Maxing Out: Stocks as Lotteries and the Cross-Section of Expected Returns

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April 2008

Preliminary and Incomplete

ABSTRACT

Motivated by existing evidence of a preference among investors for assets with lottery-like payoffs and that many investors are poorly diversified, we investigate the significance of extreme positive returns in the cross-sectional pricing of NYSE, AMEX, and NASDAQ stocks over the sample period July 1962-December 2005. Portfolio-level analyses and the firm-level cross-sectional regressions indicate a negative and significant relation between the maximum daily return over the past one month (MAX) and expected stock returns. Average raw and risk-adjusted return differences between stocks in the lowest and highest MAX deciles exceed 1% per month. These results are robust to controls for size, book-to-market, momentum, short-term reversals, liquidity, and skewness. Of particular interest, including MAX reverses the puzzling negative relation between returns and idiosyncratic volatility recently documented in Ang et al (2006).

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I. Introduction

What determines the cross-section of expected stock returns? This question has been central to modern financial economics since the path breaking work of Sharpe, Lintner and Mossin.[1] Much of this work has focused on the joint distribution of individual stock returns and the market portfolio as the determinant of expected returns. In the classic CAPM setting, i.e., with either quadratic preferences or normally distributed returns, expected returns on individual stocks are determined by the covariance of their returns with the market portfolio. Introducing a preference for skewness leads to the three moment CAPM of Kraus and Litzenberger (1976), which has received some empirical support in the literature as, for example, in Harvey and Siddique (2000).

Diversification plays a critical role in these models due to the desire of investors to avoid variance risk, i.e., to diversify away idiosyncratic volatility, yet a closer examination of the portfolios of individual investors suggests that these investors are, in general, not well-diversified.[2] There may be plausible explanations for this lack of diversification,[3] but nevertheless this empirical phenomenon suggests looking more closely at the distribution of individual stock returns rather than just co-moments as potential determinants of the cross-section of expected returns. Motivated by the additional existing evidence that investors have a preference for lottery-like assets, i.e., assets that have a relatively small probability of a large payoff,[4] we examine the role of extreme positive returns in the cross-sectional pricing of stocks.

Specifically, we sort stocks by their maximum daily return during the previous month and examine the monthly returns on the resulting portfolios over the period July 1962 to December 2005. For value-weighted decile portfolios, the difference between returns on the portfolios with the highest and lowest maximum daily returns is -1.03%. The corresponding Fama-French-Carhart four-factor alpha is -1.18%. Both return differences are statistically significant at all standard significance levels. This evidence suggests that investors may be willing to pay more for stocks that exhibit extreme positive returns, and thus these stocks exhibit lower returns in the future.

This interpretation is consistent with cumulative prospect theory as laid out in Barberis and Huang (2005). Errors in the probability weighting of investors cause them to over-value stocks that have a small probability of a large positive return. It is also consistent with the optimal beliefs framework of Brunnermeier, Gollier and Parker (2007). In this model, agents optimally choose to distort their beliefs about future probabilities in order to maximize current utility. Critical to these interpretations, stocks with extreme positive returns in a given month are also more likely to exhibit this phenomenon in the future.

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[1] Cite.
[2] Odean (1999), Mitton and Vorkink (2007), Goetzmann and Kumar (2008).
[3] Van Nieuwerburgh and Veldkamp (2008)
[4] Cite.

Not surprisingly, the stocks with the most extreme positive returns are not representative of the full universe of equities. For example, they tend to be small, illiquid securities with high returns in the sorting month. To ensure that it is not these characteristics, rather than the extreme returns, that are driving the documented return differences, we perform a battery of bivariate sorts and re-examine the raw return and alpha differences. The results are robust to sorts on size, book-to-market ratio, momentum (return in months t-12 to t-2), short-term reversal (return in month t-1), and illiquidity. Results from cross-sectional regressions corroborate this evidence.

What is the correct interpretation of this apparently robust empirical phenomenon? A recent paper by Ang et al (2006) documents the anomalous finding that stocks with high idiosyncratic volatility have low subsequent returns. It is no surprise that the stocks with extreme positive returns also have high idiosyncratic (and total) volatility when measured over the same time period. This positive correlation is almost by construction since realized monthly volatility is calculated as the sum of squared daily returns. Could the maximum return simply be proxying for idiosyncratic volatility? We investigate this question using two methodologies, bivariate sorts on maximum returns and idiosyncratic volatility and firm-level cross-sectional regressions. The conclusion is that not only is the effect of extreme positive returns we document robust to controls for idiosyncratic volatility but that this effect reverses the idiosyncratic volatility effect documented in Ang et al (2006). When sorted first on maximum returns, the return difference between high and low idiosyncratic portfolios is *positive* and both economically and statistically significant. In a cross-sectional regression context, when both variables are included, the coefficient on the maximum return is negative and significant while that on idiosyncratic volatility is *positive*, albeit significant. These results are consistent with our preferred explanation—poorly diversified investors dislike idiosyncratic volatility, like lottery-like payoffs and influence prices and hence future returns.

A slightly different interpretation of our evidence is that extreme positive returns proxy for skewness, and investors exhibit a preference for skewness. For example, Mitton and Vorkink (2007) develop a model of agents with heterogeneous skewness preferences and show that the result is an equilibrium in which idiosyncratic skewness is priced. This interpretation is difficult to refute because skewness of returns is difficult to measure, particularly at a monthly horizon. What we do show is that the extreme return effect is robust to estimated skewness using daily returns over a month.

A further interesting question is whether the effect of extreme positive returns could be a result of investor over-reaction to firm-specific good news. As this over-reaction is reversed, returns in the subsequent month would be lower than justified by the operative model of risk and return. This hypothesis is difficult to reject definitively, but it does seem to be inconsistent with the existing literature. In particular, the preponderance of existing evidence indicates that stocks under-react not over-react to firm specific news.[5] One prominent and relevant example is the post-earnings announcement drift phenomenon, wherein the stock price continues to drift in the same direction as the price move at the earnings announcement.[6] Thus if the extreme positive returns were caused by good earnings news we should expect to see under-reaction not over-reaction. In fact, given that some of the firms in our high maximum return portfolio are undoubtedly there because of price moves on earnings announcement days, the low future returns are actually reduced in magnitude by this effect. A second example is that of takeover announcements. In this case target firms are likely to be in our high maximum return portfolios. However, as documented by Mitchell and Pulvino (2001), the subsequent average returns on these firms are high not low. Again the literature suggests under-reaction not over-reaction to firm specific news.

