論 説

Idiosyncratic Volatility and Investor Sentiment: Evidence From Chinese Stock Market

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Abstract

The paper analyzes the idiosyncratic volatility puzzle before and after the 2008 financial crisis in Chinese stock market. This puzzle represents a negative correlation between idiosyncratic volatility and future return of stocks and it was widely verified in stock markets throughout the world. However, in the Chinese stock market, the correlation between the idiosyncratic volatility and the stock return has been found to be either negative or positive. The different result in the Chinese market is probably caused by the impact of the financial crisis (2008) which was not taken into account in the previous studies. In addition, this paper firstly uses the cross-sectional skewness of price-to-book ratio as investor sentiment indicator to investigate the relationship between the idiosyncratic volatility and investor sentiment in the Chinese stock market. This research finds that the short-term puzzle is not observed before the financial crisis (2000-2008), but observed in the full period (2000-2016) and after the financial crisis (2009-2016) when investors were in an optimistic mood. Besides, different from the Japanese stock market, this research does not find the existence of a long-term idiosyncratic volatility puzzle in the Chinese market.

Key words: Idiosyncratic volatility puzzle; Investor sentiment; Financial crisis

1. Introduction

Traditional capital asset pricing theory contends that systematic risk alone determines the expected return of a stock. As a precondition of sufficiently diversified investment, idiosyncratic or nonsystematic risk, which is unique to a company or industry, should be avoided. However, Merton (1987) claimed that most individual investors do not hold

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diversified portfolios but only invest in a small number of familiar stocks. Most investors are averse to risks arising from buying unfamiliar stocks rather than avoid idiosyncratic risks through diversified investment. Idiosyncratic volatility is widely used as a proxy variable of idiosyncratic risk to review the correlation with the expected return on stocks.

Global stock markets confirm the negative relationship between idiosyncratic volatility and a stock's expected return, a phenomenon considered as the "idiosyncratic volatility puzzle." For example, Ang et al. (2006) calculated the residual standard deviation from the regression analysis using a model designed by Eugene Fama and Kenneth French (Fama-French three-factor model) and found idiosyncratic volatility, thus proving the presence of an idiosyncratic volatility puzzle in the United States (US) stock market. Similarly, Hirosaki (2012) confirmed the same in the Japanese stock market. Unlike majority of the past studies focusing on the short-term idiosyncratic volatility of the past one month, Hirose and Iwanaga (2011b) used the data of the past 60 months to recognize and measure the long-term idiosyncratic volatility puzzle in the Japanese stock market.

However, following Ang et al. (2006), the Chinese stock market displayed either a negative or positive correlation between idiosyncratic volatility and stock return, depending on past studies. For example, Liu et al. (2014) used the Chinese A-shares from January 2, 1997 to December 31, 2011 to reveal the existence of an idiosyncratic volatility puzzle. On the contrary, in an analysis of the Chinese A-shares and B-shares from January 1997 to June 2011, Luo (2013) found that higher idiosyncratic volatility leads to a higher stock return.

The present study examines the idiosyncratic volatility puzzle before and after the 2008 financial crisis. The Chinese stock market was severely affected by the 2008 global financial crisis. By 2008, the stock price of Chinese stock market changed dramatically and the market became unstable. Since the establishment of the Shanghai and Shenzhen exchanges in the 1990s, the market is still immature. The Chinese stock market differs from that of the developed markets because the main participants are individual investors with low awareness of market risks. Few current researches consider the financial crisis as the boundary to verify the puzzle. Therefore, the present study analyzes the short- and long-term idiosyncratic volatility puzzles of the Chinese market and the changes before and after the financial crisis. The study also examines the impact of investor sentiment indicators on the puzzle.

The results of the study are as follows. First, in the full period it was confirmed that the lower average monthly return yield when there was lower short-term idiosyncratic volatility. Second, before the financial crisis (2000–2008), no short-term idiosyncratic volatility puzzle was observed whether in the low sentiment or high sentiment group. However, it was observed in the full period (2000–2016) and after the financial crisis (2009–2016) during the period of high investor sentiment. Finally, unlike in the Japanese stock

market, the present study did not find the existence of a long-term idiosyncratic volatility puzzle in the Chinese stock market.

