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The nexus among maxing out effect and idiosyncratic volatility premium puzzle in China's A Share Market under the background of eco-innovation and sustainability

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ABSTRACT
The paper investigates whether eco-innovation, sustainability, and asset pricing effect of maximum daily return (maxing out effect), truly and steadily exists in A share market of China and the nexus among maxing out effect and idiosyncratic volatility in China's A Share Market. Regression analyses were conducted using the data of listed companies in China's A share market from July 1993 to May 2021. The empirical results show that the maxing out effect, eco-innovation and sustainability steadily exists in a sample country. In practice, this research help to improve asset pricing efficiency, provide high-quality materials for investor education, guide arbitrage trading activities, and improve resource allocation efficiency in the stock market.

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Ecco-innovation; sustainability; maxing out effect; idiosyncratic volatility

1. Introduction

Due to the stable growth of China, it has now become the world's second largest economy. But at the same time, due to high growth rate, the country has to pay a cost in terms of high input, consumption and pollution. It is quite unreasonable if environment is compromised for the sake of myopic economic growth. Thereby, government of China timely took a step of transitioning from economic growth to economic development. In addition, in general assembly's 17th session, it is pointed out that there should be a policy regarding the acceleration of economic development, where development is viewed through the lens of sustainability. Also, it is obvious too that sustainable development cannot function well without sustainable innovation that indicates the transitioning of pollution control towards industrial ecology (Cheema et al., 2020; Kamarudin et al., 2021; Lin et al., 2022).

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Asset pricing is also a hot topic in modern financial economics. Early researchers have investigated the determinants of expected stock return (Lintner, 1975; Mossin, 1966; William, 1964). Since then, many modern economists have investigated this question comprehensively. Many researchers believe that the expected stock return is determined by the return distribution of individual stock and market portfolios. If the return distribution is normal, then the expected stock returns will be determined by market risk.

Considering skewness preference, Kraus and Litzenberger (1976) established the three-moment capital asset pricing model. Asset portfolios that can be fully diversified is the basic assumption of this asset pricing model. Under this assumption, all rational investors can diversify idiosyncratic risk and only require systematic risk premiums. However, most investors only hold a limited number of assets to keep their privacy and earn abnormally high returns (Jermsittiparsert, 2021; Van Nieuwerburgh & Veldkamp, 2010). Therefore, investors may consider the idiosyncratic risk when making asset pricing decisions.

Recent research has found that a stock's maximum daily return in the existing month can negatively predict stock return in the following month and this effect is robust in the US stock market (Bali & Cakici, 2008; Cheon & Lee, 2018; Kurniawan et al., 2022). This effect is called maxing out effect, which has attracted many scholars' attention. Current researchers have proved that this asset pricing effect is both statistically and economically significant worldwide.

There are also researches that have studied the existence and causes of the maxing out effect in the similar context. Narter et al. (2017), for instance, investigated the pricing effect of extreme returns in the Chinese stock market. Cheema et al. proved the MAX premium effect driven by investor optimism during high sentiment periods. Yao et al. (2021) proved that retail attention attracted by stocks (consecutively) closing at the price limits and subsequent retail trades contribute to the success of the maxing out effect. There are also papers that investigate the relationship between 'idiosyncratic volatility return premium' and maxing out effect. Gu et al. (2018) found that the negative 'idiosyncratic volatility return premium' is much stronger and more persistent in stocks with high limits of arbitrage in the Chinese stock market. Wan (2018) found that the maxing out effect is subsumed by the 'idiosyncratic volatility' anomaly in the Chinese stock market during the period 1997 to December 2014. Contrarily, Van Hai et al. (2020) found that the maxing out effect is not a source of the 'idiosyncratic volatility effect' and appears to be independent from the idiosyncratic volatility effect in the Chinese stock market. So, we can see that there are disputes on whether the maxing out effect is a real effect on the relationship between the maxing out effect and 'idiosyncratic volatility premium puzzle'. Without clarifying the relationship between the two asset pricing effects, it is impossible to determine whether the maxing out effect in China's A share market is a real effect of asset pricing. Therefore, this paper investigates the existence of the maxing out effect and whether this effect could be subsumed by the idiosyncratic volatility premium puzzle.

