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Momentum, Idiosyncratic Volatility and Market Dynamics: Evidence from China

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Abstract

Recent evidence on the relation between momentum and idiosyncratic volatility (IV) in the U.S. is mixed. We verify the relation between momentum and IV in China and find at best, no relation supporting the view that idiosyncratic risk is not a significant arbitrage cost for momentum returns. While the absence of a positive relation between momentum returns and IV rejects both the underreaction and the overconfidence and self-attribution stories of momentum, we find support for the overconfidence and self-attribution story from our results on market dynamics and momentum. Our results are robust when verified in other Asian markets. We also find support for the suggestion that cross-country differences in momentum returns could be the result of differences in market dynamics rather than differences in levels of individualism as suggested earlier in the literature.

JEL Classification: G12, G14

Keywords: momentum; idiosyncratic volatility; market dynamics; arbitrage cost; overconfidence

1. Introduction

The momentum anomaly was first documented in the U.S. stock markets by Jegadeesh and Titman (1993) who showed that recent winner (loser) stocks continue winning (losing) over the next three to 12 months and that a zero-cost portfolio that buys recent winners and short sells recent losers produced significant abnormal returns. The momentum anomaly has since been documented in several other countries and other asset classes (e.g. Asness, Moskowitz and Pedersen, 2013; Rouwenhorst, 1998).

Though the existence of the momentum anomaly is now well accepted, its source and the reason for its persistence are still contentious. Two of the most prominent behavioural explanations of the momentum anomaly include the underreaction story of Barberis, Shleifer and Vishny (1998) and Hong and Stein (1999), and the overconfidence and self-attribution story of Daniel, Hirshleifer and Subrahmanyam (1998). Meanwhile the persistence of these anomalous momentum profits is usually attributed to arbitrage costs. These arbitrage costs come in the form of holding and transaction costs. Holding costs are considered as the primary source of arbitrage costs (Ackert and Tian, 2000; Ben-David and Roulstone, 2005; Pontiff, 2006; Shleifer and Vishny, 1997) while idiosyncratic is risk deemed as the primary holding cost (Pontiff, 2006; Shleifer and Vishny, 1997).

Arena, Haggard and Yan (2008) examine the relation between price momentum and idiosyncratic volatility (IV) in U.S. stocks and find a strong positive relation supporting both the underreaction and overconfidence stories. Their results also support the view that the persistence of the momentum anomaly is the consequence of idiosyncratic risk limiting arbitrage. However, in a subsequent study, McLean (2010) finds that momentum returns are not related to IV. McLean (2010) shows that Arena et al.'s (2008) results were derived using a biased sample that excluded small size and low-priced stocks thereby eliminating most of the high IV stocks in their sample. Apart from rejecting both the underreaction and

overconfidence stories, McLean's (2010) results imply that idiosyncratic risk is not a limit to the arbitrage of momentum returns. McLean (2010) suggests instead that the momentum effect persists due to transactions costs. We extend the literature on momentum and idiosyncratic risk by focusing on China, the world's largest emerging market and test the robustness of our results in other selected Asian markets.

The underreaction model of Barberis et al. (1998) propose that investors underreact to new public information which prolongs the time for this information to adjust into prices. This results in momentum or price continuation that gives rise to momentum returns. Alternatively, Hong and Stein (1999) posit that momentum is driven by the activities of news watchers and momentum traders with the former primarily relying on private information for their trades and the latter primarily relying on historical data. Hong and Stein argue that an assumption of slow diffusion of private information will initially lead to under reaction from news watchers which then results in momentum. This in turn attracts momentum traders whose activities result in overreaction that eventually turns into long-term reversal. In as much as a stock's idiosyncratic volatility (IV) is a proxy for firm-specific information, there should be a positive relation between Momentum and IV if momentum is driven by investor underreaction to firm-specific information.

Daniel et al. (1998) propose another model in which investors exhibit overconfidence and self-attribution bias. In this framework, investors are overconfident with their private information and therefore underreact to public information. Due to self-attribution bias, confirming public information increases investor overconfidence while disconfirming public information only dampens it disproportionately. Thus, their model offers two mechanisms that contribute to the momentum profitability, gradual correction of investor underreaction to the public information and the continued investor overreaction to private information due to self-attribution bias. Based on Einhorn (1980), Daniel et al. (1998) *presume* that investors

will become more overconfident in nebulous situations where "feedback on their information or decisions is slow or inconclusive than where feedback is clear and rapid" (Daniel et al. 1998, p. 1859). This presumption implies that momentum returns would be higher for stocks that are hard to value. To the extent that high IV stocks are hard to value, the framework also suggests a positive relationship between momentum returns and IV.

Apparently, both the underreaction, and the overconfidence and self-attribution models predict a positive relation between momentum returns and IV, hence this relation cannot discriminate between these models. However, we can discriminate between these models in terms of their predictions about the effect of market dynamics on momentum returns. The overconfidence and self-attribution model of Daniel et al. (1998) predicts higher momentum returns when markets continue in the same state than when they transition to a different state. This is because of increased investor overconfidence and continued overreaction to private information in light of confirming public information, e.g., when buys are followed by UP markets or sells are followed by DOWN markets. In contrast, the underreaction model of Hong and Stein (1999) predicts higher momentum returns when the market continues UP or transitions UP. This is because increased wealth during UP markets reduces investor risk aversion and reduced risk aversion among momentum traders causes them to delay their overreaction which in turn leads to higher momentum returns.

Asem and Tian (2010) examine momentum returns in the U.S. markets during market continuations and market transitions. They define market continuation as a case when the past 12-month (t-11 to t) and subsequent month (t+1) market returns are both positive or negative, and market transition when the past 12-month and subsequent month market returns have unidentical signs. They find higher momentum returns in market continuations relative to the market transitions consistent with the overconfidence and self-attribution model of Daniel et al. (1998), but inconsistent with the underreaction model of Hong and Stein (1999). Hanauer

(2014) also finds higher and significant momentum returns in Japan when the market continues in the same state. Furthermore, he argues that it is the different market dynamics and not the low level of individualism that causes low momentum returns in Japan. Meanwhile Cheema and Nartea (2017) also find that momentum returns in China are stronger when markets continue in the same state than when they transition to a different state but only when markets continue in the DOWN state. In fact they find that momentum returns in China exclusively follow DOWN market states. Therefore their results are more consistent with Daniel et al.'s model rather than Hong and Stein's.

In this paper, we focus on the relation between momentum and IV in China, and in particular during DOWN markets where momentum returns are strongest. We choose to focus on China for two reasons. First it is not only the world's largest emerging market but also the world's second largest stock market based on the combined market capitalization of the Shanghai and Shenzhen stock exchanges. The Chinese economy is also the second largest globally and China is the world's largest investor. Understandably, China's financial markets are vital in sustaining global economic growth making it imperative for the finance community to gain a better understanding of its stock markets. Second, the Chinese stock markets are interesting case studies as they are a segmented market dominated by domestic retail investors who are known to exhibit several behavioural biases i.e., they are overconfident, exhibit the disposition effect, and are prone to the representativeness bias (Chen, Kim, Nofsinger and Rui, 2004). The government imposed restrictions on capital flows and holdings virtually render the Chinese stock markets as a segmented market allowing us to consider investors who have preferences that are completely different from other developed markets that are integrated or other emerging markets that are partially integrated (Nartea, Kong and Wu, 2017).

We use a combined sample of A-shares in the Shanghai and Shenzhen stock exchanges of China over the period 1995-2016 and contrary to the findings of Arena et al. (2008) for the U.S., but consistent with the results of McLean (2010), we do not find a positive relation between momentum and IV. In fact, we find a weakly negative (not positive) but statistically insignificant relationship between unconditional momentum returns and IV. We report an equal-weighted momentum return (alpha) spread of -0.23% (-0.25%) per month between high IV and low IV portfolios with a corresponding value-weighted return (alpha) spread of -0.40% (-0.19%) per month. These results survive a battery of robustness tests.

Conditioning momentum returns on market dynamics, we confirm the earlier results reported in Cheema and Nartea (2017) that momentum returns in China exclusively follow DOWN market states especially when the market continues in the DOWN state. Consequently, we test for the presence of a positive relation between momentum returns and IV when the market continues in the DOWN state where momentum returns are supposed to exist. However, the absence of a positive relation between momentum returns and IV persists, even in this market state.

In international robustness tests, we also find that momentum returns in Japan, Malaysia, Indonesia, Korea, Hong Kong and Singapore are higher in market continuations, both in the UP and DOWN states, than in market transitions providing strong support to the overconfidence and self-attribution model of Daniel et al. (1998) but not to the underreaction model of Hong and Stein (1999). More importantly, the absence of a relation between momentum and IV persists in these countries even in market continuations.