The paper is organized as follows. Section II provides the univariate portfolio-level analysis, and the bivariate analyses and firm-level cross-sectional regressions that examine the usual set of suspects. Section III focuses more specifically on extreme returns and idiosyncratic volatility. Section IV presents results for skewness and MAX. Section V provides further robustness checks, and Section VI concludes.

II. Extreme Positive Returns and Cross-Section of Expected Returns

A. Data

The first data set includes all New York Stock Exchange (NYSE), American Stock Exchange (AMEX), and NASDAQ financial and nonfinancial firms from the Center for Research in Security Prices (CRSP) for the period from July 1962 through December 2005. We use daily stock returns to calculate the maximum daily stock return for each firm in each month as well as such variables as the market beta, idiosyncratic volatility, and various skewness measures. These variables are defined in detail in the Appendix and are discussed as they are used in the analysis. The second data set is COMPUSTAT, which is primarily used to obtain the equity book values for individual firms.

B. Univariate Portfolio-Level Analysis

Table I presents the value-weighted and equal-weighted average monthly returns of decile portfolios that are formed by sorting the NYSE/AMEX/NASDAQ stocks based on the maximum daily return within the previous month (MAX). The results are reported for the sample period July 1962 to December 2005.[7]

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[5] See Daniel, Hirshleifer and Subrahmanayam (1998) for a survey of some of this literature.
[6] Bernard and Thomas (1989) and many subsequent papers.
[7] We start the sample in 1962 for the main analysis because this starting point corresponds that used in much of the literature on the cross-section of expected returns. However, we demonstrate the robustness of the results in an extended sample in Section V.

Portfolio 1 (Low MAX) is the portfolio of stocks with the lowest maximum daily returns during the past month, and portfolio 10 (high MAX) is the portfolio of stocks with the highest maximum daily returns during the previous month. The value-weighted average raw return difference between decile 10 (High MAX) and decile 1 (low MAX) is –1.03% per month with a Newey-West (1987) t-statistic of –2.83. In addition to the average raw returns, Table I also presents the magnitude and statistical significance of the difference in intercepts (Fama-French-Carhart four factor alphas) from the regression of the value-weighted portfolio returns on a constant, the excess market return, SMB, HML, and UMD factors of Fama, French and Carhart.[8] As shown in the last row of Table I, the difference in alphas between the high MAX and low MAX portfolios is –1.18% per month with a Newey-West t-statistic of –4.71. These differences are economically significant and statistically significant at all conventional levels.

Taking a closer look at the value-weighted averages returns across deciles, it is clear that the pattern is not one of a uniform decline as MAX increases. The average returns of deciles 1 to 7 are approximately the same, in the range of 1.00% to 1.16% per month, but going from decile 7 to decile 10, average returns drop significantly, from 1.00% to 0.86% , 0.52% and then to –0.02% per month. Interestingly, the reverse of this pattern is evident across the deciles in the average across months of the average maximum return of the stocks within each decile. By definition, this average increases monotonically from deciles 1 to 10, but this increase is far more dramatic for deciles 8, 9 and 10. These deciles contain stocks with average maximum daily returns of 9%, 12%, and 24%, respectively. Given a preference for upside potential, investors may be willing to pay more for, and accept lower expected returns on, assets with these extremely high positive returns. In other words, it is conceivable that investors view these stocks as valuable lottery-like assets, with a small chance of a large gain.

Of course, the maximum daily returns documented in Table I are for the portfolio formation month, not for the subsequent month over which we measure returns. Investors may pay high prices for stocks that have exhibited extreme positive returns in the past in the expectation that this behavior will be repeated in the future, but a natural question is whether these expectations are rational. Table II investigates this issue by presenting the average month-to-month portfolio transition matrix. Specifically, it presents the average probability that a stock in decile *i* in one month will be in decile *j* in the subsequent month. If maximum daily returns were completely random, then all the probabilities should be approximately 10%, since a high or low maximum return in one month should say nothing about the maximum return in the following month. Instead, all the diagonal elements of the transition matrix exceed 10%, illustrating that MAX is persistent. Of greater importance, this persistence is especially strong for

[8] SMB (small minus big), HML (high minus low), and UMD (up minus down) are size, book-to-market, and momentum factors described in Kenneth French's data library: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/.

the extreme portfolios. Stocks in decile 10 have a 35% chance of appearing in the same decile next month. Moreover, they have a 68% of being in deciles 8-10, all of which exhibit high maximum daily returns in the portfolio formation month and low return in the subsequent month. We do not measure investor expectations directly, but the direction of the results documented in Table II is certainly consistent with rational expectations.

As shown in the second column of Table I, similar, although somewhat less economically and statistically significant results, are obtained for the returns on equal-weighted portfolios. The average raw return difference between the low MAX and high MAX portfolios is –0.65% per month with a t-statistic of –1.83. The corresponding difference in alphas is –0.66% per month with a t-statistic of –2.31. Going forward we will focus primarily on the value-weighted portfolios, although we will revisit equal-weighted portfolios in Section V, for two reasons. First, returns on these portfolios are generally considered to be more robust due to the lower weight they put on small stocks whose returns may be subject to greater measurement error. Second, using value-weighted portfolios highlights the economic significance of the results by ensuring that apparently large returns are not driven by the very smallest stocks in the sample. These issues are especially relevant for our analysis since small stocks tend to be concentrated in the higher MAX portfolios as discussed below.