1.1. Literature review

Empirical researches have found the presence of the maxing out effect in many developed stock markets. Annaert et al. (2013) found several features of the stocks with high maxing out effect, which include small market value, relatively low liquidity, high book-to-market ratio, and strong idiosyncratic volatility. Zhong and Gray (2016) discovered that the maxing out effect exists in Australian stock market in 1991–2013, and observed a robust maxing out effect after controlling for stock characteristics. This implies that the maxing out effect can be explained from risk perspective, but not from the viewpoint of mispricing. Dong et al. (2018) proved that the maxing out effect exists in the US stock market, and that the effect can be explained by the return reversal effect of monthly stock. Ali et al. (2020) tested the maxing out effect in the Finnish stock market and observed a less significant maxing out effect in the months with high panic moods (e.g., months when investors expect high future return volatility). For instance, some investors are unwilling to participate in speculative trading of stocks with high maxing out effect when they expect high return volatility. Tao et al. (2020) found that news reports on lottery-like stocks reduce information uncertainty in these stocks and the maxing out effect is more significant in stocks without media coverage. Some scholars suggest that the maxing out effect also exists in emerging stock markets. Nartea et al. (2014) found the maxing out effect in the South Korean stock market, especially in small cap stocks. Their finding is consistent with the viewpoint that a small cap stock is a typical lottery-like asset (Hensawang, 2022; Kumar, 2009). Nartea et al. (2017) also discovered the coexistence of the maxing out effect and idiosyncratic volatility premium puzzle and ascribed the phenomenon to regulation of price limits and individual investors' dominated market. Berggrun et al. (2019) verified the maxing out effect in the Brazilian stock market and found that this effect is more prevalent during economic contraction periods when speculative demand for stocks increases. Seif et al. (2018) found that the maxing out effect in emerging markets is more robust than that in developed stock markets and believe that this effect represents a new kind of mispricing in emerging markets that cannot be explained by ordinary risk factors. Nartea et al. (2017) found that the maxing out effect in China's A share market exceeds more than one month, i.e., the stock price needs longer time to reverse to its fundamental. Considering the regulatory limits on trading price in the Taiwan stock market, Hung and Yang (2018) eliminated the potentially high homogeneity of the maxing out effect in this market by substituting this effect with the time difference between stock price reaching upper and lower trading limits. Recent literature also suggests the presence of the maxing out effect in A market share of China. For example, Jianhua (2016) proved the existence of the maxing out effect in market share of China, and explained this asset pricing effect with the hot hand effect of investors in the short term and the negative impact of gambler's fallacy on decision making. Gang and Liu (2017) empirically confirmed that the maxing out effect exists in A share market of China, pin pointing that this effect is more significant in a period of high investor sentiment. Ye et al. (2017) stated that the cognitive bias of investors in decision-making is affected by enterprise transparency and market sentiment, both of which could explain the maxing out effect. Dong et al. (2018) proved the presence of the maxing out effect in Chinese and American stock markets, and partially explained this effect with liquidity shock. Wan (2018) found that the maxing out effect coexists with the 'idiosyncratic volatility premium puzzle' in A market share of China. Li et al. (2019) validated the existence of the maxing out effect in similar context and regarded investors with the intent of gambling as the main drivers of this effect. Taking the period after the 2008 global financial crisis as the sample period, Jing and Han (2019) found that the global financial crisis does not weaken the investor's preference for extremely high return, nor reduce the maxing out effect in similar region. Sudapet et al. (2021) and Zhu and Zhang (2020) proved that the maxing out effect exists in market share of China and that this anomaly originates from the limits on arbitrage.

Many theoretical and empirical evidences confirm that investors prefer assets with potential high returns. This is supported by the long-term existence of the lottery market (Nguyen et al., 2021; Ojogiwa, 2021). Chien et al. (2022) and Snowberg and Wolfers (2010) found that the expected return per dollar in the horse racing game decreases with the extremely high return. Garrett and Sobel (1999) believed that investors are attracted by the extreme positively skewed payoff distribution of the game. Kumar (2009) found that investors in the stock market prefer lottery-like assets for their low price, high idiosyncratic volatility, and extreme high idiosyncratic return. Some scholars discovered that investors favor stocks with lottery-like features. Yu (2020) learned that individual investors are typical lottery-seeking investors in market share of China: they purchase many speculative lottery-like stocks before earnings announcements. These stocks tend to be overvalued before earning announcement, and have abnormally low returns in the case of stock price reversal. It is difficult for the market to correct the mispricing due to high arbitrage risk and weak arbitrage force. Zhao & Liu manifested that the stocks with unrealized loss are more attractive to investors under high idiosyncratic volatility. Bali and Cakici (2008) noticed that the maximum daily return of a stock in the American stock market can negatively predict the stock return in the following month at the firm level. Both portfolio analysis and firm-level regressions prove that the maxing out effect is robust after controlling for market value, book-to market ratio, momentum, short-term reversal, liquidity, and skewness. Specifically, the monthly hedge return is about 1% for buying stocks with a low maximum daily return and selling stocks with a high maximum daily return. Bali and Cakici (2008) also found that the maxing out effect can reverse the idiosyncratic volatility premium puzzle and attribute the maxing out effect to the investors' preference for lottery-like stocks. They explain this effect under the framework of prospect theory and optimal expectancy. Fong and Toh (2014) ascribed the maxing out effect in the American stock market to the low return of stocks with high maxing out effect, rather than the high return of stocks with low maxing out effect. The maxing out effect is strongly dependent on the sentiment in the stock market. Wan (2018) and Zhao et al. (2022) proved that the maxing out effect in market share of China is impacted due to 'idiosyncratic volatility premium puzzle'. Considering the maxing out effect as a form of return reversal, Dong et al. (2018) found that the maxing out effect is significant in both China and US stock markets, and the effect in China is caused by liquidity shock, but that in US stock market is mainly induced by monthly return reversal.

To sum up, the above literature shows that maxing out effect is not only robust in developed stock markets, but also exists in many emerging markets. However, there is no consensus on the relationship between the maxing out effect and idiosyncratic volatility premium puzzle in China's context, or whether this maxing out effect is significant in a longer sample period. If these concerns are not addressed, it remains a puzzle whether the maxing out effect is a real asset pricing effect. Therefore, this paper aims to investigate the existence of the maxing out effect in A share market of China and chose time period from July 1992 to May 2020. Moreover, it further clarifies the relationship between this effect and the idiosyncratic volatility premium puzzle (Rejekiningsih et al., 2022; Sadiq et al., 2023).

2. Materials and methods

2.1. Sample

The data related to accounting and stock returns was extracted from CSMAR. Moreover, the study considered A-shares firms which are listed in both stock exchanges; Shanghai and Shenzhen. The time period chosen for the study was July 1993 to May 2021. The reason to choose this period is to maximize the sample period. Finally, the total no of observations used in the study were 324,819.

2.2. Variables

The independent variable is $MAX(N)_{i,t-1}$, which equals to N-days moving average return of stock i in month t-1, and is calculated by the following model(1).

$$\mathrm{MAX}(N)_{i,t-1} = \mathrm{MAX}\left[\frac{1}{N}\left(r_{i,\tau-N+1} + \ldots + r_{i,\tau-1} + r_{i,\tau}\right)\right] \quad (1)$$

Where, $\tau \geq N$, i and denotes τ-th effective trading day of stock i; $r_{i,\tau}$ is the realized return of stock i on the τ-th effective trading day in month t-1.

