Extreme returns and idiosyncratic risks: evidence from an emerging market

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Abstract

In this paper, we show that there is a negative premium for MAX stocks in the Korean stock market. However, there is no evidence that the MAX effect overwhelms the effects of idiosyncratic risk. When we control for idiosyncratic risk, the negative relationship between extreme returns and future returns is less robust. Rather, the cross-effect of the extreme returns and the idiosyncratic risk factors explains the negative premium. Furthermore, our results are not fully explained by the exposure to the market timing and economic state. Overall, both the extreme return and idiosyncratic risk effects appear to coexist in the Korean stock market, but they are not independently.

Keywords Extreme returns, Idiosyncratic risk, Lottery-type stocks, Idiosyncratic volatility, Idiosyncratic skewness

Paper type Research paper

1. Introduction

Recent studies show that stock with the extremely positive returns in the past month ($t-1$) experience negative returns this month (t). Bali *et al.* (2011) refers to the highest daily return of each stock for the previous month as "MAX". They construct the decile portfolios based on MAX and show that difference between market adjusted returns for the lowest and highest MAX portfolios is 1% per month.

The evidence of the negative MAX–expected return relationship is now available for a number of countries including the USA (Bali *et al.*, 2011), Australia (Zhong and Gray, 2016), China (Nartea *et al.*, 2017), Korea (Kim and Ahn, 2012; Nartea *et al.*, 2014; Kim and Cho, 2018), India (Aziz and Ansari, 2018), European countries (Annaert *et al.*, 2013 [1]; Walkshäusl, 2014), advanced emerging markets (Seif *et al.*, 2018) and for African stock markets (Wu *et al.*, 2019). Recently, Cheon and Lee (2018) [2] extend the results from Bali *et al.* (2011) to 42 countries and show the presence of the negative MAX–expected return relationship internationally.

JEL classification – G11, G12

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In most stock markets, there is a negative premium of the extreme return, but relationship between the extreme return effect and the idiosyncratic risk effect is different for each country's stock market. Bali *et al.* (2011) show that the negative relation between idiosyncratic volatility and stock returns [idiosyncratic volatility (IV) effect; first documented by Ang *et al.* (2006)] is reversed after controlling for the extreme return effect. These results are similar in the results of Zhong and Gray (2016), who analyzed the Austrian stock market.

However, Nartea *et al.* (2017) find that the negative MAX premium exists in the Chinese financial market, but the MAX effect does not overwhelm the idiosyncratic volatility effect. They suggest that the MAX anomaly and the idiosyncratic volatility anomaly are separate effects, and both can coexist in the emerging stock markets.

Most of the papers analyzing the Korean stock market show that MAX premium exists in the Korean stock market [3]. These studies investigate:

- the MAX effects in the Korean stock market; and
- the relation between investor attention and MAX effect.

Kang and Sim (2013) analyze the cross-sectional effects of MAX stock. They show that there is a negative MAX premium in the Korean stock market and suggest individual investors' preference for MAX stocks as an explanatory factor of the MAX premium. Koh and Kim (2017) also provide an evidence of the reversal effect of MAX stocks in Korean stock market. They find that individual investors lead MAX effect, and they show that net-selling of MAX stocks by institutional investors and foreign investors reverses the returns on overvalued lottery stocks. Kang and Yun (2020) find that the attention-catching stocks – daily winner and losers – performed significantly less than non-attention-catching stocks. They find that stocks with no daily winners or losers experience do not exhibit the MAX negative premium.

In this paper, we provide evidence that investors' preferences for lottery-type stocks is an important explanatory factor in the negative premium of the extreme returns. However, there is no evidence that the MAX effect overwhelms the effects of idiosyncratic risk. We first use IV and idiosyncratic skewness (Iskew) as proxy variables for the idiosyncratic risk. Next, we include the idiosyncratic risk factor and the interaction term of the MAX $\times$ IV (or Iskew) as well as the MAX and other control variables in the regression analysis model. As a result, the negative extreme return effect disappeared.

This paper has several differences from previous studies. First, we provide evidence that both the extreme return effects and idiosyncratic risk effects can coexist in the Korean stock market, MAX effect does not exist independently. Previous studies on the Korean stock market do not cover the co-existence of the extreme return effects and the idiosyncratic risk effects. Second, our findings show that the results of analyzing the developed stock markets that the MAX effect weakens the anomalous IV effect [4] do not need to be held in emerging markets. This point is in line with the results of Nartea *et al.* (2017) which analyze the Chinese stock market. It emphasizes the possibility of country-variation in the relationship between IV (or Iskew) and MAX effects. Finally, we analyze whether the extreme return effects and interaction effects are driven by the downside risks and the market states. We report on the ability of our proposed strategy to time the market. This allows us to judge how much of the high/low MAX (or MAX $\times$ idiosyncratic) spread is because of exposure to these factors and how much of it is unexplained.

The remainder of the paper is organized as follows. In Section 2, we describe our data set. In Section 3, we present the main empirical results, whereas in Section 4, we analyze whether our results depend on market timing and market states. The conclusions are presented in Section 5.

2. Data

2.1 Data sources and variable construction

In this section, we describe the data and define the variables for empirical analysis. Our sample includes all common stocks listed on the Korea Stock Exchange (KSE) and the Korea Securities Dealers Automated Quotation (KOSDAQ) from January 2000 to December 2016. We obtain stock price data from the FN guide data set. We require that a stock must have at least 15 daily price observations within the month to be included in our sample. We also exclude stocks below 1,000 won (about $1). Our final sample contains a total of 293,636 firm-month observations.

Following Bali *et al.* (2011) methodology, MAX is the highest daily return over the previous month. As an alternative variable for MAX, MAX (3) is defined as the average of the three highest daily returns over the previous month.

We use IV and Iskew as idiosyncratic risk factors. IV is computed using the following regression model daily returns for each firm, each month, give IV:

$$R_{i,d} - r_{f,d} = \alpha_i + \beta_i \left(R_{m,d} - r_{f,d} \right) + \varepsilon_{i,d} \tag{1}$$

where $R_{i,d}$ is the return on stock i on day d, $R_{m,d}$ is the market return on day d, $r_{f,d}$ is the risk-free rate on day d and $\varepsilon_{i,d}$ is the idiosyncratic return on day d. IV for each firm-month is the variance of $\varepsilon_{i,d}$.

Iskew of individual stocks is computed by the following regression for each stocks from Harvey and Siddique (2000) and Bali *et al.* (2011):

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

where $R_{i,d}$ is the return on stock i on day d, $R_{m,d}$ is the market return on day d, $r_{f,d}$ is the risk-free rate on day d and $\varepsilon_{i,d}$ is the idiosyncratic return on day d. Iskew of stock i in month t is defined as the skewness of daily residuals $\varepsilon_{i,d}$ in month t.

The firm characteristic variables are defined as follows: SIZE is the market capitalization of the stock (in billion won). BEME is book-to-market ratio. Pre1yr_ret is the past one-year return excluding the previous month. Trading volume is the stock trading volume of the previous year. ILLIQ is the Amihud (2002) illiquidity index, which equals the ratio of a stock's absolute returns to its value traded. Based on daily data, the Amihud's illiquidity index is calculated as the yearly average of the ratio of the daily absolute return to daily volume (previous year). Firm age is the age of the firm in a given year at the time of the incorporation. Return on assets (ROA) is calculated by dividing the pre-tax income by the total assets of the previous year.

2.2 Summary statistics

Table 1 summarizes the descriptive statistics of stock characteristics in the sample. In Panel A, we present the statistics for the sample based on the lottery characteristics. There are 293,636 stock-month observations for an average of 1,439 stocks each month. The mean of MAX and MAX(3) are 7.46% and 5.52%, respectively. In Panel B, the average of firm size, book-to-market ratio and the past one-year return are 540.36bn won, 0.38 and 7.56%, respectively.

