison of momentum return performances between the traditional momentum strategy and the idiosyncratic momentum strategy for stock with options.