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FINANCIAL ECONOMICS | RESEARCH ARTICLE

Does option trading affect idiosyncratic momentum?

Songchan Guo¹ and Unyong Pyo^{1*}

Abstract: Portfolios in idiosyncratic momentum are formed on past residuals of the Fama-French three factor model rather than past total returns. This study examines whether the idiosyncratic momentum strategy can sustain excess returns following the emergence of traded options. We compare idiosyncratic momentum returns with traditional momentum returns over different holding periods and over difference in traded options. Our results show that idiosyncratic momentum returns for stocks with options are positive for three, six, and twelve months following the formation date, while traditional momentum returns for those with options are insignificant or even turn to negative. We also find strong evidence that the enhanced information efficiency led by short selling has impacts more on traditional momentum than on idiosyncratic momentum. While traditional momentum disappears on stocks with traded options, idiosyncratic momentum survives and is still anomalous to the efficient market hypothesis.

Subjects: Corporate Finance; Investment & Securities; Risk Management

JEL Classification: G40; G14

Keywords: traditional momentum; idiosyncratic momentum; stock option trading; short sale constraints

ABOUT THE AUTHOR

Songchan Guo: My primary research is on behavioral finance. Although financial markets are generally considered efficient, it can show weakness in its efficiency as shown in this article. I believe that the momentum strategy is still open to productive research in behavioral finance.

Unyong Pyo: My research area covers behavioral finance, asset pricing, executive compensation, and corporate finance. Publishing articles in other areas, I return to behavioral finance for momentum strategy as examined in the paper. As finance research uncovers the profitability of momentum strategy, excess turns disappear over time. However, idiosyncratic momentum still survives and offers an interesting research question in behavioral finance.

PUBLIC INTEREST STATEMENT

The current article investigates idiosyncratic momentum strategy (IMS) relative to traditional momentum strategy (TMS) in the existence of traded stock options.

The momentum strategy implies that outperforming stocks maintain their good performance in the future, while under-performing stocks keep losing their stock price performance. Both strategies are implemented based on the past stock returns. While TMS are formed based on past total returns, IMS are constructed based on past residuals from the Fama-French 3-factor model, which is a well-known asset pricing model in investments.

While constraints on short-selling stock are known to contribute to TMS, traded stock options relax the constraints and increase stock price informativeness. The study found that IMS outperforms TMS, which loses profitability over time and over traded options. IMS generates excess returns even with traded stock options and still is considered anomaly on the asset pricing model.

1. Introduction

Excess returns from momentum strategies challenge the principle of weak form of market efficiency. Jegadeesh and Titman (1993) present the traditional momentum strategy (TMS), where portfolios are formed based on past total returns, and show that portfolios with a long position in past winners and a short position in past losers generate momentum profits. Subsequently, financial economists have conducted theoretical and empirical research to understand momentum strategies. In reviewing studies in momentum profits, Subrahmanyam (2018) attempts to streamline different explanations in momentum and suggest removing alternative explanations for better understanding.

Arena et al. (2008) document that stocks with higher idiosyncratic volatilities lead to higher momentum profits, confirming that momentum profits are more easily being arbitrated away for stocks with low unsystematic risk. Gutierrez and Pirinsky (2007) present the idiosyncratic momentum strategy (IMS), where portfolios are formed based on past residual returns. They find that IMS are profitable for years following the formation date. More recently, Blitz et al. (2018) confirm that IMS delivers excess returns and argue that idiosyncratic volatilities 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 IMS profits in the U.S. stock market. However, they do not consider impacts of option trading on momentum returns.

We build on Blitz et al. (2018) to examine whether IMS could deliver significant returns relative to TMS in the U.S. stock markets following the introduction of options trading markets. 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 losses that might occur 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. However, as the number of stocks with traded options has dramatically increased since the Chicago Board Options Exchange (CBOE) was established in 1973, returns from TMS has been shrunk in the U.S. stock market over the recent decades.

Examining TMS, Abhyankar et al. (2018) find that enhanced arbitrage capital flows and lower stock trading costs reduce momentum returns. The stock option market reduces short-selling constraints and improves stock price informativeness. As a result, they also show evidence that the expansion of stock option market is connected to shrinking momentum returns. If idiosyncratic momentum profits are positive and stable more than the traditional momentum profits following the emergence of traded options, we expect that option trading does not affect idiosyncratic momentum. Our results might support the finding of Blitz et al. (2018) that IMS is superior to TMS with traded options, implying that the idiosyncratic momentum might offer an even bigger anomaly on the asset pricing literature.