Therefore, our results support the view that idiosyncratic risk is not a binding limit to the arbitrage of momentum returns in China as well as in other Asian markets, consistent with the U.S. results of McLean (2010). Meanwhile, though the absence of a positive relation between momentum returns and IV is inconsistent with either the underreaction or

overconfidence stories of momentum, our result showing that momentum returns are conditioned by market dynamics in China and in other Asian markets provides support for the overconfidence and self-attribution story of Daniel et al. (1998), where continued overreaction to the private information in light of the confirming public information contributes to the profitability of momentum strategy, but is inconsistent with the underreaction story of Hong and Stein (1999).

Finally, it is interesting to note that the generally low unconditional momentum returns in China and other Asian markets relative to the U.S. could possibly be explained by cross-country differences in market dynamics as earlier shown by Hanauer (2014) for Japan and a few other markets, rather than to cross-country differences in individualism as suggested earlier by Chui, Titman, and Wei (2010). We find in China and in other Asian markets that relative to the U.S., there were less market continuations where momentum returns are stronger, and more market transitions where momentum returns are weaker if not negative. This is unsurprising given evidence that Asian stock markets are more volatile than the U.S markets (e.g. Diamonte, Liew and Stevens, 1996; Lin, Menkveld and Yang, 2009).

We contribute to the literature in several ways. First in view of the mixed evidence on the relation between momentum and IV based on U.S. data, we provide important out of sample evidence from China the world's largest emerging market, as well in selected Asian markets, of the absence of a positive relationship between momentum and IV supporting the suggestion that idiosyncratic risk is not a limit to the arbitrage of momentum returns. Second, our evidence on the conditionality of momentum returns on market dynamics lends further support to the findings of Asem and Tian (2010) in the U.S. markets, and bolsters the overconfidence and self-attribution model of Daniel et al. (1998) but not the underreaction model of Hong and Stein (1999), and therefore helps in discriminating between the two models. Third we provide additional evidence supporting the suggestion that cross-country

differences in momentum returns could possibly be explained by cross-country differences in market dynamics rather than by differences in levels of individualism as suggested in the earlier literature.

The rest of the paper is organized as follows: section 2 discusses the sample and methods, section 3 examines the relationship between momentum returns and idiosyncratic risk in China with some robustness tests, section 4 conducts additional international tests, and section 5 concludes.

2. Sample and methods

2.1 Sample

The sample includes all A-shares listed in the Shanghai and Shenzhen stock exchanges of China from January 1995 to August 2016 with data sourced from the China Securities Market and Accounting Research (CSMAR). There are two types of shares listed in Chinese markets, A-shares and B-shares. We only include A-shares since they account for almost 99% of market capitalisation and B-shares are usually small and illiquid stocks.[1] We exclude the period before January 1995 because of the limited number of firms listed during that period. In order to be included in the sample, a firm must have at least one year of returns, size and book-to-market data. Following Chui, Titman and Wei (2010), we set stocks with monthly returns greater (less) than 100 (-95) percent to 100 (-95) percent.[2] We start with 240 firms at the portfolio formation date and this increases to 1755 at the end of the sample period.

2.2 Momentum strategy

[1] A-shares are denominated in Chinese Yuan and are accessible to mainland Chinese residents. B-Shares are denominated in U.S. dollars and are accessible to foreign investors. However from 2001, B-shares were allowed to be traded by mainland Chinese residents with foreign currency.

[2] Our results remain similar without setting returns greater (less) than 100 (-95) percent to 100 (-95) percent extreme returns. Furthermore, our results remain similar if we exclude stocks with extreme returns.

We calculate momentum returns based on the methodology proposed by Jegadeesh and Titman (1993). We use the conventional 6-month formation period for the momentum strategy.[3] A month is skipped between the formation and holding period to mitigate the bid-ask bounce effect. We exclude all those stocks in a portfolio with any missing values either during the formation or holding period. At the beginning of each month, t+1, we rank all stocks in ascending order on the basis of their past 6-month returns (t-6 to t-1). We then form quintile portfolios where portfolio P5 (P1) represents the winners (losers) quintile. We buy (sell) the winners (losers) quintile. The portfolios are held for k months (k = 3, 6, 9 and 12). Following Jegadeesh and Titman (1993), we calculate momentum returns based on overlapping portfolios. The number of overlapping portfolios in any month is equal to 1/k of the holding period months. P5-P1 represents the return of the momentum trading strategy of buying winners and selling losers. We also provide Fama-French risk-adjusted momentum returns (alpha).[4]

2.3 IV measures

We calculate IV (IV-M hereafter) as the standard deviation of the residuals from the following market model equation:

$$r_{i,t} = \alpha_i + \beta_{i1}\, rm_t + e_{i,t} \quad (1)$$

where $r_{i,t}$ is the monthly return on stock i; rm_t is the value-weighted monthly market return of Chinese A shares, and $e_{i,t}$ is the regression residual. We estimate equation (1) for each stock on the formation date using monthly data over the past 12-month period (t-11 to t).[5]

[3] We find similar results for other formation periods, i.e. 3-. 9- and 12-months. We do not report these results to save the space but are available upon request.

[4] We generate market, SMB and HML values following procedures described in Fama and French (1993). For market excess return, we use the excess return of the value-weighted market index of Chinese A-shares over the one-month interest rate charged by the People's Bank of China to financial institutions.

[5] We require a stock to have at least 10 valid monthly return observations in a 12-month period to estimate IV. McLean (2010) estimates IV using monthly data over the past 36 months; however, our sample period is small

As a robustness test, following Ang, Hodrick, Xing and Zhang (2006) we also use within-month daily return data to estimate idiosyncratic volatility (IV-D hereafter) for each stock using equation (1). We multiply the standard deviation of residuals from daily returns within-month by the square root of the number of trading days in a month.[6]

2.4 Descriptive statistics

Panel A of Table 1 reports the summary statistics for the variables used in this study. The mean (median) idiosyncratic volatility is 10.31 (9.16), and 10.77 (9.58) for IV-M and IV-D, respectively. The magnitude of IV-D is not directly comparable with IV-M because it is estimated over a different time frame. The mean (median) share price is CNY11.90 (CNY9.35), and the mean (median) firm size in CNY million is 9,445 (3,191). The number of firm-month observations is 317,478.

[Table 1 about here]

Panel B shows the correlation matrix for our variables. The correlation between IV-M and IV-D is small (0.42) consistent with Fink, Fink and He (2012) who show that IV measures are not highly correlated when using different data frequencies (e.g., daily versus monthly data) to estimate IV. Both IV measures are positively correlated with price, inconsistent with Arena et al. (2008). There is a negative correlation between firm size and both IV-M and IV-D, consistent with Arena et al. (2008) and Bali and Cakici (2008).

Panel C of Table 1 reports the characteristics of the momentum-sorted quintile portfolios. The momentum quintiles are formed at the beginning of each month t+1 by sorting stocks on past returns from t-6 to t-1. Consistent with McLean's (2010) results for U.S. markets, we also find a U-shaped pattern in our idiosyncratic risk proxies. Both losers (P1)

and we could lose a significant portion of data if we estimate IV using monthly data over the past 36 months. In any case, as a robustness test, we follow McLean (2010) and find similar results (please see Section 4.1).

[6] For within-month daily returns data, we require a stock to have at least 10 daily return observations (two-week trading period) during a month to be included in our sample.

and winners (P5) have relatively higher idiosyncratic risk than the rest of the quintile portfolios. We find a U-shaped pattern for firm size with P1 and P5 being larger than the other quintiles; however, firm size of P5 is larger than the firm size of P1. Share price appears to increase, though not monotonically, from P1 to P5. These patterns indicate that winners tend to be big size stocks with high price while losers tend to be medium size stocks with low price.

Panel D of Table 1 shows the characteristics of the IV-sorted tercile portfolios. The IV terciles are formed at the beginning of each month t+1 by sorting on IV-M. Unsurprisingly, all measures of idiosyncratic risk increase monotonically from low- to high-IV terciles which give us added assurance of the consistency of our IV proxies. The firm size of the low IV tercile is significantly larger than other IV terciles, indicating that low IV stocks are big firms. The rest of the two IV terciles have similar firm size. Share price increases monotonically from low- to high-IV terciles. This indicates that high-IV stocks tend to be small, and high-priced.

