Research on Investment Preference and the MAX Effect in Chinese Stock Market

Xiaoju GOU

School of Management, University of Science and Technology of China, Hefei 230026, China

Limei BIE

School of Management, University of Science and Technology of China, Hefei 230026, China

Abstract Investors prefer to invest the stocks with high history returns, which results in that the return of the stock with high history maximum return is often lower than that with low history maximum return, i.e., the MAX effect. We show that the MAX effect is also significant in China stock market, that is, there is a significant negative relationship between maximum return and expected return. We then conduct portfolio analysis and Fama-Macbeth cross-sectional regression and find that range of price and turnover rate can explain the MAX effect in a certain extent, idiosyncratic volatility and idiosyncratic skewness cannot explain the negative relationship between maximum return and expected return. Moreover, maximum return explains the idiosyncratic volatility puzzle partially.

Keywords MAX effect; idiosyncratic volatility; idiosyncratic skewness; range of price

1 Introduction

Investors are assumed to be rational and risk-averse in traditional financial theory, and only care about the returns and risk of investment portfolio, instead of selective preference to assets. However, a large number of studies have shown different conclusions with this case. Investors often have different risk tolerance of different assets due to different knowledge, resources and environment, which results in different preference, such as small cap effect, home bias, lottery-like investment preference, investment of the sense of belonging, social responsibility investment preferences, etc.

Kumar^[1] found that personal investment shows a preference for lottery-like stocks, namely, low price, high quality stock volatility, high idiosyncratic skewness. Statman^[2] firstly pointed out that considering the transaction costs, both gambling and frequent trading of stocks are negative-sum games. Bali^[3] found that investors prefer to the assets with extreme positive returns, and considered maximum daily return as proxy variable of extreme positive return. They found a financial anomaly named the MAX effect where the stocks with high maximum daily returns (High MAX) over the past month often perform poorly compared with stocks with low maximum daily returns (Low MAX). Fong and Toh^[4] controlled investor sentiment variables and found that the MAX effect depends on investor sentiment significantly, and the MAX effect of investors with high sentiment is more significant than that with low sentiment.

Brunnermeier, et al.^[5] pointed out that investors overconfidence can lead to the deviation of the objective from subjective probability, excessively emphasis on the tail of the return distribution. According to the Cumulative Prospect Theory, Barberis and Huang^[6] thought that investors would give a high probability weight to the tail of the distribution of asset returns. They believed investors overestimate the probability of extreme positive returns, chase lottery-like stocks excessively, and are willing to pay high prices, which results in negative returns of lottery-like stocks. Bali^[3] pointed out that the explanation of MAX effect is consistent with the Cumulative Prospect Theory. The phenomenon of frequent rises and falls in Chinese stock market in recent years, as well as significantly higher turnover rate and price-earning ratio than the rest of the world stock market, which indicates that most Chinese investors are speculative. However, there is little research on MAX effect in Chinese stock market. To bridge this gap, we examine whether the MAX effect exists in Chinese stock market?

Mitton and Vorkink^[7] detected that idiosyncratic skewness are priced in equilibrium, i.e., the stocks with positive idiosyncratic skewness usually tend to have negative returns. Zheng, et al.^[8] investigated the Chinese stock market and got the same conclusion. It is obvious that the stock with high historical maximum return tends to show a positive skewness. However, what effect does skewness have on the MAX effect?

Ang, et al.^[9, 10] found stocks with high idiosyncratic volatility tend to have a low income in the future, which is known as the idiosyncratic volatility puzzle. It is easy to know that a stock with extreme positive return tends to have high idiosyncratic volatility. Numerous researches have considered maximum return as proxy variable of idiosyncratic volatility. They concluded that investor whose risk is not fully diversified pursuits lottery-like stock excessively instead of high idiosyncratic volatility, which affects stock prices and their future returns. Bali^[3] found that the negative relationship between idiosyncratic volatility and expected return is no longer significant after controlling the influence of maximum returns. Liu, et al.^[11] investigated China's A-share market and found that the maximum return can explain idiosyncratic volatility puzzle to a certain extent, but the negative relationship between idiosyncratic volatility and expected return is still significant after controlling the maximum return. So what impact does idiosyncratic volatility have on the MAX effect?

Compared with the stocks with smooth price movement, investors prefer stocks with price changes in a large range to achieve the "buy low and sell high" strategy and obtain excess returns. According to the no-arbitrage pricing theory, overinvestment and frequent trade fair in the shares will affect the stock prices and their future return, so the preference for the stock with large price range would lead to negative returns. We think that the asset with extreme positive return often has large price change margin, and therefore we examine whether the range of price has an impact on the MAX effect.

The rest of this paper is organized as follows. Section 2 describes data definition and data sources. Section 3 provides details of how MAX portfolios are formed, followed by a descriptive analysis of these portfolios in terms of their formation period returns, firm size, turnover rate, liquidity, momentum, short-term reversal, idiosyncratic risk, idiosyncratic skewness and range of price. Finally, the cross-sectional regression further verifies the existence of the MAX effect.