To get a clearer picture of the composition of the high MAX portfolios, Table III presents summary statistics for the stocks in the deciles. Specifically, the table reports the average across the months in the sample of the median values within each month of various characteristics for the stocks in each decile. We report values for the maximum daily return (in percent), the market beta, the market capitalization (in millions of dollars), the book-to-market (BM) ratio, our measure of illiquidity (scaled by 10^5), the price (in dollars), the return in the portfolio formation month, and the return over the 11 months prior to portfolio formation.[9] The return in the portfolio formation month is labeled REV and the return over the previous 11 months is labeled MOM because these two variables indicate the extent to which the portfolios are subject to short-term reversal and intermediate-term momentum effects, respectively.[10] Betas are calculated monthly using a regression of daily excess stock returns on daily excess market returns. Following Amihud (2002), illiquidity is measured as the ratio of the absolute stock return to the dollar trading volume over the month. Detailed definitions of these variables are given in the Appendix.

The portfolios exhibit some striking patterns. When we move from the low MAX to the high MAX decile, the median daily maximum return of stocks increases from 1.62% to 17.77%; the median market beta increases from 0.29 to 1.13; the median size decreases from \$316.19 million to \$21.52

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[9] The qualitative results from the “average” statistics are very similar to those obtained from the “median” statistics. Since the median is a robust measure of the center of the distribution that is less sensitive to outliers than the mean, we choose to present the median statistics in Table II.

[10] See Jegadeesh and Titman… cite.

million; the median illiquidity increases from 0.28×10^{-5} to 4.00×10^{-5}; the median price of stocks decreases from $25.44 to $6.47; and the median 1-month return increases from ?? to ??. While not all these patterns are perfectly monotonic, the statistics indicate that stocks with extreme positive daily returns are, on average, small, illiquid, and low-priced, with high systematic risk and high returns. In contrast, the median book-to-market ratio and the median return over the prior 11 months are approximately the same across portfolios, although high MAX stocks do have a slight value tilt.

Given these differing characteristics, there is some concern that the 4-factor model used in Table I is not adequate to capture the true difference in risk and expected returns across the portfolios sorted on MAX. For example, the HML and SMB factors of Fama and French do not fully explain the returns of portfolios sorted by book-to-market ratios and size.[11] Moreover, the 4-factor model does not control explicitly for the differences in expected returns due to differences in illiquidity or other known empirical phenomenon such as short-term reversals. With the exception of short-term reversals, it seems unlikely that any of these factors can explain the return differences in Table I because high MAX stocks have characteristics that are usually associated with high expected returns, while these portfolios actually exhibit low returns. Nevertheless, in the following two subsections, we provide different ways of dealing with the potential interaction of the maximum daily return with firm size, book-to-market, liquidity, and past returns. Specifically, we test whether the negative relation between MAX and the cross-section of expected returns still holds once we control for size, book-to-market, momentum, short-term reversal and liquidity using bivariate portfolio sorts and Fama-MacBeth (1973) regressions.

C. Bivariate Portfolio-Level Analysis

This section examines the relation between maximum daily returns (MAX) and future stock returns after controlling for size, book-to-market, momentum, short-term reversal, and liquidity. We control for size by first forming decile portfolios ranked based on market capitalization. Then, within each size decile, we sort stocks into decile portfolios ranked based on MAX so that decile 1 (decile 10) contains stocks with the lowest (highest) MAX. Panel A of Table IV shows that in each size decile, the lowest (highest) MAX decile has higher (lower) value-weighted average returns. The column labeled "Average Returns" averages across the 10 size deciles to produce decile portfolios with dispersion in MAX, but which contain all sizes of firms. This procedure creates a set of MAX portfolios with very similar levels of firm size and thus these MAX portfolios control for differences in size. After controlling for size, the value-weighted average return difference between the low MAX and high MAX portfolios is

[11] See, for example, Fama and French (). Daniel and Titman () attribute this failure to the fact that returns are driven by characteristics not risk. We take no stand on this issue, but instead conduct a further battery of tests to demonstrate the robustness of our results.

about –1.22% per month with the Newey-West t-statistic of –4.49. The 10-1 difference in the 4-factor alphas is –1.19% per month with a t-statistic of –5.98. Thus, market capitalization does not explain the high (low) returns to low (high) MAX stocks.

The fact that these results are, if anything, both economically and statistically more significant than those presented for the univariate sort in Table I is perhaps not too surprising. As shown in Table III, the high MAX stocks, which have low subsequent returns, are generally small stocks. The standard size effect would suggest that these stocks should have high returns. Thus, controlling for size should enhance the effect on raw returns and even on 4-factor alphas to the extent that the SMB factor is an imperfect proxy. However, there is a second effect of bivariate sorts that works in the opposite direction. Size and MAX are correlated, hence variation in MAX within size-sorted portfolios is smaller than in the broader universe of stocks. That this smaller variation in MAX still generates substantial return variation is further evidence of the significance of this phenomenon.

We control for book-to-market (BM) in a similar way, with the results reported in Panel B of Table IV. Again the effect of MAX is preserved, with a value-weighted average raw return difference between the low MAX and high MAX deciles of –0.93% per month and a corresponding t-statistic of –3.23. The 10-1 difference in the FF-4 alphas is also negative, –1.06% per month, and highly significant.

When controlling for momentum in Panel C, the raw return and alpha differences are smaller in magnitude, but they are still economically large and statistically significant at all conventional levels. Of greater interest is the control for short-term reversals. Since firms with large positive daily returns also tend to have high monthly returns, it is conceivable that MAX could be proxying for the well known reversal phenomenon at the monthly frequency. However, as shown in Panel D, this is not the case. After controlling for the monthly return, the return and alpha differrinces are still 81 and 98 basis points, respectively.

Finally, we control for liquidity by first forming decile portfolios ranked based on the illiquidity measure of Amihud (2002), with the results reported in Panel E of Table IV. Again, variation in MAX is apparently priced in the cross-section, with large return differences and corresponding t-statistics. Thus, liquidity does not explain the negative relation between maximum daily returns and future stock returns.