Using data on the U.S. stocks from CRSP (Center for Research in Security Prices) and on the corresponding financial results from Compustat database during 1972–2017, we compute traditional momentum and idiosyncratic momentum returns as in Blitz et al. (2018) for the entire period and the two sub-periods: 1972–1995 and 1996–2017 for the three holding periods: 3, 6, and 12 months. The second sub-period during 1996–2017 represents the expansion of the stock option market. Our results show that TMS generates an average monthly return of 0.563%, 0.948%, and 0.138% for the periods 1972–2017, 1972–1995, and 1996–2017, respectively, when we set the holding period as 3 months, but the return for the second sub-period is insignificant. When we extend the holding periods to 6 and 12 months, the traditional momentum returns keep declining and become negative over the last sub-period: 1996–2017. More specifically, we find that for stocks with options traditional momentum profits are negative and lower than those for stocks without options over the same period.

When we examine IMS, we find that returns are significant at 0.611%, 0.751%, and 0.458% over the corresponding periods, when the holding period is 3 months. While the idiosyncratic momentum return for the first sub-period is somewhat smaller than the traditional momentum return, we find that the pattern is reversed during the last sub-period. As we extend holding periods to 6 and 12 months, IMS consistently generates positive returns.

On the other hand, Abhyankar et al. (2018) adopt TMS and show that high short interest indicates lower mispricing power and hence lower momentum returns. If investors can hedge short positions on stocks with traded options, the short interest in loser portfolios of stocks with options is expected to be higher than that in loser portfolios of stocks without options. Hence, the short interest in WML (Winner-Minus-Loser) spread for stocks with options will be negative. They confirm that the short interest in WML spread for stocks with options is significantly negative, while that for stocks without options is insignificant. That is, stocks without options are more likely to generate higher momentum returns than stocks with options.

We contribute to the literature of behavioral finance in three ways. First, we find evidence to support the findings of Blitz et al. (2018) that IMS can generate more stable profits than TMS even after the emergence of traded options. Second, while Abhyankar et al. (2018) show that option trading reduces momentum returns, we find that the impacts of option trading on idiosyncratic momentum returns are trivial. That is, option trading has more impact on TMS than on IMS. Third, we show that enhanced information efficiency by incorporating option trading has less impacts on the profitability of IMS. Our results are consistent with the findings in

Gutierrez and Pirinsky (2007) that investors' overreaction attributes to TMS, while investors' under reaction attributes to IMS. Our findings suggest that IMS presents an even bigger challenge to the conventional asset pricing literature.

We construct the rest of the paper as follows. Section 2 provides reviews on the relevant literature and develops hypotheses. We describe our data and models designed to test the hypotheses in Section 3. We present empirical results and implications in Section 4. Conclusion is provided in Section 5.

2. Literature review and hypotheses

2.1. Traditional momentum strategy (TMS)

Presenting their pioneering work in behavioral finance, De Bondt and Thaler (1985) find that past losers outperform past winners in the long-run and suggest that investors tend to show overreaction to unforeseen news. Jegadeesh and Titman (1993) present momentum effects with TMS. They show 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-month holding periods following the formation date in the U.S. market. They argue that the out-performance of momentum strategy is due to investor's under-reaction to news. Furthermore, Fama and French (1996) show that the three-factor model fails to explain momentum anomaly though it explained some other anomalies. 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.

Ang et al. (2006) find that high idiosyncratic volatilities on stock returns have a negative effect on cross-sectional stock returns and that such relation persists even after controlling for momentum effects. By analyzing the U.S. stock data from 1965 to 2002, Arena et al. (2008) show that portfolios with higher idiosyncratic volatilities generate higher momentum profits, whereas those profits are

reversed faster than profits from portfolios with lower idiosyncratic volatilities. They suggest that under-reaction to firm-specific information is the reason of momentum returns. Pyo and Shin. (2013) confirm that high idiosyncratic volatilities attribute to higher momentum returns in the Korean stock market. They confirm that the Fama-French three-factor model fails to explain momentum profits.