These results broadly differ from existing research in the Chinese market as so far there have been no studies on the reversal before and after the financial crisis. The Chinese stock market has been volatile since 2008. The contrasting results between Liu et al. (2014) and Luo (2013) in the Chinese market is probably because they do not consider the financial crisis. Moreover, unlike the Japanese stock market, the present study found no long-term idiosyncratic volatility puzzle in the Chinese stock market.

Compared with the previous studies on the Chinese market, the methodology has also been improved. First, the present study analyzes the A-share comprehensive project in the past 17 years (2000–2016) and considers, for the first time, the financial crisis as the boundary and verifies the short-term idiosyncratic volatility puzzle. Furthermore, the cross-section skewness of the Price-Book Ratio (PBR) is a novel investor sentiment indicator considered to investigate the relationship between the idiosyncratic volatility puzzle and investor sentiment in the Chinese market.

This study is presented as follows. Section 2 describes the idiosyncratic volatility puzzle and investor sentiment indicators based on past studies. Section 3 describes the study data and methodology used. Section 4 examines the short-term idiosyncratic volatility puzzle of the Chinese stock market. Section 5 provides the conclusions.

2. Literature Review

2.1 Idiosyncratic Volatility Puzzle

The relationship between the idiosyncratic volatility and stock return largely differs according to the calculation methodology, analysis period, and analysis object of the idiosyncratic volatility. For example, with the daily data of common stocks listed on the New York Stock Exchange (NYSE), the National Association of Securities Dealers Automated Quotations (NASDAQ), and the American Stock Exchange (AMEX) from 1963 to 2002, Ang et al. (2006) considered the residual standard deviation as the short-term idiosyncratic volatility indicator of one month by regressing the Fama-French three-factor model. They highlighted the negative relationship between the idiosyncratic volatility and stock return by dividing the stocks into quintiles based on the idiosyncratic volatility. The study result is robust to control for size, book-value ratio, volume, liquidity, momentum, and so on. Ang et al. (2009) also used the same measurement methodology to highlight that in the stock markets of the Group of Seven (G7) and other 23 developed countries, the stocks with higher idiosyncratic volatility have lower returns. In other words, the idiosyncratic volatility puzzle was not only found in the US stock market but also in that

of other countries. Hirosaki (2012) analyzed the stocks listed on the Tokyo Price Index (TOPIX) from August 1980 to December 2010 for the short-term idiosyncratic volatility following the method by Ang et al. (2006) and confirmed the presence of the idiosyncratic volatility puzzle in the Japanese stock market as well. He claimed that the puzzle might be explained by the Miller effect[1)] and the return reversal effect in the Japanese stock market.

Liu et al. (2014) used the Chinese A-shares from January 2, 1997 to December 31, 2011 and concluded that the idiosyncratic volatility puzzle exists in the Chinese stock market as well. Thus, they noted that the puzzle can be explained by the stock price range, turnover, and maximum daily return.

On the contrary, some advance researches refute the negative correlation relationship between the idiosyncratic volatility and stock return. They reported that the puzzle might exist because the one-month lagged idiosyncratic volatility is used as the expected idiosyncratic volatility. Considering the stocks listed on NYSE, AMEX, and NASDAQ from July 1963 to December 2006, Fu (2009) predicted the expected idiosyncratic volatility through the exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model. He claimed the expected returns are higher when the expected idiosyncratic volatility is high. Deng and Zheng (2011) used the autoregressive moving average (ARMA) model to divide historical idiosyncratic volatility into expected and nonexpected idiosyncratic volatility. They found a positive correlation between expected idiosyncratic volatility and the stock return in the Chinese A-shares.

Luo (2013) analyzed the correlation between the idiosyncratic volatility and excess return using the data of the Chinese A-shares and B-shares from January 1997 to June 2011. Following the methodology of Ang et al. (2006), he showed higher excess returns on the stock when the historical idiosyncratic volatility is higher. The expected and nonexpected idiosyncratic volatility are predicted by the ARMA model. Similar to the historical idiosyncratic volatility, the expected idiosyncratic volatility is positively correlated with the excess return of stocks.