Controlling variables are defined as the following. $R_{i,t}$ is the monthly return of stock i in month t. $BETA_{i,t-1}$ is the beta coefficient of stock i, which is derived from 260 daily trading data before month t. $MOM_{i,t-1}$ is the momentum factors, which are measured by the cumulative return of stock i in months t-2 and t. $REV_{i,t-1}$ is the short-term reversal factors, which equals the realized return of stock i in month t-1. $SIZE_{i,t-1}$ is the size factor, which equals the logarithm of the total market value of stock i at the end of month t-1.

One of the most important variables is the idiosyncratic volatility of stock i in month t($IVOL_{i,t}$). $IVOL_{i,t}$ is calculated following the two steps proposed by Harvey and Siddique (2000). First, in each month, we estimate model (2) using trading data in the past 260 effective days, and then calculate daily residual returns of each stock in the past 260 effective days. Second, we calculate $IVOL_{i,t}$, which equals to standard deviation of stock i's residual returns in the past 260 effective days.

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

Dummy variables. In each month, we sort the sample based on $MAX(N)_{i,t-1}$ and construct three portfolios. The dummy variables $H\_M_{i,t-1}$ and $L\_M_{i,t-1}$ proxy for the portfolios with the highest and lowest $MAX(N)_{i,t-1}$, respectively.

2.3. Summary statistics of the variables

Table 1 shows that the mean values of $MAX\ (1)_{i,t}$ -$MAX\ (5)_{i,t}$ were 0.054, 0.038, 0.031, 0.027, and 0.025, respectively. All of them were significant at the 1% level. Thus, the maximum N-day moving average return decreases with the growing number of days. Besides that, the lower and upper quartiles of $R_{i,t}$ were −0.067 and 0.075, respectively, and the median and skewness of $R_{i,t}$ were 0.000 and 1.099, respectively. These evidences indicate that the distribution of $R_{i,t}$ is skewed to the right.

2.4. Methodology

To obtain the evidences on the existence of the maxing out effect and its relationship with idiosyncratic volatility premium puzzle, we employ four kinds of methods. First, we conduct univariate portfolio analysis to obtain how maximum daily stock return affects expected stock return by calculating the time series mean of raw return and Alpha of each portfolio constructed by $MAX(N)_{i,t-1}$. Second, following Bali et al.'s (2011) methods, the question whether maximum daily stock return within one month affects the following monthly stock return can be tested by the following regression model (3).

$$R_{i,t} = \beta_0 + \beta_1 * \mathrm{MAX}(N)_{i,t-1} + \beta_2 * BETA_{i,t-1} + \beta_3 * REV_{i,t-1} + \beta_4 * MOM_{i,t-1} + \beta_5 * MB_{i,t-1} + \beta_6 * SIZE_{i,t-1} + \varepsilon_{i,t} \tag{3}$$

Third, the dummy variables and their cross items with $MAX(N)_{i,t-1}$ are introduced into model (3) to judge whether maxing out effect varies with the level of $MAX(N)_{i,t-1}$, and this is the new regression model (4).

$$R_{i,t} = \beta_0 + \beta_1 * L\_M_{i,t-1} + \beta_2 * H\_M_{i,t-1} + \beta_3 * \mathrm{MAX}(N)_{i,t-1} + \beta_4 * L\_M_{i,t-1} * \mathrm{MAX}(N)_{i,t-1} + \beta_5 * H\_M_{i,t-1} * \mathrm{MAX}(N)_{i,t-1} + \beta_6 * BETA_{i,t-1} + \beta_7 * REV_{i,t-1} + \beta_8 * MOM_{i,t-1} + \beta_9 * MB_{i,t-1} + \beta_{10} * SIZE_{i,t-1} + \varepsilon_{i,t} \tag{4}$$

Table 1. Descriptive statistics.

Constructs	Mean	Median	Min	Q1	Q3	Max	Std	Skew
R	0.012***	0.000	−0.440	−0.067	0.075	1.935	0.131	1.099
MAX (1)	0.054***	0.047	0.001	0.032	0.075	0.110	0.028	0.473
MAX (2)	0.038***	0.032	−0.004	0.021	0.050	0.110	0.023	1.036
MAX (3)	0.031***	0.026	−0.006	0.016	0.040	0.110	0.020	1.401
MAX (4)	0.027***	0.022	−0.009	0.014	0.035	0.110	0.019	1.614
MAX (5)	0.025***	0.020	−0.014	0.012	0.032	0.110	0.019	1.723
MIN (2)	−0.036***	−0.031	−0.110	−0.046	−0.021	0.005	0.022	−1.261
BETA	1.039***	1.033	−9.398	0.900	1.164	18.427	0.341	3.856
MOM	0.068***	0.023	−1.651	−0.152	0.236	2.908	0.341	0.918
MB	3.949***	2.889	0.001	1.738	4.788	50.123	4.019	4.067
SIZE	14.755***	14.770	10.039	13.836	15.604	21.497	1.313	0.177
IVOL	0.019***	0.017	0.001	0.012	0.025	0.088	0.010	1.077
SKEW	0.410***	0.402	−4.338	−0.086	0.909	4.334	0.842	−0.065

Source: author's estimation.

Fourth, we conduct bivariate portfolio analysis to obtain evidences on whether the maxing out effect can be explained by the idiosyncratic volatility premium puzzle.

3. Empirical results

Ten equal portfolio were created for each month and has been sorted through MAX(N)i, t-1. Moreover, for each portfolio, return was also measured. Besides, for each portfolio, time series mean was also computed. From Table 2, it can be seen that return in terms of time series means along with corresponding mean differences among extreme level portfolios was also mentioned.