3. Momentum returns and idiosyncratic risk

3.1 Momentum measured via different weighting schemes

Table 2, reports average monthly returns and Fama-French alphas (hereafter alphas) of equal-, value-, IV- and inverse IV-weighted momentum portfolios for 3-, 6-, 9- and 12-month holding periods. With IV- weighted (inverse IV-weighted) portfolios, the proportion of a stock in the portfolio depends on the relative magnitude of its IV, i.e., the return of a stock with higher (lower) IV gets more weight than a stock with smaller (larger) IV in IV-weighted (inverse IV-weighted) portfolios. The equal-weighted (EW), value-weighted (VW), IV-weighted (IVW) and inverse IV-weighted (INV-IVW) momentum returns, i.e., P5-P1, show no evidence of an unconditional momentum effect in China consistent with the literature (e.g. Cakici, Chan and Topyan, 2011; Cheema and Nartea, 2017; Chen, Kim, Yao

and Yu, 2010; Chui et al., 2010; Griffin, Ji and Martin, 2005; Pan, Tang and Xu, 2013; Wang, 2004; Wu, 2011). However, we find evidence of a momentum effect based on the significant alphas for the 6-month holding period in both VW and INV-IVW portfolios and for the 9-month holding period in the VW portfolio.[7] More importantly, if momentum is positively related to IV as in the U.S., we expect momentum returns and alphas of the IV-weighted portfolios to be more significant than those of the EW, VW and INV-IVW portfolios. Instead we find that both momentum returns and alphas of the IV-weighted portfolios are all insignificant for all holding periods and generally lower than those of the EW, VW and INV-IVW portfolios. Therefore our preliminary evidence on the relationship between momentum returns and IV in China is contrary to the U.S. evidence of Arena et al. (2008) but consistent with McLean (2010).

[Table 2 about here]

3.2 Momentum returns cross-sorted on IV

In this section, we directly test the relation between momentum returns and IV. We independently sort our sample into tercile portfolios at the beginning of the month t+1 according to IV-M (low, medium and high) and into quintiles by past returns (t-6 to t-1).[8]

Table 3 reports the EW and VW momentum returns and alphas of each IV tercile. Results in Table 3 show that the positive relation between momentum returns and IV documented by Arena et al. (2008) is largely absent in China. In fact we find that momentum returns are stronger for low IV portfolios compared with high IV portfolios though the

[7] The significant 6- and 9-month holding period Fama-French alphas compared to the raw momentum returns indicates higher momentum returns among big size stocks which are characterised as low IV stocks. In unreported results, we find significant momentum returns for all the holding periods once we exclude stocks that are below the median market capitalization from our sample.

[8] We use the conventional 6-month formation and holding period for the momentum strategy from here on. However, we find similar results for different formation and holding period of momentum strategy. We also conduct dependent sorts on IV and past returns and find similar results. These results are available upon request.

difference is statistically insignificant. In Panel A, the EW momentum returns (alpha) of low IV portfolios at 0.46% (0.77%) per month are higher than the EW momentum returns of high IV portfolios at 0.23% (0.42%) per month. Similarly in Panel B, the VW momentum returns (alpha) of low IV portfolios at 0.71% (.90%) per month are higher than the momentum returns of high IV portfolios at 0.31% (0.71%) per month. The EW return (alpha) spread is -0.23 % (-0.25%) per month and the corresponding VW return (alpha) spread is -0.40% (-0.19%) per month.

[Table 3 about here]

In sum, we find that the positive relation between momentum returns and IV documented by Arena et al. (2008) in the U.S. is absent in China. Instead, we find a weakly negative but statistically insignificant relationship between momentum returns and IV. This is inconsistent with both the underreaction and the overconfidence and self-attribution explanations of momentum both of which predict a positive relation between momentum returns and IV. However, our results are consistent with the U.S. findings of McLean (2010) supporting the view that idiosyncratic risk is not a binding limit to the arbitrage of momentum returns. As McLean (2010) suggests, this implies that momentum may be a mispricing that persists not because of limits to arbitrage caused by idiosyncratic risk but more so by binding transactions costs. McLean (2010) posits further that transactions costs would most likely be more binding for smaller mispricing while idiosyncratic risk will have a more important role for larger mispricing. This argument is in line with findings of Lesmond, Schill and Zhou (2004) who report a cross-sectional relation between momentum profits and transaction costs, and show that momentum profits in the U.S. markets do not exceed transaction costs. We suggest that momentum profits in China are low enough to be within

transactions costs and therefore persist because of transactions costs rather than through the presence of idiosyncratic risk.[9]

3.3 Momentum returns conditioned on market dynamics and IV

In a recent study, Cheema and Nartea (2017) report that momentum returns in China are conditioned by market dynamics. First, we replicate their results with a slightly longer sample period. Following Cheema and Nartea (2017) and Asem and Tian (2010), we classify market states based on lagged 12-month and subsequent value-weighted market returns. If the lagged 12-month (*t*-11 to *t*) and subsequent (*t*+1 month) market return are both nonnegative (negative) then the market state is identified as UP/UP (DN/DN). Similarly, if the lagged 12-month (*t*-11 to *t*) market return is nonnegative (negative) and subsequent (*t*+1 month) market return is negative (nonnegative) then the market state is identified as UP/DN (DN/UP).

Panel A of Table 4 reports momentum returns conditioned on market dynamics. Consistent with Cheema and Nartea (2017) we find positive (1.45% per month, *t*-stat=2.93) and significant momentum returns when the market continues in the DOWN state (DN/DN) and negative though insignificant momentum returns when the market continues in the UP state (UP/UP) or transitions UP or DOWN (UP/DN or DN/UP). This results support the overconfidence and self-attribution model of Daniel et al. (1998) but not the underreaction model of Hong and Stein (1999).

Our results show that the Chinese market continues in the DOWN state, where we document significant momentum returns, for only 58 out of 248 months in our sample, with the rest of the months generating negative momentum returns. This could explain why unconditional momentum returns in China are generally low.[10]

[9] Mei, Scheinkman and Xiong (2009) document high transaction cost in the Chinese stock markets, i.e., 0.40% per trade. In addition, there is 0.10% stamp tax per trade paid to the government (See the official website of Shanghai Stock Exchange: http://www.sse.com.cn).

[10] We find significant unconditional momentum returns in U.S. at 0.88% per month (*t*-stat=2.07) over the period from 1995 to 2015. Furthermore, we find that there are more market continuations (145 months) in U.S. where

[Table 4 about here]

Next we examine the relationship between momentum and IV on returns that are conditioned on market dynamics, in particular during market continuations in the DOWN state where momentum returns are found to be significant. Panel B of Table 4 reports IV-sorted momentum returns conditioned on market dynamics. As stated in section 3.2, at the beginning of month t+1, we sort stocks into tercile portfolios according to IV-M (low, medium and high) and into quintiles by past returns (t-6 to t-1).

We find either negative or insignificant momentum returns for all IV terciles when the market continues in the UP state or transitions to another state. However, we find positive and significant momentum returns for all IV terciles when the market continues in the DOWN state. More importantly, we do not find a positive relationship between momentum returns and IV in any market state. Instead, we find a significant negative relationship between momentum returns and IV during market continuations in the DOWN state. Hence the absence of a positive relationship between momentum returns and IV persists even in the DN/DN state where momentum returns are strongest.

In sum, the absence of a positive relation between momentum returns and IV is consistent with the U.S. results of McLean (2010) and suggests that idiosyncratic risk is not a binding limit to the arbitrage of momentum returns. Though this result is inconsistent with both the underreaction and the overconfidence and self-attribution explanations of momentum, we find support for the overconfidence and self-attribution story from our results on the relation of momentum returns and market dynamics. We suggest that the absence of a relation between momentum and IV could be the result of high IV stocks being a poor proxy

momentum returns are found to be large and significant compared to either insignificant momentum returns or momentum losses in market transitions (95 months). We do not find any positive relationship between momentum returns and IV in U.S. even when we condition it on market dynamics. We do not report these results to save the space.

for hard to value stocks and/or that investors do not generally become overconfident in nebulous settings, and therefore does not necessarily reject the overconfidence and self-attribution story. We explore this further by employing firm size as an additional proxy for hard to value stocks.[11] We expect a negative relationship between momentum returns and firm size since small size firms are usually considered hard to value stocks. We independently sort our sample into tercile portfolios at the beginning of the month t+1 according to firm size (small, medium and big) and into quintiles by past returns (t-6 to t-1) and report the results in Table 5. Contrary to our expectation, we find small and insignificant momentum returns for small and medium size terciles but relatively large and significant momentum returns for the big size tercile. Furthermore, we find a positive but insignificant relationship between momentum returns and firm size which further confirms our earlier results with IV that momentum is weak, not strong, in hard to value stocks.

[Table 5 about here]

4. Robustness Tests

4.1 Exclusion of small size and low priced stocks and the use of alternative IV proxies

In this section, we examine the robustness of our results after excluding small, and low-priced stocks and by using alternative IV proxies.[12] First, we exclude small and low-priced stocks to ensure that the results are not driven by small and illiquid stocks or the bid-ask bounce. We consider two filters: (i) stocks priced below CNY5, and (ii) stocks with a market capitalization that places them in the bottom 30% of the sample firms at the portfolio

[11] We thank the referee for suggesting this test.

