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Investor heterogeneity and momentum-based trading strategies in China

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ABSTRACT

The conventional momentum strategy performs poorly overall in China, because stock prices behave very differently when markets are open for trading *versus* when they are closed. Stocks that are past intraday (overnight) winners persistently outperform those that are past intraday (overnight) losers in the subsequent intraday (overnight) periods. However, the same intraday- (overnight-) momentum strategy suffers dramatically in the subsequent overnight (intraday) periods. Further analysis shows that past intraday (overnight) winners tend to be more (less) speculative stocks which are highly demanded during the day (night). Overall, our results are consistent with investor heterogeneity, and this persistent tug of war virtually eliminates the effectiveness of investors pursuing the momentum-based trading strategy in China.

1. Introduction

Momentum—the tendency that stocks perform relatively well in the past continue to outperform in the intermediate horizon—has drawn substantial interests from academia and practitioners since the seminal work of Jegadeesh and Titman (1993). The strong performance of the momentum-based trading strategies persists over time and prevails across different markets.[1]

Despite that momentum seems everywhere, there are notable exceptions such as China and other East Asian stock markets. For example, Kang, Liu, and Ni (2002); Pan, Tang, and Xu (2013); and Gao, Guo, and Xiong (2020) find that the conventional momentum strategy (based on the past twelve-month formation period) performs very weak in the Chinese stock market. The similar "no momentum" effect (*i.e.*, insignificant momentum return) among 14 and 10 East and Southeast Asian markets is documented in Chui, Titman, and Wei (2010) and Griffin, Ji, and Martin (2003), respectively. Altanlar, Guo, and Holmes (2019) attribute the "no momentum" effect (*versus* the conventional "momentum" effect) to a cultural difference between East and West.

In this paper, we aim to explore the potential explanations for the insignificant momentum phenomenon in the Chinese stock market by decomposing the asset returns into the intraday and overnight components based on Lou, Polk, and Skouras (2019). Lou et al. (2019) document a strong same-period continuation and cross-period reversal pattern for the intraday and overnight returns in the US stock market. They attribute this tug of war between day and night to the presence of heterogeneous clientele (*i.e.*, intraday and overnight clients), who would each dominate a certain trading session within the day. This persistent tug of war thus leads to the same-period return persistence and cross-period return reversal.

While we follow the Lou et al. (2019) approach and use the intraday and overnight return components to proxy for the trading activities of the different clientele in China, it is worth mentioning several key institutional characteristics regarding the Chinese stock market. First,

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[1] Fama and French (2018) dub the momentum phenomenon as "the most prominent anomaly" which persists over time and challenges their (rational) asset pricing models (*i.e.*, the Fama and French three- and five-factor models). The momentum phenomenon prevails in the US equity market (see Carhart (1997); Cooper et al. (2004); Sagi and Seasholes (2007); Min and Kim (2016); and Hou, Xue, and Zhang (2020), and also in the international markets (see among others, Liu, Strong, and Xu (1999); Forner and Marhuenda (2003); Mengoli (2004); Nijman, Swinkels, and Verbeek (2004); Baltzer, Jank, and Smajlbegovic (2019); Rouwenhorst (1998, 1999); Chan, Hameed, and Tong (2000); Grundy and Martin (2001); Lewellen (2002); Patro and Wu (2004); Fama and French (2012); Asness, Moskowitz, and Pedersen (2013); and Huang, Li, Wang, and Zhou (2020)).

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the opening price in China is determined by a 10-minute pre-open call auction (see Fig. A1, Table A1). The specific trading mechanisms in China provide one important basis for the claim of investor heterogeneity. In principle, the trading mechanism in the pre-open auction facilitates price discovery, because traders need to incorporate new information released after the market close in the prior day in placing their orders.[2] For example, Gao, Han, Li, and Xiong (2019) find investors trading during the pre-open call auction period are likely to be early-informed, while those trading prior to market close tend to be less informed. Second, individual investors contribute to more than 80% of the total trading volume in the Chinese A-share market, while trading is more institutional-based in the US. The sheer volume of trading generated by individuals indicates that intraday returns (*i.e.*, open-to-close) are largely influenced by retail investors. In comparison, influence by individual investors is mainly reflected in the overnight return component in the US (Lou et al., 2019). Therefore, we would hypothesize that stocks that have relatively high intraday returns tend to be of speculative nature, because they are more likely to be highly demanded by individual investors in China during the day. In comparison, stocks that have relatively high overnight returns tend to be of more quality (*i.e.*, large value firms).

To verify the investor heterogeneity claim and its possible impact on the day and night returns in the cross section, we provide a comprehensive examination of the momentum-type strategies in China.

First, we start by re-examining the conventional momentum strategy in China. Following the Jegadeesh and Titman (1993) approach, we find that the conventional momentum strategy performs poorly overall in China. This applies to all looking-back periods and holding periods.

Second, we find that stock prices behave very differently when markets are open for trading *versus* when they are closed. Using Lou et al. (2019) return decomposition, we find that intraday return and overnight return are strongly negatively correlated at the monthly frequency. This indicates that stocks that experience a high price increase during the day (*i.e.*, open-to-close) tend to experience the dramatic price reversal over the night (*i.e.*, close-to-open), and *vice versa*.

Third, to verify the investor heterogeneity claim and its possible impact in the cross section, we form two decomposed strategies based on the conventional momentum-type way, dubbed as *intraday-momentum* and *overnight-momentum* strategies. That is, at the end of each month, we sort all available stocks into decile groups based on their cumulated intraday (overnight) returns in the formation period. The self-financed winner-minus-loser portfolio (10 − 1) thus mimics the trading behaviors of the intraday and overnight clientele. We find strong evidence that stocks that are past intraday (overnight) winners persistently outperform those that are past intraday (overnight) losers in the subsequent intraday (overnight) periods. However, the same intraday- (overnight-) momentum strategy suffers dramatically in the subsequent overnight (intraday) periods. This tug of war effect virtually eliminates the effectiveness of investors pursuing the momentum-based trading strategy, and could be the reason for the overall poor conventional momentum performance in China.

Fourthly, consistent with our hypothesis that stocks that are intraday winners tend to be of speculative nature and those that are overnight winners tend to be of quality nature, we document that there is a strong distinction between the intraday winner stocks and overnight winner stocks. Consistent with the investor heterogeneity claim, stocks with a large upward trend during the day tend to be relatively small, growth, and high turnover firms with high idiosyncratic risk, less analyst coverage, and relatively high institutional ownership. In comparison, stocks that outperform over the night tend to be relatively large, value, low turnover firms with low idiosyncratic risk, more analyst coverage, less analyst dispersion, and relatively high institutional ownership. As it stands, investor clientele with different preferences choose to trade a subset of stocks under their preferred trading periods within the day.

Finally, we perform a number of robustness checks and further extensions. We find the tug of war is highly persistent in China, and the intraday (overnight) return persistence at the firm-level is robust after accounting for a number of well-known return predictors in the cross section. Moreover, the intraday- and overnight-momentum phenomena are robust under different market states, month of the year, and day-of-week.

The remainder of this paper is organized as follows. Section 2 documents the data and return definition. Section 3 provides the baseline results of conventional momentum strategies. Section 4 provides the evidence based on the intraday and overnight-based strategies. Section 5 provides the characteristics of intraday and overnight momentum. Section 6 performs a battery of extensions and robustness tests. Section 7 concludes.

2. Data and return definition

2.1. Data and data sources

Our sample data starts with all Chinese A-share stocks,[3] and is retrieved from the China Stock Market & Accounting Research (CSMAR) Database. As our research focus on intraday and overnight performance, we start by retrieving all available daily data (*i.e.*, open and close price) for individual stocks. We then apply the following filter rules to the sample data. First, we remove the special treatment stocks from the sample. Second, we require a stock to have at least two full years' trading data to be included in the final sample. Third, stocks without trading data since January 2018 (including the delisted stocks and those with few trading data in the recent year) are also excluded from our final sample, to ensure the data timeliness. After applying these filtering rules, our final sample contains 3060 stocks for the sample period of January 1991 to January 2019 in total.

2.2. Return definition

We follow the method in Lou et al. (2019) to construct the daily return, and its intraday and overnight components for individual stocks.

Specifically, the daily return in day t is defined as the percent return using the close prices in day t and day $t-1$, respectively:

$$R_{daily,t} = (close_t - close_{t-1})/close_{t-1} \quad (1)$$

The intraday return component in day t is constructed as the percentage price change based on the open price and close price in day t:

$$R_{intraday,t} = (close_t - open_t)/open_t \quad (2)$$

Following Lou et al. (2019), the overnight return component in day t is constructed as the geometric return with the following formula based on the daily return and intraday return in day t:

[2] We provide a description about the trading mechanisms and the related returns in Appendix A1.

[3] The sample used in this paper includes only the A-shares in the Chinese stock market. It excludes B-shares and H-shares. We choose A-shares as out testing assets based on the following reasons: Firstly, the number of B-shares and H-shares are small and cannot provide enough data for our momentum study. Moreover, the different trading mechanisms of these stocks also make the results incomparable and complicated, and thus, we cannot distinguish the potential different performances are from the investors' heterogeneity or the mechanism difference. Finally, the momentum study of the Chinese stock market in previous literature is based on the A-shares, therefore, in this paper, we also put our emphasis on this stock category. We are grateful for the anonymous reviewer's comment and in our future study about the microstructure of the Chinese stock market, we will take all kinds of stocks into consideration and hope to find the influence of investor heterogeneity and trading mechanism on the different performances of these stocks.

$$R_{overnight,t} = \frac{1 + R_{daily}}{1 + R_{intraday}} - 1 \quad (3)$$

With each month, we then cumulate all intraday and overnight returns across days to get the monthly measures of the intraday and overnight return components for each stock. We set the monthly intraday and overnight return components as missing, if there are less than 5 daily observations within a month.

3. Conventional momentum strategies

3.1. The playground: Return-based strategies in China

We start the analysis by performing a comprehensive re-examination of the momentum-based trading strategies in China, similar to Jegadeesh and Titman (1993). This replication clarifies the unique features of the playground for our asset pricing tests in later sections.

At the end of each month, we sort all available stocks into ten decile portfolios, based on their cumulative returns in the formation period (*i.e.*, look-back period). The formation period varies for 1, 3, 6, 9, and 12 months, respectively. Following the convention in Jegadeesh and Titman (1993), we skip the most recent month for the 3-, 6-, 9-, and 12-month formation periods. The portfolios are then held for one month (*i.e.*, holding period) before rebalancing. Portfolio 1 (Chui et al., 2010) contains the bottom (top) decile stocks with the lowest (highest) cumulative returns in the formation period. All portfolios are value-weighted.[4]

Table 1 presents the portfolio performance for the conventional return-based trading strategies in China. First, we find a strong short-term return reversal effect in China. That is, stocks with high (low) returns in the prior month tend to have low (high) returns in the subsequent month. A value-weighted zero-cost strategy that goes long the prior one-month winners (*i.e.*, portfolio 10) and short prior one-month losers (*i.e.*, portfolio 1) generates a negative return spread of −0.98% per month, which is statistically significant at the 5% level. After accounting for risk, its associated Fama-French three- and five-factor alphas are −0.86% and −0.90%, respectively, which are both significant at the 5% and 1% level. As it stands, there exists a strong short-term reversal effect in China, indicating a pervasive negative return autocorrelation at the monthly frequency. This is similar to the US evidence as documented in Jegadeesh (1990).

Second, there is no intermediate-term return momentum in China. As we vary the length of the formation period for 3-, 6-, 9-, and 12-months, there are no, if any, momentum-based return premiums. Interestingly, the zero-cost winner-minus-loser strategy generates slightly negative return spreads for 3-, 6-, and 9-month looking-back periods (though they are not statistically significant). The lack of return momentum in China is consistent with the findings in prior works such as Kang et al. (2002); Pan et al. (2013); and Gao et al. (2020), among others. In fact, the no return momentum effect is common among eastern Asian markets.

Overall, we find a strong short-term return reversal effect, but no intermediate-term return momentum in China, both of which are consistent with the previous studies.

3.2. Intraday and overnight return dynamics

In this subsection, we first examine the dynamics of the intraday and overnight returns during the sample period. Table 2 presents the descriptive statistics of the *monthly* measures of the intraday, overnight, and daily returns. That is, intraday, overnight, and daily returns are cumulated within a month to generate their monthly values for each

[4] We also use the equal-weighted way to do the robustness tests, and the conclusions are quite similar. Results based on the equal-weighted way are always available upon request.

Table 1
Conventional return-based investment strategies.