2 Research Design

2.1 The Proxy Variable of Extreme Positive Returns

Based on the daily stock return data per month, we select the maximum return of each stock as a proxy variable for extreme positive returns. However, this method may be too simple, and may have a greater impact on changes in stock returns, thus we adopt the monthly mean value of N ($N = 1, 2, 3, 4, 5$) maximum return benefits as alternative proxy variable of extreme positive return.

2.2 Portfolio Constitution

To decide the weight of stock portfolio, we take into account the possible scale effects where smaller company stocks may have a higher return. Using equal weight to calculate portfolio return might amplify the return of stocks with small scale, which results in some bias for testing the relationship between maximum return and portfolio return. As a result, we employ the value-weighted method to calculate the portfolio return.

2.3 Variable Specifications

To test the robustness and impact factors of the MAX effect in Chinese stock market, we introduce the following control variables.

1) Idiosyncratic Volatility (IV): Based on the methods of Ang, et al.^[10], we employ the Fama-French three-factor regression model:

$$R_{i,t} - \gamma_{i,t} = \alpha_i + \beta_i^{\text{MKT}} \text{MKT}_t + \beta_i^{\text{SMB}} \text{SMB}_t + \beta_i^{\text{HML}} \text{HML}_t + \epsilon_{i,t}, \quad (1)$$

where $R_{i,t}$ represents the return of stock i in the t day, $\gamma_{i,t}$ is the risk-free return in the t day. The risk-free return data are from RESSET database, MKT_t , SMB_t and HML_t represent the market premium factor, size factor and a book-to-market factor, respectively. We use $\sqrt{\text{var}(\epsilon_{i,t})}$ to measure the idiosyncratic volatility per month.

2) Idiosyncratic skewness (ISK): We use the method of Harvey and Siddique^[12], and it is estimated by Equation (2):

$$R_{i,t} - \gamma_{i,t} = \alpha_i + \beta_i(R_{m,t} - \gamma_{f,t}) + \gamma_i(R_{m,t} - \gamma_{f,t})^2 + \epsilon_{i,t}, \quad (2)$$

where the skewness of each stock in month t is measured by the skewness of $\epsilon_{i,t}$.

3) Range of price (RP): Driven by the arbitrage opportunities, investors tend to invest in the stock with large price change to realize the “buy low and sell high” strategy and gain excess returns. Range of price is the largest change within one month. In this paper, we use the difference between the monthly highest closing price and lowest closing price to measure the range of price of each stock.

4) Turnover rate (TUR): This indicator is measured by the ratio of trading amount and market value.

5) Company Size (SIZE): It is measured by the natural logarithm of the company's total market value.

6) Liquidity (ILLIQ): According to Amihud^[13], we employ the ratio of the absolute value of return and volume to measure the liquidity index. In fact, what Amihud measured is the

illiquidity of the stock, the greater the ILLIQ, the smaller the liquidity of the stock.

$$\text{ILLIQ}_{i,t} = \frac{1}{\text{Days}_{i,t}} \sum_{i=1}^{\text{Days}_{i,t}} \frac{|R_{i,t}|}{V_{i,t}}, \quad (3)$$

where $R_{i,t}$ is the return of stock i in day t , $V_{i,t}$ is the transaction amount of stock i in day t and $\text{Days}_{i,t}$ is the number of effective trading days from the first effective trading day to day t in the current month.

7) Momentum (MOM): Following Jegadeesh and Titman^[14], the momentum variable for each stock in month t is defined as the cumulate returns of each in month $t - 3$ and $t - 2$.

8) Short-term reversal (REV): According to the definition in Jegadeesh^[15], we consider the stock return in last month as the stock return reversal in the current month.

3 Empirical Research

3.1 Sample Selection

We select all the A-shares in Chinese Shanghai and Shenzhen Stock Exchanges as the research object. The stock data are selected from CSMAR financial database during the sample period January 3, 2000 to December 31, 2014. The needed information of company's book value and risk-free rate to compute Fama-French three factor model is selected from RESSET Database. In addition, we eliminate the stock data of list companies on GEM and the companies with short listed time and the stock data within the month that the number of trading day is less than 7.

3.2 The Existence Test of MAX Effect

First, we employ investment portfolio approach to test the existence of MAX effect in Chinese stock market. Portfolio analysis aims to build a portfolio based on different indices by testing whether there are significant differences among different combinations of returns in the holding period. We choose the maximum return of each stock based on the stock's daily return data every month from January 2000 to December 2014 and then sort the stocks from low to high according to the daily maximum return. Stocks are divided into five portfolios by quintile points. At last, we calculate the market-value weighted return of each portfolio in next month.