[12] To save space, we only provide EW momentum returns in the robustness tests. The VW momentum returns are similar to EW momentum returns, and are available upon request.

formation date.[13] Stock prices in China are generally low, with a mean stock price of CNY11.90. Hence, it is reasonable to exclude only stocks priced below CNY5. We report the results in Table 6.

As indicated in Table 1, our total sample contains 317,748 firm-month observations. Excluding stocks priced below CNY5 as in the exclusion (i) eliminates 16.40% of the total sample, almost equally affecting all IV terciles. Excluding the smallest 30% of the stocks in terms of market capitalization as in the exclusion (ii), eliminates firms belonging mostly to the medium and high-IV terciles. The exclusion of low-priced and small size stocks in our sample does not disproportionately affect any one specific IV portfolio unlike in McLean's (2010) U.S. study where the exclusion of small and low-priced stocks eliminated 80% of the firms in the high-IV portfolio.

Panel A of Table 6 reports momentum returns sorted on IV under exclusion (i). Our original results survive the exclusion of stocks priced below CNY5. Instead of a positive relation between momentum and IV, we find a negative but insignificant momentum return (alpha) spread of -0.18% (-0.19%) per month.

[Table 6 about here]

Panel B shows the results with exclusion (ii). We still report a negative but insignificant relation between momentum returns and IV. However, momentum returns of all IV terciles become significant once we exclude the 30% smallest size firms at the portfolio formation date which indicates that momentum returns in China are strong among big size firms.

Panel C shows the results when we use the market-model IV computed using monthly returns over past 36 months instead of 12 months. Similar to the results in Table 3, we find a

[13]As additional filters we also exclude the stocks in bottom 10% and the bottom 20% of the sample firms and find similar results. We also form three momentum and two IV portfolios and find similar results. These are available upon request.

weak relationship between momentum returns and IV. Panel D shows the results when we use the market-model IV computed using daily returns (IV-D) as an alternative idiosyncratic risk proxy (as discussed in Section 2.3). Similar to the results in Table 3, we find a weak relationship between momentum returns and IV when we sort on IV-D. More importantly, these results also show that momentum returns of high IV portfolios in China are not necessarily higher than those of low IV portfolios.

4.2 Fama-MacBeth regressions

As an additional robustness test we conduct Fama-MacBeth cross-sectional regressions of firm-level returns on IV and selected firm characteristics as control variables. We also include the momentum measure and create an interaction term between momentum returns and IV. We estimate the following model:

$$r_{i,t} = \alpha_i + \beta_{1,t} SIZE_{i,t} + \beta_{2,t} BTM_{i,t} + \beta_{3,t} MOM_{i,t} + \beta 4_{,t} IV_{i,t} + \beta_{5,t} MOM*HIGH\_IV_{i,t} + \varepsilon_{i,t} \quad (2)$$

The dependent variable is the average monthly stock return over the subsequent six-months (t+1 to t+6), skipping month t. SIZE is the natural logarithm of market capitalization at the end of the previous month. BTM is the natural logarithm of the book value of equity of the previous fiscal year divided by the end of previous month's market capitalization. MOM is past return over t-6 to t-1 months. IV is the standard deviation of the residuals in equation (1). The high-IV dummy variable (HIGH_IV) is equal to one if the firm is in the highest IV tercile; otherwise zero. We then interact IV with the momentum (MOM) measure.

[Table 7 about here]

Table 7 reports the regression coefficients and Newey-West corrected t-statistics with ten lags to account for the overlap in 6-month holding period returns. Regression 1 is the base regression which shows positive but insignificant MOM coefficient, consistent with our results in Table 2. In regression 2, we include SIZE and BTM factors. Regression 2 shows

negative SIZE and positive BTM coefficients, consistent with Fama and French (1992). The MOM coefficient in regression 2 is positive and statistically significant once we control for SIZE and BTM factors indicating that momentum returns are strong (weak) in big (small) size firms consistent with our momentum returns sorted on firm size in Table 5. In regression 3, we include IV and the interaction term between momentum and IV. Regression 3 also shows a positive and significant momentum (MOM) coefficient. More importantly, regression 3 shows a negative and significant (*t*-stat = -3.52) coefficient of MOM*HIGH_IV indicating a reverse momentum effect in high IV stocks, consistent with the portfolio-sorting results reported earlier that momentum returns in China are weak for high IV stocks. Therefore our cross-sectional regression results confirm the absence of a positive relation between momentum returns and IV in China.

4.3. International Robustness

In this section we examine the relationship between momentum returns and IV in other Asian markets. We conduct this for Japan, Malaysia, Indonesia, Korea, Hong Kong and Singapore.[14] We collect data from DataStream International for the period from January 1995 to December 2015.

4.3.1 Momentum returns and IV

First we show (with the exception of Korea) that there are low or non-existent unconditional momentum returns in Asian markets, generally consistent with Chui et al. (2010).[15] We find momentum returns for Japan at 0.10% per month (*t*-stat=0.35), Malaysia at 0.27% per month (*t*-stat=0.70), Indonesia at 0.54% per month (*t*-stat=1.04), Korea at 1.00%

[14] We chose the Asian countries that have an enough number of stocks to form portfolios sorted on IV and past returns.

[15] Chui et al. (2010) find low and insignificant momentum returns in these six Asian countries except for Hong Kong.

per month (*t*-stat=2.17), Hong Kong at 0.22% per month (*t*-stat=0.55), and Singapore at 0.56% per month (*t*-stat=1.40).[16]

Next we sort stocks in each country into IV terciles to examine if momentum returns exist, at least for high IV terciles. Table 8 reports average monthly momentum returns for portfolios sorted into IV terciles for all the countries.[17] We find that momentum returns of high IV portfolios are insignificant for all Asian countries except for Korea. In particular, we report momentum returns of the high IV portfolio in Japan at 0.22% per month (*t*-stat=0.83), Malaysia at 0.20% per month (*t*-stat=0.51), Indonesia at -0.05% per month (*t*-stat=-0.05), Korea at 1.22% per month (*t*-stat=2.64), Hong Kong at 0.29% per month (*t*-stat=0.71), and Singapore at 0.61% per month (*t*-stat=1.32). More importantly momentum returns of high IV portfolios are not higher than momentum returns of low IV portfolios in these Asian markets.

[Table 8 about here]

4.3.2 Momentum returns conditioned on market dynamics

In this section, first we examine if momentum returns in our six selected Asian countries are also conditioned by market dynamics.[18] We follow the nomenclature and classification for UP/UP, UP/DN, DN/UP and DN/DN market states in Section 3.3.

Table 9 reports momentum returns conditioned on market dynamics. Panel A (D) shows momentum returns when the market continues in the UP (DOWN) state. Panel B (C) shows momentum returns when the market transitions from the UP (DOWN) to the DOWN (UP) state. We find stronger results in these Asian markets than in China. We report positive and significant momentum returns when the market continues in the same state, whether UP

[16] We do not tabulate these results to save the space.

[17] We also form two IV and three momentum portfolios and find similar results. These are available upon request.

[18] Hanauer (2014) has shown earlier that momentum returns in Japan and Korea are indeed conditioned by market dynamics.

or DOWN (in China it was only when the market continued DOWN), and negative or insignificant momentum returns when the market transitions to a different state. Panel A shows positive and significant momentum returns for all the countries when the market continues in the UP state. Likewise Panel D shows positive and significant momentum returns in all countries when the market continues in the DOWN state. In contrast, Panel B shows that momentum returns are insignificant in all countries when the market transitions from UP to DOWN states, and Panel C shows that momentum returns are negative when the market transitions from DOWN to UP states which is generally in line with the 'momentum crashes' which occur contemporaneous with market rebounds as documented by Daniel and Moskowitz (2016) for the U.S. These results are similar to the findings of Asem and Tian (2010) for the U.S. and Hanauer (2014) for Japan, and are consistent with the prediction of the overconfidence and self-attribution model of Daniel et al. (1998). In contrast, the results for the DN/UP and DN/DN market states are inconsistent with underreaction model of Hong and Stein (1999) which predicts high momentum returns in the former and low momentum returns in the latter.