	J-month formation period, 1-month holding period, value-weighted portfolios (*J*=3, 6, 9, 12)																	
	1-month			3-month			6-month			9-month			12-month					
	1	10	10 − 1	1	10	10 − 1	1	10	10 − 1	1	10	10 − 1	1	10	10 − 1
Exret	1.14*	0.16	−0.98**	1.16	0.61	−0.55	0.86	0.54	−0.31	0.74	0.68	−0.05	0.67	0.69	0.02
	(1.76)	(0.19)	(−2.40)	(1.56)	(0.87)	(−1.48)	(1.06)	(0.88)	(−0.58)	(0.99)	(0.95)	(−0.11)	(0.85)	(0.97)	(0.04)
FF3 alpha	0.23	−0.62**	−0.86**	0.24	−0.23	−0.47	−0.07	−0.20	−0.13	−0.18	−0.03	0.15	−0.34	0.08	0.41
	(1.07)	(−2.23)	(−2.29)	(1.17)	(−0.90)	(−1.16)	(−0.25)	(−0.54)	(−0.22)	(−0.67)	(−0.09)	(0.27)	(−1.37)	(0.22)	(0.75)
FF5 alpha	0.25	−0.65**	−0.90***	0.46*	−0.09	−0.55	0.08	−0.37	−0.45	0.02	−0.24	−0.27	−0.11	−0.11	0.00
	(1.15)	(−2.43)	(−2.64)	(1.78)	(−0.46)	(−1.43)	(0.29)	(−1.10)	(−0.82)	(0.09)	(−0.73)	(−0.52)	(−0.46)	(−0.34)	(0.00)

The table reports the performance of conventional return-based trading strategies. At the end of each month, we sort stocks into decile portfolios based on their formation period cumulative returns (in ascending orders), and hold the portfolios for one month before rebalancing. Following the convention, we skip the most recent month for the 3-, 6-, 9-, and 12-month formation periods. The loser portfolio, the winner portfolio, and the zero-cost winner-minus-loser portfolio are denoted as 1, 10, and 10 − 1, respectively. Portfolio returns in excess of the risk-free rate, the risk-adjusted returns of the Fama-French three- and five-factor models are denoted as Exret, FF3 alpha, FF5 alpha, respectively. Newey-West adjusted t-statistics are reported in parenthesis. All reported returns are in percentage points. Statistical significance at the 1%, 5%, and 10% levels are denoted as ***, **, and, * respectively. The sample period is between 1991 and 2019.

Table 2
Descriptive statistics.

Panel A: Summary statistics of daily, intraday, and overnight returns (in %)

	5%	25%	50%	75%	95%	Mean	S.D.	Positive	Obs.
Daily	−20.12	−6.42	0.91	8.85	24.72	1.46	14.23	53.46%	379,456
Intraday	−15.78	−4.51	2.34	10.10	24.41	3.11	12.42	59.08%	379,456
Overnight	−14.11	−5.10	−1.65	1.38	8.47	−2.03	8.13	35.35%	379,456

Panel B: Pairwise correlation and proportion of same sign

	Correlations	Same sign ratio
(Intraday, Daily)	0.802***	83.87%
(Overnight, Daily)	0.452***	57.61%
(Intraday, Overnight)	−0.090***	42.35%

Panel C: Proportion of trading volume during the pre-open call auction

	5%	25%	50%	75%	95%	Mean	S.D.	Obs.
Volume Ratio	3.07%	6.37%	12.00%	15.19%	28.16%	9.95%	8.32%	355,407

The table reports the summary statistics of the sample data. Panel A presents the 5%, 25%, 50%, 75%, and 95% quantiles values, mean, standard deviation (S.D.), proportion of positive values (Positive), and the total number of observations (Obs.) for daily returns (Daily), intraday returns (Intraday), and overnight returns (Overnight), which are cumulated on a monthly basis. Panel B presents the pairwise correlation coefficient, and the proportion of the return pairs with the same sign for the daily returns, intraday returns, and overnight returns, which are cumulated on a monthly basis. Panel C reports the 5%, 25%, 50%, 75%, and 95% quantile values, sample mean, standard deviation (S.D.) of the (daily) proportion of trading volume during the pre-open call auction period averaged on a monthly basis. Statistical significance at the 1%, 5%, and 10% levels are denoted as ***, **, and, * respectively. The sample period for Panel A and B (C) is between 1991 (1996) and 2019 (2018).

stock each month.

Panel A of Table 2 reports the 5%, 25%, 50%, 75%, and 95% quantiles, mean, standard deviation, proportion of positive values, and the total number of observations. As it stands, the performance of three returns is quite different. For the full sample, we find that the mean monthly return (*i.e.*, Daily) has a value of 1.46% with a standard deviation of 14.23%. The intraday return has a larger mean value of 3.11% per month with a standard deviation of 12.42%. Strikingly, the overnight return has a negative mean of −2.03% per month with a moderate standard deviation of 8.13% (as compared to its intraday counterpart). In fact, the difference between the mean of intraday returns and that of overnight returns is huge with a two-sample t-statistic that is significant at the 1% level (untabulated for brevity purpose). Nearly 53.46% and 59.08% of the (monthly aggregated) daily and intraday returns are positive. In comparison, only 35.35% of the month overnight returns are positive, which collaborates with the fact that the (unconditional) expected value for the firm-level overnight returns is negative.

It should be noted that the negative mean for overnight returns is consistent with the overnight return puzzle documented in China (see Qiao & Dam, 2020), and is in vast contrast with the US evidence where overnight returns tend to be highly positive (see Berkman, Koch, Tuttle, et al. (2012) among others).

Panel B presents the pairwise correlation coefficients and the proportion of the return pairs with the same sign for the daily, intraday, and overnight returns. The cumulated intraday and daily returns are highly correlated with a correlation coefficient of 0.802 (significant at the 1% level), and 83.87% of the paired return observations are of the same sign. In comparison, the cumulated overnight and daily returns are less correlated with a correlation coefficient of 0.452, and only 57.61% of their paired return observations are of the same sign. Strikingly, the monthly intraday and overnight returns are negatively correlated with a correlation coefficient of −0.090 (i.e. significant at the 1% level). Moreover, less than half of their paired return observations are of the same sign, indicating that there is a strong tendency of (cross-period) reversal between intraday and overnight returns at the monthly frequency.

Panel C reports the 5%, 25%, 50%, 75%, and 95% quantile values, sample mean, standard deviation (S.D.) of the (daily) proportion of trading volume during the pre-open call auction period averaged on a monthly basis. With the average value as 9.95% and the median value as 12.00% of trading volume ratio, results in this panel reveal the important role of pre-open call auction period in China, especially considering the trading time of this period is only 10-minutes (compared to 240-minutes for the intraday trading).

To sum up, we find strong evidence that returns during the intraday trading period and pre-open call auction period are negatively correlated at the monthly frequency, which might be influenced by the different trading mechanisms during two periods and thus attracting the heterogeneous investors' preferences. Our finding is consistent with the investor heterogeneity claimed by Lou et al. (2019): investors differ in their tendency to trade in the specific trading period (trading mechanism) and the clientele difference could result in the different return performances. The different performances of returns from two periods and the potential heterogeneous investor preferences could have an influence on the traditional momentum study in China, and be the main motivation of this paper to use the separated intraday and overnight components as the basis for the further anomaly analysis.

3.3. Return decomposition of the conventional momentum strategy

Lou et al. (2019) document that there is a persistent tug of war between intraday and overnight traders, and the momentum return is earned entirely overnight in the US. They also argue that the tug of war largely reduces the efficacy of pursuing these prominent trading

Table 3
Intraday- and overnight-momentum strategies, 1-month holding period.

Panel A: Intraday performance in the holding period, the *J*-month formation period daily-momentum strategy

	3 months			6 months			9 months			12 months		
	1	10	10 − 1	1	10	10 − 1	1	10	10 − 1	1	10	10 − 1
Exret	1.89***	2.31***	0.42	1.72**	2.42***	0.70	1.64**	2.40***	0.76	1.52**	2.35***	0.83*
	(2.97)	(3.64)	(1.40)	(2.31)	(4.77)	(1.45)	(2.32)	(4.16)	(1.65)	(2.08)	(4.11)	(1.90)
FF3 alpha	1.22***	1.79***	0.57*	1.02**	1.97***	0.95*	1.01*	1.94***	0.93*	0.76	1.99***	1.23**
	(2.89)	(4.28)	(1.84)	(1.98)	(5.68)	(1.95)	(1.88)	(5.22)	(1.69)	(1.50)	(5.63)	(2.58)
FF5 alpha	1.36***	1.64***	0.28	1.11**	1.79***	0.68	1.17**	1.76***	0.59	0.89*	1.81***	0.92*
	(3.29)	(4.01)	(0.88)	(2.25)	(5.08)	(1.37)	(2.24)	(4.89)	(1.09)	(1.75)	(5.09)	(1.88)

Panel B: Overnight performance in the holding period, the *J*-month formation period daily-momentum strategy

Exret	−1.22**	−2.34***	−1.12***	−1.38***	−2.44***	−1.06***	−1.33***	−2.32***	−0.98***	−1.29***	−2.23***	−0.94***
	(−2.59)	(−4.86)	(−5.17)	(−3.07)	(−5.23)	(−3.85)	(−2.86)	(−5.18)	(−3.37)	(−2.78)	(−5.12)	(−2.83)
FF3 alpha	−1.47***	−2.66***	−1.19***	−1.66***	−2.72***	−1.06***	−1.60***	−2.57***	−0.96***	−1.54***	−2.49***	−0.95***
	(−3.53)	(−5.55)	(−4.92)	(−4.11)	(−5.66)	(−3.62)	(−3.78)	(−5.89)	(−3.19)	(−3.57)	(−5.83)	(−2.74)
FF5 alpha	−1.36***	−2.70***	−1.34***	−1.56***	−2.73***	−1.17***	−1.55***	−2.58***	−1.04***	−1.45***	−2.49***	−1.04***
	(−3.29)	(−5.73)	(−5.82)	(−3.96)	(−5.86)	(−4.27)	(−3.64)	(−6.13)	(−3.55)	(−3.35)	(−6.11)	(−3.09)

Panel C: Intraday performance in the holding period, the *J*-month formation period intraday-momentum strategy

Exret	1.15*	3.08***	1.93***	0.84	3.15***	2.31***	0.60	3.21***	2.61***	0.51	3.17***	2.65***
	(1.74)	(5.40)	(6.75)	(1.20)	(6.70)	(5.19)	(0.85)	(6.24)	(6.27)	(0.73)	(5.71)	(7.16)
FF3 alpha	0.51	2.48***	1.97***	0.17	2.70***	2.53***	−0.08	2.81***	2.89***	−0.26	2.79***	3.05***
	(1.12)	(6.94)	(6.31)	(0.36)	(8.69)	(5.53)	(−0.16)	(8.66)	(6.09)	(−0.56)	(8.45)	(7.91)
FF5 alpha	0.64	2.34***	1.70***	0.29	2.52***	2.23***	0.06	2.64***	2.59***	−0.08	2.64***	2.73***
	(1.41)	(6.85)	(5.19)	(0.60)	(8.14)	(4.52)	(0.12)	(8.33)	(5.37)	(−0.18)	(8.26)	(6.49)

Panel D: Overnight performance in the holding period, the *J*-month formation period intraday-momentum strategy

Exret	−0.49	−3.01***	−2.52***	−0.30	−3.33***	−3.03***	−0.18	−3.29***	−3.11***	−0.12	−3.13***	−3.01***
	(−1.13)	(−6.90)	(−11.20)	(−0.69)	(−7.31)	(−10.62)	(−0.40)	(−7.27)	(−9.85)	(−0.28)	(−8.20)	(−9.91)
FF3 alpha	−0.69*	−3.32***	−2.63***	−0.56	−3.59***	−3.04***	−0.39	−3.53***	−3.14***	−0.34	−3.43***	−3.09***
	(−1.77)	(−7.88)	(−10.50)	(−1.41)	(−8.27)	(−10.43)	(−0.93)	(−8.61)	(−9.46)	(−0.89)	(−9.39)	(−9.09)
FF5 alpha	−0.59	−3.34***	−2.75***	−0.48	−3.61***	−3.12***	−0.32	−3.55***	−3.24***	−0.25	−3.43***	−3.19***
	(−1.50)	(−8.29)	(−11.29)	(−1.25)	(−8.62)	(−10.49)	(−0.75)	(−9.08)	(−9.44)	(−0.64)	(−10.01)	(−9.12)

Panel E: Intraday performance in the holding period, the *J*-month formation period overnight-momentum strategy