Past studies on the idiosyncratic volatility puzzle is mainly about the short-term idiosyncratic volatility estimated in one-month lagged data. However, few studies focus on the long-term idiosyncratic volatility.

Hirose and Iwanaga (2011b) analyzed the correlation between the long-term idiosyncratic volatility and the expected return. Considering the monthly data of TOPIX from January 1980 to January 2011, the long-term historical idiosyncratic volatility calculated using the data of the past 60 months revealed the presence of the long-term idiosyncratic volatility puzzle. They also claimed that the long-term idiosyncratic volatility puzzle could be explained by the long-term return reversal.

2.2 Investor Sentiment

Amihud (2002) had a major impact among the studies on investor sentiment indicators. He demonstrated a positive correlation between the illiquidity indicator and expected return of stock. Baker and Wurgler (2006) analyzed investor sentiment by the closed-end fund discount (CEFD); NYSE share turnover; the initial public offerings (IPOs), number of IPOs (NIPO), and the IPO average first-day returns (RIOP); the share of equity issues in total equity; and dividend premium. Hirose (2003) used the PBR skewness as the investor sentiment indicator by examining the stocks listed in TOPIX of the Japanese market from March 1983 to November 2001 and the Standard & Poor's (S&P) 500 index of the United States from December 1987 to October 2001, showing a high correlation between sentiment indicator and liquidity indicator. Moreover, the phenomenon proved that sentiment indicator and the liquidity indicator could predict the expected return of stock. The results showed that PBR variation may be used as a new indicator of investor sentiment. Hirose and Iwanaga (2011a) analyzed a listed stock of TOPIX from January 1989 to May 2010 and focused on not only the variance of PBR but also its skewness. They concluded that the investor sentiment will be more optimistic when the skewness of PBR is higher, whereas the investor sentiment is more pessimistic when the skewness of PBR is lower. In other words, the cross-sectional skewness of PBR could also be used as an indicator of investor sentiment.

3. Data and Methodology

3.1 Data

In the present study, all data are listed on The China Stock Market and Accounting Research Database from January 1, 2000 to December 31, 2016. The Chinese A-shares in all companies in Shanghai and Shenzhen[2] (3409 companies) use the daily return and monthly return, trading days, book value, and aggregate market value. The stocks that trade less than 15 days a month are excluded. Therefore, 1,206 companies in Shanghai and 1,879 in Shenzhen were eligible based on the above qualifications.

3.2 Methodology

3.2.1 Idiosyncratic Volatility Indicator

According to Ang et al. (2006), the present study uses the Fama-French three-factor model with daily data during the month to calculate the monthly idiosyncratic volatility.

$$R_{i,d}-R_{f,d}=\alpha_i+\beta_i MKT_d+\gamma_i SMB_d+\varphi_i HML_d+\varepsilon_{i,d} \quad (1)$$

where $R_{i,d}$ is the return of stock i on day d; $R_{f,d}$ is the daily risk-free rate; MKT_d, SMB_d,

Table 3.1 Summary Statistics, 2000–2016

This table represents the descriptive statistics for the variable. *Ri* is the monthly return of the stock, *MV* is the market value, *BV* is the book value, and *BM* is the book-to-market ratio. *IVOLS* is the short-term idiosyncratic volatility indicator and *PBRS* (PBR skewness) indicates the investor sentiment.

variable	obs	Mean	sd	min	max
Ri	123982	0.0036	0.1497	−0.7819	4.5781
IVOLS	119659	0.0915	0.0881	0.0010	13.1389
PBRS	119659	0.6341	0.5094	−0.2414	2.3510
MV	124194	6.58E+08	2.60E+09	25020	2.02E+11
BV	124194	2.33E+09	1.74E+10	−1.11E+10	8.48E+11
BM	124194	1.1406	1.4186	−20.3563	37.1000

and HML_d are the daily Fama-French factors.