[Table 9 about here]

Finally, we examine the relationship between momentum returns and IV during market continuations where, as we have shown, momentum returns are found to be significant. As in section 3.2, at the beginning of month t+1, we sort stocks into tercile portfolios according to IV-M (low, medium and high) and into quintiles by past returns (t-6 to t-1). We report the results in Table 10. Recall from Panel A of Table 9 that all countries have significant momentum returns when the market continues in the UP state. However, the corresponding Panel A of Table 10 shows no evidence of a positive relationship between momentum returns and IV when the market continues in the UP state. Likewise, recall from Panel D of Table 9 that all countries have significant momentum returns when the market

continues in the DOWN state. The corresponding Panel D in Table 10 also shows no evidence of a positive relationship between momentum returns and IV. In fact, Japan and Korea exhibit a significant negative relation between momentum returns and IV. Hence even during market continuations when momentum returns are strongest in these Asian countries, we do not find evidence of a positive relation between momentum and IV.

Similar to our results in Section 3.3 for China, we find that in these Asian countries that relative to the U.S., there are more market transitions where momentum returns are weaker, and less market continuations where momentum returns are stronger. A higher number of market transitions in Asian countries relative to U.S. is not surprising since Asian stock markets are more volatile than the U.S. markets (e.g. Diamonte et al., 1996; Lin et al., 2009). Therefore, the low unconditional momentum returns in Asian countries could be due to cross-country differences in market dynamics rather than to cross-country differences in individualism as suggested earlier by Chui, Titman, and Wei (2010).

[Table 10 about here]

5. Concluding remarks

The existing evidence on the relation between momentum and IV is mixed. Arena et al. (2008) document a positive relation between momentum and IV in the U.S. stock markets which supports both the underreaction and the overconfidence and self-attribution explanations of the momentum anomaly. However in a subsequent study McLean (2010) argues that there is no relation between momentum and IV and shows that Arena et al.'s (2008) results were obtained by excluding small size and low priced stocks thereby eliminating most of the high IV stocks in their sample. Apart from rejecting both the underreaction and the overconfidence and self-attribution stories, McLean's (2010) results imply that idiosyncratic risk is not a limit to the arbitrage of momentum returns.

We verify the relation between momentum and IV in China and in selected Asian countries. Consistent with McLean (2010) we find at best, no relation between momentum and IV in China and in selected Asian markets supporting the view that idiosyncratic risk is not a significant arbitrage cost for momentum returns. While the absence of a positive relation between momentum returns and IV also rejects both the underreaction and overconfidence stories of momentum, we find support for the overconfidence and self-attribution story from our results on market dynamics and momentum. We find that when we condition momentum return on market dynamics, momentum returns are significantly higher when markets continue in the same state than when they transition to a different state, consistent with the prediction of Daniel et al.'s (1998) model but inconsistent with of the model of Hong and Stein (1999). We also find support for the suggestion that cross-country differences in momentum returns could be the result of different market dynamics rather than differences in levels of individualism as earlier suggested by Chui et al. (2010).

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Table 1: Descriptive statistics

This table reports the summary statistics and the correlation matrix of the idiosyncratic risk and firm specific variables used in this study. It also reports the characteristics of quintile portfolios sorted on momentum and terciles portfolios sorted on idiosyncratic volatility (IV). Panel A reports the statistics for the entire sample. Panel B reports the Pearson correlation coefficients. Panel C reports mean values across momentum quintiles. Panel D reports mean values across IV terciles. The momentum quintiles are formed each month by sorting stocks on past returns from *t*-6 to *t*-1 months. The IV terciles are formed each month by sorting on IV. IV-M is the standard deviation of the residuals from the market-model regression using monthly returns over past 12 months (see section 2.3 for a detailed description). IV-D is the standard deviation of the residuals from the market-model regression using daily returns over the past month (see section 2.3 for a detailed description). For IV-D, we multiply the standard deviation of residuals of daily returns within-month by the square root of the number of trading days in the month. Firm price is the monthly closing stock price at the end of the previous month. Size is the firm market value in CNY millions at the end of the previous month. The sample period is from 1995 to 2016.

Panel A: Sample summary statistics

Variable	N	Mean	Std. Dev.	Median	25P	75P
IV-M	317478	10.31	6.84	9.16	6.62	12.53
IV-D	317478	10.77	6.84	9.58	6.75	13.45
Price	317478	11.90	10.03	9.35	6.21	14.36
Size	317478	9445	47250	3191	1739	6585

Panel B: Correlation matrix

Variable	IV-M	IV-D	Price	Size
IV-M	1.00			
IV-D	0.42	1.00		
Price	0.21	0.15	1.00	
Size	-0.01	-0.01	0.10	1.00

Panel C: Characteristics of momentum portfolios: mean values

Past 6-month Return	P1(Losers)	P2	P3	P4	P5 (Winners)
IV-M	10.21	9.08	9.34	10.14	12.96
IV-D	10.27	9.97	10.10	10.44	11.39
Price	9.93	9.84	10.26	11.38	14.28
Size	7741	7004	7040	7639	8465

Panel D: Characteristics of IV portfolios: mean values

Past 6-month Return	IV1 (Low)	IV2	IV3 (High)
IV-M	6.39	9.47	15.15
IV-D	6.61	9.63	14.82
Price	9.82	11.48	13.19
Size	10337	6823	6081

Table 2: Momentum portfolios via alternative weighting schemes

This table reports average monthly return of equal-, value-, IV-, and inverse IV-weighted quintiles of momentum portfolios. Firm IV is the standard deviation of the residuals from the market model regression over the past 12 months (see section 2.3 for a detailed description). The momentum portfolios are formed each month by sorting stocks on past returns from *t*-6 to *t*-1 months. The momentum portfolios are held for the next 3, 6, 9 and 12 months, skipping month *t*. Momentum returns (P5-P1) are calculated by buying past winners and selling past losers. Both the raw and adjusted returns (alpha) are reported in per cent and *t*-statistics provided in parentheses. Alpha refers to the Fama-French three factor model alpha using the average monthly returns for momentum portfolios. The sample period is from 1995 to 2016.

	Equal-weighted				Value-weighted			
	P1	P5	P5-P1	Alpha	P1	P5	P5-P1	Alpha
k=3	1.70	2.07	0.29	0.46	1.30	1.56	0.11	0.29
	(2.54)	(3.11)	(1.05)	(1.71)	(2.08)	(2.56)	(0.33)	(0.99)
k=6	1.74	2.08	0.25	0.41	1.13	1.44	0.36	0.58
	(2.58)	(3.13)	(0.99)	(1.73)	(1.85)	(2.41)	(1.21)	(2.16)
k=9	1.85	2.10	0.06	0.25	1.23	1.46	0.26	0.46
	(2.73)	(3.17)	(0.28)	(1.28)	(2.00)	(2.45)	(0.98)	(1.97)
k=12	1.94	2.10	-0.07	0.15	1.34	1.47	0.07	0.23
	(2.87)	(3.19)	(-0.32)	(0.76)	(2.19)	(2.48)	(0.31)	(1.17)

	IV-weighted				Inverse IV-weighted			
	P1	P5	P5-P1	Alpha	P1	P5	P5-P1	Alpha
k=3	1.66	2.04	0.21	0.39	1.73	2.09	0.33	0.51
	(2.44)	(3.01)	(0.73)	(1.37)	(2.61)	(3.20)	(1.19)	(1.84)
k=6	1.69	2.07	0.18	0.38	1.76	2.10	0.29	0.53
	(2.48)	(3.04)	(0.73)	(1.78)	(2.65)	(3.21)	(1.11)	(2.04)
k=9	1.79	2.06	0.02	0.26	1.87	2.11	0.10	0.38
	(2.61)	(3.06)	(0.08)	(1.41)	(2.81)	(3.25)	(0.43)	(1.59)
k=12	1.87	2.06	-0.09	0.13	1.97	2.13	-0.04	0.25
	(2.73)	(3.07)	(-0.42)	(0.71)	(2.95)	(3.28)	(-0.18)	(1.19)

Table 3: Momentum portfolios cross-sorted on IV

This table reports the equal- and value-weighted average monthly returns and Fama-French three factor alphas of momentum portfolios that are cross-sorted into IV terciles. The past returns and IV are sorted independently. Firm IV is the standard deviation of the residuals from the market model regression over the past 12 months (see section 2.3 for a detailed description). The momentum portfolios are formed each month by sorting stocks on past returns from *t*-6 to *t*-1 months. The momentum portfolios are held for 6 months, skipping month *t*. Momentum returns (P5-P1) are calculated by buying past winners (P5) and selling past losers (P1). Both the raw returns and risk-adjusted returns (alphas) are reported in per cent and *t*-statistics provided in parentheses. Alpha refers to the Fama-French three factor model alpha using the average monthly returns for momentum portfolios. The sample period is from 1995 to 2016.