D. Firm-Level Cross-Sectional Regressions

So far we have tested the significance of the maximum daily return as a determinant of the cross-section of future returns at the portfolio level. This portfolio-level analysis has the advantage of being non-parametric in the sense that we do not impose a functional form on the relation between MAX and future returns. The portfolio-level analysis also has two potentially significant disadvantages. First, it throws away a large amount of information in the cross-section via aggregation. Second, it is a difficult setting in which to control for multiple effects or factors simultaneously. Consequently, we now examine the cross-sectional relation between MAX and expected returns at the firm level using Fama and MacBeth (1973) regressions. We present the time-series averages of the slope coefficients from the regressions of stock returns on maximum daily return (*MAX*), market beta (*BETA*), log market capitalization (*SIZE*), log book-to-market ratio (*BM*), momentum (*MOM*), short-term reversal (*REV*), and illiquidity (*ILLIQ*). The average slopes provide standard Fama-MacBeth tests for determining which explanatory variables on average have non-zero premiums. Monthly cross-sectional regressions are run for the following econometric specification and nested versions therof:

$$R_{i,t+1} = \lambda_{0,t} + \lambda_{1,t} MAX_{i,t} + \lambda_{2,t} BETA_{i,t} + \lambda_{3,t} SIZE_{i,t} + \lambda_{4,t} BM_{i,t} + \lambda_{5,t} MOM_{i,t} + \lambda_{6,t} REV_{i,t} + \lambda_{7,t} ILLIQ_{i,t} + \varepsilon_{i,t+1}$$

where $R_{i,t+1}$ is the realized return on stock *i* in month *t*+1. The predictive cross-sectional regressions are run on the one-month lagged values of *MAX*, *BETA*, *SIZE*, *BM*, *MOM*, *REV*, and *ILLIQ*.

Table V reports the time series averages of the slope coefficients $\lambda_{i,t}$ (i = 1, 2, …, 7) over the 522 months from July 1962 to December 2005 for NYSE/AMEX/NASDAQ stocks. The Newey-West adjusted t-statistics are given in parentheses. The univariate regression results show a negative and statistically significant relation between the maximum daily return and the cross-section of future stock returns. The average slope, $\lambda_{1,t}$, from the monthly regressions of realized returns on *MAX* alone is –0.0434 with a t-statistic of –2.92. The economic magnitude of the associated effect is similar to that documented in Tables I and III for the univariate and bivariate sorts. The spread in median maximum daily returns between deciles 10 and 1 is approximately 16%. Multiplying this spread by the average slope yields an estimate of the monthly risk premium of -69 basis points.

In general, the coefficients on the individual control variables are also as expected—the size effect is negative and significant, the value effect is positive and significant, stocks exhibit intermediate-term momentum and short-term reversals, and illiquidity is priced. The average slope on BETA is negative and statistically insignificant, which contradicts the implications of the CAPM but is consistent with prior empirical evidence. In any case, these results should be interpreted with caution since BETA is estimated over a month using daily data, and thus is subject to a significant amount of measurement error. The regression with all 6 control variables shows similar results.

Of primary interest is the last line of Table V, which shows the results for the full specification with MAX and the 6 control variables. In this specification the average slope coefficient on MAX is ??, substantially larger than in the univariate regression, with a commensurate increase in the t-statistic to ??. This coefficient corresponds to a ??? basis point difference in expected monthly returns between median stocks in the high and low MAX deciles. The explanation for the increased magnitude of the estimated effect in the full specification is straightforward. Since stocks with high maximum daily returns tend to be small and illiquid, controlling for the increased expected return associated with these characteristics pushes the return premium associated with extreme positive return stocks even lower. These effects more than offset the reverse effect associated with short-term reversals, which partially explains the low future returns on high MAX stocks.

The clear conclusion is that cross-sectional regressions provide strong corroborating evidence for an economically and statistically significant negative relation between extreme positive returns and future returns, consistent with models that suggest that idiosyncratic skewness or lottery-like payoffs should be priced in equilibrium.

III. Idiosyncratic Volatility and Extreme Returns

While arguably MAX is a theoretically motivated variable, there is still a concern that it may be proxying for a different effect. In particular, stocks with high volatility are likely to exhibit extreme returns of both signs. Moreover, stocks with high maximum daily returns in a given month will also have high realized volatility in the same month, measured using squared daily returns, almost by construction. Ang et al. (2006) document that idiosyncratic volatility has a significant negative price in the cross-section, i.e., stocks with high idiosyncratic volatility have low subsequent returns, thus it is plausible that MAX is proxying for this effect. We examine this issue in detail in this section.

As preliminary evidence, Table VI provides the average monthly cross-sectional correlations between three variables of interest—MAX (the maximum daily return within the month), IVOL (monthly realized idiosyncratic volatility measured using the residuals from a daily market model within the month),[12] and MIN (the negative of the minimum daily return within the month). We reverse the sign on the minimum daily returns so that high values of MIN correspond to more extreme returns. The correlations between IVOL and both MAX and MIN are approximately 0.75, which is very high. MAX and MIN are also quite closely related, with a correlation of 0.55. Clearly stocks with high volatility exhibit extreme returns and vice versa.

A second important piece of preliminary evidence is to verify the relation between idiosyncratic volatility and future returns in our sample. Table VII presents the results from a univariate portfolio sort on IVOL, similar to that given in Table I for MAX. In fact, the results look very similar to those in Table I. For value-weighted returns, deciles 1 through 7 (lower idiosyncratic volatility) all exhibit average monthly returns of around 1%. These returns fall dramatically for the higher volatility stocks, all the way

[12] Idiosyncratic volatility and total volatility are essentially identical when measured within a month due to the low explanatory power of the market model regression. In our sample, the average cross-section correlation between these variables exceeds 0.98.

to 0.02% per month for decile 10. Both the return differences and the four-factor alpha differences are economically and statistically significant. These results coincide closely with the results in Ang et al. (2006), although they form quintiles rather than deciles and use a slightly shorter sample period. Of some interest, there is no evidence of an idiosyncratic volatility effect in equal-weighted portfolios. This result is not new and can be found in Bali and Cakici (2008). Columns 3 and 4 of the table show the average across months of the average idiosyncratic volatility and MAX within the deciles. IVOL increases across the portfolios by construction, and it rises dramatically for the top deciles. Given the correlation documented above it is not surprising that average maximum daily returns also increase across the IVOL-sorted portfolios. In fact, the range is not that much smaller than in the MAX-sorted portfolios.