When N equals 1, 2, 3, 4 and 5, the time series mean of the highest (lowest) $MAX(N)_{i,t-1}$ portfolios in month t was 1.500 (0.260), 1.414 (0.219), 1.378 (0.365), 1.314 (0.375), and 1.346 (0.478), respectively, and the mean returns of the lowest $MAX(N)_{i,t-1}$ portfolios were all significant at 5%. The time series mean differences between the extreme portfolios were 1.240, 1.195, 1.010, 0.939, and 0.868, respectively. Moreover, the portfolio return decreased with the rise of $MAX(N)_{i,t-1}$, and this potential was relatively prevalent in the last five portfolios with large $MAX(N)_{i,t-1}$. For example, when N equals to 1, the monthly return of portfolios 5, 6, 7, 8, 9 and 10 are 1.592, 1.423, 1.188, 0.924, 0.699, and 0.260, respectively, showing a clear declining trend. All the above results suggest that the expected return decreases with $MAX(N)_{i,t-1}$, especially in stocks with large $MAX(N)_{i,t-1}$.

In summary, univariate portfolio return analysis confirms the existence of the maxing out effect in market share of China, especially in stocks with a large $MAX(N)_{i,t-1}$. Since the portfolio returns include risk premiums, the following subsection will conduct further analysis using the risk adjusted return of Fama &French's (1993) three-factor model.

We calculate the monthly returns of each portfolio and regression with Fama and French (1993) three factors, producing the alpha return of each portfolio. Table 3 presents the monthly alpha return of each $MAX(N)_{i,t-1}$ portfolio and the alpha return difference between extreme portfolios.

When N equals 1, 2, 3, 4, and 5, the 'alpha returns' of the lowest (highest) $MAX(N)_{i,t-1}$ portfolios were 0.553 (−0.895), 0.499 (−0.868), 0.463 (−0.702), 0.397 (−0.673), and

Table 2. Mean of equal portfolios constructed by $MAX(N)_{i,t-1}$ and return differences between extreme portfolios.

Portfolios	$N = 1$	$N = 2$	$N = 3$	$N = 4$	$N = 5$
L-1	1.500** (2.648)	1.414** (2.53)	1.378** (2.431)	1.314** (2.300)	1.346** (2.372)
2	1.644*** (2.707)	1.738** (2.869)	1.665** (2.764)	1.679** (2.801)	1.588** (2.663)
3	1.774*** (2.857)	1.620** (2.646)	1.652** (2.689)	1.580** (2.590)	1.600** (2.638)
4	1.571** (2.520)	1.749** (2.781)	1.641** (2.639)	1.599** (2.585)	1.619** (2.614)
5	1.592** (2.565)	1.434** (2.274)	1.449** (2.318)	1.484** (2.406)	1.510** (2.410)
6	1.423** (2.239)	1.448** (2.298)	1.300** (2.073)	1.359** (2.158)	1.341** (2.128)
7	1.188** (1.919)	1.166** (1.850)	1.307** (2.052)	1.287** (2.036)	1.291** (2.033)
8	0.924 (1.499)	1.059* (1.703)	1.042* (1.683)	1.113* (1.766)	1.047* (1.645)
9	0.699 (1.124)	0.732 (1.171)	0.777 (1.240)	0.784 (1.248)	0.764 (1.328)
H-10	0.260 (0.408)	0.219 (0.349)	0.365 (0580)	0.375 (0.619)	0.478 (0.771)
L-H	1.240 (1.46)	1.195 (1.42)	1.010 (1.19)	0.939 (1.10)	0.868 (1.03)

Note: *, **, and *** are statistically significant at the 10%, 5%, and 1% levels, respectively.
Source: author's estimation.

Table 3. Alpha return of each $MAX(N)_{i,t-1}$ portfolio and alpha return differences between extreme portfolios.

Portfolios	$N=1$	$N=2$	$N=3$	$N=4$	$N=5$
L-1	0.553*** (3.44)	0.499*** (3.03)	0.463** (2.84)	0.397** (2.39)	0.419** (2.51)
2	0.567*** (4.13)	0.681*** (4.75)	0.633*** (4.40)	0.660*** (4.37)	0.571*** (3.94)
3	0.694*** (4.86)	0.554*** (4.12)	0.587*** (4.18)	0.519*** (3.98)	0.548*** (4.25)
4	0.501*** (4.00)	0.665*** (5.01)	0.561*** (4.62)	0.507*** (4.02)	0.531*** (4.09)
5	0.541*** (4.71)	0.348** (2.81)	0.350** (2.67)	0.392*** (3.16)	0.420*** (3.16)
6	0.341** (2.44)	0.390*** (3.35)	0.194 (1.53)	0.279** (2.37)	0.244** (1.97)
7	0.152 (1.27)	0.081 (0.65)	0.117** (1.95)	0.188 (1.42)	0.191 (1.57)
8	−0.084 (−0.64)	−0.002 (−0.01)	−0.013 (−0.11)	0.003 (0.28)	−0.039 (−0.31)
9	−0.336** (−2.56)	−0.311** (−2.26)	−0.264** (−1.97)	−0.267** (−2.09)	−0.268*** (−2.12)
H-10	−0.895*** (−5.70)	−0.868*** (−5.46)	−0.702*** (−4.29)	−0.673*** (−4.42)	−0.578*** (−3.72)
L-H	1.448	1.367	1.165	1.070	0.997

Note: *, **, and *** are statistically significant at the 10%, 5%, and 1% levels, respectively.
Source: author's estimation.

Table 4. Regression results of model (3).