2.2. Idiosyncratic momentum strategy (IMS)

While TMS forms portfolios with past total returns, IMS forms portfolios based on past residual returns. Gutierrez and Pirinsky (2007) present that IMS is profitable for years following the formation date, while the TMS reverses significantly. Blitz et al. (2018) argue, “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 a portfolio taking a long position on winners from IMS and a short position on losers from TMS generates long-term excess returns. Furthermore, they confirm similar results in Japan, Europe, Asia Pacific and emerging markets. However, they did not consider momentum returns relative to option trading.

Therefore, our first hypothesis is:

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

Dividing their sample data into two groups based on whether stocks have options or not during the period 1996–2016, Abhyankar et al. (2018) find that stock option markets can provide more information about stocks by lowering short-sale barriers. If the stocks in loser portfolios have put options traded on them, option market makers would hedge their potential losses by selling the underlying stocks. Therefore, investors bear less constraints on short-selling stocks. However, when Abhyankar et al. (2018) demonstrate that the increased profits from past loser stocks with options lead to the attenuation of momentum profits, they use TMS.

Therefore, our second hypothesis is:

H2. The Idiosyncratic momentum strategy (IMS) generate profits during 1996 to 2017, while the traditional momentum strategy (TMS) does not, when momentum portfolios are held for 3, 6, 12 months.

2.3. Momentum strategy and options markets

Abhyankar et al. (2018) partition all stocks into two groups, stocks with and without options over the period 1996–2016. They show that TMS is more profitable for stocks without options, but not significant for stocks with options. Grossman (1988) argues 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 TMS and IMS and that the differences between the returns are more pronounced in TMS.

Therefore, our third hypothesis is:

H3. Momentum strategies are less profitable for stocks with options than those without options, and the decreased profitability is more pronounced in the traditional momentum strategy (TMS) than in the idiosyncratic momentum strategy (IMS).

2.4. Momentum strategy and short interest

Short interest represents the percentage of shares that sold short. It is a market sentiment indicator that shows 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. In short-selling, traders borrow stocks from share owners, sell them, and eventually buy back the shares in the future hopefully at a lower price. By doing so, traders can hedge potential losses.

While constraints in short-selling stocks reduce short interest, 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 on 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 is, stocks without options are more likely to generate higher momentum returns than stocks with options. By running Fama and MacBeth (1973) regressions, Abhyankar et al. (2018) also find that the coefficient of short interest is negative, indicating that lower short interest results in higher mispricing and higher momentum profits. However, they focus on TMS rather than IMS in their study. If the average short interest is lower in idiosyncratic momentum than in traditional momentum, then we confirm the findings in Blitz et al. (2018) that IMS is more profitable than TMS.

Thus, our fourth hypothesis is:

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

3. Data and methodology

3.1. Data

We obtain monthly stock returns data from the Center for Research in Security Prices (CRSP) during January 1969–December 2017. Since we use observations from January 1969 to December 1971 to construct 36-month rolling windows, our data covers periods during January 1972–December 2017. 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 NASDAQ markets (i.e. exchange codes 1, 2, and 3). We exclude stocks with prices lower than 5 USD at the end of the month, and financial stocks (i.e. stocks with SIC codes between 6000 and 6900). 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. Data on short interest from the Supplemental Short Interest file are collected from COMPUSTAT. To retain a longer sample, we use the mid-month data, which is available before September 2017. We calculate shares sold short on each stock 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), which makes our data 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.

3.2. Methodology

We employ holding periods commonly adopted in the literature of momentum studies: 3, 6, and 12 months in contrast to Abhyankar et al. (2018) and Blitz et al. (2018), who adopt one-month holding periods.

3.2.1. Traditional momentum

Following the methodology in Blitz et al. (2018), we calculate total returns during the period from the past 12 to the past 2 months 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 3, 6, and 12 months following a formation date. P1 denotes loser portfolios, where stocks have performed worst and P10 denotes winner portfolios, where 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.

3.2.2. Idiosyncratic momentum

We take multiple steps to compute idiosyncratic momentum. As conducted in Blitz et al. (2018), we follow the methodologies in Gutierrez and Pirinsky (2007) 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 Fama-French 3-factor model.

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{mkt,i}(R_{mkt,i} - R_{f,t}) + \beta_{hml,i}R_{hml,t} + \beta_{smb,i}R_{smb,t} + \varepsilon_{i,t} \quad (1)$$

where $(R_{i,t} - R_{f,t})$ is the excess return of stock i in month t over risk-free rate in month t .