To examine the relation between extreme returns and volatility more closely, we first examine three bivariate sorts in Table VIII. We control for idiosyncratic volatility by first forming decile portfolios ranked based on the idiosyncratic volatility measure given in equation (3). In Panel A, IVOL 1 denotes a portfolio of stocks with the lowest idiosyncratic volatility whereas IVOL 10 denotes a portfolio of stocks with the highest idiosyncratic volatility. Within each *IVOL* decile, we sort stocks into decile portfolios ranked based on the maximum daily return so that decile 1 (decile 10) contains stocks with the lowest (highest) *MAX*. In each *IVOL* decile except the first, the lowest (highest) *MAX* decile has higher (lower) value-weighted average returns. The last two columns report the differences in average returns and the FF-4 alphas along with the Newey-West t-statistics after controlling for idiosyncratic risk. The value-weighted average raw return difference between the low-MAX and high-MAX deciles is –0.35% per month with the t-statistic of –2.42. The 10-1 differences in the FF-4 alphas is also negative, –0.34% per month, and highly significant. These magnitudes are much smaller than we have seen previously, but this result is hardly surprising. Idiosyncratic volatility and MAX are highly correlated, thus after controlling for idiosyncratic volatility, the spread in maximum returns is significantly reduced. Nevertheless, idiosyncratic volatility does not completely explain the high (low) returns to low (high) MAX stocks.

What happens if we perform the reverse sort, i.e., if we examine the explanatory power of idiosyncratic volatility after controlling for MAX? We first form decile portfolios ranked based on the maximum daily returns over the past one month. Then, within each MAX decile, we sort stocks into decile portfolios ranked based on IVOL so that decile 1 (decile 10) contains stocks with the lowest (highest) IVOL. Panel B of Table VIII shows that in each MAX decile, the lowest (highest) IVOL decile has lower (higher) average returns. The column labeled “Average Returns” averages across the 10 MAX deciles to produce decile portfolios with dispersion in IVOL, but which contain all MAXs of firms. This procedure creates a set of IVOL portfolios with very similar levels of MAX and thus these IVOL portfolios control for differences in MAX. After controlling for MAX, the average return difference between the high IVOL and low IVOL portfolios is about 0.98% per month with the Newey-West t-statistic of 4.88. The 10-1 difference in the FF-4 alphas is 0.95% per month with a t-statistic of 4.76. Thus, after controlling for MAX, we find a significant and positive relation between IVOL and the cross-section of expected returns. This is the reverse of the counter-intuitive negative relation documented by Ang et al (2006).

A slightly different way to examine the relation between extreme returns and volatility is to look at minimum returns. If it is a volatility effect that is driving returns, then MIN (the minimum daily return over the month), which is also highly correlated with volatility, should generate a similar effect to MAX. On the other hand, much of the theoretical literature would predict that the effect of MIN should be the opposite of that of MAX. For example, if investors have a skewness preference, then stocks with negatively skewed returns should require higher returns. Similarly, under the CPT of Barberis and Huang, small probabilities or large losses are over-weighted, and thus these stocks have lower prices and higher expected returns.

Table VIII provides results for bivariate sorts on MAX and MIN. We first form decile portfolios ranked based on the minimum daily returns over the past one month (MIN). Then, within each MIN decile, we sort stocks into decile portfolios ranked based on MAX so that decile 1 (decile 10) contains stocks with the lowest (highest) MAX. Panel C shows that in each MIN decile, the lowest (highest) MAX decile has higher (lower) value-weighted average returns. The column labeled “Average Returns” averages across the 10 MIN deciles to produce decile portfolios with dispersion in MAX, but which contain all MINs of firms. This procedure creates a set of MAX portfolios with very similar levels of downside risk and thus these MAX portfolios control for differences in downside risk. After controlling for MIN, the value-weighted average return difference between the low MAX and high MAX portfolios is about –0.80% per month with the Newey-West t-statistic of –3.86. The 10-1 difference in the FF-4 alphas is –0.95% per month with a t-statistic of –5.42.

Panel D shows the reverse sort, i.e., portfolios sorted on MIN after controlling for MAX. The return and alpha differences are positive and statistically significant. Stocks with extreme low returns have higher expected returns in the subsequent month.

In addition to the portfolio-level analyses, we run firm-level Fama-MacBeth cross-sectional regressions with both MAX and MIN. Table IX presents the average slope coefficients and the Newey-West adjusted t-statistics. For all econometric specifications, the average slope on MAX remains negative and significant, confirming our earlier findings from the bivariate sorts of MAX and MIN. After controlling for MIN as well as market beta, size, book-to-market, momentum, short-term reversal, liquidity, and idiosyncratic volatility, the average slope on MAX is -0.090 with a t-statistic of -6.22.

The average slope on MIN is positive, statistically significant and of approximately the same size as the coefficient on MAX, except for the full specification that includes the 6 control variables. For this specification, the sign is preserved but the magnitude and statistical significance are dramatically reduced. Given the restrictive nature of the linear specification and the multi-colinearity in the independent variables the true roel of MIN is still an open issue. Note that the original minimum returns are multiplied by –1 in constructing the variable MIN. Therefore, the positive slope coefficient means that there is a significantly positive relation between MIN and the cross-section of expected returns, i.e, the more a stock fell in value the higher the future expected return.

The final interesting evidence in Table IX is in regard to IVOL. In the univariate regression the average slope coefficient is negative, but it is not statistically significant. This lack of significance is attributable to two factors. First, as shown in Table VII, there is little or no relation between volatility and future returns in equal-weighted portfolios. The cross-sectional regressions put equal weight on each firm observation. Second, the relation between volatility and returns may be nonlinear. Interestingly, the sign of the coefficient on IVOL becomes positive, albeit not significant, when controlling for MAX and MIN and stays positive when the other 6 control variables are added to the specification.