Table 1 presents the value-weighted average monthly returns of decile portfolios. Decile 1 (Low MAX) is a portfolio of stocks with the lowest maximum daily returns in the last month and decile 5 (High MAX) is a portfolio of stocks with the highest maximum returns in the previous month. The second column is a portfolio of excess returns. The difference between decile 5 (High MAX) and decile 1 (Low MAX) is -0.08348% , Newey-West-t value (in parentheses) is -2.1184 , which indicates that the difference between the two groups is significantly negative. The third column is the regression intercepts (Alpha) after systemic risk adjustment by FF-3 factor model. The Alpha difference between High MAX and Low MAX portfolios is -0.7512% and the corresponding Newey-West-t of significance test is -2.1304 . Both excess return and Alpha value of FF-3 factor model show that there exists a significantly negative relationship between maximum return and expected return.

Considering taking the monthly maximum return as a proxy variable of extreme positive return may be too simple, we retake the average maximum daily returns of N ($N = 1, 2, 3, 4, 5$)

days in one month as maximum return index as the history maximum return to group, and test whether there are significant differences between different portfolios during the holding period.

Table 1 Returns of portfolios sorted by daily maximum return

	Excess Return	FF3 Alpha
Low MAX	0.0474	0.0503
2	0.6199	0.5884
3	0.4398	0.4739
4	0.1873	0.2459
High MAX	-0.7874	-0.7009
High-Low	-0.8348	-0.7512
	(-2.1184)	(-2.1304)

Table 2 Returns on portfolios sorted by the average maximum returns of N days

Panel A: Excess return					
Decile	$N = 1$	$N = 2$	$N = 3$	$N = 4$	$N = 5$
Low MAX	0.0474	0.0409	0.0438	0.047	0.0628
2	0.6199	0.6659	0.7146	0.7198	0.7207
3	0.4398	0.5693	0.5815	0.6559	0.6652
4	0.1873	0.2078	0.2464	0.282	0.3083
High MAX	-0.7874	-0.9758	-1.0782	-1.1963	-1.2487
High-Low	-0.8348	-1.0167	-1.122	-1.2433	-1.3115
	(-2.1184)	(-2.387)	(-2.5429)	(-2.7516)	(-2.9105)
Panel B: FF3 Alpha					
Decile	$N = 1$	$N = 2$	$N = 3$	$N = 4$	$N = 5$
High-Low	-0.7512	-0.9989	-1.10068	-1.2031	-1.2634
	(-2.1304)	(-2.2022)	(-2.2764)	(-2.4337)	(-2.5651)

Table 2 presents the value-weighted returns on portfolios of stocks sorted by multi-day maximum returns. Decile portfolios are formed every month from January 2000 to December 2014 by sorting stocks based on the average of the N highest daily returns (MAX (N)) over the past one month. In Table 2, values in column 2 to column 6 are the return of each portfolio sorted by the mean of N ($N = 1, 2, 3, 4, 5$) maximum returns, and MAX (N) is the portfolio comprises of the mean of N maximum returns. Panel A lists the excess returns. The difference between High MAX and Low MAX portfolios ranged from -0.8348% of MAX (1) to -1.3115% of MAX (5), and the significance is also enhanced. Panel B is the difference of Alpha value of FF-3 factor model, and the differences between High MAX and Low MAX portfolios from MAX (1) to MAX (5) are also significantly negative, which suggests that the results of the extreme positive return are similar when employing different proxy variables, and proves the robustness

of the MAX effect. For the sake of simplicity, we use the maximum return per month as the proxy variable of extreme positive return.

3.3 Robustness Test

3.3.1 Portfolio Characterization

Before the robustness test, we first carry on a statistical sample description. We sort the stocks based on the maximum return for each month from January 2000 to December 2014, and then calculate the variables for each MAX portfolio. In Table 3, D1 is a portfolio of the stocks with smallest maximum returns and D5 is a portfolio of the stocks with biggest maximum return. We present the various characteristics of each portfolio where MAX is the mean of the maximum returns of all the portfolios and SIZE is the natural logarithm of the company's total market capitalization.

The result shows that there is no significant difference in company size and stock price among the portfolios of Low MAX portfolio (D1) and High MAX portfolio (D5). However, D5 is slightly higher than D1 in the company size and stock price, which is different from the result of Fong and Toh^[4]. They employ the US stock market as research subject and find that company size and stock price reduce as the maximum return rises, that is, assembled, company size and stock price decrease gradually in the portfolios from D1 to D5, which could be a difference of the MAX effect between Chinese stock market and the U.S. stock market. TUR, IV, ISK and RP are gradually increased from D1 to D5. D1 portfolio shows the lowest liquidity, but D5 portfolio shows the highest liquidity, while Fong and Toh^[4] found that both the Low MAX portfolio and High MAX portfolio have low liquidity.