	N	MAX	MAX(3)	IV	Iskew
Panel A. MAX and IRISK characteristics					
Mean	293,636	7.46	5.52	0.03	0.03
Median	293,636	6.54	4.83	0.03	0.03
Std	293,636	4.14	3.15	0.02	0.02

Panel B. Firm characteristics

	N	Firm size	BEME	Pre1yr__ret	Trading volume	ILLIQ	Firm age	ROA
Mean	293,636	540.36	0.38	7.56	4.87	0.96	26.80	0.88
Median	293,636	64.66	0.20	−1.65	2.35	0.09	24.42	2.83
Std	293,636	3,499.51	0.75	45.67	11.79	2.27	16.24	9.61

Notes: This table shows the descriptive statistics. The sample includes the common stocks between 2000 and 2016 that are traded on KSE and KOSDAQ. Panel A shows a summary statistic of the sample stocks' lottery characteristics. MAX is the highest daily return in the month. MAX(3) is the average of the three highest daily returns in the month. IV is the variance of the residuals in the regression analysis using equation (2). Iskew is obtained from the residuals of the regression analysis using equation (3). Panel B shows the summary statistics on the firm characteristics of sample stocks. Firm size is the market capitalization of the stock (in billion won). BEME is the book-to-market ratio. Pre1yr_ret is the past one-year return excluding the previous month. Trading volume is the stock trading volume of the previous year. ILLIQ is the Amihud's (2002) illiquidity index, which equals the ratio of a stock's absolute returns to its value traded. Firm age is the age of the firm in a given year at the time of the incorporation. ROA is calculated by dividing the pre-tax income by total assets of the previous year

Table 1.
Summary statistics

We report the results of the decile MAX portfolio analysis according to Bali *et al.* (2011) and Kim and Ahn (2012) analysis method in Table 2 to determine the coincidence of their findings in our sample. We represent the average monthly returns of decile portfolios by sorting stocks based on the maximum daily return over the previous one month. Panel A (Panel B) reports the average returns, Fama–French alphas [5], kurtosis and skewness of MAX (MAX(3)) decile portfolios. The last two rows in table present the skewness and kurtosis of MAX returns over the past month.

In decile portfolios classified as MAX, the average return difference between the portfolio 10 (high MAX) and portfolio 1 (low MAX) is −1.94% per month for equally weighted returns and −1.89% per month for value-weighted returns. In decile portfolios classified as MAX(3), the average return difference between the portfolio 10(high) and portfolio 1(low) is −2.40% per month for equally weighted returns and −2.48% per month for value-weighted returns.

The average equal-weighted alpha of the highest decile MAX is −1.82%, whereas the average of lowest decile MAX is 0.41%. The average spread between the highest and lowest decile is −2.23% and statistically significant at the 1% level. We also have similar results for value-weighted risk-adjusted returns. These results are consistent with the results of previous version that reported raw returns. These results are consistent with the empirical works of Bali *et al.* (2011) and Kim and Ahn (2012).

3. Extreme returns and idiosyncratic risks

3.1 Regression analysis

We use the Fama–Macbeth methodology to investigate the negative MAX premium and the interaction effect of MAX × idiosyncratic risk (hereafter, *IRSK*). We use the following

	Low	2	3	4	5	6	7	8	9	High	H–L	*t*-stat
Panel A. Max												
Equal-weighted returns												
Rawret	1.67	1.78	1.85	1.84	1.74	1.46	1.48	0.73	0.52	−0.27	−1.94***	−5.10
α^{3FF}	0.41	0.31	0.37	0.61	0.87	0.46	0.55	−0.85	−0.99	−1.82	−2.23***	−6.41
Value-weighted returns												
Rawret	0.18	0.70	0.24	0.31	0.60	0.81	0.52	0.51	0.08	−1.71	−1.89***	−3.40
α^{3FF}	−1.21	−0.76	−1.40	−1.29	−0.30	−0.40	−1.18	−1.38	−1.76	−3.59	−2.39***	−4.74
Stock return characteristics												
Kurtosis	4.61	1.88	1.51	1.54	1.48	1.96	1.78	2.38	3.67	13.91		
Skewness	−1.04	−0.65	−0.37	−0.31	−0.14	0.08	0.12	0.39	0.83	2.46		
Panel B. Max(3)												
Equal-weighted returns												
Rawret	1.55	1.83	1.80	1.76	1.59	1.79	1.47	1.04	0.83	−0.85	−2.40***	−5.27
α^{3FF}	0.32	0.39	0.33	0.31	0.28	0.36	0.18	0.01	0.07	−2.32	−2.63***	−5.39
Value-weighted returns												
Rawret	0.11	0.71	0.78	0.51	0.75	0.78	0.86	0.36	−0.26	−2.37	−2.48***	−3.71
α^{3FF}	−1.27	−0.79	−0.86	−1.09	−0.99	−0.99	−0.85	−0.77	−1.72	−4.05	−2.78***	−4.59
Stock return characteristics												
Kurtosis	6.40	1.65	1.62	1.23	1.22	1.38	1.12	1.70	1.68	12.59		
Skewness	−1.31	−0.72	−0.61	−0.51	−0.41	−0.31	−0.23	−0.06	0.10	2.25		

Notes: This table shows average returns of MAX and MAX(3) decile portfolios. We report the raw returns and the risk-adjusted alphas are the intercept from the three-factor model (Fama and French, 1993). The last two rows present return distribution characteristics. The reported return distribution characteristics are skewness and kurtosis of MAX returns over the past month. We report the Newey and West (1987) adjusted *t*-statistics are in the last column. Asterisks denote the statistical significance level: * for 0.1, ** for 0.5, *** for 0.01

Table 2.
Max returns

regression equation to investigate the interaction effects of the extreme return (*MAX*) and idiosyncratic risk (*IRISK*):

$$R_{i,t} = b_0 + b_1 \times MAX_{i,t-1} + b_2 \times \left(MAX_{i,t-1} \times IRISK_{i,t-1}\right) + b_3 \times IRISK_{i,t-1} + \sum_{k=1}^{7} \gamma_{k,i,t-1} X_{k,i,t-1} + \varepsilon_{i,t} \quad (3)$$

where $R_{i,t}$ is the stock return for the month (t). MAX is the highest daily return within the month ($t-1$). Here, *IRISK* is defined as two variables: IV and Iskew. The vector of control variables (X) comprise Size, BEME, Pre1yr_ret, trading volume, ILLIQ, firm age and ROA. The details are defined in Section 2.1. The dependent variable is the stock return for the month (t). The independent variables are lag variables that represent firm characteristics ($t-1$) [6].

Table 3 shows the coefficient estimates from various regression specifications. In Column (1), we use MAX as a key variable without including idiosyncratic risk variables. As a result, the correlation coefficient of MAX is negative and statistically significant. This result is consistent with previous studies showing negative MAX premiums in the USA (Bali *et al.*, 2011), Korea (Kim and Ahn, 2012) and international financial markets (Cheon and Lee, 2017).