Exret	3.44***	0.81	−2.63***	3.31***	0.56	−2.74***	3.53***	0.56	−2.97***	3.34***	0.39	−2.96***
	(5.87)	(1.16)	(−7.96)	(5.42)	(0.84)	(−10.36)	(5.89)	(0.88)	(−10.41)	(5.17)	(0.60)	(−10.98)
FF3 alpha	2.79***	0.18	−2.61***	2.70***	−0.11	−2.80***	2.86***	−0.08	−2.94***	2.69***	−0.26	−2.95***
	(8.53)	(0.39)	(−8.10)	(7.72)	(−0.23)	(−10.60)	(8.34)	(−0.19)	(−10.54)	(7.09)	(−0.58)	(−11.62)
FF5 alpha	2.82***	0.20	−2.63***	2.73***	−0.13	−2.86***	2.90***	−0.16	−3.06***	2.73***	−0.29	−3.02***
	(8.53)	(0.41)	(−7.66)	(7.77)	(−0.28)	(−10.42)	(8.53)	(−0.34)	(−10.72)	(7.13)	(−0.61)	(−11.66)

Panel F: Overnight performance in the holding period, the *J*-month formation period overnight-momentum strategy

Exret	−3.52***	−0.56	2.95***	−3.77***	−0.14	3.63***	−3.82***	−0.08	3.74***	−3.71***	0.01	3.72***
	(−8.07)	(−1.37)	(21.02)	(−7.16)	(−0.37)	(11.66)	(−7.66)	(−0.19)	(15.47)	(−7.23)	(0.03)	(15.48)
FF3 alpha	−3.91***	−0.87**	3.04***	−4.07***	−0.41	3.67***	−4.12***	−0.34	3.78***	−4.01***	−0.24	3.77***
	(−9.30)	(−2.09)	(19.92)	(−8.66)	(−1.01)	(12.22)	(−9.28)	(−0.84)	(15.13)	(−8.72)	(−0.59)	(16.20)
FF5 alpha	−3.88***	−0.82*	3.06***	−4.04***	−0.32	3.72***	−4.07***	−0.28	3.79***	−3.97***	−0.20	3.77***
	(−9.27)	(−1.97)	(19.33)	(−8.66)	(−0.79)	(11.50)	(−9.25)	(−0.70)	(14.09)	(−8.69)	(−0.47)	(15.26)

At the end of each month, we sort stocks into decile portfolios based on their cumulative return components (in ascending orders) in the formation period. The length of the formation periods are 3-, 6-, 9-, and 12-months, respectively. The loser, the winner, and the zero-cost winner-minus-loser portfolios are denoted as 1, 10, and 10 − 1, respectively. Panels A (C, E) and B (D, F) use the formation period cumulative daily (intraday and overnight) returns to sort stocks, and the holding periods are intraday and overnight periods over the next month, respectively. All portfolios are value-weighted. Portfolio returns in excess of the risk-free rate, the risk-adjusted returns of the Fama-French three- and five-factor models are denoted as Exret, FF3 alpha, FF5 alpha, respectively. Newey-West adjusted t-statistics are reported in parenthesis. All reported returns are in percentage points. Statistical significance at the 1%, 5%, and 10% levels are denoted as ***, **, and, * respectively. The sample period is between 1991 and 2019.

strategies (such as momentum). Following their logic, we test whether trading back-and-forth within a day indeed explains the "no momentum" effect in China. If the tug-of-war explanation is valid, we should expect to find the conventional momentum strategy in China to be extremely successful in one period and reverts almost completely in the other period. Moreover, it remains interesting to examine whether conventional momentum in China generates profits during the day or over the night, which could be different from the US evidence.

Panels A and B in Table 3 report the performance of conventional momentum strategy during the day and over the night. The intraday and overnight performance are indeed consistent with a back-and-forth war between the clientele. For example, the 12-month conventional momentum strategy generates a risk-adjusted return of 0.92% per month under the Fama-French five-factor model, which is significant at the

10% level (in Panel A). However, this superior performance during the day is completely reversed over the night, because the same strategy experiences a dramatic loss of 1.04% per month (under the Fama-French five-factor model) during the overnight period (in Panel B). The similar back-and-forth between day and night virtually eliminates all profits for the conventional momentum strategies with an alternative length of the looking-back period.[5]

Overall, the offsetting performances during the day and over the night for the conventional momentum strategy is consistent with the tug-of-war explanation, as the two groups of heterogenous investors tend to trade at a different time within the day.

Looking carefully across the table, another interesting pattern worth noting is that the conventional momentum strategy in China earns its profits purely during the day, which is opposite to the pattern documented in the US. The intraday strength of the momentum strategy in China, however, corroborates with the fact that most individual investors trade heavily during the day.

4. Intraday *versus* overnight based strategies

4.1. Intraday versus overnight based strategies with one-month holding period

The conventional momentum strategies perform poorly overall in China, indicating that there is little (positive) return autocorrelation among monthly returns. This, however, does not preclude the possibility that there exists strong persistence for the two return components: intraday and overnight returns at the monthly frequency. According to Lou et al. (2019), the presence of "intraday" and "overnight" clientele dominate certain trading session within the day (*i.e.*, the pre-open call auction and the continuous double-auction periods), which might lead to strong persistence among two return components.

To verify the investor heterogeneity claim, we form two return-based trading strategies, dubbed as *intraday-momentum* and *overnight-momentum* strategies, which mimic the trading behaviors of the intraday and overnight clientele. At the end of each month, we sort all available stocks into decile groups based on their cumulated intraday (overnight) returns in the formation period. Similar to the conventional momentum-type strategy in Jegadeesh and Titman (1993), the formation window varies for 3, 6, 9, and 12 months, respectively. The portfolios are then held for one month (*i.e.*, holding period) before rebalancing. Portfolio 1 (Chui et al., 2010) contains the bottom (top) decile stocks with the lowest (highest) cumulative intraday (overnight) returns in the formation period. Note that our approach is different from Lou et al. (2019) who use only lagged one-month cumulative intraday (overnight) returns to form portfolios (one-month formation length is generally used for the study of short-term reversal performance, actually). Instead, we are using the past *J*-month cumulative intraday (overnight) returns, which reveals the relatively longer-term return persistence in the intraday (overnight) return process.

Therefore, a zero-cost trading strategy that goes long the intraday winner (decile 10) and short the intraday loser (decile 1) mimics the trading preference of the intraday investors. Similarly, a self-funded trading strategy that buys the overnight winner (decile 10) and sells the overnight loser (decile 1) mimics the trading preference of the overnight investors.

Panels C and D in Table 3 break down the performance of the intraday momentum strategy during the day and over the night. In Panel C, when we use the 3-month formation window to generate the intraday momentum signal, the value-weighted intraday momentum strategy generates a monthly return differential of 1.93% with a Newey-West t-statistic of 6.75. The risk-adjusted return based on the Fama-French three- (five-) factor model amounts to 1.97% (1.70%), which is statistically significant at the 1% level (*i.e.*, the Newey-West *t*-statistic of 6.31 (5.19)). Moreover, the sheer magnitude of the monthly return spread (both before and after adjusting the risk exposure) of this strategy is of strong economic significance from a practical perspective. In general, as we increase the length of the formation window, the return spread (both before and after adjusting the risk exposure) tends to increase. For instance, the return differentials of the zero-cost intraday momentum strategies are 1.93%, 2.31%, 2.61% and 2.65% for the 3-, 6-, 9-, and 12-month look-back periods, respectively. This seems to indicate that a longer formation window is associated with stronger portfolio performance for the intraday momentum strategy. Overall, the strong performance of the intraday momentum during the intraday period of the subsequent month indicates strong return persistence of the intraday return component, and also collaborates that intraday investors dominate the trading session during the day.

However, the same intraday-momentum strategy suffers dramatically during the overnight periods in the subsequent month. As can be seen in Panel D, the value-weighted intraday-momentum strategy based on the 3-month formation window generates a monthly negative return differential of −2.52% with a t-statistic of −11.20. The alpha of the Fama-French three- (five-) factor model amounts to −2.63% (−2.75%) per month, with a Newey-West *t*-statistic of −10.50 (−11.29). The magnitude of the return differential also gets larger as we increase the length of the look-back period. In general, the relatively large profits (*i.e.*, positive return differential) earned during the intraday period are completely reverted during the overnight period, because the return spread turns negative with similar, if not more, in magnitude. The same patterns apply to the risk-adjusted returns. Therefore, the cross-period return reversal pattern is consistent with the investor heterogeneity that intraday and overnight clientele (with different views on asset value and different trading mechanism preferences) each dominates in their preferred trading sessions, causing the dramatic cross-period reversal within the day.

Panels E and F in Table 3 break down the performance of the overnight momentum strategy during the day and over the night. It depicts a very similar same-period momentum and cross-period reversal pattern as that of the trading strategy based on the cumulated intraday returns. For example, the overnight-momentum strategy based on a three-month looking-back period yields a negative return differential of −2.63% per month and a FF3 (FF5) alpha of −2.61% (−2.63%), which are all significant at the 1% level (Panel E). This deficit in portfolio return is completely reverted in the overnight period, because the same strategy generates the positive return spreads of 2.95% and a FF3 (FF5) alpha of 3.04% (3.06%), which are all significant at the 1% level (Panel F). The success (failure) of the overnight-momentum strategy during the overnight (intraday) period again indicates the strong same-period return persistence (cross-period return reversal) for the overnight returns.[6]

To sum up, the intraday-momentum and overnight-momentum strategies, which mimic the trading behaviors of the intraday and overnight clientele, depict a persistent tug of war between the two groups of investors: Stocks that are highly demanded during the day are also under close scrutiny over the night (by the other investor group),

[5] The offsetting performances of intraday and overnight components based on the conventional momentum strategy also exist in the longer holding periods (3 months to 12 months). We do not report these results for the brevity purpose, but they are always available upon request.

[6] Besides, we also find the portfolio returns of intraday and overnight momentum strategies are mainly from the different deciles: The portfolio return of intraday momentum strategy is mainly from the intraday winner (*i.e.*, portfolio 10). However, the portfolio return of overnight momentum strategy is mainly from the overnight loser (*i.e.*, portfolio 1), which further supports the different clientele effects of two strategies (Based on the stock characteristics in Table 5, the intraday winner and overnight loser have similar firm characteristics. That is, intraday and overnight investors trade in opposite directions on more or less the same set of stocks to make profits (*i.e.*, a reflection on the clientele effects).

and *vice versa*.

4.2. Longer holding periods

In the prior subsection, the holding period of the intraday- (overnight-) momentum strategy is fixed at one month. However, if the return dynamics for the intraday (overnight) returns are highly persistent over time (as they are correlated with the demand of the intraday and overnight clientele), we should expect the intraday- (overnight-) momentum strategy to depict a very similar *same-period return persistence* and *cross-period return reversal* pattern when we increase the length of the holding periods (*i.e.*, multi-month investment horizons).

Therefore, we test the performance of the *intraday-momentum* and *overnight-momentum* strategies with *k*-month holding periods (*i.e.*, $k = 3$, 6, 9, and 12 months). We follow Jegadeesh and Titman (1993) approach to calculate the monthly strategy returns. That is, at each month, we have *k* active portfolios, and the portfolio return for that month is the arithmetic mean of the *k* active portfolios.

Table 4 presents the portfolio performance of the *intraday-momentum* and *overnight-momentum* strategies with longer holding periods. For brevity purpose, we only report the results of the zero-cost long-and-short portfolio, which buys the intraday (overnight) winners and sells the intraday (overnight) losers.

The intraday-momentum strategies continue to work during the daytime. Irrespective of the length of the looking-back period, the excess returns are all highly positive with different lengths of the holding periods (*i.e.*, *t*-statistics are uniformly larger than 5). As we increase the length of the looking-back period (*i.e.*, from 3 months up to 12 months), the magnitude of the excess return gradually increases. Similar patterns apply to the risk-adjusted returns of the Fama-French three- and five-factor models (see Panel A of the table).[7]

Similar to the one-month holding period, the intraday-momentum strategies with longer holding periods continue to suffer losses in the (subsequent) overnight periods. The losses during the overnight period almost fully offset the gains achieved during the day, confirming again the strong cross-period reversal effect (see Panel B of the table).

Panel C and D of the table depict the intraday and overnight performance of the overnight-momentum strategies with different holding periods (*i.e.*, from 3 months up to 12 months). As it stands, the zero-cost overnight-momentum strategy suffers dramatically during the day across all holding periods. However, these losses tend to be fully reverted over the night, as the overnight-momentum strategies uniformly generate highly positive returns both before and after adjusting for the risk exposure. Similarly, we find that the magnitude of the overnight-momentum strategy slightly strengthens as we increase the length of the looking-back period (*i.e.*, from 3 months up to 12 months), and weakens with the length of the holding period.

To sum up, the strong performance of the intraday- (overnight-) momentum strategies during the day (over the night), and its seemingly predictable reversal over the night (during the day) are fairly stable across all looking-back and holding periods. This demonstrates a persistent *same-period return continuation* and *cross-period return reversal* effect in China, and further support the offsetting performances during the day and overnight periods could be the reason for weak momentum performance in China.