The present study uses the short-term (*IVOLS*) and long-term (*IVOLL*) idiosyncratic volatility indicators to verify the idiosyncratic volatility puzzle in the Chinese stock market. Then, the residual standard deviation ($\varepsilon_{i,t}$) is calculated based on equation (2), and the result is multiplied by the square root of the number of trading days in each month is taken as *IVOLS,* that is, the short-term idiosyncratic volatility of each stock in each month.

$$IVOL_{i,t}=\sqrt{n_t}\,Std(\varepsilon_{i,t}) \tag{2}$$

The long-term idiosyncratic volatility (*IVOLL*) is calculated using the monthly data to obtain the residual standard deviation from the regression analysis, similar to the method used for the short-term idiosyncratic volatility. Given that the long-term idiosyncratic volatility (*IVOLL*) uses the data from 36 months, from January 2003 to December 2016; in this study, each n is set as 36.

3.2.2 Investor Sentiment Indicators

Hirose and Iwanaga (2011a) considered the cross-sectional skewness of PBR as the investor sentiment indicator. They discussed that the cross-sectional skewness of PBR is higher when the investor sentiment (optimism) is better. Consequently, the present study also uses the cross-sectional skewness of PBR as an indicator of investor sentiment. In this study, the market value is divided into two groups by median, and the stocks whose standard deviation of log (PBR) is no less than 2 in each group are excluded from the calculated objects.

$$PBRS_t=\frac{n}{(n-1)(n-2)}\sum_{i=1}^{n}\left\{\frac{\log(PBR_{i,t})-\overline{\log(PBR_{i,t})}}{\sqrt{PBRV_t}}\right\}^3 \tag{3}$$

Table 4.1 Portfolios Sorted by Short-term Idiosyncratic Volatility

This table reports the quintile portfolios by sorting stocks based on the idiosyncratic volatility each year. For each portfolio, *IVOLS* is the short-term idiosyncratic volatility, *VW RETRUN* is the monthly value weighted return of stock *i*, "5 −1" is the difference between portfolio 5 and portfolio 1.

Rank	*IVOLS*	*VW RETRUN*
1 low	0.0512	0.0156
2	0.0697	0.0236
3	0.0851	0.0238
4	0.1042	0.0234
5 high	0.1515	0.0323
5−1	0.1003	0.0166
t	[170.03]***	[19.25]***

*$p<0.1$, **$p<0.05$, and ***$p<0.01$

4. Idiosyncratic Volatility Puzzle

4.1 Short-term Idiosyncratic Volatility Puzzle

The presence of a short-term idiosyncratic volatility puzzle in the Chinese stock market is confirmed in the present study, which indicates a negative relationship between the short-term idiosyncratic volatility calculated using the data from the past one month and the stock returns in the study sample. Each month, the stocks are classified into five portfolios based on the short-term idiosyncratic volatility (*IVOLS*), and the mean of each factor is examined.[3] The null hypothesis that the difference in the average monthly return of portfolio 5 to portfolio 1 is equal to zero is tested. Table 4.1 presents the details of the portfolio analysis.

Table 4.1 demonstrates that higher short-term idiosyncratic volatility led to a higher average monthly yield. Moreover, the difference in the monthly return between portfolio 5 and portfolio 1 is positive and achieves at a significance level of 1% (0.0166, *t*-statistic: 19.25).

Therefore, no short-term idiosyncratic volatility puzzle was observed in the Chinese stock market. In the previous research on China, Liu et al. (2014) reported a negative relationship between idiosyncratic volatility and stock return in the Chinese stock market. They also highlighted that the volatility of stock price, turnover, and maximum daily return could explain the puzzle. Luo (2013) showed that in the Chinese stock market, a higher idiosyncratic volatility leads to higher excess return of stocks.

4.2 Short-term Idiosyncratic Volatility Puzzle and Investor Sentiment

Further, the impact of investor sentiment on the idiosyncratic volatility puzzle is

Table 4.2 Short-term Idiosyncratic Volatility Puzzle in Low PBRS versus High PBRS

This table reports the monthly value weighted returns for portfolios formed by sorting stocks based on the idiosyncratic volatility and investor sentiment indicator each year. For each portfolio, *IVOLS* is the short-term idiosyncratic volatility, and *PBRS* is the indicator of investor sentiment. "5-1" is the difference between portfolio 5 and portfolio 1 sorted by *IVOLS*.