Panel A: Equal-weighted Momentum Returns							
IV	P1	P2	P3	P4	P5	P5-P1	Alpha
Low	1.80	2.13	2.34	2.28	2.26	0.46	0.77
	(2.75)	(3.32)	(3.62)	(3.58)	(3.66)	(1.49)	(2.43)
Med	1.75	2.04	2.22	2.19	2.10	0.35	0.73
	(2.59)	(3.05)	(3.32)	(3.34)	(3.41)	(1.25)	(2.66)
High	1.66	2.11	2.02	1.96	1.88	0.23	0.42
	(2.34)	(2.88)	(2.84)	(2.78)	(2.80)	(0.88)	(2.03)
High-Low	-0.15	-0.02	-0.31	-0.32	-0.38	-0.23	-0.25
	(-0.70)	(-0.09)	(-1.53)	(-1.61)	(-1.64)	(-0.97)	(-1.00)

Panel B: Value-weighted Momentum Returns							
IV	P1	P2	P3	P4	P5	P5-P1	Alpha
Low	1.28	1.47	1.66	1.72	1.99	0.71	0.90
	(2.06)	(2.46)	(2.80)	(3.00)	(3.28)	(1.85)	(2.23)
Med	1.17	1.50	1.48	1.40	1.52	0.36	0.77
	(1.88)	(2.44)	(2.40)	(2.38)	(2.66)	(1.11)	(2.40)
High	1.14	1.50	1.71	1.38	1.45	0.31	0.71
	(1.72)	(2.19)	(2.53)	(2.13)	(2.31)	(0.96)	(2.20)
High-Low	-0.14	0.03	0.06	-0.35	-0.53	-0.40	-0.19
	(-0.51)	(0.12)	(0.20)	(-1.35)	(-1.76)	(-1.12)	(-0.50)

Table 4: Momentum returns, IV and market dynamics

This table reports equal-weighted average monthly returns of momentum portfolios that are cross-sorted into IV terciles and conditioned on market dynamics. Panel A reports equal-weighted average monthly returns of momentum portfolios conditioned on market dynamics. Panel B reports equal-weighted average monthly returns of momentum portfolios that are cross-sorted into IV terciles and conditioned on market dynamics. Firm IV is the standard deviation of the residuals from the market model regression over the past 12 months (see section 2.3 for a detailed description). The market state is identified based on lagged market returns over months *t*-11 to *t* and subsequent market returns over month *t*+1. If lagged market returns and subsequent market returns are nonnegative (negative), market state is UP/UP (DN/DN). If lagged market returns are nonnegative (negative), and subsequent market returns are negative (nonnegative), then the market state is defined as UP/DN (DN/UP). The momentum portfolios are formed each month by sorting stocks on past returns from *t*-6 to *t*-1 months. The momentum portfolios are held for 6 months, skipping month *t*. Momentum returns (P5-P1) are calculated by buying past winners (P5) and selling past losers (P1). N represents the number of months for each market state. All the returns are reported in per cent and *t*-statistics provided in parentheses. The sample period is from 1995 to 2016.

Panel A: Momentum returns (%) conditioned on market dynamics				
	UP/UP	UP/DN	DN/UP	DN/DN
P1	9.13	-6.89	8.52	-6.81
	(9.91)	(-7.31)	(8.39)	(-8.57)
P5	9.01	-6.96	7.83	-5.36
	(10.14)	(-7.65)	(9.19)	(-6.55)
P5-P1	-0.12	-0.07	-0.69	1.45
	(-0.39)	(-0.14)	(-1.42)	(2.93)
N	79	53	58	58

Panel B: Momentum returns (%) sorted on IV and conditioned on market dynamics				
	UP/UP	UP/DN	DN/UP	DN/DN
Low IV	0.39	-0.12	-0.73	2.26
	(0.63)	(-0.21)	(-1.21)	(4.20)
Med IV	0.51	0.37	-1.23	1.70
	(0.92)	(0.66)	(-2.29)	(3.37)
High IV	0.09	-0.01	-0.48	1.33
	(0.18)	(-0.03)	(-0.91)	(2.83)
High-Low	-0.30	0.11	0.25	-0.93
	(-0.53)	(0.24)	(0.58)	(-3.06)
N	79	53	58	58

Table 5: Momentum portfolios cross-sorted on firm size

This table reports the equal-weighted average monthly returns and Fama-French three factor alphas of momentum portfolios that are cross-sorted into firm size terciles. The past returns and firm size are sorted independently. Firm size is the market capitalization of each firm at the end of each month *t*. The momentum portfolios are formed each month by sorting stocks on past returns from *t*-6 to *t*-1 months. The momentum portfolios are held for 6 months, skipping month *t*. Momentum returns (P5-P1) are calculated by buying past winners (P5) and selling past losers (P1). Both the raw returns and risk-adjusted returns (alphas) are reported in per cent and *t*-statistics provided in parentheses. Alpha refers to the Fama-French three factor model alpha using the average monthly returns for momentum portfolios. The sample period is from 1995 to 2016.

Equal-weighted Momentum Returns							
IV	P1	P2	P3	P4	P5	P5-P1	Alpha
Small	2.44	2.82	2.85	2.87	2.84	0.40	0.39
	(3.36)	(4.03)	(4.08)	(4.06)	(3.82)	(1.17)	(1.06)
Med	1.60	1.96	2.06	2.10	2.01	0.41	0.40
	(2.33)	(2.89)	(3.03)	(3.07)	(2.93)	(1.78)	(1.64)
Big	0.97	1.26	1.48	1.50	1.62	0.65	0.91
	(1.55)	(2.03)	(2.39)	(2.45)	(2.61)	(2.25)	(3.07)
Small-Big	1.47	1.56	1.38	1.37	1.23	-0.24	-0.52
	(4.20)	(5.46)	(4.32)	(3.89)	(2.78)	(-0.69)	(-1.43)

Table 6: Momentum portfolios cross-sorted on market model IV (with exclusions) and alternative IV proxy

This table reports the equal- weighted average monthly returns and Fama-French three factor alphas of momentum portfolios that are cross-sorted into IV terciles. Panel A reports momentum returns excluding stocks priced below CNY5. Panel B reports momentum returns excluding small size stocks with market capitalization that places them in the bottom 30% stocks. Panel C reports momentum returns by using the IV measure estimated with market-model regression over the past 36 months (see section 2.3 for a detailed description). Panel D reports momentum returns by using the IV measure estimated with market-model regression over the past month daily returns (see section 2.3 for a detailed description). Stocks are sorted on past returns and IV independently. Firm IV is the standard deviation of the residuals from the market model regression over the past 12 months (see section 2.3 for a detailed description). The momentum portfolios are formed each month by sorting stocks on past returns from *t*-6 to *t*-1 months. The momentum portfolios are held for 6 months, skipping month *t*. Momentum returns (P5-P1) are calculated by buying past winners (P5) and selling past losers (P1). Both the raw and risk-adjusted returns (alpha) are reported in per cent and *t*-statistics provided in parentheses. Alpha refers to the Fama-French three factor model alpha using the average monthly returns for momentum portfolios. The sample period is from 1995 to 2016.

Panel A: Momentum returns (%) sorted on IV after excluding stocks priced below CNY5

IV	P1	P2	P3	P4	P5	P5-P1	Alpha
Low	1.65	1.95	2.11	2.23	2.17	0.53	0.77
	(2.58)	(3.15)	(3.44)	(3.61)	(3.52)	(1.62)	(2.28)
Med	1.51	1.84	2.00	2.08	2.03	0.52	0.86
	(2.31)	(2.84)	(3.12)	(3.24)	(3.33)	(1.92)	(3.25)
High	1.45	1.88	1.78	1.82	1.80	0.34	0.58
	(2.13)	(2.66)	(2.61)	(2.62)	(2.66)	(1.44)	(2.38)
High-Low	-0.20	-0.07	-0.33	-0.41	-0.38	-0.18	-0.19
	(-0.95)	(-0.34)	(-1.70)	(-2.04)	(-1.48)	(-0.69)	(-0.70)

Panel B: Momentum returns (%) sorted on IV after excluding the smallest 30% of the stocks

IV	P1	P2	P3	P4	P5	P5-P1	Alpha
Low	1.40	1.66	1.94	1.94	2.30	0.89	1.17
	(2.20)	(2.65)	(3.11)	(3.15)	(3.64)	(2.53)	(3.15)
Med	1.38	1.60	1.83	1.77	1.81	0.43	0.81
	(2.09)	(2.45)	(2.80)	(2.80)	(2.99)	(1.54)	(2.80)
High	1.16	1.58	1.58	1.56	1.61	0.45	0.72
	(1.68)	(2.21)	(2.30)	(2.29)	(2.43)	(1.76)	(2.76)
High-Low	-0.24	-0.08	-0.36	-0.39	-0.69	-0.45	-0.44
	(-1.13)	(-0.35)	(-1.61)	(-1.83)	(-2.56)	(-1.55)	(-1.44)