Table 3 The statistical description of each portfolio

	D1	D2	D3	D4	D5
MAX	1.8449	4.6626	5.8239	6.8697	12.0034
SIZE	21.6689	22.0439	21.9168	21.8874	21.9313
Price	9.6406	10.7237	10.2009	10.3942	11.1938
TUR	0.0104	0.0211	0.0241	0.0277	0.0342
ILLIQ	54.4159	18.2555	18.9765	18.2143	15.5841
IV	1.1896	2.4019	2.7043	2.9726	4.0107
ISK	-0.2996	0.0008	0.1612	0.2807	0.6915
RP	10.9469	18.5569	18.9314	20.4431	25.3709
MOM	0.7579	0.9971	0.6272	1.1423	1.5631
REV	-0.1443	-0.1071	-0.0143	0.0434	0.3082

In this section we examine the relation between maximum daily returns and future stock returns after controlling size, momentum, short-term reversals, liquidity, turnover rate, idiosyncratic risk, idiosyncratic skewness and range of price. We first sort the stocks by control variables every month, and divide each portfolio into five deciles according to the maximum return, constituting a 5×5 matrix of return portfolio. After fixing other factors, we then test

if there are significant differences in the returns of different maximum return portfolios in the holding period. To avoid triviality, we only present the results of the lowest maximum return portfolio and the highest maximum return portfolio.

Firstly, we test the influence of liquidity on the MAX effect. We first form the decile portfolio ranked based on the liquidity. Then, within each liquidity decile, we sort stocks into decile portfolio ranked based on the MAX, constituting a 5×5 matrix of return portfolio. Instead, the second column of Table 4, Panel A presents returns averaged across the five liquidity deciles to produce decile portfolios with dispersion in MAX, but which contains the stocks from low liquidity to high liquidity on average. This procedure creates a set of MAX portfolios with similar levels of firm liquidity, and thus, these MAX portfolios control for differences in liquidity, thereby eliminating the influence of the liquidity on the return of High MAX and Low MAX portfolios. In Table 4, Column 2 of Panel A presents the time-series averages of value-weighted excess returns from Low MAX to High MAX portfolio in the sample period after controlling the impact of liquidity. The difference of excess return between High MAX and Low MAX portfolios is -1.0678% . The corresponding Newey-West-t value is -3.0439 , which is significantly negative. Panel B is the Alpha of FF-3 factor model for each portfolio, the difference High MAX and Low MAX portfolios remains significantly negative. It shows that the differences of both the excess return and the Alpha of FF-3 factor model between High MAX and Low MAX portfolios are larger than those in Table 1 and the significance are also improved. When controlling the liquidity and maximum returns, there is still a significant negative relationship between maximum return and expected return. The liquidity of D5 portfolio is significantly higher than D1 liquidity in Table 3, indicating there is no significant impact of liquidity on the MAX effect.

Jegadeesh and Titman^[14] found that the return of the intermediate term keeps the state in the past, return in the short term reverses the past state. So here we consider whether the intermediate-term momentum and the short-term reversal have an influence on the MAX effect. To answer this question, we select three months' momentum data as momentum factors and last month's return as reversal factors. Similar to the method of structuring the MAX portfolios by controlling the liquidity variable, we form the MAX portfolios by controlling the momentum and return reversal, respectively, and get the results of columns 3 and 4 in Table 4. The differences of intermediate-term momentum and short-term reversal between High MAX portfolios and Low MAX portfolios in Panel A are 1.2173% and 1.2786% , respectively, and the corresponding Newey-West-t values are -6.9972 and -5.2477 respectively. After adjusting the systemic risk by FF-3 factor model in Panel B, there still exists significant difference of risk premium between High MAX and the Low MAX portfolios in the future, which are -1.1574% and -1.1964% , respectively, and the corresponding Newey-West-t value of significance test are -6.2093 and -4.7495 , respectively. We find that after controlling the intermediate-term momentum and short-term reversal of return, respectively, the differences between High MAX and low MAX portfolios are improved and the significances are also improved. The results indicate that after controlling the intermediate-term momentum and short-term reversal of return, the negative relationship between maximum return and expected return is still significant. Therefore, the intermediate-term momentum and short-term reversal of return cannot explain the MAX effect.

Table 4 Portfolio returns after controlling variables

Decile	ILLIQ	MOM	REV	TUR	SIZE
Panel A: Excess return					
Low MAX	0.4528	0.3887	0.5094	0.4464	0.4111
D2	0.6579	0.6584	0.6419	0.5062	0.9125
D3	0.4229	0.4436	0.3788	0.5464	0.7227
D4	0.3151	0.2202	0.1583	0.4105	0.556
High MAX	-0.615	-0.8286	-0.7692	-0.2879	-0.4867
High-Low	-1.0678 (-3.3573)	-1.2173 (-6.9972)	-1.2786 (-5.2477)	-0.7343 (-1.6362)	-0.8978 (-2.3763)
Panel B: FF3 Alpha					
High-Low	-1.0645 (-2.7657)	-1.1574 (-6.2093)	-1.1964 (-4.7495)	-0.7081 (-1.4923)	-0.8754 (-2.2346)