Portfolios	$N=1$	$N=2$	$N=3$	$N=4$	$N=5$
Intercept	0.105***	0.104***	0.101***	0.099***	0.097***
	(44.50)	(44.31)	(43.23)	(42.66)	(41.85)
$MAX(N)_{i,t-1}$	−0.331***	−0.471***	−0.553***	−0.606***	−0.591***
	(−42.74)	(−48.74)	(−50.51)	(−52.40)	(−50.19)
$BETA_{i,t}$	0.003***	0.004***	0.004***	0.004***	0.003***
	(5.81)	(6.12)	(6.13)	(6.11)	(5.89)
$REV_{i,t-1}$	−0.167***	−0.162***	−0.160***	−0.158***	−0.160***
	(−98.23)	(−94.07)	(−92.68)	(−91.81)	(−92.67)
$MOM_{i,t}$	0.199***	0.200***	0.200***	0.200***	0.200***
	(305.98)	(307.13)	(307.48)	(307.89)	(307.42)
$MB_{i,t-1}$	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***
	(−4.33)	(−4.25)	(−4.26)	(−4.32)	(−4.43)
$SIZE_{i,t-1}$	−0.006***	−0.006***	−0.006***	−0.006***	−0.006***
	(−40.73)	(−40.39)	(−39.51)	(−39.10)	(−38.87)
Adj_R^2	21.63%	21.75%	21.79%	21.84%	21.78%
F	15724.2	15840.4	15877.4	15918.7	15870.6
N	341867	341867	341867	341867	341867

Note: *, **, and *** are statistically significant at the 10%, 5%, and 1% levels, respectively.
Source: author's estimation.

0.419 (−0.578), respectively, most of which were significant at 1% level; the 'corresponding alpha return differences' between extreme portfolios amounted to 1.448, 1.367, 1.165, 1.070, and 0.997, respectively. All these evidences suggest that alpha returns decrease with $MAX(N)_{i,t-1}$. What is more, the alpha returns of portfolios 5-10 are 0.541, 0341, 0.152, −0.084, −0.336, and 0.895, respectively. Most of them are significant at 1% level. This means the alpha return of month t decreases with $MAX(N)_{i,t-1}$, and the decreasing trend is relatively prevalent in stocks with high $MAX(N)_{i,t-1}$.

According to the portfolio-level analysis on raw return and alpha return, the maxing out effect exists in China's A share market, especially in stocks with high $MAX(N)_{i,t-1}$. The alpha return analysis shows that the maxing out effect can be explained with risk premium. More convincing evidences will be provided through regression analysis below.

Table 4 presents the regression results of model (3). When N equals 1, 2, 3, 4, and 5, the coefficients of $MAX(N)_{i,t-1}$ were −.331, −.471, −.553, −.606, and −.591. All these coefficients are significant at 1% level. Besides that, the coefficients of $BETA_{i,t}$ and $MOM_{i,t}$ are all positive and significant, indicating the positive asset pricing effect

Table 5. Regression results of model (4).

Variables	$N=1$	$N=2$	$N=3$	$N=4$	$N=5$
Intercept	0.106***	0.106***	0.106***	0.105***	0.102***
	(42.37)	(42.89)	(43.04)	(43.08)	(42.11)
$L\_M_{i,t-1}$	−0.000	−0.001	−0.004***	−0.006***	−0.006***
	(−0.03)	(−0.46)	(−3.62)	(−5.37)	(−5.90)
$H\_M_{i,t-1}$	−0.018***	−0.009***	−0.008***	−0.008***	−0.007***
	(−11.29)	(−6.84)	(−6.87)	(−6.73)	(−6.16)
$MAX(N)_{i,t-1}$	−0.334***	−0.507***	−0.690***	−0.814***	−0.781***
	(−19.08)	(−21.23)	(−24.46)	(−25.66)	(−23.47)
$L\_M_{i,t-1}*MAX(N)_{i,t-1}$	0.199***	0.140***	0.210***	0.253***	0.224***
	(8.43)	(4.94)	(6.53)	(7.19)	(6.14)
$H\_M_{i,t-1}*MAX(N)_{i,t-1}$	0.040	0.009	0.122***	0.136***	0.174***
	(1.52)	(0.24)	(2.73)	(2.72)	(3.34)
$BETA_{i,t}$	0.003***	0.004***	0.004***	0.003***	0.003***
	(5.94)	(6.14)	(6.07)	(5.98)	(5.77)
$REV_{i,t-1}$	−0.167***	−0.162***	−0.160***	−0.158***	−0.160***
	(−97.72)	(−93.65)	(−92.36)	(−91.37)	(−91.93)
$MOM_{i,t}$	0.198***	0.199***	0.200***	0.201***	0.200***
	(304.05)	(305.62)	(305.83)	(306.54)	(306.10)
$MB_{i,t-1}$	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***
	(−4.31)	(−4.25)	(−4.27)	(−4.31)	(−4.42)
$SIZE_{i,t-1}$	−0.006***	−0.006***	−0.006***	−0.006***	−0.006***
	(−40.97)	(−40.61)	(−39.62)	(−39.08)	(−38.78)
Adj_R^2	21.68%	21.77%	21.80%	21.85%	21.80%
N	341867	341867	341867	341867	341867

Note: *, **, and *** are statistically significant at the 10%, 5%, and 1% levels, respectively.
Source: author's estimation.

of systematic risk and long-term stock price momentum. The coefficients of $REV_{i,t-1}$ and $SIZE_{i,t-1}$ are both negative, which indicate the short-term reversal effect of stock price return, and the relatively high expected return of small enterprises.

In sum, the regression results of model (3) verify the existence of the maxing out effect, and these evidences are consistent with the results of portfolio analyses.

The results of portfolio analysis and regression analysis all confirm the existence of the maxing out effect in market share of China and indicate that this effect is more significant in stocks with a high maximum daily return. In this subsection, we estimate model (4) to prove how the level of maximum daily return affect the significance and extend this asset pricing effect. The regression results are displayed in Table 5.