Table 3.
Fama and MacBeth regressions: MAX and idiosyncratic risks

Variables	MAX (1)	IV (2)	Iskew (3)	MAX (4)	IV (5)	Iskew (6)
Intercept	2.105*** (3.10)	0.680 (0.79)	0.644 (0.74)	3.077*** (2.85)	1.382 (1.05)	1.373 (1.04)
Max	−0.141*** (−5.41)	0.261*** (4.89)	0.250*** (4.66)	−0.154*** (−5.95)	0.252*** (4.71)	0.241*** (4.49)
MAX × IRISK		−5.412*** (−2.95)	−5.447*** (−2.94)		−5.651*** (−3.06)	−5.649*** (−3.03)
IRISK		−11.186 (−0.37)	−7.188 (−0.24)		−7.416 (−0.25)	−4.125 (−0.14)
Size	−0.045** (−2.22)	−0.049** (−2.47)	−0.049** (−2.46)	−0.024 (−1.38)	−0.026 (−1.55)	−0.027 (−1.58)
BEME	0.598*** (2.87)	0.699*** (3.44)	0.692*** (3.40)	0.692*** (3.45)	0.804*** (4.09)	0.797*** (4.05)
Pre1yr__ret	−0.001 (−0.37)	0.001 (0.32)	0.000 (0.24)	−0.001 (−0.89)	−0.000 (−0.23)	−0.000 (−0.29)
Trading Volume	−0.011 (−0.88)	−0.004 (−0.35)	−0.004 (−0.38)	−0.013 (−1.06)	−0.006 (−0.51)	−0.006 (−0.54)
ILLIQ	0.003 (0.51)	0.010* (1.75)	0.009* (1.71)	0.003 (0.66)	0.010** (1.98)	0.010* (1.93)
Firm age	0.004 (0.52)	0.003 (0.43)	0.004 (0.44)	−0.001 (−0.13)	−0.002 (−0.23)	−0.001 (−0.21)
ROA	1.412*** (3.24)	1.038** (2.54)	1.055** (2.58)	1.502*** (3.49)	1.118*** (2.79)	1.132*** (2.82)
Industry-fixed effects	No	No	No	Yes	Yes	Yes
Adjusted R-Sq	0.034	0.043	0.043	0.065	0.074	0.074
N	271,620	271,620	271,620	271,620	271,620	271,620

Notes: This table present results of monthly Fama–Macbeth regressions. The dependent variable is the stock return for the month t. Independent variables are lag variables ($t-1$). MAX is the highest daily return in the past month. IV is the variance of the residuals in the regression analysis using equation (2). Iskew is obtained from the residuals of the regression analysis using equation (3). Size is the market capitalization of the stock (in million won). BEME is the book-to-market ratio. Pre1yr_ret is the past one-year return excluding the previous month. Trading volume is the stock trading volume of the previous year. ILLIQ is the Amihud's (2002) illiquidity index, which equals the ratio of a stock's absolute returns to its value traded. Firm age is the age of the firm in a given year at the time of the incorporation. ROA is calculated by dividing the pre-tax income by total assets of the previous year. All regressions include the industry-fixed effects using two-digit KSIC. Newey-West (1987) adjusted standard errors with the lag of four months are used to compute t-statistic (in parentheses). Asterisks denote the statistical significance level: * for 0.1, ** for 0.5, *** for 0.01

Next, Columns (2) and (3) in Table 3 show the regression analysis results, including the interaction term of MAX and IRISK. Column (2) shows the results of the regression analysis using IV as the first defining characteristic of the idiosyncratic risks. In Column (2), the correlation coefficients on the interaction terms MAX × IRISK are negative and statistically significant. Similar results are obtained in regression analyses using Iskew [in Column (3)]. Next, we include industry-fixed effects in the regression models. In both Columns (5) and (6), the correlation coefficient of the MAX-IRISK interaction term is significantly negative.

One interesting result is that the correlation coefficients on MAX are positive in Columns (2) and (3). Thus, the effect of MAX does not overwhelm the effects of IRISK. Both the MAX and IRISK effects appear to coexist in the Korean stock market, but they do not exist independently.

3.2 Alternative variable

In this subsection, we use the alternative variable of MAX to account for the existence of the daily stock price limit rule in the Korean stock market. Because of the existence of the 15% limit rule, stocks could not rise more than 15% per day. Under this system, the use of the MAX variable could potentially underestimate the effect of stocks that experience stock price rises for multiple days. For example, under MAX, stocks with a 15% stock price rises for three consecutive days and stocks with a 15% stock price rise for a single day could be included in the same portfolios (high MAX). In this regard, we consider MAX (3) as an alternative variable for MAX. MAX(3) is the average of the three highest daily returns within the month. We repeat the analysis of equation (4) by replacing MAX(3):

$$\mathrm{R}_{\mathrm{i,t}} = b_0 + b_1 \times MAX(3)_{i,t-1} + b_2\left(MAX(3)_{i,t-1} \times IRISK_{i,t-1}\right) + b_3 \times IRISK_{i,t-1} + \sum_{k=1}^{7} \gamma_{k,i,t-1} X_{k,i,t-1} + \varepsilon_{i,t} \tag{4}$$

where $\mathrm{R}_{\mathrm{i},t}$ is the stock return for this month (t). MAX(3) is the average of the three highest daily returns within the month. Here, *IRISK* is defined as two variables: IV and Iskew. We also include firm size, BEME, previous one-year return, trading volume, illiquidity, firm age and ROA in the regression. To ensure the robustness of our results in the previous section, we expect negative b_2 for IV and Iskew.

We report the empirical results in Table 4. The regression results confirm our prediction. MAX × IRISK interaction terms (b_2) are negative and statistically significant for IV and Iskew. Also, in Columns (2) and (3), the extreme effect alone vanishes, and the interaction effect of MAX and IRSIK is significantly negative. We find similar results when including industry-fixed effects in the regression model. Taken together, these results are consistent with the results in the previous subsection.

3.3 Univariate portfolio-level analysis

In this chapter, we analyze abnormal returns of the portfolios double-sorted on “MAX and idiosyncratic risk” by using the portfolio methodology. The portfolio methodology makes easier to interpret intuitively and capture nonlinear relationships. To examine the return reversals based on MAX and idiosyncratic risk, we use the sequential sort procedure. At the end of each month, stocks are sorted into quintiles based on MAX and then on idiosyncratic risk variable (IV or Iskew), and are held for one month. We first construct five portfolios based on the MAX, and then sort them into five portfolios based on the idiosyncratic risk

Table 4.
Fama and MacBeth regressions: MAX(3) and idiosyncratic risks

Variables	MAX (1)	IV (2)	Iskew (3)	MAX (4)	IV (5)	Iskew (6)
Intercept	2.233*** (3.45)	0.795 (1.23)	0.779 (1.23)	3.237*** (2.94)	1.586 (1.49)	1.608 (1.51)
Max	−0.220*** (−5.91)	0.312*** (3.75)	0.285*** (3.55)	−0.244*** (−6.97)	0.265*** (3.33)	0.241*** (3.16)
MAX × IRISK		−6.322*** (−4.89)	−6.333*** (−4.92)		−6.320*** (−4.90)	−6.301*** (−4.93)
IRISK		−14.217 (−0.65)	−8.557 (−0.41)		−8.299 (−0.39)	−3.639 (−0.18)
Size	−0.046** (−2.30)	−0.051*** (−2.62)	−0.051*** (−2.60)	−0.024 (−1.44)	−0.028* (−1.67)	−0.028* (−1.71)
BEME	0.628*** (3.01)	0.724*** (3.58)	0.715*** (3.53)	0.730*** (3.65)	0.826*** (4.23)	0.818*** (4.18)
Pre1yr__ret	−0.000 (−0.20)	0.001 (0.48)	0.001 (0.39)	−0.001 (−0.69)	−0.000 (−0.15)	−0.000 (−0.23)
Trading Volume	−0.011 (−0.79)	−0.008 (−0.60)	−0.008 (−0.63)	−0.013 (−0.98)	−0.010 (−0.78)	−0.011 (−0.81)
ILLIQ	0.003 (0.62)	0.011* (1.89)	0.010* (1.83)	0.004 (0.81)	0.011** (2.12)	0.011** (2.05)
Firm age	0.002 (0.29)	0.003 (0.41)	0.003 (0.41)	−0.003 (−0.39)	−0.002 (−0.26)	−0.002 (−0.26)
ROA	1.353*** (3.10)	1.035** (2.52)	1.059** (2.57)	1.443*** (3.35)	1.136*** (2.81)	1.156*** (2.85)
Industry-fixed effects	No	No	No	Yes	Yes	Yes
Adjusted R-Sq	0.037	0.046	0.045	0.068	0.076	0.076
N	271,620	271,620	271,620	271,620	271,620	271,620