Columns 5 and 6 in Table 4 represent the excess return of maximum return portfolio and Alpha value of FF-3 factor model, respectively, controlling TUR and SIZE. We find that after controlling the impact of turnover rate, the excess return difference between High MAX and Low MAX portfolios is -0.7343% and the intercept term of FF-3 factor model is -0.7081% , both of which decrease slightly than that in Table 1. The corresponding Newey-West-t values are -1.6362 and -1.4923 , respectively, and the significance decreases, too, which means that after controlling the effect of the turnover rate, the negative relationship between maximum return and expected return decreases and TUR has a certain effect on the MAX effect. After controlling the company size, there is no big difference of excess return. The intercept of FF-3 factor model between High MAX and Low MAX portfolios are -0.8978% and -0.8754% , respectively, and the Newey-West-t value are -2.3763 and -2.2346 , respectively, which presents that the relationship between maximum return and expected return is still significantly negative after controlling the company size.

3.3.2 Idiosyncratic Skewness and MAX Effect

We obtain the positive relationship between maximum return and idiosyncratic skewness from Table 3, and the skewness of High MAX portfolio is significantly higher than that of Low MAX portfolio. In the research of lottery-like stocks, Zheng, et al.^[16] took the maximum return as the proxy variable of idiosyncratic skewness, because the lottery-like stocks are overinvested by lottery-preferenced investors excessively, and the annual return is 5% less than other stocks at least. Zheng, et al.^[8] employed Chinese A-share market as the research object, and proved a negative relationship between idiosyncratic skewness and expected return. In order to verify the influence of the idiosyncratic skewness on the MAX effect, we first verify the influence of ISK on the expected return. We form the decile portfolios based on ISK and calculate value-weighted return and Alpha value of FF-3 factor model of each ISK portfolio in the next month. Panel A of Table 5 presents the ISK return and the Alpha value of FF-3 factor model of each portfolio, and the differences of high ISK portfolio and low ISK portfolio are -0.4571% and -0.4501% ,

respectively, and the corresponding Newey-West-t values are -2.1911 and -2.1867 , respectively, which indicates that the relationship between ISK and expected return is significantly negative. Panel B is the maximum return portfolio controlling the ISK. The formation method of portfolio is consistent with the aforementioned method of controlling other variables. We find that after controlling the ISK, the differences of the excess return and the Alpha value of FF-3 factor model between High MAX and Low MAX portfolios increase significantly, which are -1.4563% and -1.3664% , respectively, and the corresponding Newey-West-t values are -6.9352 and -5.5686 , respectively, with the significance improved. Table 3 shows that the skewnesses of High and Low MAX portfolios are 0.6915 and -0.2996 , respectively, and high skewness means lower expected return. After controlling the influence factors of ISK, there is no difference between ISK of each portfolio, and the skewness of high return portfolio is lower than before, while the skewness of low return portfolio is higher than before, thus the return difference between the two portfolios gets larger. After controlling ISK, there is still a significantly negative relationship between maximum return and expected return, so ISK cannot explain the MAX effect.

Table 5 Returns of stocks portfolios sorted by ISK and maximum return group after controlling ISK

	Excess Return	FF3 Alpha
Panel A: Sorted by ISK		
Low ISK	0.0303	0.2147
2	0.0247	0.1891
3	0.0274	0.1906
4	0.0376	0.3098
High ISK	-0.0154	-0.2355
High-Low	-0.4571 (-2.1911)	-0.4501 (-2.1867)
Panel B Sorted of MAX after controlling ISK		
Low MAX	0.6952	0.5498
2	0.6374	0.5058
3	0.4585	0.3852
4	0.0636	-0.0298
High MAX	-0.7611	-0.8166
High-Low	-1.4563 (-6.9352)	-1.3664 (-5.5686)

3.3.3 Idiosyncratic Volatility, Range of Price and MAX Effect

Merton^[17] pointed out that in the capital market equilibrium model with incomplete information, the stocks with high idiosyncratic volatility should get risk compensation and high future return. However, the subsequent numerous empirical studies, e.g., Ang, et al.^[9, 10], demonstrate that there is a significantly negative correlation between idiosyncratic volatility

and expected return. This anomaly is called idiosyncratic volatility puzzle. There is a lot of existing research about the existence of Chinese stock market volatility, e.g., Zuo, et al.^[18], Deng and Zheng^[19], Huang, et al.^[20], Xu^[21], Yang and Han^[22]. Liu and Xing^[11] chose Chinese A-share market as the research object to test the existence of idiosyncratic volatility puzzle and obtained that the interaction of maximum daily return, range of price and turnover rate may be the main reason of idiosyncratic volatility puzzle. They found that the maximum daily return has certain influence on the idiosyncratic volatility. So what is the influence of idiosyncratic volatility on the MAX effect? The change of stock price from low to high in the short term often results in investors' optimistic mind, so investors prefer the stocks with large range of price in the past to realize the "buy low and sell high" strategy and obtain excess returns when making investment decisions. According to the principle of no arbitrage pricing, investors' excessive investment and frequent trade reduce the returns of this kind of stocks, therefore range of price may be the cause of idiosyncratic volatility puzzle. Table 3 shows that the range of price increases from 10.9469 of Low MAX portfolio up to 25.3709 of High MAX portfolio, so we need to further consider the impact of range of price on the MAX effect.