When N equals to 1 and 2, the estimated coefficients of $L\_M_{i,t-1}$ are both negative but insignificant, and the estimated coefficients of $H\_M_{i,t-1}$ are −.018 and −.009, as both show signficance. When N equals to 3, 4 and 5, the estimated coefficients of $L\_M_{i,t-1}$ ($H\_M_{i,t-1}$) are −0.004 (-0.008), −0.006 (-0.008), and −0.006 (−0.007), respectively, all of which are significant at 1% level. All these evidences prove that abnormal returns of stocks with high $MAX(N)_{i,t-1}$ are lower than that of stocks with low $MAX(N)_{i,t-1}$, i.e., the maxing out effect is relatively significant in stocks with high $MAX(N)_{i,t-1}$. Furthermore, the estimated coefficients of $MAX(N)_{i,t-1}$ are significantly negative, which confirm the robustness of the maxing out effect. When N equals to 1 and 2, the estimated coefficients of $H\_M_{i,t-1}*MAX(N)_{i,t-1}$ are both positive but insignificant, while the estimated coefficients of $L\_M_{i,t-1}*MAX(N)_{i,t-1}$ are .199 and .140, both of which are significant. When N equals to 3, 4 and 5, the estimated coefficients of $H\_M_{i,t-1}*MAX(N)_{i,t-1}$ ($L\_M_{i,t-1}*MAX(N)_{i,t-1}$) are 0.122 (0.210), 0.136 (0.253), and 0.174 (0.2240), all of which are significant. This shows the maxing out effect is relatively prevalent in stocks with high $MAX(N)_{i,t-1}$.

In sum, the regression results are in line with the results of the portfolio analysis. All these analyses confirm the existence of the maxing out effect in China's A share market, and this effect is especially significant in stocks with a high level of maximum daily return.

The empirical evidences above all prove that the maxing out effect is robust in China's A share market and that this effect is more significant in stocks with high level of maximum daily return. However, stocks with a high level of maximum daily return often have relatively high level of idiosyncratic volatility. Thus, there remains an issue whether the maxing out effect is a new real effect. To solve this issue, we carried out bivariate portfolio analysis and regression analysis.

First, we constructed three equal portfolios sorted by $IVOL_{i,t-1}$ ($MAX(N)_{i,t-1}$) in each month. Second, we constructed three equal portfolios sorted by $MAX(N)_{i,t-1}$ ($IVOL_{i,t-1}$) in each $IVOL_{i,t-1}$ ($MAX(N)_{i,t-1}$) sorted portfolio. Third, we calculated the return of each $MAX(N)_{i,t-1}$ and $IVOL_{i,t-1}$ sorted portfolios in each month. After that, we regressed each monthly portfolio return on Fama and French (1993) three factors model to estimate the alpha return of each $MAX(N)_{i,t-1}$ and $IVOL_{i,t-1}$ sorted portfolios, as well as the alpha return difference between the extreme portfolio and the corresponding Z-statistics. All these results are presented in Table 6.

Panel A presents the monthly alpha returns of each $IVOL_{i,t-1}$ sorted portfolio for the corresponding alpha return differences between extreme portfolios after controlling for $MAX(N)_{i,t-1}$. We can see that the alpha return of each $IVOL_{i,t-1}$ portfolio decreased with $IVOL_{i,t-1}$ within each $MAX(N)_{i,t-1}$ ($N = 1, 2, 3, 4, 5$) portfolio and that most alpha returns of $IVOL_{i,t-1}$ portfolios are significantly different from zero. Besides that, the alpha return of each extremely high and low $IVOL_{i,t-1}$ portfolio within each $MAX(N)_{i,t-1}$ portfolio are all positive. For example, the alpha returns of the 1st to 3rd $IVOL_{i,t-1}$ portfolios within the third $MAX\ (1)_{i,t-1}$ portfolio are 0.215, −0.346, and −1.071, respectively; the corresponding significance levels are 10%, 1% and 1%, respectively. The alpha return difference between the 1st and 3rd $IVOL_{i,t-1}$ sorted portfolios is 1.286, which is significant at 1% level. Overall, the data in Panel A shows that the idiosyncratic volatility premium puzzle is robust after controlling for $MAX(N)_{i,t-1}$. All these evidences indicate that the idiosyncratic volatility premium puzzle can not be substituted by the maxing out effect.

Panel B presents the alpha return of each $MAX(N)_{i,t-1}$ sorted portfolios and the corresponding alpha return difference between extreme portfolios after controlling $IVOL_{i,t-1}$. It can be seen that among the high $IVOL_{i,t-1}$ portfolios, the alpha return of each $MAX(N)_{i,t-1}$ ($N = 1, 2, 3, 4, 5$) portfolio increased with the decline of $MAX(N)_{i,t-1}$, accompanied by significant differences between the extreme $MAX(N)_{i,t-1}$ portfolios. When N equals to 1, 2, 3, 4, and 5, the alpha return differences between the lowest and highest $MAX(N)_{i,t-1}$ portfolios within high $IVOL_{i,t-1}$ portfolios were 0.889, 1.560, 0.685, 0.668, and 0.590, respectively; all of them deviated significantly from zero. However, the alpha returns of each $MAX(N)_{i,t-1}$ ($N = 1, 2, 3, 4, 5$) portfolio are not different significantly within medium and low $IVOL_{i,t-1}$ portfolios.

The above evidences suggest that the maxing out effect is robust in stocks within high idiosyncratic volatility portfolios, but not prevalent in other portfolios. Hence, the maxing out effect in high idiosyncratic volatility stocks is a real asset pricing effect, which cannot be substituted by the idiosyncratic volatility premium puzzle.

Table 6. Monthly alpha returns of portfolios sorted by $MAX(N)_{i,t-1}$ ($IVOL_{i,t-1}$) after controlling for $IVOL_{i,t-1}$ ($MAX(N)_{i,t-1}$).