Notes: This table present results of monthly Fama-Macbeth regressions. The dependent variable is the stock return for the month t. Independent variables are lag variables (t−1). MAX (3) is the average of the three highest daily returns of the previous month. IV is the variance of the residuals in the regression analysis using equation (2). Iskew is obtained from the residuals of the regression analysis using equation (3). Size is the market capitalization of the stock (in million won). BEME is book to market ratio. Pre1yr_ret is the past one-year return excluding the previous month. Trading volume is the stock trading volume of the previous year. ILLIQ is the Amihud's (2002) illiquidity index, which equals the ratio of a stock's absolute returns to its value traded. Firm age is the age of the firm in a given year at the time of the incorporation. ROA is calculated by dividing the pre-tax income by total assets of the previous year. All regressions include the industry fixed effects using 2-digit KSIC. Newey-West(1987) adjusted standard errors with the lag of four months are used to compute t-statistic (in parentheses). Asterisks denote the statistical significance level: * for 0.1, ** for 0.5, *** for 0.01

within each portfolio. Therefore, we form 25 sequentially sorted portfolios, and calculate the following month's returns on 25 (5 × 5) portfolios.

Table 5 represents average equally weighted stock returns of the 5 × 5 portfolios sorted on MAX and IV, and MAX and Iskew. Panel A of Table 5 reports the average raw returns of each portfolio. There is statistically significant negative return in the portfolio of the highest MAX and highest IV. The equal-weighted return of the highest MAX and highest IV portfolio is −2.548% per month with a *t*-statistic of 3.376. The equal-weighted return of high MAX-high Iskew is −2.555% (with *t*-stat = 3.370) in subsequent month. Panel B shows the Fama-Fresnch (1993) three-factor alphas of 25 portfolios. The abnormal returns of high MAX-high IV and high MAX-high Iskew are −3.869% (with *t*-stat = 7.476), and −3.829% (with *t*-stat = 7.321) in the subsequent month respectively.

Overall, the expected return for the following month for all stocks classified as MAX is not significantly negative, but the expected return for stocks with the high MAX and high idiosyncratic risk is negative. These results are consistent with the results of the regression models.

3.4 Sub-period analysis: financial crisis and reform of the stock price range

In this subsection, the sample period is divided into sub-periods. We use two sub-sample period criteria. The first is the financial crisis and the second is the reform of the stock price range system. According to the first criterion, we divide the whole period sample into sub-sample periods covering the financial crisis: from January 2000 to December 2008, from January 2009 to December 2009 and from January 2010 to December 2016. If our results are driven by a macroeconomic event or by a specific time event, our previous results will disappear in the subsamples. We also check whether the results are affected by the relaxation of the restriction on the stock price range in the Korean stock market. We divided the whole sample before and after the effective date of the reform of the stock price range system [7].

Sub-period analysis results are reported in Table 6. The first three columns of Table 6 report the results of sub-period analysis based on the financial crisis, and the fourth and fifth columns report sub-period analysis results based on the change in the price limit rule. In Panel A, the coefficients of MAX are significantly positive in all first three columns. On the other hand, the coefficients of MAX × IV interaction term are negative and statistically significant in all three columns. In all first three columns of Panel B, the estimated coefficients of MAX are positive and statistically significant. Also, the interaction terms on MAX × Iskew are significantly negative in all columns.

Next, we repeat our analysis again for before and after the price limit expansion. The results are reported in the fourth and fifth columns of Table 6. In both the last two columns of Panel A, the coefficients of MAX is significantly positive, and MAX × IV interaction term is negative and statistically significant. As reported in Panel B, these results also appear when Iskew is used as the IRISK factor.

Overall, Table 6 indicates that our results do not depend on macroeconomic conditions or changes in the financial market regulations.

4. Market timing and market states

4.1 Market timing of high/low MAX spread strategy

In this subsection, we further analyze the source of the Max premium. We suspect that the high MAX portfolios have considerable downside risk and substantially more so than the low MAX portfolio. From this point of view, we examine whether market timing ability can explain the negative MAX premium. In addressing the market timing issue, we use two of

Table 5.
Returns on portfolios on stocks sorted by MAX and idiosyncratic risks

	(a) Idiosyncratic Volatility: IV						(b) Idiosyncratic Skewness: Iskew				
	Low	2	3	4	High		Low	2	3	4	High
Panel A. Raw returns											
MAX											
Low	1.560***	1.675***	1.871***	1.760***	1.719***	Low	1.547***	1.613***	1.932***	1.742***	1.751***
2	2.127***	2.016***	1.879***	1.701***	1.485**	2	2.067***	1.948***	1.999***	1.663**	1.534**
3	1.758***	1.885***	1.710**	1.641*	1.236	3	1.752***	2.010***	1.666**	1.538*	1.266
4	1.571**	1.319*	1.366*	0.453	0.515	4	1.619**	1.207*	1.395*	0.352	0.654
High	1.256**	1.055*	0.873	−0.317	−2.548***	High	1.220**	1.074*	0.833	−0.253	−2.555***
	(c) Idiosyncratic volatility: IV						(d) Idiosyncratic skewness: Iskew				
Panel B. Abnormal returns											
MAX											
Low	0.425**	0.439**	0.398**	0.237	0.277	Low	0.408**	0.343**	0.494**	0.245	0.287
2	0.599**	0.549***	0.421**	0.482***	0.497	2	0.515**	0.568***	0.505**	0.482**	0.480
3	0.475***	0.688***	0.921**	1.034	0.449	3	0.513**	1.004***	0.705**	0.870	0.479
4	−0.136	−0.292	0.031	−0.895**	0.439	4	−0.086	−0.443	0.030	−0.858***	0.506
High	−0.400	−0.572	−0.571	−1.863***	−3.869***	High	−0.394	−0.600	−0.597***	−1.839***	−3.843***

Notes: This table shows the raw returns and Fama-French (1993) three-factor alphas on the double-sorted portfolios. Stock are categorized into 25 (5 × 5) portfolios based on the quintiles breakpoints. We first construct five portfolios based on the MAX, and then sort them into five portfolios based on the idiosyncratic risk within each portfolio. Idiosyncratic volatility (IV) is the variance of the residuals in the regression analysis using equation (2). Idiosyncratic skewness (Iskew) is obtained from the residuals of the regression analysis using equation (3). We calculate the following month's return on 25 (5 × 5) portfolios. Asterisks denote the statistical significance level: * for 0.1, ** for 0.5, *** for 0.01