Panel C: Momentum returns (%) sorted on market model IV using monthly returns over past 36 months

IV	P1	P2	P3	P4	P5	P5-P1	Alpha
Low	1.85	2.18	2.33	2.33	2.39	0.54	0.64
	(2.85)	(3.32)	(3.59)	(3.63)	(3.72)	(1.90)	(2.13)
Med	1.82	2.07	2.12	2.22	2.04	0.22	0.33
	(2.70)	(3.07)	(3.22)	(3.23)	(3.12)	(0.78)	(1.11)
High	1.67	2.01	2.02	1.98	1.84	0.16	0.27
	(2.38)	(2.88)	(2.85)	(2.76)	(2.64)	(0.58)	(0.93)
High-Low	-0.17	-0.17	-0.31	-0.35	-0.55	-0.38	-0.38
	(-0.80)	(-0.83)	(-1.56)	(-1.76)	(-2.38)	(-1.78)	(-1.68)

TABLE 6: Continued

Panel D: Momentum returns (%) sorted on market model IV using daily returns							
IV	P1	P2	P3	P4	P5	P5-P1	Alpha
Low	1.90	2.20	2.37	2.32	2.26	0.36	0.79
	(2.90)	(3.44)	(3.76)	(3.76)	(3.80)	(1.29)	(2.86)
Med	1.87	2.16	2.30	2.22	2.20	0.33	0.71
	(2.75)	(3.23)	(3.44)	(3.38)	(3.47)	(1.26)	(2.72)
High	1.39	1.88	1.84	1.85	1.75	0.37	0.54
	(1.97)	(2.56)	(2.53)	(2.56)	(2.55)	(1.43)	(1.99)
High-Low	-0.51	-0.32	-0.53	-0.48	-0.51	0.01	-0.25
	(-2.38)	(-1.28)	(-2.03)	(-1.76)	(-1.98)	(0.03)	(-1.12)

Table 7: Fama-MacBeth regressions

This table reports the results of Fama-MacBeth cross-sectional regressions. The dependent variable is the average monthly return over a six-month (*t*+1 to *t*+6) holding period. SIZE is the natural logarithm of market value at the end of the previous month. BTM is the natural logarithm of the book value of equity of the previous fiscal year divided by the end of previous month's market capitalization. MOM is past return over *t*-6 to *t*-1 months. Firm IV is the standard deviation of the residuals from the market model regression over the past 12 months (see section 2.3 for a detailed description). HIGH_IV is a dummy variables and it is equal to one if the firm is in the highest IV tercile, otherwise zero. The Newey West corrected *t*-statistics with ten lags are reported in parentheses to account for the overlap in 6-month holding period returns. The sample period is from 1995 to 2016.

	Regression 1	Regression 2	Regression 3
Intercept	0.13	0.66	0.67
	(2.59)	(3.96)	(4.05)
MOM	0.04	0.05	0.09
	(1.55)	(2.52)	(3.03)
SIZE		-0.03	-0.03
		(-3.20)	(-3.21)
BTM		0.04	0.03
		(1.82)	(1.69)
IV			-0.18
			(-3.66)
MOM*HIGH_IV			-0.06
			(-3.52)

Table 8: Momentum portfolios cross-sorted on IV in selected Asian countries

This table reports the equal-weighted average monthly returns of momentum portfolios that are cross-sorted into IV terciles for Japan, Malaysia, Indonesia, Korea, Hong Kong and Singapore. The past returns and IV are sorted independently. Firm IV is the standard deviation of the residuals from the market model regression over the past 36 months (see section 2.3 for a detailed description). The momentum portfolios are formed each month by sorting stocks on past returns from *t*-6 to *t*-1 months. The momentum portfolios are held for 6 months, skipping month *t*. Momentum returns (P5-P1) are calculated by buying past winners (P5) and selling past losers (P1). The raw returns are reported in per cent and *t*-statistics provided in parentheses. The sample period is from 1995 to 2015.

Panel A: Momentum returns (%) for Japan sorted on IV

IV	P1	P2	P3	P4	P5	P5-P1
Low	0.59	0.55	0.57	0.59	0.77	0.18
	(1.37)	(1.61)	(1.88)	(2.12)	(2.64)	(0.59)
Med	0.73	0.64	0.59	0.61	0.67	-0.06
	(1.58)	(1.58)	(1.56)	(1.70)	(1.89)	(-0.23)
High	0.23	0.52	0.57	0.56	0.45	0.22
	(0.38)	(1.01)	(1.13)	(1.13)	(0.87)	(0.83)
High-Low	-0.36	-0.03	0.00	-0.03	-0.32	0.04
	(-1.25)	(-0.11)	(-0.02)	(-0.12)	(-1.07)	(0.19)

Panel B: Momentum returns (%) for Malaysia sorted on IV

IV	P1	P2	P3	P4	P5	P5-P1
Low	0.81	0.97	1.13	1.14	1.35	0.53
	(1.16)	(1.54)	(1.98)	(2.28)	(2.80)	(1.24)
Med	0.81	0.85	0.96	1.14	1.22	0.41
	(1.05)	(1.20)	(1.46)	(1.91)	(2.31)	(1.01)
High	0.28	0.55	0.54	0.63	0.48	0.20
	(0.32)	(0.69)	(0.69)	(0.85)	(0.68)	(0.51)
High-Low	-0.53	-0.42	-0.60	-0.52	-0.87	-0.34
	(-1.46)	(-1.45)	(-1.91)	(-1.63)	(-2.26)	(-0.93)

Panel C: Momentum returns (%) for Indonesia sorted on IV

IV	P1	P2	P3	P4	P5	P5-P1
Low	1.68	1.93	1.92	2.18	2.64	0.69
	(1.80)	(2.60)	(2.69)	(3.32)	(3.58)	(0.82)
Med	1.51	2.00	2.30	2.43	2.36	0.85
	(1.62)	(2.36)	(2.83)	(3.19)	(3.21)	(1.25)
High	2.74	2.10	2.94	2.68	2.69	-0.05
	(2.44)	(2.30)	(3.40)	(2.98)	(3.35)	(-0.05)
High-Low	1.01	0.18	1.02	0.50	0.14	-0.86
	(1.12)	(0.27)	(1.79)	(0.77)	(0.19)	(-0.77)

TABLE 8: Continued

Panel D: Momentum returns (%) for Korea sorted on IV						
IV	P1	P2	P3	P4	P5	P5-P1
Low	1.28	1.60	1.76	1.85	1.87	0.59
	(1.76)	(2.52)	(2.94)	(3.26)	(3.22)	(1.17)
Med	1.08	1.47	1.67	1.89	2.08	0.99
	(1.35)	(2.11)	(2.52)	(2.90)	(3.15)	(2.00)
High	-0.57	0.45	0.65	0.88	0.65	1.22
	(-0.66)	(0.58)	(0.88)	(1.20)	(0.92)	(2.64)
High-Low	-1.85	-1.15	-1.11	-0.98	-1.22	0.63
	(-4.19)	(-3.15)	(-3.20)	(-2.90)	(-3.10)	(1.39)

Panel E: Momentum returns (%) for Hong Kong sorted on IV						
IV	P1	P2	P3	P4	P5	P5-P1
Low	1.33	1.25	1.50	1.72	2.40	1.07
	(1.68)	(1.98)	(2.77)	(3.45)	(4.22)	(1.67)
Med	1.42	1.29	1.57	1.56	1.30	-0.12
	(1.66)	(1.72)	(2.26)	(2.36)	(2.03)	(-0.26)
High	0.99	1.51	1.42	1.55	1.28	0.29
	(1.04)	(1.64)	(1.60)	(1.79)	(1.57)	(0.71)
High-Low	-0.34	0.26	-0.08	-0.18	-1.12	-0.78
	(-0.59)	(0.47)	(-0.15)	(-0.33)	(-1.95)	(-1.22)

Panel F: Momentum returns (%) for Singapore sorted on IV						
IV	P1	P2	P3	P4	P5	P5-P1
Low	0.31	0.91	0.96	1.02	1.34	1.03
	(0.42)	(1.41)	(1.85)	(2.13)	(2.70)	(2.03)
Med	0.58	0.89	1.19	1.15	1.36	0.78
	(0.74)	(1.25)	(1.87)	(2.06)	(2.58)	(1.56)
High	0.50	1.00	0.87	0.88	1.11	0.61
	(0.56)	(1.26)	(1.14)	(1.30)	(1.65)	(1.32)
High-Low	0.20	0.09	-0.08	-0.14	-0.22	-0.42
	(0.44)	(0.24)	(-0.21)	(-0.42)	(-0.52)	(-0.80)

Table 9: Momentum returns and market dynamics in selected Asian countries

This table reports equal-weighted average monthly returns of momentum portfolios conditioned on market dynamics for Japan, Malaysia, Indonesia, Korea, Hong Kong and Singapore. The market state is identified based on lagged market returns over months *t*-11 to *t* and subsequent market returns over month *t*+1. If lagged market returns and subsequent market returns are nonnegative (negative), market state is UP/UP (DN/DN). If lagged market returns are nonnegative (negative), and subsequent market returns are negative (nonnegative), then the market state is defined as UP/DN (DN/UP). The momentum portfolios are formed each month by sorting stocks on past returns from *t*-6 to *t*-1 months. The momentum portfolios are held for 6 months, skipping month *t*. Momentum returns (P5-P1) are calculated by buying past winners (P5) and selling past losers (P1). N represents the number of months for each market state. All the returns are reported in per cent and *t*-statistics provided in parentheses. The sample period is from 1995 to 2015.