[7] It should be noted that the decrease in the magnitude of the excess returns as we increase the holding periods does not mean the profits of the strategy with longer holding periods are smaller, because strategies with longer holding periods have less portfolio turnover and thus incur fewer transaction costs. Therefore, strategies with longer periods are still likely to have high after-transaction-cost profits.

5. Characteristics of intraday and overnight momentum

5.1. Firm characteristics in different momentum strategies

The empirical patterns of the *intraday-momentum* and *overnight-momentum* strategies in prior sections indicate a strong same-period continuation effect: Stocks that are past intraday winners (losers) continue to outperform (underperform) in the subsequent intraday periods, while those that are past overnight winners (losers) continue to outperform (underperform) in the subsequent overnight periods. More importantly, there is a strong cross-period reversal effect: Past intraday winners (losers) tend to underperform (outperform) in the subsequent overnight periods. Similarly, Past overnight winners (losers) tend to underperform (outperform) in the subsequent intraday periods.

The same-period continuation and cross-period reversal effect persisting for multiple months seems to indicate that the intraday and overnight clientele have the special trading preference (or priority) in their dominated trading sessions. Therefore, in this section, we examine the stock features of the intraday (overnight) winners and losers.

Panel A (B) of Table 5 reports the average firm-characteristics for stocks in decile 1 and 10 portfolios that are sorted (in ascending order) by their past 3-, 6-, 9-, and 12-month cumulated intraday (overnight) returns, respectively. The average difference in firm characteristics between two decile portfolios (denoted as $10 - 1$) is also reported, together with its associated Newey-West t-statistic. The firm characteristics include firm size (*lnME*), turnover ratio (*TURN*), book-to-market ratio (*lnBTM*), analyst coverage (*ANACOV*), dispersion (*DISP*), idiosyncratic skewness (*ISKEW*), and idiosyncratic volatility (*IVOL*), institutional ownership (*IO*), price (*PRC*), market beta (*BETA*), Amihud illiquidity ratio (*ILLIQ*). Variable definitions are available in Table A2. All variables are winsorized at the 1% and 99% levels.

As it stands, stocks that are intraday winners (decile 10) tend to be of smaller market capitalization than those that are intraday losers (decile 1). The average difference in *lnME* between decile 10 and decile 1 portfolios is significantly negative across all looking-back periods. On the contrary, stocks that are overnight winners (decile 10) tend to have relatively larger market capitalization than those that are overnight losers (decile 1).

When examining the valuation ratio, it seems that intraday winners (decile 10) tend to have relatively lower values of *lnBTM* than intraday losers (decile 1) across all looking-back periods. That is, intraday clientele seem to prefer growth firms over value firms during their dominated trading period. We find a reverse pattern for the overnight clientele, because the overnight winners (decile 10) tend to have relatively larger values of *lnBTM* than overnight losers (decile 1). The average difference in the book-to-market ratio between the two decile groups is statistically significant at the 1% level across all looking-back periods.

Next, we look the turnover ratio (*TURN*). There exists a notable difference in trading volume between the intraday winner and loser groups. Irrespective the length of the looking-back period, the average turnover of the intraday winner stocks is approximately 60% higher than that of the intraday losers. The difference in *TURN* between the groups is highly significant with t-statistic in excess of 7. On the contrary, overnight winners tend to have much lower turnover ratios than overnight losers, indicating that the overnight clientele prefer to buy (sell) stocks with low (high) trading volume.

When examining analyst coverage (*ANACOV*), it indicates that stocks of intraday winners are covered by fewer analysts than those of intraday losers. In comparison, overnight winners are covered by more analysts than those of overnight losers. This is not surprising, because analyst coverage is highly correlated with firm size. Large firms tend to have more analysts to cover. Therefore, the average difference in *ANACOV* between the intraday (overnight) winner and loser groups is consistent with that for firm size (*lnME*).

Dispersion in analyst forecasts (*DISP*) measures the difference of

Table 4
Intraday- and overnight-momentum strategies, longer holding periods.

Panel A: Intraday performance of the intraday-momentum strategy with the *J*-month formation and *K*-month holding periods

	K=	*Exret*				*FF*3 *alpha*				*FF*5 *alpha*			
		3 M	6 M	9 M	12 M	3 M	6 M	9 M	12 M	3 M	6 M	9 M	12 M
Formation period, *J*=	3 M	1.70***	1.68***	1.48***	1.26***	1.88***	1.83***	1.64***	1.43***	1.69***	1.73***	1.53***	1.31***
		(5.44)	(6.58)	(8.04)	(7.75)	(5.74)	(6.41)	(7.96)	(8.27)	(4.84)	(6.13)	(7.22)	(7.02)
	6 M	2.22***	2.11***	1.82***	1.50***	2.48***	2.32***	2.07***	1.74***	2.27***	2.17***	1.88***	1.56***
		(5.36)	(6.54)	(6.82)	(6.18)	(5.57)	(6.42)	(7.26)	(6.96)	(4.82)	(5.77)	(6.08)	(5.61)
	9 M	2.55***	2.27***	1.85***	1.55***	2.88***	2.60***	2.19***	1.85***	2.60***	2.35***	1.92***	1.61***
		(6.91)	(7.29)	(6.89)	(6.03)	(7.22)	(8.01)	(8.08)	(7.36)	(6.26)	(6.74)	(6.52)	(5.77)
	12 M	2.41***	1.98***	1.66***	1.48***	2.81***	2.35***	2.03***	1.81***	2.50***	2.06***	1.76***	1.56***
		(6.60)	(6.06)	(5.67)	(5.56)	(7.38)	(6.86)	(6.85)	(7.09)	(6.04)	(5.49)	(5.37)	(5.47)

Panel B: Overnight performance of the intraday-momentum strategy with the *J*-month formation and *K*-month holding periods

Formation period, *J*=	3 M	−2.12***	−1.75***	−1.50***	−1.34***	−2.15***	−1.76***	−1.52***	−1.36***	−2.20***	−1.84***	−1.57***	−1.41***
		(−11.40)	(−10.95)	(−10.26)	(−9.87)	(−10.45)	(−10.28)	(−9.61)	(−9.24)	(−10.54)	(−10.08)	(−9.45)	(−8.93)
	6 M	−2.53***	−2.12***	−1.90***	−1.75***	−2.52***	−2.15***	−1.93***	−1.78***	−2.63***	−2.26***	−2.00***	−1.86***
		(−10.22)	(−9.30)	(−8.60)	(−8.70)	(−9.69)	(−8.43)	(−7.97)	(−8.16)	(−9.70)	(−8.48)	(−8.01)	(−8.18)
	9 M	−2.65***	−2.26***	−2.05***	−1.89***	−2.69***	−2.32***	−2.09***	−1.93***	−2.78***	−2.39***	−2.15***	−1.99***
		(−10.10)	(−9.19)	(−8.91)	(−9.06)	(−9.34)	(−8.57)	(−8.38)	(−8.64)	(−9.38)	(−8.62)	(−8.46)	(−8.71)
	12 M	−2.63***	−2.28***	−2.06***	−1.93***	−2.70***	−2.34***	−2.09***	−1.95***	−2.80***	−2.42***	−2.15***	−2.02***
		(−9.63)	(−9.13)	(−9.00)	(−9.25)	(−8.98)	(−8.61)	(−8.59)	(−8.88)	(−9.04)	(−8.66)	(−8.65)	(−9.00)

Panel C: Intraday performance of the overnight-momentum strategy with the *J*-month formation and *K*-month holding periods

	K=	*Exret*				*FF*3 *alpha*				*FF*5 *alpha*			
		3 M	6 M	9 M	12 M	3 M	6 M	9 M	12 M	3 M	6 M	9 M	12 M
Formation period, *J*=	3 M	−2.21***	−1.93***	−1.69***	−1.59***	−2.26***	−1.96***	−1.71***	−1.61***	−2.35***	−2.01***	−1.71***	−1.60***
		(−9.31)	(−10.58)	(−11.04)	(−12.17)	(−8.78)	(−10.45)	(−11.92)	(−13.57)	(−8.98)	(−10.65)	(−11.63)	(−13.49)
	6 M	−2.50***	−2.20***	−2.09***	−1.95***	−2.53***	−2.23***	−2.10***	−1.96***	−2.63***	−2.29***	−2.10***	−1.96***
		(−10.11)	(−9.35)	(−10.33)	(−10.50)	(−10.28)	(−10.09)	(−11.36)	(−11.67)	(−10.56)	(−10.07)	(−11.07)	(−11.58)
	9 M	−2.63***	−2.43***	−2.28***	−2.14***	−2.65***	−2.44***	−2.27***	−2.11***	−2.72***	−2.48***	−2.26***	−2.11***
		(−9.98)	(−10.10)	(−10.43)	(−10.29)	(−10.39)	(−10.69)	(−11.20)	(−11.53)	(−10.48)	(−10.71)	(−11.03)	(−11.33)
	12 M	−2.84***	−2.53***	−2.34***	−2.24***	−2.85***	−2.51***	−2.30***	−2.18***	−2.93***	−2.53***	−2.28***	−2.18***
		(−10.99)	(−10.83)	(−10.75)	(−10.42)	(−11.41)	(−11.29)	(−12.25)	(−12.31)	(−11.45)	(−11.28)	(−12.02)	(−11.93)

Panel D: Overnight performance of the overnight-momentum strategy with the *J*-month formation and *K*-month holding periods

Formation period, *J*=	3 M	2.74***	2.39***	2.17***	2.00***	2.74***	2.43***	2.22***	2.04***	2.77***	2.46***	2.24***	2.06***
		(17.87)	(20.40)	(22.42)	(21.43)	(16.79)	(18.77)	(19.73)	(19.54)	(16.14)	(17.65)	(18.85)	(19.39)
	6 M	3.22***	2.93***	2.65***	2.46***	3.25***	3.00***	2.72***	2.52***	3.32***	3.06***	2.75***	2.54***
		(14.40)	(17.43)	(18.62)	(19.38)	(13.68)	(15.95)	(16.95)	(18.24)	(12.93)	(14.86)	(16.29)	(17.84)
	9 M	3.38***	3.06***	2.81***	2.61***	3.45***	3.15***	2.90***	2.69***	3.48***	3.18***	2.91***	2.69***
		(18.55)	(19.84)	(20.51)	(20.57)	(16.65)	(17.46)	(18.66)	(19.45)	(15.49)	(16.40)	(17.62)	(18.70)
	12 M	3.36***	3.06***	2.83***	2.65***	3.43***	3.17***	2.93***	2.74***	3.46***	3.18***	2.92***	2.73***
		(19.74)	(20.72)	(20.34)	(20.31)	(17.86)	(19.00)	(19.40)	(19.96)	(16.75)	(17.24)	(17.94)	(19.10)

The table presents the average monthly excess return, and the Fama-French three- and five-factor alphas of the zero-cost intraday- (overnight-) momentum strategies with J-month formation period and K-month holding period. The formation and holding periods are 3-, 6-, 9-, and 12-months (denoted as 3 M, 6 M, 9 M, and 12 M), respectively. At each month, there are K active portfolios, and the monthly return is calculated as the arithmetic mean of the K active portfolios. Panels A (C) and B (D) report the results of the intraday- (overnight-) moment strategy during the intraday and overnight periods, respectively. Newey-West adjusted t-statistics are reported in parenthesis. All values are in percentages. Statistical significance at the 1%, 5%, and 10% levels are denoted as ***, **, and, * respectively. The sample period is between 1991 and 2019.

Table 5
Firm characteristics.