	2000–2008	Financial crisis 2008–2009	2010–2016	Expand stock price limit (15%–30%) Before	After
Panel A. Idiosyncratic volatility					
Max	0.146	0.715	0.097	0.266	0.107
	(3.711)***	(11.675)***	(4.032)***	(11.662)***	(2.410)**
	[3.040]***	[8.009]***	[2.777]***	[8.106]***	[1.650]*
Int (Max × Iskew)	−3.018	−4.389	−1.344	−4.633	−1.613
	(2.714)***	(2.627)***	(3.710)***	(7.500)***	(2.994)***
	[2.308]**	[1.680]*	[2.097]**	[4.914]***	[1.927]*
IV	−31.204	−131.293	−24.520	−19.482	−7.273
	(2.045)**	(5.521)***	(3.489)***	(2.263)**	(0.520)
	[1.757]*	[4.147]***	[2.223]**	[1.555]	[0.397]
Controls	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes
Industry-fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted *R*-Sq	0.450	1.620	0.250	0.350	0.640
N(use)	109,682	32,489	129,449	259,414	12,206
Panel B. Idiosyncratic skewness					
Max	0.137	0.693	0.086	0.254	0.102
	(3.493)***	(11.399)***	(3.614)***	(11.235)***	(2.350)**
	[2.841]***	[7.942]***	[2.471]**	[7.799]***	[1.592]
Int (Max × Iskew)	−3.050	−4.049	−1.282	−4.588	−1.505
	(2.749)***	(2.433)**	(3.549)***	(7.446)***	(2.804)***
	[2.336]*	[1.582]	[1.985]**	[4.904]***	[1.781]*
Iskew	−27.976	−131.288	−22.240	−17.045	−8.974
	(1.842)*	(5.556)***	(3.194)***	(1.992)**	(0.651)
	[1.588]	[4.225]***	[2.044]**	[1.375]	[0.503]
Controls	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes
Industry-fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted *R*-Sq	0.450	1.600	0.250	0.340	0.640
N(use)	109,682	32,489	129,449	259,414	32,285

Notes: This table shows coefficient estimates from pooled regressions. We divide the sample into five subperiods based on the large changes in the two stock markets. First, we divide the sample periods into three subperiods covering the financial crisis (2008–2009). Second, we divide the sample period based on the rule change to expand the price limit range (May 2016). The dependent variable is the stock return for this month (t). Independent variables are lag variables ($t-1$). Idiosyncratic volatility is the variance of the residuals in the regression analysis using equation (2). Idiosyncratic skewness is obtained from the residuals of the regression analysis using equation (3). We also include the following variables as control variables in the regression models: Size, BEME, Pre1yr_ret, trading volume, ILLIQ, firm age and ROA. All regressions include the year-fixed effects and industry-fixed effects using two-digit KSIC. The parentheses represent t-values and the square brackets represent t-values obtained from White's (1980) heteroskedasticity-consistent method. Asterisks denote the statistical significance level: * for 0.1, ** for 0.5, *** for 0.01

Table 6. Subperiod analysis

the popular approaches: Treynor and Mazuy (TM; 1996) and Henriksson and Merton (HM; 1981). Both TM and HM capture the convexity of portfolio returns to the market return, indicating a successful timing ability. From this point of view, we also investigate the market timing ability of the joint strategy MAX × IRISK. A good side effect of market timing tests is to explore downside risks by separating the downside beta from the upside beta.

In addressing the market timing issue, we use two of the popular approaches: Treynor and Mazuy (TM; 1996) and Henriksson and Merton (HM; 1981). First, we follow Treynor and Mazuy (1996) and perform the following quadratic regressions:

$$R_{j,t} = \alpha_j + \beta_{j,mkt} r_{MKT,t} + \beta_{j,mkt^2} r^2_{mkt,t} + \varepsilon_{j,t}, \quad j = 1, \ldots, 10 \tag{5}$$

where $R_{j,t}$ is the returns on the decile portfolio, $r_{MKT,t}$ is the market excess return and $r^2_{mkt,t}$ is the squared market excess return. The significantly positive coefficient of $r^2_{mkt,t}$ indicates successful market timing.

We next follow Henriksson and Merton (1981) and perform the following regressions:

$$R_{j,t} = \alpha_j + \beta_{j,mkt} r_{MKT,\ t} + \gamma_{j,MKT} r_{MKT,\ t} I_{r_{mkt}>0} + \varepsilon_{j,t} \tag{6}$$

where $I_{r_{mkt}>0}$ is the indicator function taking the value of one when the market excess return is greater than zero, otherwise taking the value of zero. The significantly positive $\gamma_{j,MKT}$ indicates successful market timing.

We report the results of the market timing regressions in Table 7. There are two interesting results. First, both β_{m^2} and γ_m are statistically insignificant in both TM and HM regressions, indicating there is no evidence of market timing ability. Nevertheless, high MAX portfolio has negative and significant values of β_{m^2} and γ_m. We report on the results of the value-weighted portfolios in this table, but the results of equal-weighted portfolio are similar. These results suggest that the low market exposure of the portfolio in the up-market results in the below average returns, while the high market exposure of the portfolio in the down-market conditions results in the above average losses. Thus, there are bad-market timing.

Second, alphas of the high MAX portfolio are still significantly negative under both regressions after controlling the market-timing effect. The results of Table 7 suggest that market timing is not the diver of the abnormal returns generated by the MAX strategy.

Next, we also investigate the market timing ability of MAX × IRISK. We perform double sorts on the MAX and IRISK. Table 8 represents the results of market timing model for the MAX and IRISK joint portfolios. In Table 8, "HH" corresponds to the portfolio of high MAX and high IRISK. "HL" corresponds to the portfolio of high max and low IRISK. "LL" corresponds to the portfolio of low Max and low IRISK. "HH-HL" corresponds to return on the long (HH)–short (HL) strategy. HH–LL is defined similarly.

In Table 8, coefficients on β_{m^2} and γ_m are significantly negative for all cases. Also, alphas are statistically significantly negative for all HH portfolios. The last row provides the differences of alphas between HH and LL and the differences of alphas between HH and HL, which are negative and statistically significant for all cases. These results are similar in the equal-weighted portfolios. It shows that the premium of MAX × IRISK strategy remains strong with the consideration of market-timing analysis.

4.2 Conditional regressions with market states variables

In this subsection, we address whether there exist any patterns between MAX spread strategy and business cycle. We assume that the presence of significant abnormal return has been detected, and it would be of interest to try and explain some of the drivers of those abnormal returns using a conditional asset pricing version. For example, at the abnormal return mostly concentrated during economic downturns or market downturns or in times of high/low market dividend yields. From this point of view, we address whether there exists any pattern between MAX–IRISK strategy and business cycle.

Table 7.
Market timing

	TM				HM			
	A	β_m	β_{m^2}	Adj. R^2	α	β_m	γ_m	Adj. R^2
LOW	0.047 (0.13)	0.495*** (11.67)	−0.007 (−1.62)	39.39	0.776 (0.13)	0.680*** (11.67)	−0.399 (−1.62)	39.07
2	0.197 (0.44)	0.550*** (9.14)	−0.002 (−0.44)	38.77	0.767 (0.44)	0.685*** (9.14)	−0.255 (−0.44)	39.43
3	0.231 (0.59)	0.625*** (8.94)	−0.011 (−1.63)	43.91	1.499 (0.59)	0.944*** (8.94)	−0.673 (−1.63)	44.13
4	0.001 (0.00)	0.673*** (9.43)	−0.007 (−1.22)	44.71	0.900 (0.00)	0.899*** (9.43)	−0.473 (−1.22)	44.93
5	−0.481 (−0.69)	0.911*** (12.39)	−0.001 (−0.11)	46.29	0.030 (−0.69)	1.025*** (12.39)	−0.196 (−0.11)	46.54
6	−0.137 (−0.27)	0.796*** (12.26)	−0.001 (−0.19)	54.35	0.346 (−0.27)	0.904*** (12.26)	−0.181 (−0.19)	54.68
7	−0.787 (−1.21)	0.910*** (12.86)	0.002 (0.39)	66.18	−0.208 (−1.21)	1.027*** (12.86)	−0.150 (0.39)	66.16
8	−0.310 (−0.50)	0.894*** (10.25)	−0.004 (−0.50)	53.91	0.591 (−0.50)	1.107*** (10.25)	−0.403 (−0.50)	54.76
9	−0.563 (−1.35)	1.022*** (17.28)	−0.009 (−1.67)	66.82	0.372 (−1.35)	1.261*** (17.28)	−0.515 (−1.67)	66.59
High	−1.599*** (−3.45)	0.841*** (11.58)	−0.016*** (−3.31)	50.58	−0.271*** (−3.45)	1.194*** (11.58)	−0.810*** (−3.31)	47.15