$(R_{mkt} - R_f)$ is market risk premium. R_{hml} and R_{smb} are the factors of value stocks over growth stocks and small caps over big caps. α_i and β_s are the parameters to be estimated. The reason that we use 36-month rolling windows is to make sure that we have adequate numbers of observations to acquire accurate estimates. Therefore, the eligible stocks to run the above regression are those which have the entire 36 monthly returns.

Second, the idiosyncratic returns are constructed as:

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

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

$$idiosyncratic\ momentum = \frac{\sum_{t=12}^{t-2} e_{i,t}}{\sqrt{\sum_{t=12}^{t-2} (e_{i,t} - \bar{e}_t)^2}} \quad (3)$$

where \bar{e}_t denotes as the average residual returns.

While traditional momentum portfolios are sorted based on past 12-month total returns skipping the most recent month, idiosyncratic momentum portfolios are sorted based on past 122 months idiosyncratic returns standardized by its standard deviation during the same period. Gutierrez and Pirinsky (2007) show that standardizing returns can improve the measure of returns derived from firm-specific information. Hence, we standardize returns to reduce the concerns of

noisy information and improve the reliabilities of the idiosyncratic momentum return measurements.

We hold all idiosyncratic momentum portfolios for 3, 6, and 12 months following the formation date. P1 represents loser portfolios, P10 represents 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.

4. Empirical results

Examining 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 represent time periods without options and with options, respectively. We start by presenting our traditional and idiosyncratic momentum returns produced by spread portfolios with holding period, $K = 3, 6, 12$ months following a formation date. 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.

4.1. Momentum returns

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 three months. Table 1 reports average excess returns of each decile portfolio, where all returns are monthly and value-weighted. The spread portfolios are constructed by taking a long position in winner

Table 1. Performance of Traditional Momentum Portfolios for 3-month Holding Period

Holding Period K=3									
	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	0.393	-0.024	-0.022	0.358	-0.202	-0.196	0.431	0.170	0.180
2	0.523	0.184	0.191	0.554	0.015	-0.003	0.490	0.370	0.389
3	0.628	0.254	0.255	0.642	0.142	0.155	0.613	0.378	0.377
4	0.664	0.270	0.262	0.647	0.084	0.081	0.684	0.474	0.472
5	0.698	0.331	0.333	0.822	0.257	0.259	0.562	0.406	0.417
6	0.729	0.400	0.423	0.934	0.397	0.464	0.502	0.396	0.414
7	0.840	0.517	0.558	0.989	0.466	0.537	0.676	0.568	0.609
8	0.838	0.527	0.558	1.112	0.599	0.651	0.536	0.445	0.482
9	0.856	0.517	0.589	1.211	0.681	0.749	0.464	0.327	0.415
Winners	0.956	0.656	0.743	1.307	0.850	0.921	0.569	0.427	0.543
WML	0.563	0.680	0.765	0.948	1.052	1.116	0.138	0.257	0.363
T-stat	3.20	3.39	3.76	4.90	4.70	4.84	0.46	0.75	1.06

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 and 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 cover January 1972 to December 2017, January 1972 to December 1995 and January 1996 to December.

portfolios and a short position in loser portfolios and are held for three months. Table 1 also reports CAPM alphas and alphas from the Fama-French three-factor model for each decile portfolio and spread portfolio over the three sample periods. We find patterns similar to findings by Abhyankar et al. (2018) for TMS. WML spread portfolios generate significant momentum returns of 56.3 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 at 94.8 bps. However, WML momentum strategies become much less profitable with a return of 13.8 bps during the second sub-period from January 1996 to December 2017.

Table 2 presents descriptive statistics of the performance of idiosyncratic momentum portfolios that are held for three months. 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. Over the entire sample time period from 1972 to 2017, the WML portfolios generate a positive momentum return of around 61.1 bps. Over the period from 1972 to 1995, IMS provides even a much higher return of 75.1 bps. The momentum return drops to 45.8 bps during period 1996 to 2017. However, it is still significant as opposed to that in TMS. For CAPM and the Fama-French three-factor, their alphas show patterns similar to average excess returns: with highest WML returns over period from 1972 to 1995 and with lowest but still significant WML returns over the period from 1996 to 2017.