Panel A. Monthly alpha returns of portfolios sorted by $IVOL_{i,t-1}$ after controlling for $MAX(N)_{i,t-1}$

	N = 1			*N* = 2			*N* = 3			*N* = 4			*N* = 5		
$IVOL_{i,t-1}$	L-1	2	H-3	L-1	2	H-3	L-1	2	H-3	L-1	2	H-3	L-1	2	H-3
L-1	0.670***	0.705***	0.215*	0.692***	0.681***	0.329**	0.670***	0.726***	0.455***	0.648***	0.813***	0.477***	0.658***	0.802***	0.510***
	(4.40)	(5.73)	(1.67)	(4.64)	(5.36)	(2.43)	(4.41)	(5.68)	(3.40)	(4.27)	(6.28)	(3.61)	(4.28)	(6.25)	(3.90)
2	0.649***	0.429***	−0.346**	0.688***	0.399**	−0.251**	0.671***	0.315**	−0.193	0.648***	0.358**	−0.155	0.653***	0.387***	−0.163
	(4.55)	(3.65)	(−2.69)	(4.75)	(3.15)	(−1.92)	(4.56)	(2.46)	(−1.46)	(4.38)	(2.85)	(−1.20)	(4.55)	(2.99)	(−1.23)
H-3	0.482***	0.103	−1.071***	0.376**	0.019	−1.095***	0.373**	−0.088 − 0.63)	−1.087***	0.252*	−0.120	−1.080***	0.213	−0.157	−1.064***
	(3.15)	(0.72)	(−6.43)	(2.46)	(0.15)	(−6.56)	(2.44)		(−6.65)	(1.71)	(−0.80)	(−6.78)	(1.39)	(−1.12)	(−6.68)
Diff (1-3)	0.188	0.602	1.286***	0.316	0.662**	1.424***	0.297	0.814**	1.542***	0.396	0.933**	1.557**	0.445	0.959*	1.574***
Z-statistic	(0.26)	(1.00)	(3.54)	(0.86)	(1.95)	(3.88)	(0.80)	(2.35)	(4.24)	(1.08)	(2.65)	(4.31)	(0.71)	(1.79)	(4.37)

Panel B. Monthly alpha returns of portfolios sorted by $MAX(N)_{i,t-1}$ after controlling for $IVOL_{i,t-1}$

	N = 1			*N* = 2			*N* = 3			*N* = 4			*N* = 5		
$MAX(N)_{i,t-1}$	L-1	2	H-3	L-1	2	H-3	L-1	2	H-3	L-1	2	H-3	L-1	2	H-3
1	0.610***	0.470***	−0.073	0.610***	0.778***	0.670***	0.557***	0.416**	−0.121	0.554***	0.417**	−0.122	0.548***	0.452***	−0.138
	(4.04)	(3.27)	(−0.50)	(3.83)	(5.77)	(5.06)	(3.59)	(2.85)	(−0.78)	(3.43)	(2.88)	(−0.78)	(3.53)	(3.06)	(−0.86)
2	0.724***	0.469***	−0.416***	0.392**	0.465***	0.375**	0.777***	0.304**	−0.524***	0.758***	0.311**	−0.539***	0.765***	0.316**	−0.585***
	(5.16)	(3.86)	(−2.99)	(2.73)	(3.79)	(2.80)	(5.67)	(2.29)	(−4.08)	(5.84)	(2.43)	(−3.96)	(5.64)	(2.48)	(−4.35)
3	0.723***	0.293**	−0.962***	−0.0972	−0.469***	−0.886***	0.724***	0.513***	−0.806***	0.745***	0.505***	−0.790***	0.746***	0.466***	−0.728***
	(5.40)	(2.30)	(−6.37)	(−0.65)	(−3.36)	(−5.87)	(5.40)	(3.99)	(−5.00)	(5.66)	(3.80)	(−5.21)	(5.61)	(3.54)	(−4.81)
Diff (1-3)	−0.113	0.177	0.889**	0.7072	1.250***	1.560***	−0.167	−0.097	0.685*	−0.191	−0.088	0.668*	−0.198	−0.014	0.590**
Z-statistic	(−0.15)	(0.30)	(2.44)	(1.48)	(3.36)	(4.63)	(−0.22)	(−0.15)	(1.82)	(−0.25)	(−0.14)	(1.80)	(−0.26)	(−0.02)	(1.98)

Note: *, **, and *** are statistically significant at the 10%, 5%, and 1% levels, respectively.
Source: author's estimation.

Table 7. Regression results of robustness test.

Variables	$N=1$	$N=2$	$N=3$	$N=4$	$N=5$
Intercept	0.100***	0.101***	0.100***	0.100***	0.098***
	(40.60)	(41.68)	(41.75)	(41.94)	(41.61)
$L\_IVOL_{i,t-1}$	0.005***	0.007***	0.006***	0.008***	0.007***
	(4.84)	(6.71)	(8.23)	(8.80)	(9.03)
$H\_IVOL_{i,t-1}$	−0.009***	−0.008***	−0.009***	−0.009***	−0.100***
	(−6.70)	(−7.13)	(−8.68)	(−10.10)	(−11.15)
$L\_IVOL_{i,t-1}*MAX(N)_{i,t-1}$	0.074***	0.049*	0.018	0.013	0.038
	(3.31)	(1.71)	(0.56)	(0.38)	(1.10)
$H\_IVOL_{i,t-1}*MAX(N)_{i,t-1}$	−0.065***	−0.099***	−0.107***	−0.103***	−0.117***
	(−3.17)	(−4.15)	(−4.11)	(−3.83)	(−4.32)
$MAX(N)_{i,t-1}$	−0.148***	−0.255***	−0.320***	−0.380***	−0.367***
	(−9.76)	(−13.31)	(−14.93)	(−17.12)	(−16.42)
BETAi,t	0.004***	0.004***	0.004***	0.004***	0.004***
	(6.91)	(7.28)	(7.40)	(7.49)	(7.42)
REVi,t-1	−0.165***	−0.160***	−0.158***	−0.156***	−0.157***
	(−96.40)	(−92.48)	(−91.22)	(−90.26)	(−90.75)
$MOM_{i,t}$	0.199***	0.200***	0.201***	0.201***	0.201***
	(306.94)	(308.16)	(308.58)	(309.26)	(309.23)
$MB_{i,t-1}$	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***
	(−4.04)	(−3.93)	(−3.92)	(−3.94)	(−4.00)
$SIZE_{i,t-1}$	−0.006***	−0.006***	−0.006***	−0.006***	−0.006***
	(−42.05)	(−42.12)	(−41.77)	(−41.57)	(−41.50)
Adj_R^2	21.96	22.06	22.11	22.17	22.16
N	341866	341867	341867	341867	341867