IVOLS	*PBRS*	
	1 low	2 high
1 low	0.0158	0.0141
2	0.0281	0.0063
3	0.0238	0.0122
4	0.0262	0.0025
5 high	0.0326	0.0121
5-1	0.0168	−0.0203
t	[17.90]***	[−1.17]

*$p<0.1$ **$p<0.05$ ***$p<0.01$

examined. Hirose and Iwanaga (2011a) considered the cross-sectional skewness of PBR as an indicator of investor sentiment. When investors are optimistic, the cross-sectional skewness of PBR is considered to be high; on the contrary, when investors are pessimistic, it is considered to be low. In other words, the higher (lower) skewness of cross-section PBR is, the better (or worse) investor sentiment will be.

Initially, at the end of each month, the sample is divided into two subgroups based on the skewness of PBR (*PBRS*) in the preceding month. Then, within each subgroup, five portfolios are formed by the short-term idiosyncratic volatility. Table 4.2 reports the monthly returns of each portfolio during each subperiod and the difference in the return of portfolio 5 to portfolio 1 (sorted by *IVOLS*).

Table 4.2 shows that during the period of low investor sentiment in the prior month, there is a significant positive relationship between the *IVOLS* and the stock return. The difference in the monthly return achieves at a significance level of 1% (0.0168, *t*-statistic: 17.90). In contrast, during the period of high investor sentiment in the prior month, the stock return will be lower when the short-term idiosyncratic volatility is higher. The difference between the highest and the lowest *IVOLS* portfolios is equal to −0.0203, but not statistically significant (*t*-statistics = −1.17).

Then, in order to observe the impact of investor sentiment on the relationship between the idiosyncratic volatility and the expected stock return before and after the financial crisis, the overall data is divided into two parts, before and after the financial crisis, with the same analysis in Table 4.2. Panel A of Table 4.3 represents the results before the financial crisis (2000-2008), and panel B represents the results after the financial crisis (2009-2016).

Table 4.3 shows that during the period of low investor sentiment in the prior month in

Table 4.3 Short-term Idiosyncratic Volatility Puzzle in Low PBRS versus High PBRS

This table reports the monthly value weighted returns for portfolios formed by sorting stocks based on the idiosyncratic volatility and investor sentiment indicator each year. For each portfolio, *IVOLS* is the short-term idiosyncratic volatility, and *PBRS* is the indicator of investor sentiment. "5-1" is the difference between portfolio 5 and portfolio 1 sorted by *IVOLS*. Panel A is the result before the financial crisis (2000-2008), panel B is the result after the financial crisis (2009-2016).

Panel A subperiod I 2000-2008		
IVOLS	*PBRS*	
	1 low	2 high
1 low	0.0185	0.0534
2	0.0134	0.0783
3	0.0106	0.0595
4	0.0153	0.0791
5 high	0.0171	0.0925
5-1	−0.0014	0.0391
t	[−0.84]	[8.45]***
Panel B subperiod II 2009-2016		
IVOLS	*PBRS*	
	1 low	2 high
1 low	0.0156	0.0075
2	0.0306	0.0019
3	0.0256	0.0048
4	0.0283	−0.0035
5 high	0.0350	−0.0018
5-1	0.0194	−0.0092
t	[15.92]***	[−5.06]***

*$p<0.1$ **$p<0.05$ ***$p<0.01$

panel A, the stock return will be higher when the short-term idiosyncratic volatility is lower. The difference between the highest and the lowest *IVOLS* portfolios is equal to −0.0014, but not statistically significant (*t*-statistics=−0.84). During the period of high investor sentiment in the prior month in panel A, higher short-term idiosyncratic volatility led to a higher stock return. The difference between the highest and the lowest *IVOLS* portfolios is equal to 0.0391, and statistically significant (*t*-statistics=8.45). In panel B, the stock return will be higher when the short-term idiosyncratic volatility is higher during the period of low investor sentiment in the prior month. The difference in the stock return achieves at a significance level of 1% (0.0194, *t*-statistic: 15.92). In contrast, there is a significant negative relationship during the period of high investor sentiment. The difference in the stock return achieves at a significance level of 1% (−0.0092, *t*-statistic: −5.06).