Panel A: Momentum returns following UP/UP market						
	Japan	Malaysia	Indonesia	Korea	Hong Kong	Singapore
P1	4.42	3.77	6.38	3.64	4.21	3.25
	(7.43)	(6.47)	(7.53)	(5.01)	(6.29)	(4.99)
P5	5.31	4.41	7.82	5.86	4.87	4.60
	(8.49)	(9.25)	(12.48)	(7.86)	(8.04)	(8.36)
P5-P1	0.89	0.64	1.44	2.22	0.66	1.34
	(2.12)	(1.88)	(2.55)	(3.85)	(1.72)	(3.47)
N	72	106	105	87	100	92

Panel B: Momentum returns following UP/DN market						
	Japan	Malaysia	Indonesia	Korea	Hong Kong	Singapore
P1	-3.53	-5.63	-6.06	-4.87	-4.02	-5.09
	(-5.55)	(-10.59)	(-6.07)	(-6.99)	(-2.39)	(-6.57)
P5	-4.29	-4.98	-5.19	-4.28	-4.96	-4.47
	(-7.26)	(-7.23)	(-5.21)	(-5.31)	(-2.91)	(-5.39)
P5-P1	-0.77	0.65	0.87	0.59	-0.94	0.62
	(-1.65)	(1.40)	(1.10)	(1.38)	(-1.22)	(1.23)
N	51	65	62	59	52	54

Panel C: Momentum returns following DN/UP market						
	Japan	Malaysia	Indonesia	Korea	Hong Kong	Singapore
P1	6.34	11.77	10.32	10.64	10.14	10.37
	(5.94)	(3.88)	(3.8)	(4.38)	(4.21)	(4.06)
P5	3.93	7.11	7.30	8.25	7.54	6.41
	(8.02)	(4.23)	(5.29)	(5.37)	(4.92)	(4.97)
P5-P1	-2.41	-4.66	-3.02	-2.39	-2.61	-3.96
	(-3.08)	(-2.69)	(-1.47)	(-1.45)	(-1.84)	(-2.53)
N	55	40	41	41	48	47

Panel D: Momentum returns following DN/DN market						
	Japan	Malaysia	Indonesia	Korea	Hong Kong	Singapore
P1	-6.21	-12.41	-9.03	-7.81	-9.83	-8.69
	(-8.50)	(-5.79)	(-2.97)	(-4.09)	(-5.51)	(-5.86)
P5	-4.11	-8.83	-7.79	-6.04	-6.41	-5.65
	(-7.90)	(-5.76)	(-3.99)	(-4.27)	(-4.33)	(-4.80)
P5-P1	2.10	3.57	1.25	1.77	3.41	3.04
	(4.31)	(3.09)	(1.72)	(1.91)	(3.82)	(4.83)
N	62	29	32	53	40	47

Table 10: Momentum portfolios cross-sorted on market model IV and market dynamics in selected Asian countries

This table reports equal-weighted average monthly momentum returns of IV-sorted portfolios, conditioned on market dynamics for Japan, Malaysia, Indonesia, Korea, Hong Kong and Singapore. The market state is identified based on lagged market returns over months *t*-11 to *t* and subsequent market returns over month *t*+1. If lagged market returns and subsequent market returns are nonnegative (negative), market state is UP/UP (DN/DN). If lagged market returns are nonnegative (negative), and subsequent market returns are negative (nonnegative), then the market state is defined as UP/DN (DN/UP). Firm IV is the standard deviation of the residuals from the market model regression over the past 12 months (see section 2.3 for a detailed description). The momentum portfolios are formed each month by sorting stocks on past returns from *t*-6 to *t*-1 months. The momentum portfolios are held for 6 months, skipping month *t*. N represents the number of months for each market state. All the returns are reported in per cent and *t*-statistics provided in parentheses. The sample period is from 1995 to 2015.

Panel A: Momentum returns sorted on IV following UP/UP market						
IV	Japan	Malaysia	Indonesia	Korea	Hong Kong	Singapore
Low	1.24	0.84	1.51	1.44	2.23	0.91
	(2.69)	(1.83)	(1.82)	(2.75)	(2.59)	(1.89)
Med	0.36	1.19	1.29	2.48	0.17	1.73
	(0.97)	(3.13)	(1.70)	(3.97)	(0.29)	(3.08)
High	0.73	0.15	0.35	2.40	0.93	1.03
	(1.72)	(0.36)	(0.33)	(3.68)	(1.74)	(1.68)
High-Low	-0.50	-0.69	-0.98	0.96	-1.30	0.12
	(-1.36)	(-1.52)	(-0.72)	(1.40)	(-1.31)	(0.14)
N	72	106	105	87	100	92

Panel B: Momentum returns sorted on IV following UP/DN market						
IV	Japan	Malaysia	Indonesia	Korea	Hong Kong	Singapore
Low	-0.58	2.03	1.04	1.02	0.87	2.92
	(-1.51)	(4.73)	(0.79)	(1.49)	(0.66)	(2.63)
Med	-0.40	1.34	1.77	1.03	-1.23	2.12
	(-1.10)	(3.41)	(1.76)	(1.75)	(-1.34)	(3.30)
High	-0.24	1.25	1.23	1.33	-0.69	1.25
	(-0.50)	(2.90)	(0.69)	(2.43)	(-0.79)	(1.57)
High-Low	0.34	-0.77	-0.11	0.31	-1.57	-1.67
	(0.93)	(-1.38)	(-0.05)	(0.48)	(-1.33)	(-1.32)
N	51	65	62	59	52	54

Panel C: Momentum returns sorted on IV following DN/UP market						
IV	Japan	Malaysia	Indonesia	Korea	Hong Kong	Singapore
Low	-3.23	-4.79	-1.84	-4.75	-4.07	-3.75
	(-4.17)	(-2.65)	(-0.59)	(-2.66)	(-2.13)	(-2.61)
Med	-2.26	-5.47	-3.45	-3.08	-3.08	-4.57
	(-3.16)	(-3.13)	(-1.45)	(-1.77)	(-2.05)	(-2.43)
High	-1.68	-3.25	-3.17	-1.08	-1.92	-2.94
	(-2.59)	(-2.17)	(-1.15)	(-0.70)	(-1.45)	(-1.92)
High-Low	1.55	1.54	-1.76	3.67	2.15	0.82
	(3.35)	(1.16)	(-0.52)	(2.82)	(1.33)	(0.84)
N	55	40	41	41	48	47

TABLE 10: Continued

Panel D: Momentum returns sorted on IV following DN/DN market						
IV	Japan	Malaysia	Indonesia	Korea	Hong Kong	Singapore
Low	2.56	3.22	0.36	3.15	3.70	3.94
	(5.02)	(2.87)	(0.13)	(2.57)	(2.90)	(4.10)
Med	1.67	3.39	3.00	1.84	3.54	2.65
	(3.79)	(2.96)	(1.75)	(1.75)	(3.72)	(3.22)
High	1.67	2.62	-0.05	0.98	2.11	2.55
	(3.59)	(1.88)	(-0.02)	(1.40)	(2.46)	(3.12)
High-Low	-0.90	-0.60	-0.63	-2.18	-1.59	-1.39
	(-2.69)	(-0.52)	(-0.16)	(-1.92)	(-1.05)	(-1.14)
N	62	29	32	53	40	47

Momentum, Idiosyncratic Volatility and Market Dynamics: Evidence from China

Highlights

- Momentum is not positively related to IV in China and selected Asian countries.
- Therefore idiosyncratic risk is not a limit to the arbitrage of momentum returns.
- Momentum returns are conditioned by market dynamics in China and selected Asian countries.
- Higher (lower) momentum return in market continuations (transitions) support overconfidence model but not the underreaction model.
- Market dynamics not individualism explains cross-country differences in momentum.