Note: *, **, and *** are statistically significant at the 10%, 5%, and 1% levels, respectively.
Source: author's estimation.

The portfolios analysis shows that 'idiosyncratic volatility premium puzzle' is robust and cannot be explained by the maxing out effect in China's A share market. The maxing out effect is insignificant in low idiosyncratic volatility stocks, but is robust in high idiosyncratic volatility stocks and can be explained by the idiosyncratic volatility premium puzzle. All these evidences indicate that 'idiosyncratic volatility premium puzzle' is a robust asset pricing effect, which cannot be explained by the maxing out effect. The maxing out effect is a real asset pricing effect and can be explained by the idiosyncratic volatility premium puzzle in stocks with a high level of idiosyncratic volatility, but the maxing out effect can partly be explained by 'idiosyncratic volatility premium puzzle' in other stocks (Setiawan et al., 2022; Shibli et al., 2021).

To further clarify the relationship between the maxing out effect and idiosyncratic volatility premium puzzle, we conducted the following regression analysis. First, we constructed three equal sub-samples sorted by $IVOL_{i,t-1}$, and the dummy variables $L\_IVOL_{i,t-1}$ and $H\_IVOL_{i,t-1}$ proxy for stocks with the lowest and highest $IVOL_{i,t-1}$, respectively. Second, we introduce the two dummy variables and their cross items with $MAX(N)_{i,t-1}$ into regression model (3) and estimate this new model at the stock level. The regression results are presented in Table 7.

It is clear that the coefficients of $L\_IVOL_{i,t-1}$ and $H\_IVOL_{i,t-1}$ are positive and negative, and both are significant. This means that the low idiosyncratic volatility stocks have a higher abnormal return than high idiosyncratic volatility stocks, whereby 'idiosyncratic volatility premium puzzle' is prevalent in A market share of China. Moreover, the coefficients of $L\_IVOL_{i,t-1}*MAX(N)_{i,t-1}$ and $H\_IVOL_{i,t-1}*MAX(N)_{i,t-1}$ are positive and negative, and both are significant. The coefficients of $MAX(N)_{i,t-1}$ are all negative and significant at 1% level. When N equals to 1, 2, 3, 4 and 5, the estimated coefficients of $MAX(N)_{i,t-1}$ are −.148, −.255, −.320, −.380, and −.367, respectively; the estimated coefficients of $H\_IVOL_{i,t-1}*MAX(N)_{i,t-1}$ are −.065, −.099, −.107, −.103, and −.117, respectively; the estimated coefficients of $L\_IVOL_{i,t-1}*MAX(N)_{i,t-1}$ are .074, .049, .018, .013, and .038, respectively. These evidences prove that the maxing out effect is significant but relatively weak in stocks with low level of idiosyncratic volatility. These evidences are consistent with bivariate portfolios analysis.

To sum up the argument, 'idiosyncratic volatility premium puzzle' can not be elaborated through maxing out in market share of China, however, maxing out can be elaborated through 'idiosyncratic volatility premium puzzle' in other stocks.

4. Conclusions

The fact that the maximum daily stock returns within the existing month can negatively predict stock returns in the following month is called the maxing out effect. This effect has been proven as a real asset pricing effect in both type of stock markets around the world. However, the relationship between the maxing out effect and idiosyncratic volatility premium puzzle is an issue of dispute. This paper empirically investigates whether the maxing out effect is robust and explores the relationship between the maxing out effect and the idiosyncratic volatility premium puzzle. The main conclusions of this research are as follows.

First, the maxing out effect is robust, especially in stocks with high maximum daily returns. This effect cannot be explained by known asset pricing factors. Second, the maxing out effect is a real asset pricing effect in stocks with high idiosyncratic volatility in market share of China. Third, the 'idiosyncratic volatility premium puzzle' is robust when controlling for the maximum daily stock return. The maxing out effect cannot explain the 'idiosyncratic volatility premium puzzle'. Fourth, the 'idiosyncratic volatility premium puzzle' is robust and can partly explain the maxing out effect, especially in stocks with low idiosyncratic volatility.

This research proves the presence of the maxing out effect in A market share of China and clarifies the relationship between this effect and 'idiosyncratic volatility premium puzzle'. These results enrich the empirical evidences on the maxing out effect and idiosyncratic volatility premium puzzle. There are two practical implications of this research. First, in China, most investors are individual investors who prefer extremely high returns; their preference may be the underlying cause for the maxing out effect. This finding is important for investor education in China's A share market. Second, a robust arbitrage opportunity is discovered for carrying out arbitrage activities and for improving the efficiency of the stock market.

Furthermore, the development trends also reveal that economic development mode of China can not be dependent on market dominate. Thereby, central government is advised to advocate the rational development mode that means the green growth must be stimulated through the domestic demand expansion and independent innovation.

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