First of all, we verify the relationship of the idiosyncratic volatility and the range of price with the expected return. Columns 2 and 3 of Panel A in Table 6 show the idiosyncratic volatility portfolios formed by sorting stocks based on the idiosyncratic volatility. We find that the difference of excess return and Alpha of FF-3 factor model between high idiosyncratic volatility portfolios and low idiosyncratic volatility portfolios are significantly negative, respectively. Columns 4 and 5 present the return on portfolios of stocks sorted by the range of price. The differences of the excess return and Alpha of FF-3 factor model between high range of price portfolios and low range of price portfolios are significantly negative, which are -1.0671% and -1.2049% , respectively. This result indicates that both idiosyncratic volatility and range of price have significantly negative relationship with expected return.

Then we form the maximum return portfolio by controlling IV and RP, respectively. The columns 2 and 3 of Panel B in Table 6 are the maximum return portfolios after controlling the idiosyncratic volatility. We find that the difference between High MAX and Low MAX portfolios remains significantly negative. After controlling the price range, the difference between High MAX and Low MAX portfolios gets significantly lower than Table 1, i.e., -0.4991% and -0.4357% , respectively, the corresponding Newey-West-t value are -0.9411 and -0.8460 , respectively, and the difference is no more significant, which indicates that after controlling the range of price, the negative relationship between maximum return and expected return is not significant any more either. So IV cannot explain the MAX effect, range of price can explain the negative relationship between maximum return and expected return in a certain extent.

Table 7 presents the idiosyncratic volatility portfolios after controlling the maximum return. Even though the excess return between high idiosyncratic volatility and low idiosyncratic volatility is smaller than the Alpha value of FF-3 factor model, the Newey-West-t value is no longer significant, which means that after controlling the maximum returns, the negative relationship between idiosyncratic volatility and expected return is not significant any more. Maximum return may be a reason of idiosyncratic volatility puzzle.

Table 6 The influence of IV and RP on MAX effect

	Excess Return	FF3 Alpha	Excess Return	FF3 Alpha
Panel A: Sorted by IV and RP				
	Idiosyncratic Volatility		Range of price	
1	0.0452	-0.0349	0.2485	0.2467
2	0.5495	0.4206	0.6818	0.6393
3	0.4561	0.3575	0.4777	0.3814
4	0.2269	0.1607	-0.0797	-0.2091
5	-0.7699	-0.8072	-0.8186	-0.9582
High-Low	-0.8150	-0.7723	-1.0671	-1.2049
	(-5.3699)	(-4.7266)	(-3.5823)	(-3.5625)
Panel B: Sorted by MAX after controlling IV and RP				
	Idiosyncratic Volatility		Range of price	
Low MAX	0.4398	0.3533	0.2734	0.1394
2	0.2958	0.1704	0.5912	0.4405
3	0.2783	0.1147	0.5686	0.4304
4	0.0240	-0.1525	0.3510	0.2187
High MAX	-0.3247	-0.4955	-0.2257	-0.2961
High-Low	-0.7645	-0.8488	-0.4991	-0.4357
	(-2.1449)	(-2.1071)	(-0.9411)	(-0.8460)

Table 7 IV portfolio after controlling MAX

	Excess Return	FF3 Alpha
Low IV	0.2021	0.1071
2	0.3997	0.2466
3	0.3365	0.2197
4	0.2869	0.1563
High IV	-0.1721	-0.263
High-Low	-0.3742	-0.3701
	(-0.737)	(-0.7469)

4 Cross-Sectional Regression Analysis

Before the cross-sectional regression analysis, we first perform a cross-sectional correlation analysis to learn the correlation between maximum returns and other control variables. We calculate the monthly correlations between maximum return and other control variables, and then obtain their average value in time series. The results are shown in Table 8. We find that cross-sectional correlation coefficients between MAX and IV, ISK, RP are high, which are 0.7511, 0.5233 and 0.3597, respectively.