		Panel A: Intraday				Panel B: Overnight			
		1	10	10 − 1	t_{10-1}	1	10	10 − 1	t_{10-1}
lnME	3 months	15.19	15.05	-0.14**	-2.50	14.77	15.10	0.33***	9.28
	6 months	15.28	14.98	-0.30***	-3.78	14.72	15.17	0.45***	9.78
	9 months	15.33	14.93	-0.40***	-4.39	14.67	15.22	0.55***	10.42
	12 months	15.37	14.88	-0.49***	-4.99	14.64	15.26	0.62***	10.78
TURN	3 months	37.26	65.88	28.61***	10.46	63.17	44.29	-18.88***	-5.39
	6 months	36.10	61.57	25.47***	8.34	62.47	41.79	-20.68***	-6.18
	9 months	35.65	59.93	24.28***	7.59	62.20	40.65	-21.55***	-6.52
	12 months	35.37	59.58	24.21***	7.15	62.37	40.07	-22.30***	-6.59
lnBTM	3 months	0.65	0.57	-0.08***	-8.38	0.58	0.62	0.05***	5.89
	6 months	0.66	0.56	-0.10***	-6.90	0.57	0.63	0.07***	6.56
	9 months	0.67	0.56	-0.12***	-6.97	0.57	0.64	0.07***	6.41
	12 months	0.68	0.55	-0.13***	-7.17	0.56	0.65	0.08***	6.82
ANACOV	3 months	2.17	1.93	-0.24**	-2.40	1.45	1.98	0.53***	6.57
	6 months	2.24	1.89	-0.35**	-2.53	1.33	2.02	0.69***	6.78
	9 months	2.28	1.83	-0.45***	-2.76	1.25	2.07	0.82***	6.97
	12 months	2.29	1.78	-0.51***	-2.83	1.21	2.09	0.89***	7.01
DISP	3 months	0.49	0.48	-0.01	-0.35	0.63	0.44	-0.18***	-3.70
	6 months	0.46	0.48	0.02	0.37	0.68	0.44	-0.24***	-3.29
	9 months	0.42	0.51	0.08	1.54	0.71	0.43	-0.28***	-3.37
	12 months	0.42	0.54	0.13*	1.97	0.74	0.42	-0.32***	-3.43
ISKEW	3 months	-0.15	-0.03	0.12**	2.18	0.07	0.03	-0.04	-0.82
	6 months	-0.10	-0.13	-0.03	-0.36	0.08	-0.07	-0.15***	-2.62
	9 months	-0.06	-0.19	-0.13	-1.50	0.10	-0.15	-0.24***	-3.90
	12 months	-0.02	-0.26	-0.23**	-2.35	0.10	-0.19	-0.29***	-4.17
IVOL (in %)	3 months	1.84	2.57	0.73***	10.64	2.41	2.16	-0.26***	-4.62
	6 months	1.77	2.44	0.68***	9.97	2.31	2.01	-0.30***	-6.46
	9 months	1.73	2.38	0.65***	9.80	2.26	1.96	-0.31***	-6.73
	12 months	1.71	2.34	0.63***	10.07	2.23	1.92	-0.31***	-6.91
IO (in %)	3 months	14.60	17.60	3.00***	3.75	13.81	14.27	0.46**	2.28
	6 months	14.08	17.60	3.52***	2.99	13.18	13.90	0.72***	2.76
	9 months	13.45	17.35	3.91***	2.91	12.49	13.57	1.08***	3.62
	12 months	13.11	16.96	3.85***	2.65	12.04	13.28	1.24***	3.70
PRC	3 months	12.26	14.02	1.76***	5.23	11.86	12.54	0.68**	2.19
	6 months	12.17	13.96	1.79***	4.19	11.68	12.46	0.78*	1.79
	9 months	11.94	14.02	2.08***	4.17	11.43	12.42	0.99**	2.13
	12 months	11.73	14.05	2.32***	4.20	11.34	12.42	1.09**	2.16
BETA	3 months	1.08	1.07	-0.01	-0.89	1.09	1.09	-0.00	-0.08
	6 months	1.08	1.06	-0.02	-1.16	1.09	1.09	0.00	0.01
	9 months	1.08	1.06	-0.03	-1.25	1.09	1.09	0.01	0.36
	12 months	1.08	1.05	-0.03	-1.20	1.09	1.09	0.00	0.26
ILLIQ	3 months	0.44	0.33	-0.11	-1.18	0.50	0.73	0.23	1.14
	6 months	0.38	0.37	-0.01	-0.07	0.51	0.65	0.14	0.73
	9 months	0.34	0.41	0.08	0.92	0.51	0.59	0.08	0.47
	12 months	0.30	0.43	0.13	1.57	0.52	0.56	0.04	0.23

Table 5 reports the time-series average of the equal-weighted average firm characteristics for the decile 1 and 10 portfolios, respectively. The decile portfolios are sorted by the past 3-, 6-, 9-, and 12-month cumulative intraday (overnight) returns. The firm characteristics include firm size (*lnME*), turnover ratio (*TURN*), book-to-market ratio (*lnBTM*), analyst coverage (*ANACOV*), dispersion (*DISP*), idiosyncratic skewness (*ISKEW*), and idiosyncratic volatility (*IVOL*), institutional ownership (*IO*), price (*PRC*), market beta (*BETA*), Amihud illiquidity ratio (*ILLIQ*). Variable definitions are in Appendix A2. All variables are winsorized at the 1% and 99% levels. The average difference in firm characteristics of the two decile portfolios (denoted as 10 − 1) and its associated Newey-West t-statistics are also reported. Statistical significance at the 1%, 5%, and 10% levels are denoted as ***, **, and, * respectively. Due to data constraints for *ANACOV*, *DISP*, and *IO*, the sample period starts from 2000 to 2018.

opinion among professional analysts. We find little difference in *DISP* between the intraday winners and the intraday losers (except for the case with 12-month looking-back period). However, there exist notable differences in *DISP* between overnight winners and overnight losers, which are all significant at the 1% level. More specifically, stocks that are overnight winners (losers) tend to have smaller (larger) dispersion in earnings forecast among professional analysts.

Moreover, we examine the idiosyncratic volatility (*IVOL*) and idiosyncratic skewness (*ISKEW*) of the individual stocks. On average, intraday winners have significantly larger *IVOL* than intraday losers, which are all statistically significant at the 1% level across all different look-back periods. On the contrary, stocks that are overnight winners tend to have significantly smaller *IVOL* than their counterparts (overnight losers). In other words, stocks that do relatively well during the day time (over the night) are more (less) likely to be speculative stocks with high idiosyncratic risk. We find a similar but somewhat weaker pattern for idiosyncratic skewness (*ISKEW*).

Finally, we examine the proportion of institutional ownership (*IO*), price (*PRC*), market beta (*BETA*) and Amihud illiquidity ratio (*ILLIQ*), and find there exist no significant differences between the winner and loser deciles of the intraday (overnight) momentum on these firm characteristics variables. Specifically, we find the consensus that intraday (overnight) winners are the stocks with relatively higher institutional ownership and larger stock price than intraday (overnight) losers and as we increase the length of the look-back periods, the difference in *IO* between decile 10 and decile 1 groups tends to get larger and more statistically significant in two momentum strategies. Moreover, the differences between market beta (*BETA*) and Amihud illiquidity ratio (*ILLIQ*) are insignificant for both intraday and overnight strategies in all different look-back periods, which indicates the systemic risk and liquidity level are not the key influencing factors for the intraday and overnight clientele.

To sum up, after examining the list of firm characteristics, we find some distinctive features for stocks that do relatively well during the day time (over the night) over their counterparts that do relatively badly over the same time of the day. Stocks with upward trend during the day tend to be relatively small, growth, and high turnover firms with high idiosyncratic risk, less analyst coverage, and relatively high institutional ownership. In comparison, stocks that outperform over the night tend to be relatively large, value, low turnover firms with low idiosyncratic risk, more analyst coverage, less analyst dispersion, and relatively high institutional ownership. Therefore, stocks that are intraday winners are of more speculative nature.

5.2. Influence on the change of institutional ownership

Based on the portfolio statistics in the prior subsection, it seems that overnight trading is more rational than intraday trading. Combining with the nature of the pre-open call auction, we have good reasons to expect that institutional investors are related to the overnight trading. To verify this claim, we perform the Fama-MacBeth cross-sectional regression at the firm level. We use the quarterly change of institutional ownership as the dependent variable, and study the relation with the contemporaneous intraday and overnight returns. In this way, we can infer the interrelation between the intraday- (overnight-) momentum and institutional investors (who are considered to be more professional and informed). The model specification is as follows:

$$Change\_IO_{i,t} = \alpha + \beta_1 * Overnight_{i,t} + \beta_2 * Intraday_{i,t} + \varepsilon_{i,t} \quad (4)$$

where the dependent variable $Change\_IO_{i,\,t}$ is the change of institutional ownership in each quarter, and the independent variables *Overnight* and *Intraday* are the quarterly cumulated overnight and intraday returns.

We also perform subsample analyses by splitting the stocks into the lower, medium, and high institutional ownership tertiles. For example, "Lowest IO" consists of stocks in the lowest *IO* tertile during the quarter, and the other two subsamples have the similar meanings. Due to data limitations on institutional ownership, the sample period used in this part is from 2007 to 2018. This also avoids the possible "regime shift" in China's stock split reform between 2005 and 2006.

Table 6 depicts a strong positive co-movement between the contemporaneous change of institutional ownership and the cumulative intraday and overnight returns. Both return components are positively related to the change in institutional ownership, and the net impact of intraday returns seem to be larger (*i.e.*, larger slope coefficients with higher t-statistics, whether based on the original data and the standardized data). Results from the subsamples reveal very similar patterns: From the lowest to the highest *IO* tertiles, the coefficients on overnight and intraday returns tend to increase.

To sum up, findings in Table 6 imply that the intraday and overnight returns both have a significantly positive influence on the change of institutional ownership, and the influence of intraday and overnight returns is still significant after controlling the counterparty one. The strong positive coefficient on cumulative overnight returns is consistent with our expectation as institutional investors tend to be more informed, they are expected to be "active" during the pre-open call auction in setting up the opening price, and could be more rational (combing the firm-characteristics reported in Table 5). Moreover, as institutional

Table 6
Influence on the Change of Institutional Ownership.

	Whole sample	Lowest IO	Medium IO	Highest IO
Panel A				
Overnight	0.063***	0.031***	0.050***	0.076***
	(10.05)	(5.65)	(5.85)	(5.44)
Intraday	0.081***	0.051***	0.071***	0.090***
	(11.08)	(7.14)	(9.34)	(10.77)
Cons	-−0.03	3.01***	1.45	−3.77*
	(−0.02)	(3.65)	(1.34)	(−1.91)
Obs	80,741	27,366	28,832	24,543
R^2	0.023	0.024	0.031	0.026
Panel B				
z (Overnight)	1.004***	0.488***	0.800***	1.219***
	(10.05)	(5.65)	(5.85)	(5.44)
z (Intraday)	1.828***	1.142***	1.607***	2.018***
	(11.08)	(7.14)	(9.34)	(10.77)

Using the Fama-MacBeth regressions, this table studies the influence of intraday and overnight returns on the current change of institutional ownership. The dependent variable $Change\_IO_{i,\,t}$ is the change of institutional ownership in each quarter, and the independent variables *Overnight* and *Intraday* are the quarterly cumulated overnight and intraday returns. We use both the whole sample and subsamples sorted by the institutional ownership at the beginning of each quarter. For example, "Lowest IO" is constituted by stocks with the lowest 1/3 *IO* in each quarter, and other two subsamples have the similar meanings. Panel B reports the coefficients on the standardized overnight and intraday returns (denoted as z(Overnight) and z(Intraday)). Newey-West adjusted t-statistics are reported in parenthesis. All values are in percentages. Significance at the 1%, 5%, and 10% level are denoted as ***, **, and * respectively. Sample period is from 2007 to 2018, after the finish of non-tradable shares reform in the Chinese stock market.

Table 7
Results based on Fama-Macbeth regression.

	Panel A: Intraday return				Panel B: Overnight return			
	3 M	6 M	9 M	12 M	3 M	6 M	9 M	12 M
Intra	0.09	0.60***	0.64***	0.66***	−0.14*	−0.22***	−0.22***	−0.27***
	(0.43)	(3.92)	(3.80)	(3.60)	(−1.79)	(−3.38)	(−3.17)	(−4.00)
Over	−0.58***	−0.38***	−0.43***	−0.47***	0.64***	0.69***	0.79***	0.80***
	(−3.17)	(−3.07)	(−3.39)	(−3.36)	(10.45)	(10.43)	(12.37)	(13.25)
lnME	−0.82***	−0.95***	−0.92***	−0.85***	0.15***	0.18***	0.18***	0.19***
	(−5.64)	(−6.78)	(−6.72)	(−6.17)	(2.91)	(4.42)	(4.22)	(4.20)
Turn	0.26	−0.04	−0.00	0.00	0.12	0.03	0.00**	0.00**
	(1.23)	(−0.53)	(−0.50)	(0.92)	(0.71)	(0.95)	(2.37)	(2.05)
ILLIQ	−0.01	−0.00	−0.00	−0.01*	−0.03*	−0.01***	−0.01**	−0.00
	(−0.22)	(−0.64)	(−0.47)	(−1.74)	(−1.89)	(−4.04)	(−2.13)	(−0.83)
BM	3.24***	1.60***	1.27***	1.55***	−1.61***	−1.00***	−0.81**	−0.81**
	(4.16)	(2.94)	(2.70)	(3.27)	(−4.41)	(−3.03)	(−2.49)	(−2.59)
Cover	−3.05***	−1.02**	−0.59	−0.39	−0.25	0.35*	0.26	0.29
	(−6.40)	(−2.43)	(−1.48)	(−0.95)	(−0.45)	(1.95)	(1.44)	(1.57)
Disp	−0.19	0.39***	0.33***	0.26**	0.35**	0.03	−0.03	−0.02
	(−0.80)	(3.14)	(2.84)	(2.39)	(2.28)	(0.54)	(−0.42)	(−0.37)
IO	0.21*	0.22**	0.13	0.08	−0.19*	−0.12*	−0.08	−0.08
	(1.70)	(2.07)	(1.33)	(0.90)	(−1.66)	(−1.91)	(−1.35)	(−1.51)
Iskew	3.18***	1.80***	1.22***	1.01***	−1.83***	−1.25***	−1.04***	−0.97***
	(6.28)	(4.40)	(3.20)	(2.64)	(−4.76)	(−6.69)	(−5.48)	(−5.36)
Ivol	0.05	0.05*	0.02	0.04	−0.04	−0.11***	−0.12***	−0.12***
	(1.35)	(1.92)	(0.74)	(1.01)	(−1.41)	(−5.76)	(−6.28)	(−6.42)
Beta	0.01	−0.02	−0.15	−0.09	−0.37***	−0.45***	−0.48***	−0.43***
	(0.14)	(−0.14)	(−1.11)	(−0.59)	(−7.76)	(−6.96)	(−5.82)	(−5.12)
Prc	−0.01	−0.03**	−0.02**	−0.02	−0.07*	−0.00	−0.00	−0.00
	(−0.39)	(−2.58)	(−2.00)	(−1.49)	(−1.77)	(−0.70)	(−0.51)	(−0.41)
Cons	17.58***	17.92***	17.56***	16.62***	−2.11***	−3.53***	−3.55***	−3.84***
	(7.18)	(7.43)	(7.41)	(6.94)	(−2.95)	(−4.87)	(−4.68)	(−4.93)
Obs	175,531	181,612	184,756	187,724	175,531	181,612	184,756	187,724
R^2	0.170	0.136	0.133	0.133	0.139	0.100	0.094	0.092
N	187	187	187	187	187	187	187	187