Consequently, the short-term puzzle is not observed before the financial crisis (2000-

2008), but observed in the full period (2000-2016) and after the financial crisis (2009-2016) during the period of high investor sentiment. The results after the financial crisis are consistent with those of Iwanaga (2019), who found that no puzzle was observed when the investors were pessimistic in the preceding month, whereas it was clearly observed when investors were optimistic in the prior month.

4.3 Regressions of Short-term Idiosyncratic Volatility

In this section, in order to confirm whether the impact of the short-term idiosyncratic volatility puzzle on stock return is related to investor sentiment, the regressions are conducted in groups according to the investor sentiment.

The short-term idiosyncratic volatility puzzle is examined using the following form:

$$R_{i,t+1}=\alpha_i+\beta_i IVOLS_t+\theta_i lnMV_t+\mu_i BM_t+\varepsilon_{i,t} \quad (4)$$

where the dependent variable $R_{i,t+1}$ represents the monthly return of stock i in month $t+1$. The lagged explanatory variables, computed in month t, include $IVOLS_t$ which represents the short-term idiosyncratic volatility; $lnMV_t$ represents the logarithm of market value; and BM_t represents the book-to-market ratio.

Table 4.4 shows the details of the regression analysis. Panel A (column 1,2) indicates that the coefficients of the short-term idiosyncratic volatility (*IVOLS*) are positive and significant during the period of low investor sentiment in the prior month. The coefficient on the *IVOLS* are 0.1629 (*t*-statistics=11.63) in column 1 and 0.0754 (*t*-statistics=4.68) in column 2. For high investor sentiment group, the coefficient on the *IVOLS* are −0.0671 (*t*-statistics = 14.48) in column 3 and −0.0972 (*t*-statistics = − 20.59) in column 4, which shows a negative relationship of *IVOLS* and the stock expected return.

For panel B (2000-2008), the coefficients on the short-term idiosyncratic volatility (*IVOLS*) are significantly positive in all columns. In other words, for the period preceding the financial crisis (2000-2008), it is observed that introducing the investor sentiment indicator enhanced the positive impact of the short-term idiosyncratic volatility toward the expected stock return.

However, panel C (2009-2016) demonstrates contrasting results compared with panel B. In all the columns, the coefficients on the short-term idiosyncratic volatility (*IVOLS*) are negative. In column 1, the coefficient is −0.0058, but not significant (*t*-statistics=−0.35). Whereas in column 3, the coefficient is negative and statistically significant (−0.1146, *t*-statistics = − 18.51). In other words, after the financial crisis (2009-2016), short-term idiosyncratic volatility puzzle is observed only during the period of high investor sentiment in the prior month.

Therefore, in the full period (2000-2016) and after the financial crisis (2009-2016), the negative relationship of *IVOLS* and the expected stock return is observed only during the

Table 4.4 Regressions of Short-Term Idiosyncratic Volatility Puzzle

This table shows the regression of the short-term idiosyncratic volatility puzzle using the following four models:

$$R_{i,t+1}=\alpha_i+\beta_i IVOLS_t+\varepsilon_{i,t}$$
$$R_{i,t+1}=\alpha_i+\beta_i IVOLS_t+\theta_i lnMV_t+\mu_i BM_t+\varepsilon_{i,t}$$

where the dependent variable $R_{i,t+1}$ represents the monthly return of stock i in month $t+1$. The lagged explanatory variables, computed in month t, include $IVOLS_t$ (the short-term idiosyncratic volatility), $PBRS_t$ (investor sentiment indicator), IV_PBRSS_t (the interaction term of idiosyncratic volatility and investor sentiment indicator), $lnMV_t$ (the logarithm of market value), and BM_t (book-to-market ratio). The sample covers the period from January 2000 to December 2016. Panel A is the result before the financial crisis (2000-2008), panel B is the result after the financial crisis (2009-2016), and panel C is the result during the entire period (2000-2016).