Table 8 The correlation analysis results of independent variable in cross-sectional regression analysis

	MAX	IV	ISK	REV	MOM	ILLIQ	SIZE	TUR	RP
MAX	1	0.7511	0.5233	-0.0061	0.0005	-0.0374	0.0127	0.1812	0.3597
IV		1	0.2507	0.0137	0.0195	-0.021	-0.006	0.3658	0.4506
ISK			1	-0.0356	-0.0253	-0.0297	-0.0467	-0.025	0.0729
REV				1	-0.0935	-0.0283	0.0698	0.0641	0.068
MOM					1	-0.0209	0.0908	0.0404	0.0844
ILLIQ						1	-0.2081	-0.0973	-0.0270
SIZE							1	-0.1711	0.3166
TUR								1	0.1375
RP									1

So far, we have verified the existence of MAX effect and its influence at the portfolio level. The advantage of portfolio analysis method is non-parametric because we do not assume any functional relationship between the variables of interest. However, it is difficult to reflect the potentially important firm-specific information, and cannot control the impact of multiple variables on returns simultaneously. As a result, we employ Fama-MacBeth regression method to further test the cross-sectional relationship between maximum returns and expected return on the corporation level. To test the effect of other variables on the relationship between maximum return and the expected return, we take MAX, IV, ISK, REV, MOM, ILLIQ, SIZE, TUR, RP and VOL as independent variables to take regression of the return in the next month, and analyse the significance (1%) of regression coefficient in time series. In order to reduce the impact of different indicators dimension on the regression results, we first normalize all the data in each cross section, then take regression of the following equation in each month formula and calculate the time-series average regression coefficients and time-series Newey-West-t values,

$$R_{i,t+1} = c_i + \lambda_{i,1}MAX_{i,t} + \lambda_{i,2}IV_{i,t} + \lambda_{i,3}ISK_{i,t} + \lambda_{i,4}REV_{i,t} + \lambda_{i,5}MOM_{i,t} + \lambda_{i,6}ILLIQ_{i,t} + \lambda_{i,7}SIZE_{i,t} + \lambda_{i,8}TUR_{i,t} + \lambda_{i,9}RP_{i,t} + \lambda_{i,10}VOL_{i,t} + \epsilon_{i,t}. \quad (4)$$

Table 9 presents the average regression coefficients from January 2000 to December 2014, with the corresponding Newey-West-t values reported in parentheses.

We first see MAX as independent variable and take regression of returns in the next month. It shows that the average time-series regression coefficient is -0.0102, and Newey-West-t is -3.7404. The regression coefficient is significantly negative, therefore there exists a significant negative relationship between maximum return and expected return, which further verifies the existence of the MAX effect.

Due to the fact that MAX is highly correlated with IV, ISK and RP, and TUR may also be an influence factor of the MAX effect when building a two-dimensional portfolio in Table 4, we take them as individual independent variable to regress the return in the next month. The time series average of regression coefficient is significantly negative, which means IV, ISK, RP and TUR all have significantly negative relationship with expected return. We then add MAX in the above model and find that the mean of MAX regression coefficient is still significantly

Table 9 The results of cross-sectional regression

MAX	IV	ISK	RP	TUR	REV	MOM	ILLIQ	SIZE
-0.0102 (-3.7404)								
	-0.0261 (-2.8071)							
		-0.0224 (-2.1965)						
			-0.0246 (-5.6703)					
				-2.7254 (-4.5811)				
-0.0111 (2.9618)	0.0064 (0.3267)							
-0.0118 (-3.9618)		0.0127 (0.9206)						
-0.0078 (-2.8483)			-0.0180 (-4.3944)					
-0.0063 (-2.6844)				-2.3430 (-4.0203)				
-0.0044 (-1.8133)			-0.0165 (-3.9636)	-2.1150 (-3.6077)				
-0.0206 (-5.3383)	0.0778 (3.4102)		-0.0209 (-4.5246)	-3.9708 (-5.5783)				
-0.0224 (-4.6404)	0.0692 (2.9709)	0.0251 (2.4933)	-0.0194 (-4.8192)	-3.7096 (-5.0049)	-0.0366 (-3.8473)	-0.0008 (-2.6832)	0.00006 (0.2066)	0.0021 (0.2915)

negative when take MAX and IV as the independent variables at the same time, but idiosyncratic volatility coefficient is not significant any more, which is consistent with the result of portfolio analysis before. When we consider MAX and ISK as the independent variables, the regression coefficient of the maximum return and the Newey-West-t value of the significance test are both bigger than that with a single variable, which indicates that the idiosyncratic volatility and idiosyncratic skewness cannot explain the MAX effect. When considering MAX and RP as the independent variables, MAX coefficient decreases, but it is still significantly negative and the significance test value also decrease. When we consider MAX and TUR as the independent variables, we find that both MAX coefficient and significance decrease, but they is significantly negative. So we conclude that the range of price and turnover rate have a certain influence on the MAX effect and can partly explain it. Then we consider the maximize return, range of price and turnover rate as independent variables, and find the maximum return coefficient of the mean time series become -0.0044 , and the corresponding Newey-West-t value is -1.8133 ,

with that the maximum return coefficient is smaller than that with a single variable and no longer significant. If we take the maximum return, idiosyncratic volatility, the range of price and turnover rate as independent variables, the maximum return coefficient is -0.0206 , and the corresponding Newey-West- t value is -5.3383 , which is significantly negative. Finally we add all the control variables into this model and obtain that MAX coefficient is still significantly negative, which further proves the existence of the MAX effect. As a result, we conclude that the idiosyncratic skewness and idiosyncratic volatility cannot explain the MAX effect. The range of price and turnover rate may be the main reason of the MAX effect; maximum return may be one reason of the idiosyncratic volatility puzzle.