Table 7 reports the results from Fama-MacBeth cross-sectional regressions based on the decomposed returns. The dependent variables used in this table are cumulated monthly intraday return (1 to 4 columns) and overnight return (5 to 8 columns) in month *t*, and the main independent variables are the cumulated intraday return (*Intra*) and overnight return (*Over*) in month $t - m$ to month $t - 1$. Where m is equal to 3, 6, 9 and 12, respectively, reported as 3 M to 12 M in this table. The control variables include firm size (*lnME*), turnover ratio (*TURN*), book-to-market ratio (*lnBTM*), analyst coverage (*ANACOV*), dispersion (*DISP*), idiosyncratic skewness (*ISKEW*), and idiosyncratic volatility (*IVOL*), institutional ownership (*IO*), price (*PRC*), market beta (*BETA*), Amihud illiquidity ratio (*ILLIQ*). Newey-West adjusted t-statistics are reported in parenthesis. All values are in percentages. Significance at the 1%, 5%, and 10% level are denoted as ***, **, and * respectively. Sample period is from 2000 to 2018, considering the limit of available firm characteristics data.

investors trade throughout the day, it is not surprising there is a strong positive relationship between changes in institutional ownership and (cumulative) intraday returns.

6. Extensions and robustness

In this section, we provide a summary of extensions and robustness checks, and their main outcomes.

6.1. Fama-MacBeth regression on return components

We perform the Fama-MacBeth cross-sectional regressions to verify the same-period continuation and cross-period reversal effect on the intraday and overnight return components. The advantage of the regression framework is that we could examine the net effect on past cumulative intraday (overnight) returns, while simultaneously control a number of well-known return determinants. The control variables include firm size (*lnME*), turnover ratio (*TURN*), book-to-market ratio (*lnBTM*), analyst coverage (*ANACOV*), dispersion (*DISP*), idiosyncratic skewness (*ISKEW*), and idiosyncratic volatility (*IVOL*), institutional ownership (*IO*), price (*PRC*), market beta (*BETA*), Amihud illiquidity ratio (*ILLIQ*).

Panel A of Table 7 regresses the intraday returns on past 3-, 6-, 9-, and 12-month cumulative intraday and overnight returns. In general, the past 3-, 6-, 9-, and 12-month cumulative overnight returns predict negatively the subsequent month's intraday return, while the past 3-, 6-, 9-, and 12-month cumulative intraday returns predict positively the subsequent month's intraday return in the cross section (see column 1, 2, 3, and 4, respectively).

Panel B of Table 7 uses the overnight returns as the dependent variable. It demonstrates that the past 3-, 6-, 9-, and 12-month cumulative overnight returns predict positively the subsequent month's overnight return, while the past 3-, 6-, 9-, and 12-month cumulative intraday returns predict negatively the subsequent month's overnight return in the cross section (see column 5, 6, 7, and 8, respectively). In both panels, the *net* effects of the past cumulative intraday and overnight returns all have the predicted signs, and, in virtually all cases, are highly significant.

To sum up, the same-period continuation and cross-period reversal effect on the intraday and overnight return components are robust under the regression framework.

Table 8
Results following the up and down markets.

		Following up market			Following down market		
		1	10	10 − 1	1	10	10 − 1
Intraday & Intraday	3 months	0.39	2.16***	1.77***	0.73***	3.22***	2.49***
		(0.61)	(4.98)	(4.80)	(2.77)	(6.09)	(5.02)
	6 months	0.11	2.34***	2.22***	0.33	3.56***	3.23***
		(0.17)	(6.90)	(3.78)	(1.06)	(7.17)	(6.41)
	9 months	−0.09	2.32***	2.41***	−0.01	3.91***	3.92***
		(−0.14)	(7.04)	(4.18)	(−0.05)	(7.73)	(7.14)
	12 months	−0.32	2.37***	2.68***	−0.00	3.73***	3.73***
		(−0.49)	(6.58)	(5.99)	(−0.00)	(7.25)	(6.03)
Intraday & Overnight	3 months	−0.56	−3.49***	−2.93***	−0.99***	−2.88***	−1.89***
		(−1.03)	(−6.12)	(−9.77)	(−5.32)	(−8.26)	(−8.33)
	6 months	−0.41	−3.88***	−3.46***	−0.89***	−2.92***	−2.03***
		(−0.76)	(−6.76)	(−10.39)	(−4.75)	(−7.12)	(−6.99)
	9 months	−0.22	−3.85***	−3.63***	−0.80***	−2.78***	−1.98***
		(−0.38)	(−7.00)	(−9.12)	(−4.09)	(−7.63)	(−8.64)
	12 months	−0.14	−3.74***	−3.60***	−0.81***	−2.69***	−1.88***
		(−0.27)	(−7.74)	(−8.70)	(−3.88)	(−8.46)	(−8.82)
Overnight & Overnight	3 months	−4.03***	−0.83	3.20***	−3.62***	−0.96***	2.66***
		(−6.93)	(−1.46)	(16.98)	(−11.19)	(−3.56)	(16.15)
	6 months	−4.24***	−0.35	3.88***	−3.67***	−0.52**	3.14***
		(−6.50)	(−0.65)	(9.69)	(−9.69)	(−2.28)	(13.50)
	9 months	−4.17***	−0.33	3.84***	−3.98***	−0.40**	3.58***
		(−6.91)	(−0.57)	(11.84)	(−9.51)	(−2.12)	(11.67)
	12 months	−4.06***	−0.23	3.83***	−3.88***	−0.31	3.57***
		(−6.48)	(−0.40)	(12.79)	(−9.57)	(−1.45)	(11.42)
Overnight & Intraday	3 months	2.75***	0.03	−2.73***	2.80***	0.59*	−2.21***
		(5.99)	(0.04)	(−6.49)	(10.41)	(1.97)	(−5.42)
	6 months	2.55***	−0.39	−2.94***	3.03***	0.57**	−2.46***
		(5.28)	(−0.63)	(−8.08)	(10.27)	(2.31)	(−8.56)
	9 months	2.73***	−0.32	−3.06***	3.12***	0.57***	−2.55***
		(5.87)	(−0.53)	(−8.11)	(7.06)	(2.94)	(−6.18)
	12 months	2.47***	−0.49	−2.96***	3.18***	0.34	−2.84***
		(4.86)	(−0.80)	(−8.51)	(7.93)	(1.34)	(−7.11)

Following Cooper et al. (2004), we define a month is following up- (down-) market state, if the cumulative market return is positive (negative) in the prior 36 months. We test whether the same-period continuation and cross-period reversal patterns for the intraday-momentum and overnight-momentum strategies continue to hold during different market states in this table. We use the 3-months to 12-months as the formation periods and report the portfolio return from one-month holding period. *Intraday & Intraday* reports the results by sorting all available stocks into decile groups based on their lagged one-month cumulated intraday returns in the formation period, goes long the value-weighted winner decile (10), short the value-weighted loser decile (1), and gets the average value of portfolio return (10 − 1)based on the cumulated intraday return. Other categories have the corresponding meanings. To be brief, we only report the portfolio return adjusted by the Fama-French three factors in this table. Newey-West adjusted t-statistics are reported in parenthesis. All values are in percentages. Significance at the 1%, 5%, and 10% level are denoted as ***, **, and * respectively. Sample period is from 1991 to 2019.

6.2. Following the different market states

We test whether the same-period continuation and cross-period reversal pattern for the *intraday-momentum* and *overnight-momentum* strategies continue to hold during different market states. Following Cooper, Gutierrez Jr, and Hameed (2004), we define a month is following up- (down-) market state, if the cumulative market return is positive (negative) in the prior 36 months. There is no noticeable difference for the intraday- (overnight-) momentum strategies under the up- and down-market states.[8] In both market states, the same-period continuation and cross-period reversal pattern continue to hold (reported in Table 8).

6.3. Month-of-the-year effect

We test whether the same-period continuation and cross-period reversal pattern remain stable over different calendar months. Specifically, we re-run the factor models in Table 3 recursively by excluding one particular calendar month from the full sample each time. Therefore, for each intraday- (overnight-) momentum strategy (*i.e.*, decile 10 minus decile 1), we get twelve monthly time-series results corresponding to the ones excluding January, February,…, and December, respectively (reported in Table 9). A joint test on the sample averages of the twelve-time series does not reject the null that they have the same risk-adjusted returns. Therefore, there seems no month-of-the-year effect on the intraday- and overnight-momentum strategies.

6.4. Day-of-the-week effect

In this subsection, we verify whether the same-period continuation and cross-period reversal pattern vary within the week (*i.e.*, day-of-the-week effect). Birru (2018) documents that the long-and-short anomaly returns are strongly related to the day of the week. As mood increases on Friday and decreases on Monday, anomaly return (mispricing) tends to high on Friday and low on Monday. Following Birru (2018), we decompose the long-and-short intraday- (overnight-) returns into their (monthly) Monday, Tuesday,…, Friday components, and re-test their risk-adjusted performance. Results of the same-period continuation and cross-period reversal pattern remain stable over different days within the week (reported in Table 10). That is, there is no statistical difference

[8] To be brief, we only report the risk-adjusted returns by the Fama-French three factors in this part and the Sections 6.3 and 6.4. The results of average excess returns and that adjusted by Fama-French five factors provide the same conclusion, and those results are always available upon request.

Table 9
Results excluding Jan to Dec.