Based on the bivariate portfolios sorts and the firm-level cross-sectional regressions with MAX, MIN, and IVOL, our conclusion is that there is no idiosyncratic volatility puzzle as indicated by Ang et al. (2006). After taking into account a preference for extreme positive returns and a dislike of extreme negative returns, we find no evidence for a significant link between idiosyncratic volatility and expected stock returns. Hence, we conclude that the reason for the presence of a negative relation between IVOL and expected returns is that IVOL is a proxy for MAX.

IV. Skewness versus MAX

Arditti (1967), Kraus and Litzenberger (1976), and Kane (1982) extend the standard mean-variance portfolio theory to incorporate the effect of skewness on valuation. They present a three-moment asset pricing model in which investors hold concave preferences and like positive skewness. Their results indicate that assets that decrease a portfolio's skewness (i.e., that make the portfolio returns more left-skewed) are less desirable and should command higher expected returns. Similarly, assets that increase a portfolio's skewness should generate lower expected returns. In this framework, systematic skewness explains the cross-sectional variation in stocks returns, whereas idiosyncratic skewness is unlikely to affect expected returns because investors hold the market portfolio in which idiosyncratic skewness is diversified away.[13,14]

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[13] Arditti (1971), Friend and Westerfield (1980), Sears and Wei (1985), Barone-Adesi (1985), and Lim (1989) provide empirical and analytical tests of total and systematic skewness.

[14] Harvey and Siddique (1999, 2000) introduce an asset pricing model with conditional co-skewness and find that stocks with lower co-skewness outperform stocks with higher co-skewness by about 30 basis points per month (or 3.60% per year).

Barberis and Huang (2005), however, show that in a model where investors have utility functions based on the cumulative prospect theory (CPT) of Tversky and Kahneman (1992), idiosyncratic skewness may be priced along with systematic skewness. Under CPT, investors demand for lottery-like assets with a small chance of a large gain and demand for insurance protecting against a small chance of a large loss. Given their preference for lottery-like assets and their dislike of large losses, CPT investors are willing to accept lower expected returns for assets with higher idiosyncratic skewness.

The question is how one can measure the preference or demand for lottery-like assets. For example, Kumar (2005), Zhang (2005), and Mitton and Vorkink (2007) use alternative measures of skewness to identify the effect of preference for extreme positive returns on expected stock returns. Since our measure of upside potential (maximum daily returns within a month) is introduced as a direct measure of return on lottery-like assets, it can be viewed as a competing variable for skewness. To determine whether the information contents of maximum daily returns and skewness are similar, we test the significance of a cross-sectional relation between maximum daily return (*MAX*) and future stock returns after controlling for total skewness (*TSKEW*), idiosyncratic skewness (*ISKEW*) and systematic skewness (*SSKEW*).

We control for total skewness by first forming decile portfolios ranked based on *TSKEW*. Then, within each *TSKEW* decile, we sort stocks into decile portfolios ranked based on *MAX* so that decile 1 (decile 10) contains stocks with the lowest (highest) *MAX*. Panel A of Table X shows that in each *TSKEW* decile, the lowest (highest) *MAX* decile has higher (lower) value-weighted average returns. The column labeled “Average Returns” averages across the 10 *TSKEW* deciles to produce decile portfolios with dispersion in *MAX*, but which contain firms with all levels of total skewness. This procedure creates a set of *MAX* portfolios with near-identical levels of total skewness and thus these *MAX* portfolios control for differences in *TSKEW*. After controlling for total skewness, the value-weighted average return difference between the low-MAX and high-MAX portfolios is about –1.03% per month with the Newey-West t-statistic of –2.99. The 10-1 difference in the FF-4 alphas is –1.01% per month with a t-statistic of –4.06. Thus, total skewness does not explain the high (low) returns to low (high) MAX stocks.

Panels B and C of Table X present results from the bivariate sorts of portfolios formed based on MAX after controlling for systematic and idiosyncratic skewness. As shown in Panel B, after controlling for systematic skewness (*SSKEW*) or co-skewness, the value-weighted average raw and risk-adjusted return differences between the low-MAX and high-MAX portfolios are in the range of 64 to 70 basis points per month and highly significant. Panel C reports that after controlling for idiosyncratic skewness (*ISKEW*), the value-weighted average raw and risk-adjusted return differences between the low-MAX and high-MAX portfolios are in the range of –0.97% to –1.02% per month with the t-statistics lying between

–2.86 and –4.61. These results indicate that systematic and idiosyncratic skewness cannot explain the significantly negative relation between MAX and expected stock returns.

As further evidence, Table XI presents the cross-sectional Fama-MacBeth regression results for the NYSE/AMEX/NASDAQ stocks after controlling for *TSKEW*, *SSKEW*, and *ISKEW*. Table VIII reports the time series averages of the slope coefficients over the sample period of July 1962 to December 2005. The Newey-West adjusted t-statistics are given in parentheses. The results show a negative and statistically significant relation between the maximum daily returns and the cross-section of future stock returns after controlling for total, systematic, and idiosyncratic skewness. Specifically, the average slope from the monthly regressions of realized returns on *MAX* and *TSKEW* or *SSKEW* and/or *ISKEW* are about –0.04 with the t-statistics ranging from –2.14 to –2.81. Consistent with earlier studies, the cross-sectional relations between expected returns and *TSKEW* and *ISKEW* are found to be negative and statistically significant, whereas *SSKEW* does not have any cross-sectional predictive power for future stock returns.

A notable point in Table VIII is that after controlling for market beta, size, and book-to-market, the statistical significance of *TSKEW* and *ISKEW* disappears, whereas the maximum daily return remains to be a significant predictor of future stock returns. Specifically, the average slope coefficient on *MAX* is about –0.08 with the t-statistics lying between –6.93 to –7.75 after controlling for beta, size, book-to-market, and alternative measures of skewness.