Panel A full period 2000-2016

	low sentiment		high sentiment	
	1	2	3	4
IVOLS	0.1629	0.0754	−0.0671	−0.0972
	[11.63]***	[4.68]***	[−14.48]***	[−20.59]***
LnMV		−0.003		−0.0057
		[−11.44]***		[−40.32]***
BM		0.0002		0.0013
		[0.90]		[7.43]***
_cons	−0.0076	0.073	0.0328	0.1704
	[−7.71]***	[10.19]***	[66.80]***	[49.04]***

Panel B subperiod I 2000-2008

	low sentiment		high sentiment	
	1	2	3	4
IVOLS	0.4605	0.4315	0.1367	0.1592
	[17.73]***	[16.36]***	[21.01]***	[24.28]***
lnMV		0.006		−0.0067
		[4.70]***		[−22.49]***
BM		−0.0065		0.0026
		[−3.53]***		[11.24]***
_cons	0.0301	−0.0928	0.002	0.1468
	[8.50]***	[−3.19]**	[2.36]*	[22.13]***

Panel C subperiod II 2009-2016

	low sentiment		high sentiment	
	1	2	3	4
IVOLS	−0.0058	−0.1038	−0.1146	−0.163
	[−0.35]	[−5.38]***	[−18.51]***	[−25.70]***
lnMV		−0.0031		−0.0075
		[−10.55]***		[−40.68]***
BM		0.0001		0.0016
		[0.36]		[6.52]***
_cons	0.0002	0.0838	0.0383	0.2237
	[0.21]	[10.42]***	[60.52]***	[48.40]***

*$p<0.1$ **$p<0.05$ ***$p<0.01$

Table 4.5 Regressions of Long-term Idiosyncratic Volatility Puzzle

This table shows the regression of the long-term idiosyncratic volatility puzzle using the following four models:

$$R_{i,t+1}=\alpha_i+\beta_i IVOLL_t+\varepsilon_{i,t}$$
$$R_{i,t+1}=\alpha_i+\beta_i IVOLL_t+\theta_i lnMV_t+\mu_i BM_t+\varepsilon_{i,t}$$

where the dependent variable $R_{i,t+1}$ represents the monthly return of stock i in month $t+1$. The lagged explanatory variables, computed in month t, include $IVOLL_t$ (the long-term idiosyncratic volatility), $lnMV_t$ (the logarithm of market value), and BM_t (book-to-market ratio). The sample covers the period from January 2003 to December 2016. Panel A is the result before the financial crisis (2000-2008), panel B is the result after the financial crisis (2009-2016), and panel C is the result during the whole period (2003-2016).

Panel A full period 2003-2016

	low sentiment		high sentiment	
	1	2	3	4
IVOLL	0.6068	0.6169	0.7477	0.7702
	[107.77]***	[103.27]***	[107.64]***	[109.17]***
lnMV		0.0001		−0.0037
		[0.48]		[−10.56]***
BM		0.0028		0.0263
		[16.33]***		[24.84]***
_cons	−0.0418	−0.048	−0.0652	0.0039
	[−64.03]***	[−10.56]***	[−66.22]***	[0.46]

Panel B subperiod I 2003-2008

	low sentiment		high sentiment	
	1	2	3	4
IVOLL	0.5985	0.6565	0.6529	0.7272
	[36.62]***	[39.52]***	[41.25]***	[44.71]***
lnMV		−0.0122		−0.0017
		[−25.14]***		[−2.75]**
BM		0.0044		0.0204
		[13.65]***		[16.16]***
_cons	−0.0638	0.2013	−0.0643	−0.0512
	[−26.10]***	[17.73]***	[−25.86]***	[−3.53]***

Panel C subperiod II 2009-2016

	low sentiment		high sentiment	
	1	2	3	4
IVOLL	0.6294	0.6411	0.7725	0.8054
	[96.70]***	[93.24]***	[96.08]***	[98.06]***
lnMV		0.0001		−0.0049
		[0.42]		[−11.65]***
BM		0.0031		0.0418
		[15.11]***		[26.05]***
_cons	−0.0423	−0.0489	−0.0663	0.0241
	[−57.43]***	[−9.21]***	[−59.24]***	[2.38]*

*$p<0.1$ **$p<0.05$ ***$p<0.01$

period of high investor sentiment in the prior month. No short-term idiosyncratic volatility puzzle is observed in the Chinese stock market before the financial crisis (2000-2008). These results are consistent with Table 4.3.