Notes: This table shows alphas, betas and adjusted R-square of the market timing regression of the value-weighted portfolios. Panel A reports the results using the Treynor and Mazuy (1966) regression with the squared market factor (β_{m^2}), and Panel B reports the results using the Henriksson and Merton (1981) regression with option such as returns on the market (γ_m). The Newey and West (1987) robust t-statistics are in parentheses. Asterisks denote the statistical significance level: * for 0.1, ** for 0.5, *** for 0.01

Table 8.
Market timing: MAX and IRISK

	Treynor and Mazuy				Henriksson and Merton			
	α	β_m	β_{m^2}	Adj. R^2	α	β_m	β_{m^2}	Adj. R^2
LL	0.064 (0.18)	0.479*** (11.32)	−0.009*** (−4.76)	38.32	0.713 (1.50)	0.655*** (7.94)	−0.414*** (−3.56)	35.44
HL	0.568 (1.16)	0.916*** (15.47)	−0.013*** (−5.01)	54.07	2.078*** (3.21)	1.297*** (11.50)	−0.805*** (−5.06)	54.17
HH	−5.358*** (−7.67)	0.985*** (11.64)	−0.007* (−1.91)	41.28	−4.921*** (−5.29)	1.109*** (6.84)	−0.303 (−1.32)	40.73
HH–LL	−5.422 *** (−7.92)	0.507 *** (6.17)	0.002 (0.42)		−5.633 *** (−5.70)	0.454 *** (2.67)	0.111 (0.44)	
HH–HL	−5.926 *** (−8.02)	0.070 (0.87)	0.006 (1.03)		−6.999*** (−6.79)	−0.188 (−1.40)	0.502* (1.84)	
LL	−0.020 (−0.06)	0.451*** (11.03)	−0.008*** (−4.47)	37.09	0.609 (1.34)	0.620*** (7.81)	−0.390*** (−3.48)	34.77
HL	0.458 (0.94)	0.893*** (15.19)	−0.013*** (−5.17)	53.08	1.994*** (3.10)	1.281*** (11.43)	−0.821*** (−5.19)	53.11
HH	−5.277*** (−7.56)	1.009 (11.94)	−0.009** (−2.47)	42.00	−4.665*** (−5.01)	1.178*** (7.26)	−0.408* (−1.78)	41.17
HH–LL	−5.257 *** (−7.52)	0.557 *** (7.39)	−0.001 (−0.32)		−5.274*** (−5.46)	0.558*** (3.86)	−0.018 (−0.08)	
HH–HL	−5.736 *** (−7.63)	0.115 (1.39)	0.004 (0.74)		−6.659 *** (−6.19)	−0.103 (−0.73)	0.413 (1.45)	

Notes: This table shows alphas, betas, and adjusted *r*-square of the market timing regression of the value-weighted double-sorted portfolios. First section reports the results using the Treynor and Mazuy (1966) regression with the squared market factor (β_{m^2}), Second section reports the results using the Henriksson and Merton (1981) regression with option-like returns on the market(γ_m). The Newey and West (1987) robust *t*-statistics are in parentheses. HH corresponds to the portfolio of High Max and IRISK (High idiosyncratic volatility and High idiosyncratic skewness). HL corresponds to the portfolio of High Max and Low IRISK. LL corresponds to the portfolio of Low Max and Low IRISK. HH-HL corresponds to return on the long(HH) – short(HL) strategy. HH-LL is defined similarly. Asterisks denote the statistical significance level: * for 0.1, ** for 0.5, *** for 0.01

Following previous literatures [Han *et al.* (2013) and Glabadanidis (2017)], the conditional model is specified as:

$$R_{j,t} = \alpha_j + \beta_{j,MKT} r_{MKT,\ t} + \beta_{j,SMB} r_{SMB,t} + \ \beta_{j,HML} r_{HML,t} \\ + \ \beta_{j,Z} Z_{t-1} + \gamma_{j,s} Z_{t-1} r_{MKT,t} + \varepsilon_{j,t}, \quad j = 1, \ldots, 10 \qquad (7)$$

where Z is the conditional variable that could affect the expected returns and/or risks. In this study, we use GDP growth and the market's dividend yield as conditional variables.

Table 9 represents the results of the conditional model. In Panel A, the coefficients of GDP growth are significantly negative. The interaction terms of market excess return with the GDP growth are positive and insignificant for most portfolios, with the exceptions that a few portfolios have positive or significant coefficients. The SMB loadings have a mixed reaction to GDP growth. These results are similar in HML loadings. Nevertheless, the alpha of high MAX portfolio is still negative and significant. The abnormal returns of the H–L strategy are significantly negative. Evidence of this panel suggests that the abnormal returns of the MAX spread cannot be fully explained by the exposure to the economic state.

Panel B of Table 9 reports the results of the conditional regressions with Fama-French (1993) three factors and the market's dividend yield. Again, both abnormal return of high/low MAX spread strategy is negative and statistically significant. In both two panels, we find that the abnormal returns for high/low MAX spread are negative and statistically significant after controlling for the market's dividend yield and the economic states.

We also report the results of the conditional model for the MAX × IRISK double-sorted portfolios in Tables 10 and 11. Table 10 represents the results of conditional regression analysis using GDP growth. The alphas of "HH–LL" and "HH–HL" still retain their significance after controlling for two conditional variables. Furthermore, the alphas of HH are negative and significant in most cases. Table 11 represents the results of conditional regression analysis using market dividend yield. The alphas of "HH–LL" became insignificant in all cases. However, the direction is consistent with previous results. Furthermore, the alphas of "HH–HL" are still significantly negative except for the stock price. Overall, we show in this subsection that our results are not fully driven by the economic states.

5. Conclusion

In this paper, we analyze the conjecture of the negative premium of extreme return and idiosyncratic risk effect. We apply and extend the argument of the previous studies that show the existence of the negative MAX premium in the stock markets. Furthermore, we show that the negative MAX premium is more prominent in:

- higher IV stocks; or
- higher Iskew stocks.

Overall, both the MAX and IRISK effects appear to coexist in the Korean stock market, but they do not exist independently.

The contribution of this paper is twofold. First, we analyze whether the extreme return effect is caused by mispricing using idiosyncratic risk anomaly. We show that mispricing can be one of the explanatory factors for the extreme return premium. Second, we find the coexistence of MAX effect and IVOL effect in the Korean stock market, which are alleged in recent studies on emerging market. We show that the negative MAX premium exists in the Korean stock market, as the results of Bali *et al.* (2011). However, when we combine MAX returns and idiosyncratic risks, the relation between return and MAX is less robust. These