	Intraday & Intraday				*Intraday & Overnight*			
	3 M	6 M	9 M	12 M	3 M	6 M	9 M	12 M
Jan	2.12***	2.65***	3.08***	3.16***	−2.53***	−2.96***	−3.11***	−3.06***
	(7.96)	(6.40)	(6.61)	(8.19)	(−10.27)	(−10.12)	(−8.96)	(−8.86)
Feb	2.12***	2.62***	3.01***	3.17***	−2.68***	−3.12***	−3.22***	−3.16***
	(7.03)	(5.63)	(6.09)	(7.83)	(−9.87)	(−10.20)	(−9.30)	(−8.64)
Mar	1.95***	2.38***	2.72***	2.94***	−2.63***	−3.04***	−3.15***	−3.11***
	(6.41)	(5.02)	(5.56)	(7.70)	(−10.07)	(−10.04)	(−9.11)	(−8.81)
Apr	1.91***	2.46***	2.82***	3.08***	−2.62***	−3.05***	−3.18***	−3.13***
	(6.02)	(5.29)	(5.61)	(8.05)	(−10.54)	(−10.40)	(−9.05)	(−8.94)
May	1.85***	2.50***	2.87***	3.07***	−2.62***	−3.03***	−3.18***	−3.10***
	(4.93)	(5.10)	(5.43)	(7.41)	(−9.57)	(−9.62)	(−8.90)	(−8.69)
Jun	1.98***	2.63***	2.86***	3.04***	−2.62***	−3.03***	−3.09***	−3.01***
	(5.47)	(5.19)	(5.61)	(7.15)	(−10.43)	(−9.56)	(−9.68)	(−8.95)
Jul	1.96***	2.45***	2.83***	3.01***	−2.71***	−3.12***	−3.13***	−3.09***
	(5.89)	(5.23)	(5.76)	(7.84)	(−10.37)	(−10.25)	(−9.72)	(−9.51)
Aug	2.14***	2.70***	3.09***	3.18***	−2.62***	−3.02***	−3.15***	−3.09***
	(5.92)	(5.56)	(6.08)	(7.90)	(−10.37)	(−10.54)	(−9.40)	(−8.94)
Feb	1.95***	2.50***	2.87***	3.11***	−2.60***	−3.06***	−3.11***	−3.04***
	(6.07)	(5.14)	(5.57)	(7.50)	(−10.06)	(−10.08)	(−9.21)	(−8.75)
Oct	2.00***	2.58***	2.90***	2.93***	−2.69***	−3.10***	−3.21***	−3.16***
	(5.59)	(5.54)	(6.63)	(6.63)	(−9.67)	(−10.37)	(−9.08)	(−8.75)
Nov	1.95***	2.57***	2.92***	3.06***	−2.58***	−2.94***	−3.02***	−3.04***
	(5.80)	(5.35)	(5.94)	(7.28)	(−10.10)	(−9.88)	(−8.90)	(−8.44)
Dec	1.79***	2.36***	2.74***	2.93***	−2.66***	−2.99***	−3.10***	−3.06***
	(5.24)	(4.92)	(5.58)	(7.40)	(−9.69)	(−9.58)	(−8.75)	(−8.57)
	Overnight & Overnight				*Overnight & Intraday*			
	3 M	6 M	9 M	12 M	3 M	6 M	9 M	12 M
Jan	3.08***	3.66***	3.78***	3.73***	−2.57***	−2.88***	−2.93***	−2.97***
	(18.93)	(11.49)	(13.84)	(14.89)	(−8.37)	(−10.80)	(−10.34)	(−11.53)
Feb	3.12***	3.80***	3.89***	3.88***	−2.69***	−2.85***	−2.99***	−3.02***
	(19.47)	(11.66)	(14.65)	(15.62)	(−7.60)	(−9.56)	(−9.78)	(−10.95)
Mar	3.07***	3.68***	3.76***	3.76***	−2.69***	−2.84***	−2.97***	−2.94***
	(19.01)	(11.55)	(14.35)	(15.48)	(−8.06)	(−10.79)	(−10.71)	(−11.94)
Apr	3.09	3.66***	3.73***	3.74***	−2.65***	−2.88***	−3.04***	−3.01***
	(21.71)	(12.87)	(16.29)	(16.36)	(−8.40)	(−10.69)	(−10.83)	(−11.64)
May	3.01***	3.67***	3.81***	3.80***	−2.64***	−2.76***	−2.94***	−2.97***
	(18.98)	(11.44)	(14.54)	(15.74)	(−8.04)	(−10.40)	(−10.19)	(−11.33)
Jun	3.01***	3.69***	3.82***	3.83***	−2.69***	−2.76***	−2.94***	−2.84***
	(20.20)	(12.54)	(16.01)	(17.57)	(−7.17)	(−9.05)	(−9.16)	(−9.75)
Jul	3.05***	3.63***	3.76***	3.76***	−2.52***	−2.73***	−2.86***	−2.89***
	(18.43)	(11.42)	(14.23)	(15.27)	(−7.43)	(−9.65)	(−9.49)	(−10.22)
Aug	2.96***	3.66***	3.80***	3.76***	−2.59***	−2.78***	−2.93***	−2.94***
	(21.76)	(12.64)	(15.33)	(16.71)	(−7.28)	(−9.28)	(−9.86)	(−10.16)
Feb	3.07***	3.72***	3.82***	3.81***	−2.54***	−2.86***	−3.02***	−3.02***
	(18.85)	(12.25)	(14.87)	(15.53)	(−8.01)	(−10.77)	(−10.86)	(−11.64)
Oct	2.98***	3.64***	3.73***	3.75***	−2.61***	−2.84***	−2.92***	−2.95***
	(21.03)	(12.76)	(15.22)	(16.26)	(−8.03)	(−9.88)	(−10.35)	(−10.93)
Nov	3.03***	3.57***	3.67***	3.66***	−2.66***	−2.78***	−2.91***	−2.95***
	(19.50)	(13.45)	(16.47)	(17.86)	(−7.57)	(−10.55)	(−10.42)	(−11.96)
Dec	3.01***	3.64***	3.76***	3.73***	−2.50***	−2.69***	−2.90***	−2.90***
	(18.45)	(11.52)	(14.17)	(15.27)	(−7.78)	(−10.62)	(−10.48)	(−11.56)

By recursively excluding one particular calendar month from the full sample each time, we study whether the same-period continuation and cross-period reversal pattern remain stable over different calendar months. We use the 3-months to 12-months as the formation periods and report the portfolio return from one-month holding period. *Intraday & Intraday* reports the results by sorting all available stocks into decile groups based on their lagged one-month cumulated intraday returns in the formation period, goes long the value-weighted winner decile (10), short the value-weighted loser decile (1), and gets the average value of portfolio return (10 − 1) based on the cumulated intraday return. Other categories have the corresponding meanings. To be brief, we only report the portfolio return adjusted by the Fama-French three factors in this table. Newey-West adjusted t-statistics are reported in parenthesis. All values are in percentages. Significance at the 1%, 5%, and 10% level are denoted as ***, **, and * respectively. Sample period is from 1991 to 2019.

Table 10
Robustness results on Monday to Friday.

	10 − 1	Monday	Tuesday	Wednesday	Thursday	Friday
Intraday & Intraday	3 months	0.23	0.62***	0.45***	0.24***	0.52**
		(1.31)	(4.17)	(3.96)	(2.29)	(4.26)
	6 months	0.33	0.67***	0.43***	0.52***	0.58***
		(1.64)	(4.84)	(3.10)	(4.48)	(3.74)
	9 months	0.47**	0.72***	0.49***	0.46***	0.70***
		(2.56)	(6.30)	(3.69)	(3.80)	(4.90)
	12 months	0.53***	0.74***	0.48***	0.47***	0.69***
		(3.21)	(7.49)	(3.84)	(3.92)	(5.01)
Intraday & Overnight	3 months	−0.55***	−0.46***	−0.58***	−0.63***	−0.40***
		(−8.73)	(−3.14)	(−7.99)	(−7.84)	(−5.94)
	6 months	−0.64***	−0.52***	−0.61***	−0.73***	−0.44***
		(−9.83)	(−3.81)	(−7.76)	(−8.34)	(−5.49)
	9 months	−0.67***	−0.59***	−0.65***	−0.72***	−0.51***
		(−9.01)	(−4.19)	(−7.13)	(−8.90)	(−6.02)
	12 months	−0.63***	−0.56***	−0.65***	−0.81***	−0.51***
		(−8.46)	(−3.96)	(−7.32)	(−9.06)	(−6.74)
Overnight & Overnight	3 months	0.64***	0.56***	0.58***	0.55***	0.56***
		(15.69)	(12.20)	(11.05)	(16.83)	(13.95)
	6 months	0.77***	0.71***	0.72***	0.68***	0.66***
		(12.26)	(9.85)	(9.64)	(15.78)	(11.31)
	9 months	0.79***	0.74***	0.73***	0.68***	0.65***
		(15.54)	(13.06)	(13.35)	(13.25)	(13.36)
	12 months	0.79***	0.73***	0.72***	0.72***	0.67***
		(16.58)	(14.11)	(13.86)	(12.15)	(13.42)
Overnight & Intraday	3 months	−0.68***	−0.51***	−0.57***	−0.55***	−0.50***
		(−6.08)	(−7.48)	(−4.48)	(−8.79)	(−4.52)
	6 months	−0.68***	−0.60***	−0.58***	−0.64***	−0.54***
		(−8.97)	(−8.05)	(−5.35)	(−10.22)	(−4.30)
	9 months	−0.76***	−0.59***	−0.48***	−0.65***	−0.60***
		(−10.45)	(−6.81)	(−4.63)	(−9.92)	(−4.67)
	12 months	−0.67***	−0.59***	−0.53***	−0.64***	−0.59***
		(−9.65)	(−6.29)	(−4.29)	(−10.33)	(−4.90)

Results in this table using the intraday and overnight returns in each weekday to verify whether the same-period continuation and cross-period reversal pattern varies within the week (*i.e.*, day-of-the-week effect). Following Birru (2018), we decompose the long-and-short intraday- (overnight-) returns into their (monthly) Monday, Tuesday, …, Friday components, and re-test their risk-adjusted performance. We use the 3-months to 12-months as the formation periods and report the portfolio return from one-month holding period. *Intraday & Intraday* reports the results by sorting all available stocks into decile groups based on their lagged one-month cumulated intraday returns in the formation period, goes long the value-weighted winner decile (10), short the value-weighted loser decile (1), and gets the average value of portfolio return (10 − 1)based on the cumulated intraday return. Other categories have the corresponding meanings. To be brief, we only report the portfolio return adjusted by the Fama-French three factors in this table. Newey-West adjusted t-statistics are reported in parenthesis. All values are in percentages. Significance at the 1%, 5%, and 10% level are denoted as ***, **, and * respectively. Sample period is from 1991 to 2019.

in portfolio returns between Monday and Friday. Therefore, the same-period continuation and cross-period reversal effects are not related to mood or investor sentiment.

6.5. Alternative factor models and removing bottom 30% smallest stocks

Our key result—the zero-cost portfolio which goes long the intraday (overnight) winners and short the intraday (overnight) losers delivers significantly *positive* risk-adjusted returns in subsequent intraday (overnight) periods, but significantly *negative* risk-adjusted returns in subsequent overnight (intraday) periods are robust by removing the bottom 30% smallest stocks (ranked by market capitalization) and under the alternative CH3 model proposed in Liu, Stambaugh, and Yuan (2019).[9] We do not rely on the Liu et al. (2019) three factors in our main analysis, simply because their factors are restricted from 2000 onwards, which would limit the sample period. In fact, using their factors with the shortened sample period, the risk-adjusted returns of the zero-cost long-and-short portfolio (*i.e.*, 10 – 1) are all significant at the 1% level (reported in Table 11), confirming the same-period continuation and cross-period reversal effect in China.

6.6. One-month formation period

We use the one-month formation period to study the short-term performance like Lou et al. (2019). Results in Table 12 report the same-period continuation and cross-period reversal pattern also exist on the one-month formation period, and there exists a similar "tug of war" performance like the US stock market.

6.7. Transaction cost analysis

We also perform transaction cost analysis for the same-period intraday (overnight) momentum strategy. That is, for the intraday (overnight) momentum strategy, we require the strategy to be implemented on a daily basis at every intraday (overnight) period. We use the Corwin and Schultz (2012) implied bid-ask spread as the proxy of daily transaction cost to study the after-transaction-cost performance of the

[9] Liu et al. (2019) argue that the smallest stocks in China are "different animals", because they are valued alternatively as potential shells in reverse mergers that circumvent tight IPO constraints. They also propose an alternative CH3 factor model with refined size and value factors.

Table 11
Performance based on CH3 factors.

		3 months	6 months	9 months	12 months
Intraday &Intraday	1	0.61	0.30	0.10	0.33
		(1.48)	(0.71)	(0.27)	(0.83)
	10	3.29***	3.43***	3.29***	3.09***
		(8.63)	(9.51)	(8.73)	(7.44)
	10 − 1	2.69***	3.13***	3.19***	2.76***
		(7.22)	(6.35)	(6.65)	(5.01)
Intraday &Overnight	1	−0.89**	−0.77*	−0.67*	−0.51
		(−2.18)	(−1.90)	(−1.73)	(−1.41)
	10	−3.54***	−3.60***	−3.59***	−3.37***
		(−8.17)	(−8.07)	(−8.28)	(−9.10)
	10 − 1	−2.65***	−2.83***	−2.92***	−2.85***
		(−11.64)	(−9.68)	(−10.14)	(−10.37)
Overnight &Overnight	1	−3.75***	−3.82***	−3.97***	−3.83***
		(−8.11)	(−8.40)	(−8.05)	(−8.35)
	10	−1.05**	−0.49	−0.52	−0.49
		(−2.47)	(−1.22)	(−1.21)	(−1.17)
	10 − 1	2.70***	3.33***	3.45***	3.34***
		(12.29)	(11.09)	(12.76)	(15.91)
Overnight &Intraday	1	3.04***	3.04***	2.99***	2.88***
		(9.73)	(9.98)	(9.76)	(9.71)
	10	0.71	0.26	0.49	0.36
		(1.53)	(0.63)	(1.26)	(0.94)
	10 − 1	−2.33***	−2.78***	−2.51***	−2.51***
		(−5.79)	(−9.78)	(−8.31)	(−8.99)

Table 11 reports the robustness test of intraday and overnight momentum strategies, adjusted by the Chinese three factors (CH3 factors) proposed by Liu et al. (2019). The formation periods are from 3-months to 12-months and we use the lagged one-month cumulated intraday (overnight) returns to sort stocks and use the one-month holding period to study the portfolio performance. *Intraday & Intraday* reports the results by sorting all available stocks into decile groups based on their lagged one-month cumulated intraday returns in the formation period, goes long the value-weighted winner decile (10), short the value-weighted loser decile (1), and gets the average value of portfolio return (10 − 1) based on the cumulated intraday return. Other categories have the corresponding meanings. Newey-West adjusted t-statistics are reported in parenthesis. All values are in percentages. Significance at the 1%, 5%, and 10% level are denoted as ***, **, and * respectively. Sample period is from 2001 to 2018, considering the available data of CH3 factors.