We find that IMS has become less profitable ever since the appearance of options market in 1996. However, Comparing Tables 1 with 2, we find that returns in IMS remains significant while

Table 2. Performance of Idiosyncratic Momentum Portfolios for 3-month Holding Period

Holding Period K = 3

Decile	January 1972— December 2017			January 1972— December 1995			January 1996— December 2017		
	Avg Ret	CAPM	FF3	Avg Ret	CAPM	FF3	Avg Ret	CAPM	FF3
Losers	0.377	0.004	0.025	0.401	-0.142	-0.132	0.349	0.171	0.205
2	0.454	0.107	0.129	0.595	0.047	0.055	0.297	0.166	0.201
3	0.620	0.259	0.283	0.644	0.128	0.143	0.593	0.399	0.429
4	0.724	0.339	0.356	0.766	0.158	0.178	0.678	0.539	0.556
5	0.772	0.396	0.417	0.892	0.323	0.361	0.638	0.471	0.499
6	0.780	0.440	0.459	0.931	0.407	0.433	0.613	0.474	0.496
7	0.805	0.502	0.513	0.970	0.462	0.493	0.623	0.539	0.547
8	0.832	0.494	0.543	1.010	0.471	0.505	0.635	0.514	0.574
9	0.838	0.535	0.554	1.047	0.577	0.624	0.606	0.483	0.511
Winners	0.988	0.629	0.678	1.152	0.590	0.654	0.807	0.668	0.720
WML	0.611	0.625	0.653	0.751	0.731	0.786	0.458	0.497	0.515
T-stat	6.09	5.38	5.33	5.73	4.75	4.95	2.98	2.83	2.90

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 and 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 and 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.

returns in TMS are not significant. We support H1 that IMS is less affected by traded options than TMS, although IMS has become less profitable since 1996.

To examine whether our results are affected by different holding periods, we consider two more holding periods with six-month and twelve-month. Table 3 reports 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. It also reports 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 the holding period is 3-month, the WML momentum portfolios generate a positive return of 56.3 bps 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. However, the average momentum return drops dramatically and becomes insignificant at 13.8 bps during 1996–2017. TMS delivers an average return of 23.5 bps over period 1972–2017, when the holding period extends to six months, but the result is not significant. The difference in returns between winner portfolio and loser's rises to approximately 70.4 bps during the period from 1972 to 2017. However, the momentum return becomes insignificant at –28.8 bps since options started trading in 1996. Past winner portfolios underperform past loser portfolios by 20.2 bps over period 1972 to 2017, when portfolios are held for 12 months after formation date. However, past winner portfolios outperform past loser portfolios by 9.2 bps over the first sub-period. During the second sub-period, the monthly average momentum return becomes negative again at around –53.8 bps. WML momentum returns are significantly negative during the entire period and the second sub-period, 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, IMS generates an average monthly abnormal return of 61.1 bps during 1972–2017. The return continues to stay high over the first sub-period from 1972 to 1995 at around 75.1 bps, but drops to 45.8 bps in the second sub-period. 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 IMS are significantly positive with holding period $K = 3, 6$, and 12 months.

Focusing on the momentum returns during the whole period, we find that the average returns are 56.3, 23.5 and –20.2 bps in TMS when holding periods are three-month, six-month and twelve-month, respectively. In contrast, the average returns are 61.1, 56.5, and 42.7 bps in IMS for the corresponding holding periods. Our results are consistent with the findings in Blitz et al. (2018) that TMS 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, IMS generate significant returns in 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 3, we find that the IMS can still generate positive average monthly returns over the period 1996–2017 although those returns slightly decline compared with those over the period 1972–1995. However, TMS becomes non-profitable over 1996 to 2017. We show that idiosyncratic momentum profits attenuate following the availability of equity options trading. Furthermore, we support our second hypothesis that IMS generate higher profits than TMS in time periods with trading options.

Table 3. Momentum Returns by Holding Periods K = 3, 6, 12

		K = 3			K = 6			K = 12		
		Whole period	Sub 1	Sub 2	Whole period	Sub 1	Sub 2	Whole period	Sub 1	Sub 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	0.401	0.349	0.296	0.320	0.269	0.349	0.382	0.310
	P5	0.772	0.892	0.638	0.696	0.837	0.539	0.656	0.822	0.467
	P10	0.988	1.152	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 and French (1993) three-factor model. Winner portfolio is denoted by P1, loser portfolio is denoted P5, 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 1) and January 1996 to December 2017 (represented by sub 2), respectively.

4.2. Increase in stocks with traded options

Table 4 displays the numbers and percentages of stocks with and without traded options for every year over our sample period from 1998 to 2017. It shows that the number and the percentage of stocks with traded options significantly increase 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.