V. Further Robustness Checks

A. Equal-Weighted Portfolios

The previous sections analyze the value-weighted average raw and risk-adjusted return differences between the low-MAX and high-MAX portfolios after controlling for size, book-to-market, momentum, short-term reversal, liquidity, and idiosyncratic volatility. This section provides the equal-weighted average raw and risk-adjusted return differences between the low-MAX and high-MAX portfolios after controlling for the same cross-sectional effects. To save space, instead of presenting the returns of all 100 (10×10) portfolios for each control variable (e.g., size), we report the average returns of the MAX portfolios that can be viewed as averages across the 10 size deciles to produce decile portfolios with dispersion in *MAX*, but which contain all sizes of firms. This procedure creates a set of *MAX* portfolios with near-identical levels of firm size and thus these *MAX* portfolios control for differences in size.

Table XII shows that after controlling for size, book-to-market, momentum, short-term reversal, liquidity, and idiosyncratic volatility, the "equal-weighted" average return difference between the low-MAX and high-MAX portfolios is about –1.11%, –0.59%, –0.76%, –0.43%, –0.81%, and –0.91% per month, respectively. We should also note that all these average raw return differences are not only economically significant, but they are statistically significant as well. The corresponding values for the equal-weighted average risk-adjusted returns are –1.06%, –0.54%, –0.88%, –0.58%, –0.79%, and –0.92% per month, and statistically significant.[15]

These results indicate that for both the value-weighted and the equal-weighted portfolios, the well-known cross-sectional effects such as size, book-to-market, momentum, short-term reversal, liquidity, and idiosyncratic volatility can not explain the high (low) returns to low (high) MAX stocks.

B. NYSE Stocks

As discussed earlier, some readers could be skeptical of our results because of a potential correlation between the maximum daily returns and size, liquidity, and idiosyncratic volatility. To relieve these concerns, we now focus on the NYSE stocks which are generally bigger, more liquid, and less volatile as compared to the AMEX and NASDAQ sample. As a robustness check, Table XIII presents the cross-sectional Fama-MacBeth regression results for the NYSE stocks over the sample period of July 1962 to December 2005.

A notable point in Table XIII is that the magnitude and statistical significance of the average slope coefficients on *MAX* turn out to be very similar to our findings from the NYSE/AMEX/NASDAQ sample. In univariate regressions, we find a negative and statistically significant relation between the maximum daily returns and the cross-section of expected returns on NYSE stocks since the average slope, $\lambda_{1,t}$, from the monthly regressions of realized returns on *MAX* alone is about –0.06 with a t-statistic of –3.54. The strong negative relation between *MAX* and expected returns is found to be robust across different asset pricing specifications. When we include *BETA*, *SIZE*, *BM*, *MOM*, *REV*, *ILLIQ*, and *IVOL* one-by-one to the univariate regressions, the average slope coefficients on *MAX* are in the range of –0.06 to –0.09, and highly significant in all cases. For all multivariate regressions presented in the last panel of Table VI, the average slopes on *MAX* range from –0.08 to –0.11 with the t-statistics lying between –4.18 and –9.28.

A notable point in these multivariate regressions is that the negative relation between expected returns and *SIZE* and *REV*, and the positive relations between expected returns and *BM* and *MOM* remain to be strongly significant. However, for some specifications, the positive relation between illiquidity and expected returns on the NYSE stocks becomes statistically insignificant. Another notable point is that the positive relation between idiosyncratic volatility and expected returns on the NYSE/AMEX/NASDAQ

[15] The only exception is the equal-weighted average raw return difference between the high MAX and the low MAX portfolios after controlling for short-term reversal. Although the average raw return difference is economically significant at –0.43% per month (or –5.16% per annum), it is not statistically significant. We should note that the equal-weighted average risk-adjusted return difference is both economically and statistically significant after controlling for short-term reversal.

stocks is found to be either positive or negative for the NYSE stocks, and either relation is statistically insignificant in most specifications. We should note that in these multivariate regressions, the average slope coefficient on *BETA* is found to be in the range of 0.10 to 0.15 with the t-statistics lying between 1.89 and 2.60. These results indicate a positive and significant relation between market beta and expected stock returns.

Overall, we can conclude that after controlling for a large number of cross-sectional effects that the literature has identified either as potential risk factors or anomalies, there is an economically and statistically significant negative relation between the maximum daily return and expected future returns for both the NYSE/AMEX/NASDAQ and the NYSE sample.

C. Extended Sample

The results carry through to the January 1926-December 2005 sample. They also hold in subsamples of the original sample.

D. Eliminating Low-Priced Stocks

Eliminating stocks with prices below $5 has little qualitative effect on the results. If anything, it strengthens the results for the equal-weighted portfolios.

E. Nonlinearities

There are no obvious nonlinearities in MAX in the cross-sectional regressions. Adding a squared term makes IVOL look better in the univariate regressions, but not in the full specification.

VII. Conclusion

We document a statistically and economically significant relation between lagged extreme positive returns, as measured by the maximum daily return over the prior month, and future returns. This result is robust to controls for numerous other potential risk factors and control variables. Of particular interest, inclusion of our MAX variable reverses the anomalous negative relation between idiosyncratic volatility and returns in Ang et al (2006). We interpret our results in the context of a market with poorly diversified investors who have a preference for lottery-like assets. Thus the expected returns on stocks that exhibit extreme positive returns are low but, controlling for this effect, the expected returns on stocks with high idiosyncratic risk are high.

One open question is why the effect we document is not traded away by other well-diversified investors. However, exploiting this phenomenon would require shorting stocks with extreme positive returns. The inability and/or unwillingness of many investors to engage in short selling has been discussed extensively in the literature. Moreover, these stocks are small and illiquid on average, suggesting that transactions costs may be a serious impediment to implementing the relevant trading strategy.

Appendix: Variable Definitions

MAXIMUM: The upside potential of a firm is measured with the maximum daily return within a month, denoted by MAX.

BETA: To estimate monthly beta of an individual stock, we assume a single factor return generating process:

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

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*.[16] The estimated slope coefficient $\hat{\beta}_{i,t}$ in equation (1) is the market beta of stock *i* in month *t*.

SIZE: Following the existing literature, firm size is measured by the natural logarithm of the market value of equity (a stock's price times shares outstanding in millions of dollars) for each stock.