Table 13
Intraday- and overnight-momentum strategies, after considering the transaction costs.
The way to construct intraday- and overnight-momentum strategies in this table is same to that in Table 3. At the end of each month, we sort stocks into decile portfolios based on their cumulative return components (in ascending orders) in the formation period. The lengths of the formation periods are 3-, 6-, 9-, and 12-months, respectively. Panels A (B) uses the formation period cumulative intraday (overnight) returns to sort stocks, and the holding periods are intraday (overnight) periods over the next month, respectively. The excess value for the portfolio returns (10 − 1) is the difference between values in Table 3 and the implied bid-ask spread proposed in Corwin and Schultz (2012). Portfolio returns in excess of the risk-free rate, the risk-adjusted returns of the Fama-French three- and five-factor models are denoted as Exret, FF3 alpha, FF5 alpha, respectively. All portfolios are value-weighted. Newey-West adjusted t-statistics are reported in parenthesis. All values are in percentages. Statistical significance at the 1%, 5%, and 10% levels are denoted as ***, ** and * respectively. The sample period is between 1991 and 2019.

Panel A: Intraday performance, the *J*-month formation period intraday-momentum strategy

	3 months	6 months	9 months	12 months
Exret	0.52*	0.94**	1.25***	1.31***
	(1.78)	(2.08)	(3.01)	(3.57)
FF3 alpha	0.56*	1.16**	1.53***	1.70***
	(1.80)	(2.53)	(3.27)	(4.54)
FF5 alpha	0.29	0.87*	1.23**	1.38***
	(0.88)	(1.75)	(2.58)	(3.35)

Panel B: Overnight performance, the *J*-month formation period overnight-momentum strategy

Exret	1.54***	2.23***	2.34***	2.33***
	(10.14)	(7.31)	(10.20)	(10.36)
FF3 alpha	1.63***	2.27***	2.39***	2.38***
	(10.25)	(7.84)	(10.27)	(11.29)
FF5 alpha	1.65***	2.32***	2.40***	2.38***
	(10.46)	(7.58)	(9.73)	(10.86)

intraday (overnight) momentum strategy.

Table 13 presents the cumulated monthly after-transaction-cost performance for the long-and-short strategies. These strategies, which are implemented on a daily basis, still generates significant profits after

Table 12
Results based on one-month formation period.

	1	10	10 − 1	1	10	10 − 1
	Intraday & Intraday			*Intraday & Overnight*		
Exret	1.17*	3.12***	1.96***	−0.56	−3.53***	−2.97***
	(1.91)	(5.07)	(6.08)	(−1.39)	(−7.31)	(−10.65)
FF3 alpha	0.49	2.57***	2.08***	−0.81**	−3.83***	−3.01***
	(1.09)	(7.77)	(6.28)	(−2.07)	(−7.74)	(−9.65)
FF5 alpha	0.52	2.41***	1.89***	−0.76*	−3.78***	−3.02***
	(1.19)	(6.75)	(5.82)	(−1.86)	(−7.97)	(−9.87)
	Overnight & Overnight			*Overnight & Intraday*		
Exret	−3.83***	−0.65	3.18***	3.78***	0.63	−3.16***
	(−8.28)	(−1.47)	(14.46)	(6.79)	(0.87)	(−8.50)
FF3 alpha	−4.10***	−0.97**	3.14***	3.14***	0.01	−3.13***
	(−10.17)	(−2.06)	(12.58)	(8.97)	(0.02)	(−7.86)
FF5 alpha	−4.08***	−0.90*	3.18***	3.14***	0.02	−3.12***
	(−10.11)	(−1.95)	(13.41)	(8.60)	(0.04)	(−7.02)

Table 12 reports the results based on one-month formation period like Lou et al. (2019). We also use four ways to study the same-period continuation and cross-period reversal pattern. *Intraday & Intraday* reports the results by sorting all available stocks into decile groups based on their cumulated intraday returns in the formation period, goes long the value-weighted winner decile (10), short the value-weighted loser decile (1), and gets the average value of portfolio return (10 − 1) based on the cumulated intraday return. Other categories have the corresponding meanings. Portfolio returns in excess of the risk-free rate, the risk-adjusted returns of the Fama-French three- and five-factor models are denoted as Exret, FF3 alpha, FF5 alpha, respectively. Newey-West adjusted *t*-statistics are reported in parenthesis. Statistical significance at the 1%, 5%, and 10% levels are denoted as ***, **, and, * respectively. The sample period is between 1991 and 2019.

considering the influence of transaction costs.[10]

7. Conclusion

In this paper, we follow Lou et al. (2019) approach to decompose the monthly stock returns into the daytime (*i.e.*, open-to-close) and the overnight (*i.e.*, close-to-open) components. This empirical decomposition helps dissect the return dynamics of the momentum-type strategies. The "no momentum" effect in China collaborates with the tug of war between heterogenous investors who tend to dominate in their preferred trading period within a day (with opposing preference for stocks in the cross period). Therefore, asset prices behave very differently when markets are open for trading *versus* when they are closed.

Moreover, stocks that are past intraday (overnight) winners persistently outperform those that are past intraday (overnight) losers in the subsequent intraday (overnight) periods. However, the same intraday-(overnight-) momentum strategy suffers dramatically in the subsequent overnight (intraday) periods. In general, past intraday (overnight) winners tend to be more (less) speculative stocks which are highly demanded during the day (night).

Overall, our results are consistent with investor heterogeneity, and this persistent tug of war virtually eliminates the effectiveness of investors pursuing the momentum-based trading strategy in China. A possible future research avenue would be to explore the trading motives of the heterogeneous investors during the day and over the night based on account-level data.

Declaration of Competing Interest

We have no potential competing interests include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding.

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Appendix

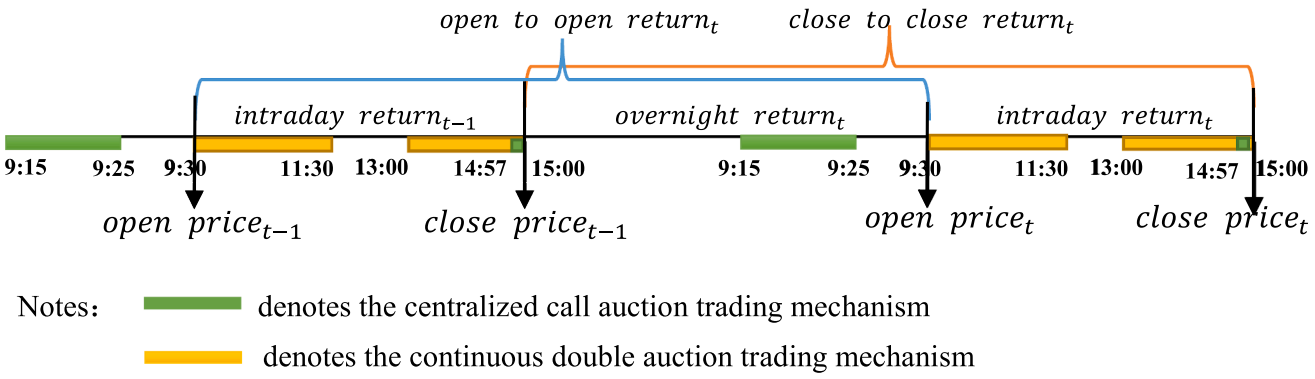

Fig. A1. Trading time, trading mechanism, prices and returns in China.

Table A1
Trading mechanism in different periods.

Nodes	Trading mechanism
9:15–9:25	Opening call auction period for SH and SZ stock markets, only limit orders are allowed and no orders can be revoked after 9:20.
9:25–9:30	Non-trading periods, the execution price at 9:25 and 9:30 are the same, which is the opening price for the Chinese stock market.
9:30–11:30	The morning-continuous double auction trading period for two markets, limit and market orders are allowed, and orders can be submitted and revoked freely.
11:30–13:00	Non-trading period
13:00–15:00	The afternoon-continuous double auction trading period for the SH (before 2018.08.20) and SZ (before 2006.07.01) stock market, limit and market orders are allowed, and orders can be submitted and revoked freely. The closing price is the execution price at 15:00.
13:00–14:57	The afternoon-continuous double auction trading period for the SH stock market since 2018.08.20 and the SZ stock market since 2006.07.01.
14:57–15:00	Close call auction period for the SH stock market since 2018.08.20 and the SZ stock market since 2006.07.01; only limit orders are allowed; no orders can be revoked. The closing price is generated during this period.

The trading characteristics of the call auction period:

(1) the price is generated by the one-time centralized matching of all submitted buy and sell orders, using the price that can bring the greatest trading volume.
(2) only limit orders are allowed and no orders can be revoked after 9:20.

[10] It should be noted that to implement a daily trading strategy in China, it does require the investor to hold one rolling-day stock inventory to circumvent the "T + 1" regulation.

(3) all buy (sell) orders with a higher bid (a lower ask) price can be executed.
(4) weakens the manipulation of big investors and can avoid the cost of the bid-ask spread.
(5) about 70% firm-specific news is released after market close and before market officially opens on next day, and thus, the pre-open call auction period can be treated as information-related.
(6) the trading volume during the pre-open period accounts for about 10% of the whole trading day.
(7) investors want to utilize the high liquidity (the big trading volume) and are sensitive to the bid-ask spread might treat the pre-open call auction period as their first choice.

The trading characteristics of the continuous double auction period:

(1) the price is determined when the highest bid price matches the lowest offer price.
(2) investors are free to submit and revoke the market order and limit order, they can monitor prices and have an immediate reaction for new-released information as soon as it arrives at the market.
(3) trading is real-time concluded, and thus, who submit the market order can be easier traded.
(4) those who want to trade immediately, want to avoid the uncertainty of one-time centralized pricing and believe they have better access to new information might choose to trade during this period

Table A2
Variable definition.

Notation	Definition[a]
BETA	Market beta, defined as the return sensitivity to the market portfolio. The market beta is calculated as the slope coefficient in the regression with a rolling 36-month window of monthly data.
lnME	The natural logarithm of the market capitalization of a stock, defined as the (natural logarithm of) firm's total market capitalization measured at the end of each month.
lnBTM	The natural logarithm of the book-to-market ratio, defined as the (natural logarithm of) firm's book-to-market equity measured at the fiscal year ending in $t-1$.
ISKEW	Idiosyncratic skewness, defined as the skewness of the daily residual terms obtained from the Harvey and Siddique (2000) regression: $R_i - RF = \alpha_i + \beta_i RMRF + \gamma_i RMRF^2 + \varepsilon_i$ The above regression is performed using daily observations over the past 12-month rolling window. The estimation procedure is repeated each month to obtain the *ex ante* ISKEW measure for each month.
IVOL	The idiosyncratic volatility, defined similarly as in Ang, Hodrick, Xing, and Zhang (2006), which is the standard deviation of residuals from the following regression. $R_i - RF = \alpha_i + \beta_i^{RMRF} RMRF + \beta_i^{SMB} SMB + \beta_i^{HML} HML + \varepsilon_i$ The *ex ante* IVOL measure is constructed using the above Fama-French three-factor model using daily observations over the prior month, which requires at least ten observations to run the regression.
ILLIQ	Amihud illiquidity ratio, defined as the 12-month rolling average of the ratio of absolute return and the dollar trading volume (Amihud, 2002).
PRC	Price level, defined as the unadjusted closing price at the end of the prior month.
TURN	Turnover ratio, defined as the cumulative daily turnover over the past one-month rolling window.
ANACOV	Analyst coverage, defined as the natural logarithm of one plus the number of earnings forecasts.
DISP	Dispersion, defined as the standard deviation of earnings forecasts.
IO	Institutional Ownership, the proportion of stocks owned by institutions. The data frequency is quarterly.

[a] Data are from the CSMAR database, which is widely used for the study of the Chinese stock market, see also in Jiang, Tang, and Zhou (2018) and Li, Li, and Zeng (2020).

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