Table 9. Conditional regressions with GDP growth and market's dividend yield

	α	β_{GDP}	β_{MKT}	β_{SMB}	β_{HML}	$\beta_{MKT \times GDP}$	$\beta_{SMB \times GDP}$	$\beta_{HML \times GDP}$	Adj. R^2
Panel A. GDP growth									
LOW	0.049 (0.12)	−0.275*** (−2.73)	0.524*** (8.43)	−0.318*** (−3.02)	−0.063 (−0.39)	0.014 (0.89)	−0.052** (−2.34)	0.024 (0.95)	62.46
2	0.732 (1.06)	−0.320** (−2.10)	0.821*** (9.81)	−0.606*** (−3.18)	−0.414*** (−2.98)	−0.028 (−1.36)	−0.009 (−0.25)	0.047** (2.11)	65.48
3	0.938 (0.88)	−0.516* (−1.74)	0.660*** (5.52)	−0.265* (−1.73)	−0.215* (−1.77)	0.015 (0.69)	−0.092** (−2.60)	0.034 (1.18)	69.68
4	1.254* (1.71)	−0.587*** (−2.90)	0.890*** (9.10)	−0.420*** (−2.78)	−0.207 (−1.38)	−0.022 (−1.04)	−0.080** (−2.56)	−0.019 (−0.73)	77.21
5	0.988 (0.99)	−0.504** (−2.17)	0.987*** (8.38)	−1.147*** (−5.92)	0.702** (1.98)	−0.027 (−0.74)	0.104** (2.50)	−0.251*** (−3.40)	78.60
6	1.027 (1.19)	−0.400* (−1.73)	0.919*** (11.06)	−0.637*** (−3.55)	−0.016 (−0.07)	−0.005 (−0.18)	−0.021 (−0.51)	−0.106*** (−2.74)	78.67
7	−1.173* (−1.82)	0.057 (0.43)	1.399*** (8.42)	−0.659*** (−4.30)	−0.690*** (−3.65)	−0.071** (−2.62)	0.022 (0.80)	0.060*** (2.76)	80.39
8	−0.856 (−1.10)	−0.022 (−0.11)	1.263*** (20.31)	−0.275 (−1.50)	−0.776*** (−5.64)	−0.040** (−2.47)	−0.091*** (−3.20)	0.075*** (3.53)	77.46
9	1.311 (1.25)	−0.699*** (−2.52)	1.072*** (11.04)	−0.140 (−0.56)	−0.309* (−1.70)	0.007 (0.27)	−0.088* (−1.77)	0.023 (0.69)	77.32
High	−2.028** (−2.56)	−0.348** (−1.98)	0.681*** (4.38)	0.017 (0.07)	0.288** (2.02)	0.038 (1.21)	−0.123*** (−3.18)	−0.012 (−0.47)	56.32
H−L (*t*-stat)	−2.077** (−2.29)	−0.073 (−0.07)	0.158*** (2.53)	0.336 (1.04)	0.350 (1.34)	0.024** (1.97)	−0.071 (−1.11)	−0.036 (−1.12)	
Panel B. Market's dividend yield									
LOW	−0.899 (−1.15)	−0.213 (−0.36)	0.486*** (3.63)	−0.376* (−1.80)	−0.205 (−0.68)	0.044 (0.69)	−0.118 (−1.10)	0.186 (1.33)	60.32
2	0.015 (0.02)	−0.609 (−0.84)	0.138 (0.92)	−0.124 (−0.52)	0.614 (1.69)	0.318*** (3.76)	−0.361** (−2.61)	−0.403** (−2.23)	65.02
3	0.867 (1.16)	−1.639** (−2.55)	0.611*** (3.50)	−0.720*** (−3.22)	0.026 (0.08)	0.054 (0.54)	−0.022 (−0.21)	0.035 (0.21)	63.99
4	−0.620 (−0.70)	−0.506 (−0.66)	0.659*** (4.83)	−0.656*** (−2.91)	0.161 (0.57)	0.082 (1.34)	−0.126 (−1.02)	−0.206 (−1.39)	69.95
5	−0.115 (−0.10)	−0.087 (−0.10)	1.189*** (5.09)	0.295 (0.93)	−1.769** (−2.14)	−0.086 (−0.70)	−0.502*** (−2.98)	0.504 (1.61)	63.37
6	0.122 (0.15)	−0.376 (−0.55)	0.892*** (4.94)	−0.716*** (−4.22)	−0.623* (−1.67)	0.036 (0.38)	−0.006 (−0.05)	0.002 (0.01)	74.67
7	−0.129 (−0.15)	−0.813 (−1.17)	0.627** (2.50)	−0.601** (−2.38)	0.652* (1.65)	0.261 (1.45)	−0.038 (−0.24)	−0.503** (−2.20)	77.81
8	1.584 (1.57)	−2.180*** (−2.99)	0.772*** (3.76)	−1.138*** (−3.39)	0.517 (1.02)	0.161 (1.37)	0.172 (0.85)	−0.369 (−1.51)	71.41
9	0.757 (0.76)	−1.806** (−2.21)	1.032*** (5.34)	−0.672* (−1.88)	−0.289 (−0.83)	0.033 (0.37)	0.033 (0.16)	0.140 (0.83)	73.37
High	−2.082* (−1.73)	−1.053 (−1.17)	1.244*** (5.74)	0.285 (0.84)	−0.004 (−0.01)	−0.229* (−1.90)	−0.522** (−2.52)	0.149 (0.66)	58.21
H–L (*t*-stat)	−1.183*** (−2.73)	−0.840 (−0.46)	0.758*** (3.80)	0.662 (1.15)	0.201 (0.98)	−0.273*** (−2.67)	−0.403 (−0.21)	−0.037 (−0.35)	

Notes: This table shows the results of the conditional regression analysis using Fama and French's(1993) three-factor model and the conditional variables indicating market conditions: $R_{j,t} = \alpha_j + \beta_{j,MKT} r_{MKT,\ t} + \beta_{j,SMB} r_{SMB,t} + \beta_{j,HML} r_{HML,t} + \beta_{j,Z} Z_{t-1} + \gamma_{j,s} Z_{t-1} r_{MKT,t} + \varepsilon_{j,t}, \quad j = 1, \ldots, 10$. The dependent variable is the returns on the value-weighted MAX portfolio formed from the MAX strategy. Panel A reports the results with the GDP growth, and Panel B reports the results with the market's dividend yield. The Newey and West (1987) robust *t*-statistics are in parentheses. Asterisks denote the statistical significance level: * for 0.1, ** for 0.5, *** for 0.01

Table 10. Conditional regressions with GDP growth: MAX and IRISK

	A	β_{GDP}	β_{MKT}	β_{SMB}	β_{HML}	$\beta_{MKT \times GDP}$	$\beta_{SMB \times GDP}$	$\beta_{HML \times GDP}$	Adj. R^2
Panel A. Idiosyncratic volatility									
LL	−0.177 (−0.34)	−0.229* (−1.94)	0.418*** (6.56)	−0.062 (−0.63)	0.065 (0.37)	0.025* (1.70)	−0.077*** (−3.36)	0.023 (0.89)	53.81
HL	1.351 (1.37)	−0.571** (−2.13)	1.004*** (9.07)	−0.342 (−1.67)	−0.360 (−2.17)	−0.001 (−0.04)	−0.061* (−1.83)	0.083*** (2.88)	68.36
HH	−5.110*** (−3.71)	−0.263 (−0.82)	0.843*** (6.57)	0.529 (1.36)	0.756** (2.35)	0.021 (0.74)	−0.147** (−2.17)	−0.121** (−2.24)	43.18
HH–LL	−4.932*** (−3.37)	−0.035 (0.03)	0.425* (1.70)	0.591 (1.27)	0.691** (2.12)	−0.003 (−0.61)	−0.071 (−0.89)	−0.143** (−2.50)	
HH–HL	−6.461*** (−4.54)	0.307 (0.96)	−0.161 (−0.77)	0.871* (1.77)	1.116** (2.54)	0.023 (0.68)	−0.087 (−1.08)	−0.203** (−2.34)	
Panel B. Idiosyncratic skewness									
LL	−0.509 (−0.91)	−0.151 (−1.30)	0.426*** (6.42)	−0.079 (−0.81)	0.044 (0.24)	0.018 (1.33)	−0.071*** (−3.22)	0.024 (0.92)	54.43
HL	1.226 (1.19)	−0.577** (−2.05)	0.940*** (8.36)	−0.298 (−1.47)	−0.259 (−1.48)	0.005 (0.17)	−0.065* (−1.86)	0.072** (2.36)	66.02
HH	−5.007*** (−3.61)	−0.284 (−0.89)	0.769*** (6.10)	0.573 (1.43)	0.679** (2.11)	0.040 (1.39)	−0.150** (−2.16)	−0.102* (−1.92)	42.46
HH–LL	−4.497*** (−3.21)	−0.133 (−0.02)	0.343* (1.73)	0.653 (1.27)	0.635** (2.16)	0.022 (−0.56)	−0.079 (−0.82)	−0.126** (−2.59)	
HH–HL	−6.233*** (−4.28)	0.294 (0.96)	−0.171 (−0.85)	0.871* (1.74)	0.937** (2.26)	0.035 (0.84)	−0.085 (−1.03)	−0.174** (−2.12)	