4.3. Momentum portfolios relative to traded options

Following Abhyankar et al. (2018), we partition our sample during the period from 1998 to 2017 into two groups: stocks with options and stocks without options because our options data from CBOE is available since 1998. In Table 5, we present value-weighted average monthly excess returns in each decile as well as those in spread portfolios, which are held for three months. We also report CAPM alphas and Fama-French alphas for each decile portfolio and WML portfolios for stocks with options and those without options. Our results show that the average spread portfolio return is 4.2 bps with t-statistics as 0.13 among stocks with options.

Table 4. 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 5. Returns for Stocks with and without Options in Traditional Momentum Portfolios with 3-month Holding Period

Holding Period K = 3

Decile	Stocks with Options			Stocks without Options		
	Avg Ret	CAPM	FF3	Avg Ret	CAPM	FF3
Losers	0.390	0.168	0.210	0.613	0.155	0.136
2	0.353	0.255	0.263	0.556	0.188	0.190
3	0.550	0.437	0.469	0.644	0.262	0.249
4	0.422	0.227	0.224	0.704	0.345	0.338
5	0.409	0.261	0.280	0.816	0.429	0.424
6	0.399	0.341	0.356	0.882	0.526	0.537
7	0.336	0.210	0.268	0.887	0.496	0.509
8	0.583	0.548	0.571	0.840	0.537	0.542
9	0.398	0.256	0.312	0.914	0.608	0.660
Winners	0.432	0.379	0.497	1.022	0.635	0.695
WML	0.042	0.212	0.287	0.408	0.480	0.559
t-stat	0.13	0.58	0.79	2.22	2.25	2.58

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 and 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.

Consistent with Abhyankar et al. (2018)'s results, we find that WML spread portfolios without options generate positive and significant momentum returns at 40.8 bps on average, and the return is around 36.6 bps higher than that for stocks with options. The CAPM and Fama-French three-factor model alphas show patterns similar to that of 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. Table 6 presents descriptive statistics on average monthly returns for stocks with and without options in idiosyncratic momentum portfolios. We observe that the average idiosyncratic momentum return for stocks with options is low at around 47.6 bps, while the average return for stocks without options is much higher at around 53.9 bps. 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 a little lower but still statistically significant for stocks with options. Based on the results above, it appears that the reduction in profits for the IMS over the period from 1998 to 2017 is mainly driven by stocks with options, when those portfolios are held for three months. We support our third hypothesis that IMS is less profitable for stocks with options. We also confirm that insignificant returns for stocks with options are pronounced for TMS.

Table 7 displays the value-weighted monthly returns of P1, P5, and P10 for stocks with and without options when the holding periods are 3, 6, and 12 months, respectively. Table 7 also presents the WML spread portfolio monthly returns and their corresponding t-statistics. Panel

Table 6. Returns for Stocks With and Without Options in Idiosyncratic Momentum Portfolios with 3-month Holding Period

Holding Period K = 3

Decile	Stocks with Options			Stocks without Options		
	Avg Ret	CAPM Alpha	FF3 Alpha	Avg Ret	CAPM Alpha	FF3 Alpha
Losers	0.215	0.101	0.135	0.442	0.027	0.034
2	0.089	0.018	0.043	0.527	0.167	0.173
3	0.453	0.244	0.282	0.713	0.393	0.399
4	0.522	0.418	0.441	0.770	0.365	0.372
5	0.615	0.465	0.503	0.767	0.403	0.424
6	0.570	0.405	0.440	0.818	0.468	0.460
7	0.469	0.404	0.418	0.928	0.641	0.635
8	0.535	0.463	0.508	0.830	0.456	0.497
9	0.407	0.268	0.316	0.882	0.546	0.555
Winners	0.691	0.585	0.645	0.981	0.635	0.680
WML	0.476	0.484	0.510	0.539	0.608	0.646
t-stat	2.62	2.41	2.52	4.51	4.38	4.60

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 and 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 and 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.

A shows return performance for stocks with and without options in traditional momentum. When momentum portfolios are held for three months, spread portfolios with stocks with options deliver an insignificant return at 4.2 bps, but those with stocks without options generate an average return of 40.8 bps. The average momentum returns become insignificantly negative at –24.9 bps and positive at 12.6 bps for portfolios with options and without options, respectively, when momentum decile portfolios are held for six months. 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 significantly negative momentum return at –51.1 bps, while stocks without options also generate a negative but small average momentum return at –29.3 bps.