5 Conclusion

We investigate and verify the existence of MAX effect in Chinese stock market and obtain that the return of the stock with High MAX tend to be lower than that of stock with Low MAX. After controlling the control variables of liquidity, momentum, short-term reversal and scale, the MAX effect still exists robustly. Investment portfolio analysis shows that idiosyncratic skewness and idiosyncratic volatility cannot explain the MAX effect, range of price and turnover have a certain influence on the MAX effect, and the maximum return is a factor of the idiosyncratic volatility puzzle. The result of Fama-MacBeth cross-sectional regression analysis shows that the relationship between maximum return and expected return is no longer significant when the range of price and turnover are considered as dependent variables. As a result, the interaction of range of price and turnover could be an influence factor of the MAX effect.

In reality, investors are easy to observe the return of stocks rather than idiosyncratic volatility, thus they are likely to invest the stocks with extremely high return. The excessive preference to the lottery-like stocks may result in negative return, which perhaps is a reason why the maximum return eliminates the idiosyncratic volatility puzzle.

References

- [1] Kumar A. Who gambles in the stock market?. *The Journal of Finance*, 2009, 64(4): 1889–1933.
- [2] Statman M. Lottery players/stock traders. *Financial Analysts Journal*, 2002, 58(1): 14–21.
- [3] Bali T G, Cakici N, Whitelaw R F. Maxing out: Stocks as lotteries and the cross-section of expected returns. *Journal of Financial Economics*, 2011, 99(2): 427–446.
- [4] Fong W M, Toh B. Investor sentiment and the MAX effect. *Journal of Banking and Finance*, 2014, 46: 190–201.
- [5] Brunnermeier M K, Gollier C, Parker J A. Optimal beliefs, asset prices, and the preference for skewed returns. *National Bureau of Economic Research*, 2007, 97: 159–165.
- [6] Barberis N, Huang M. Stocks as lotteries: The implications of probability weighting for security prices. *National Bureau of Economic Research*, 2008, 98: 2066–2100.
- [7] Mitton T, Vorkink K. Equilibrium underdiversification and the preference for skewness. *Review of Financial Studies*, 2007, 20(4): 1255–1288.
- [8] Zheng Z Z, Wang L, Wang L Z. Are idiosyncratic skewness priced?. *Journal of Management Sciences in China*, 2013, 16(5): 1–12.
- [9] Ang A, Hodrick R J, Xing Y, Zhang X. High idiosyncratic volatility and low returns: International and further US evidence. *Journal of Financial Economics*, 2009, 91(1): 1–23.
- [10] Ang A, Hodrick R J, Xing Y, Zhang X. The cross-section of volatility and expected returns. *The Journal of Finance*, 2006, 61(1): 259–299.

- [11] Liu W Q, Xing H W, Zhang X D. Investment preference and the idiosyncratic volatility puzzle. *Chinese Journal of Management Science*, 2014, 22(8): 10–20.
- [12] Harvey C R, Siddique A. Conditional skewness in asset pricing tests. *The Journal of Finance*, 2000, 55(3): 1263–1295.
- [13] Amihud Y. Illiquidity and stock returns: Cross-section and time-series effects. *Journal of Financial Markets*, 2002, 5(1): 31–56.
- [14] Jegadeesh N, Titman S. Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of Finance*, 1993, 48(1): 65–91.
- [15] Jegadeesh N. Evidence of predictable behavior of security returns. *The Journal of Finance*, 1990, 45(3): 881–898.
- [16] Zheng Z Z, Sun Q Q. Lottery-like stock trading behavior analysis: Evidence from Chinese A-share stock market. *Economic Research Journal*, 2013, 5: 128–140.
- [17] Merton R C. A simple model of capital market equilibrium with incomplete information. *The Journal of Finance*, 1987, 42(3): 483–510.
- [18] Zuo H M, Zheng M, Zhang Y. The idiosyncratic volatility and cross-sectional return: The explanation of idiosyncratic volatility puzzle in Chinese stock market. *The Journal of World Economy*, 2011, 5: 117–135.
- [19] Deng X C, Zheng Z Z. Does there exist idiosyncratic volatility puzzle in Chinese stock market?. *Journal of Business Economics*, 2011, 1(1): 60–67.
- [20] Huang B, Li Z, Gu M D. A study of idiosyncratic risk based on risk-preferred capital asset pricing model. *Management World*, 2007(11): 119–127.
- [21] Xu X J. Idiosyncratic risk and stock returns: A study of speculation behavior in China stock market. *Economic Management Journal*, 2010, 12: 127–136.
- [22] Yang H W, Han L Y. An empirical study of the relationship between the idiosyncratic volatility and cross-sectional return. *Journal of Beijing University of Aeronautics and Astronautics (Social Sciences Edition)*, 2009, 22(1): 6–10.