4.4 Regressions of Long-term Idiosyncratic Volatility

Hirose and Iwanaga (2011b) calculated the long-term idiosyncratic volatility using the data of the past 60 months to verify the long-term puzzle in the Japanese stock market. This section verifies whether the long-term idiosyncratic volatility puzzle in the Chinese stock market truly exists. Similar to the short-term indicator, the standard deviation of the residual is considered as the long-term idiosyncratic volatility indicator ($IVOLL$), which is derived from the regression analysis of the Fama-French three-factor model.

$$IVOLL_{i,t}=\sqrt{n_t}\,Std(\varepsilon_{i,t}) \tag{5}$$

Given that the long-term idiosyncratic volatility ($IVOLL$) uses the data of the past 36 months, each n is set as 36. The measurable period is taken from January 2003 to December 2016.

Table 4.5 reports the results of the regressions analysis. During all the testing periods, the coefficients on $IVOLL$ of the four columns are positive and statistically significant. Unlike the Japanese stock market, the Chinese stock market has no long-term idiosyncratic volatility puzzle. Hirose and Iwanaga (2011b) calculated the idiosyncratic volatility of the long term using the data of the past 60 months and observed the long-term puzzle in the Japanese stock market. Moreover, they concluded that the puzzle might be explained by the long-term return reversal.

5. Conclusion

This empirical study used the data of the Chinese A-share market from January 1, 2000 to December 31, 2016, focusing on the idiosyncratic volatility puzzle and investor sentiment before and after the financial crisis.

First, the study confirmed the existence of the short-term volatility puzzle in the Chinese stock market. There is a positive correlation between the short-term idiosyncratic volatility and investor sentiment, confirming that in the full period no short-term idiosyncratic volatility puzzle occurs.

Second, the cross-sectional skewness of PBR has been used for the first time as an investor sentiment indicator in the Chinese stock market to investigate the relationship between the short-term idiosyncratic volatility puzzle and investor sentiment. The short-term puzzle is not observed before the financial crisis (2000-2008), but observed in the

full period (2000-2016) and after the financial crisis (2009-2016) during the period of high investor sentiment.

This study also focused on the relationship between the long-term idiosyncratic volatility and stock return. The study results demonstrated that, unlike the Japanese stock market, there is no long-term idiosyncratic volatility puzzle in the Chinese stock market.

This is the first study that highlights the association between the financial crisis and the investor sentiment regarding the idiosyncratic volatility puzzle in the Chinese stock market. Furthermore, it is a novel attempt to verify the long-term idiosyncratic volatility puzzle in the Chinese market.

Notes

1) Miller (1977) pointed out that due to the short selling restriction; investors' buying pressure was higher than selling pressure, which led to the bias of overvaluation of stock price.

2) There are two main types of stocks that are typically available for purchase on the Shanghai and Shenzhen stock exchanges. A-shares, which account for the majority of China's tradable shares, trade in the Chinese Yuan for ordinary domestic investors. B-shares are listed on the Shanghai and Shenzhen exchanges and are open to foreign investors. Although the nominal value is the Chinese Yuan, the actual transaction is foreign exchange. Shanghai trades in US Dollars and Shenzhen trades in Hong Kong Dollars. For details, please refer to "China stock market information" pp30-pp33.

3) Hirosaki (2012) sorted the stocks into 10 portfolios based on the volatility of each month. The subject of the verification is the Tokyo Stock Exchange first section from August 1980 to December 2010.

Ang et al. (2006) sorted a quintile portfolio using common stocks from NYSE, NASDAQ, and AMEX from 1963 to 2000.

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