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 those in traditional momentum. That is, lower returns are delivered from stocks with options and higher returns from stocks without options. However, momentum remain positive and significant for 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 IMS generate returns more stable than TMS. Our findings support the third

Table 7. Returns for Stocks with and without Options in Momentum Portfolios							
		K = 3		K = 6		K = 12	
		With Opt	without Opt	With Opt	Without Opt	With Opt	Without Opt
Panel A							
Traditional Momentum	P1	0.390	0.613	0.441	0.551	0.575	0.701
	P5	0.409	0.816	0.297	0.823	0.340	0.740
	P10	0.432	1.022	0.192	0.677	0.063	0.409
	WML	0.042	0.408	-0.249	0.126	-0.511	-0.293
	T-stat	0.13	2.22	-1.00	0.88	-2.67	-2.86
Panel B							
Idiosyncratic Momentum	P1	0.215	0.442	0.187	0.329	0.213	0.363
	P5	0.615	0.767	0.486	0.726	0.362	0.746
	P10	0.691	0.981	0.555	0.819	0.476	0.715
	WML	0.476	0.539	0.368	0.490	0.263	0.352
	T-stat	2.62	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 and 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.

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 pronounced in TMS.

4.4. Short interest and momentum portfolios

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. In panel A, we find that the average short interest for stocks with options is 6.7%, which is higher than that for stocks without options at 4.1%. In panel B we report that the short interest in loser portfolios for stocks with options is very high at 10.5%, resulting in a significantly negative average short interest for WML spread portfolios at -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 a test to determine 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 significantly lower 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 for stocks with options is

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 and 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.

6.2%, while that for stocks without options is 4.3%. 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 then the lower momentum returns (Abhyankar et al., 2018). Panel B shows that the average short interest in loser portfolio for stocks with options is very high at around 7.4%, leading to a negative short interest for WML spread portfolios at -1.6%. In contrast, an average short interest for stocks without options is 5.0% for loser portfolios and that for winner portfolios 3.9%, resulting in a smaller difference for WML spread portfolios at -1.1%. Conducting whether the difference between the average short interests of the two WML spread portfolios is statistically significant, we find that the two short interests are different from zero.

That is, the short interest of stocks with options is lower than that without options.

Comparing Tables 8 with 9, we show that the average short interest ratios of portfolios with and without options is higher for traditional momentum than those for idiosyncratic momentum, resulting in a lower mispricing and therefore lower returns for TMS (Abhyankar et al., 2018). The results support the fourth hypothesis that the average short interest for idiosyncratic momentum is smaller than that for traditional 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 TMS is higher than that on IMS.

Table 10. Summary of Results

Panel A. Performances of returns during the period of 1996 to 2017

Holding Months	Traditional Momentum		Idiosyncratic Momentum	
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 = 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.

Table 10 shows the summary of our main findings. Panel A shows the comparison of momentum return performances between TMS and IMS during the period from 1996 to 2017. Panel B shows the comparison of momentum return performances between two strategies for stock with options. IMS consistently generates excess returns with or without available stock options, while TMS do not provide excess returns with available stock options.

Abhyankar et al. (2018) show that traditional momentum disappears over time with traded stock options. On the other hand, Blitz et al. (2018) suggest that idiosyncratic momentum survives over time and should be considered as a separate pricing factor in improving the efficient frontier established by common asset pricing factors. We find evidence that IMS as opposed to TMS still generates excess returns over time with traded stock options. It appears that idiosyncratic momentum is not priced in common asset pricing models even with traded stock options.

5. Conclusion

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 three, six, and twelve months. We find that idiosyncratic momentum returns are still positive during 1996–2017, although they are a little lower than those during 1972–1995, while traditional momentum returns become insignificant and even turn to negative during the same period.

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

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 can hedge their risk similar to short selling. Hence, the mispricing nature has been reduced and so have momentum returns. Our results show that the average short interest for idiosyncratic momentum portfolios is lower than that for traditional momentum portfolios. In addition, the average short interests for WML spread portfolios in IMS are smaller than that in TMS. 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 TMS is larger than that on IMS. In summary, our results show that IMS produces returns more stable than TMS following the emergence of traded options. While the options trading increases informativeness on stock pricing, the enhanced information efficiency available with options trading has impacts less on the profitability of IMS than on that of TMS.

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