Notes: This table shows the results of the conditional regression analysis using Fama and French's(1993) three-factor model and the conditional variables indicating market conditions: $R_{j,t} = \alpha_j + \beta_{j,MKT} r_{MKT,t} + \beta_{j,SMB} r_{SMB,t} + \beta_{j,HML} r_{HML,t} + \beta_{j,Z} Z_{t-1} + \gamma_{j,s} Z_{t-1} r_{MKT,t} + \varepsilon_{j,t}, \quad j = 1, \ldots, 10$. The dependent variable is the returns on the value-weighted double sorted portfolio formed from the MAX × IRISK. HH corresponds to the portfolio of high Max and IRISK (high idiosyncratic volatility and high idiosyncratic skewness). HL corresponds to the portfolio of high Max and low IRISK. LL corresponds to the portfolio of low Max and low IRISK. HH–HL corresponds to return on the long (HH)–short (HL) strategy. HH–LL is defined similarly. The Newey and West (1987) robust t-statistics are in parentheses. Asterisks denote the statistical significance level: * for 0.1, ** for 0.5, *** for 0.01

Table 11. Conditional regressions with market's dividend yield: MAX and IRISK

	α	β_{DP}	β_{MKT}	β_{SMB}	β_{HML}	$\beta_{MKT \times DP}$	$\beta_{SMB \times DP}$	$\beta_{HML \times DP}$	Adj. R^2
Panel A. Idiosyncratic volatility									
LL	−1.302 (−1.40)	0.038 (0.07)	0.602*** (2.88)	−0.464** (−2.47)	−0.007 (−0.02)	−0.062 (−0.61)	0.018 (0.18)	0.144 (0.79)	0.50
HL	−0.150 (−0.13)	−0.814 (−0.89)	1.088*** (4.97)	−0.409 (−1.04)	0.019 (0.04)	−0.074 (−0.71)	−0.168 (−0.78)	0.118 (0.52)	0.63
HH	−3.404** (−1.97)	−1.975* (−1.66)	1.049*** (3.98)	0.155 (0.31)	0.292 (0.50)	−0.036 (−0.26)	−0.217 (−0.77)	−0.090 (−0.27)	0.41
HH–LL	−2.102 −(1.54)	−2.012 −(1.49)	0.447** (2.25)	0.619 (0.83)	0.299 (2.21)	0.026 −(1.47)	−0.235 (0.27)	−0.235 −(1.44)	
HH–HL	−3.254** −(2.03)	−1.161 −(0.45)	−0.040 −(0.80)	0.563 (0.96)	0.273 (1.42)	0.038 (0.68)	−0.049 (0.46)	−0.208 −(0.88)	
Panel B. Idiosyncratic skewness									
LL	−1.344 (−1.52)	0.046 (0.08)	0.502*** (2.72)	−0.479 (−2.66)	0.034 (0.10)	−0.018 (−0.19)	0.029 (0.29)	0.118 (0.63)	0.51
HL	−0.286 (−0.25)	−0.810 (−0.90)	1.019*** (4.67)	−0.425 (−1.15)	0.157 (0.34)	−0.053 (−0.53)	−0.141 (−0.70)	0.056 (0.26)	0.61
HH	−3.040* (−1.73)	−2.220 (−1.84)	1.153*** (4.47)	0.185 (0.36)	0.096 (0.17)	−0.097 (−0.70)	−0.208 (−0.71)	0.029 (0.09)	0.41
HH–LL	−1.696 −(1.44)	−2.266 −(1.62)	0.651 −(1.40)	0.664 (2.43)	0.062 (0.63)	−0.080** (2.11)	−0.237* −(1.69)	−0.089 (0.47)	
HH–HL	−2.753** −(2.11)	−1.410 −(0.44)	0.134 −(0.39)	0.610 (0.84)	−0.061 (1.12)	−0.044 (0.25)	−0.067 (0.54)	−0.027 −(0.54)	

Notes: This table shows the results of the conditional regression analysis using Fama and French's(1993) three-factor model and the conditional variables indicating market conditions: $R_{j,t} = \alpha_j + \beta_{j,MKT} r_{MKT,t} + \beta_{j,SMB} r_{SMB,t} + \beta_{j,HML} r_{HML,t} + \beta_{j,Z} Z_{t-1} + \gamma_{j,s} Z_{t-1} r_{MKT,t} + \varepsilon_{j,t}, \quad j = 1, \ldots, 10$. The dependent variable is the returns on the value-weighted double-sorted portfolio formed from the MAX × IRISK. HH corresponds to the portfolio of high Max and IRISK (high idiosyncratic volatility and high idiosyncratic skewness). HL corresponds to the portfolio of high Max and low IRISK. LL corresponds to the portfolio of low Max and low IRISK. HH–HL corresponds to return on the long (HH)–short (HL) strategy. HH–LL is defined similarly. The Newey and West (1987) robust t-statistics are in parentheses. Asterisks denote the statistical significance level: * for 0.1, ** for 0.5, *** for 0.01

results are different from the results of studies analyzing the US or European stock market. Our results partially support the results of Bali *et al.* (2011), but we provide an evidence of the MAX effect variation by adding mispricing dimension that differs from the results of Bali *et al.* (2011) and previous studies. Our results help build a better understanding of the MAX anomalies in the emerging financial markets.

Notes

1. Annaert *et al.* (2013) cover the following 13 European countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, the Netherlands, Portugal, Slovakia and Spain.
2. Cheon and Lee (2018) analyzed the stock market of the 42 countries in three geographical regions: Argentina, Brazil, Canada, Chile, Mexico, Peru and USA; Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Poland, Portugal, Russia, Spain, Sweden, Switzerland and United Kingdom (Europe); and Australia, China, Hong Kong, India, Indonesia, Israel, Japan, Malaysia, New Zealand, Pakistan, Philippines, South Africa, South Korea, Singapore, Taiwan, Thailand and Turkey (Asia/Africa).
3. Kim and Ahn (2012); Kang and Sim (2014); Nartea *et al.* (2014); Koh and Kim (2017); Kim and Cho (2018); Kang and Yun (2020); and many other papers.
4. See Bali *et al.* (2011) and Annaert *et al.* (2013).
5. We follow Fama and French (2012) approach to construct risk factors in the Korean stock market. To construct the SMB and HML factors, we sort stock into two market caps and three book-to-market equity at the end of each June. The ME breakpoint is the median and the B/M breakpoint is the 30th and 70th percentiles of the stocks in the Korean stock market. Denoting the six portfolios double-sorted based on ME and B/M as SV (small value), SN (small neutral), SG (small growth), BV (big value), BN (big neutral) and BG(big growth), the return on SMB is calculated as $[(SV + SN + SG)/3 - (BV + BN + BG)/3]$ and the return on HML is calculated as $[(SV + BV)/2 - (SG + BG)/2]$.
6. To check for multicollinearity, we estimate the variance inflation factor (VIF), and find that the average VIF is 3.27 for IVOL and 3.26 for Iskew (less than the threshold value of 10), and the condition number value of all independent variables is 14.27 for IVOL and 14.22 for Iskew (less than the threshold value of 15).
7. On June 15, 2015, the Korea Exchange expanded the daily stock price limit from 15% to 30%. Specifically, the stocks traded on the KOSPI or KOSDAQ are allowed to rise or fall daily by up to 30% of their previous closing prices.

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Further reading

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