BOOK-TO-MARKET: Following Fama and French (1992), we compute a firm's book-to-market ratio using its market equity at the end of December of year *t*–1 and the book value of common equity plus balance-sheet deferred taxes for the firm's latest fiscal year ending in calendar year *t*–1.[17]

MOMENTUM: Following Jegadeesh and Titman (1993), momentum is defined as the cumulative return over the past 12 months by skipping a month between the portfolio formation period and the holding period, i.e., average monthly return from month *t*–12 to month *t*–2.

SHORT-TERM REVERSAL: Jegadeesh (1990) and Lehman (1990) provide evidence for short-term return reversals.[18] These papers show that contrarian strategies that select stocks based on their returns in the previous week or month generate significant abnormal returns. In this paper, we investigate the

[16] In our empirical analysis, $R_{m,d}$ is measured by the CRSP daily value-weighted index, i.e., the daily value-weighted average returns of all stocks trading at the NYSE, AMEX, and NASDAQ.

[17] To avoid giving extreme observations heavy weight in our analysis, following Fama and French (1992), the smallest and largest 0.5% of the observations on book-to-market ratio are set equal to the next largest and smallest values of the ratio (the 0.005 and 0.995 fractiles).

[18] Lo and MacKinlay (1990) find that short-term contrarian profits may be due to lead-lag effects between stocks.

robustness of a cross-sectional relation between MAX and expected returns after controlling for the past 1-month return.

ILLIQUIDITY: Liquidity generally implies the ability to trade large quantities quickly, at low cost, and without inducing a large change in the price level. Following Amihud (2002), we measure stock illiquidity as the ratio of absolute stock return to its dollar trading volume:

$$ILLIQ_{i,t} = |R_{i,t}| / VOLD_{i,t}\,, \qquad (2)$$

where $R_{i,t}$ is the return on stock *i* in month *t*, and $VOLD_{i,t}$ is the respective monthly volume in dollars. This ratio gives the absolute percentage price change per dollar of monthly trading volume. As discussed in Amihud (2002), $ILLIQ_{i,t}$ follows the Kyle's (1985) concept of illiquidity, i.e., the response of price to the associated order flow or trading volume. The measure of stock illiquidity given in equation (2) can be interpreted as the price response associated with one dollar of trading volume, thus serving as a rough measure of price impact.

IDIOSYNCRATIC VOLATILITY: To estimate idiosyncratic volatility of an individual stock, we assume a single-factor return generating process and measure idiosyncratic volatility with the standard deviation of the residuals from equation (3):

$$R_{i,d} - r_{f,d} = \alpha_i + \beta_i (R_{m,d} - r_{f,d}) + \varepsilon_{i,d}\,, \qquad (3)$$

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*. Idiosyncratic volatility of stock *i* in month *t* is defined as the standard deviation of daily residuals in month *t*: $IVOL_{i,t} = \sqrt{\mathrm{var}(\varepsilon_{i,d})}$.[19]

SKEWNESS: The *total skewness* of a stock is a measure of asymmetry of the return distribution around its mean. Specifically, total skewness (*TSKEW*) of stock *i* for month *t* is computed using daily returns within month *t*:[20]

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[19] At an earlier stage of the study, we replicate our main results using idiosyncratic volatility obtained from the Fama-French (1993) model: $R_{i,d} - r_{f,d} = \alpha_i + \beta_i (R_{m,d} - r_{f,d}) + s_i SMB_d + h_i HML_d + \varepsilon_{i,d}$. We should note that the results from equation (3) and those from the Fama-French (1993) model turn out to be very similar. The results are available from the authors upon request.

[20] The skewness of a symmetric distribution, such as the normal distribution, is zero. Positive skewness means that the distribution has a long right tail and negative skewness implies that the distribution has a long left tail.

$$TSKEW_{i,t} = \frac{1}{D_t}\sum_{d=1}^{D_t}\left(\frac{R_{i,d} - \mu_i}{\sigma_i}\right)^3$$

(4)

where D_t is the number of trading days in month *t*, $R_{i,d}$ is the return on stock *i* on day *d*, μ_i is the mean of returns of stock *i* in month *t*, and σ_i is the standard deviation of returns of stock *i* in month *t*.

Following Harvey and Siddique (2000), we decompose total skewness into idiosyncratic and systematic components by estimating the following regression for each stock:

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

(5)

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*. The *idiosyncratic skewness* (*ISKEW*) of stock *i* in month *t* is defined as the skewness of daily residuals $\varepsilon_{i,d}$ in month *t*. The *systematic skewness* (*SSKEW*) or co-skewness of stock *i* in month *t* is the estimated slope coefficient $\hat{\gamma}_{i,t}$ in equation (5).

References

Amihud, Yakov, 2002, Illiquidity and stock returns: Cross-section and time-series effects, *Journal of Financial Markets* 5, 31-56.

Ang, Andrew, Robert J. Hodrick, Yuhang Xing, and Xiaoyan Zhang, 2006, The cross-section of volatility and expected returns, *Journal of Finance* 61, 259-299.

Arditti, Fred D., 1967, Risk and the required return on equity, *Journal of Finance* 22, 19-36.

Arditti, Fred D., 1971, Another look at mutual fund performance, *Journal of Financial and Quantitative Analysis* 6, 909-912.

Bali, Turan G., and Nusret Cakici, 2008, Idiosyncratic volatility and the cross-section of expected returns, *Journal of Financial and Quantitative Analysis* 43, 29-58.

Barberis, Nicholas, and Ming Huang, 2005, Stocks as lotteries: The implications of probability weighting for security prices, Working Paper, Yale University.

Barone-Adesi, Giovanni, 1985, Arbitrage equilibrium with skewed asset returns, *Journal of Financial and Quantitative Analysis* 20, 299-313.

Beranrd, victor L., and Jacob K. Thomas, 1989, Post-earnings-announcement drift: Delayed proce response or risk premium? *Journal of Accounting Research, Supplement* 27, 1-48.

Brunnermeier, Markus K., Christian Gollier, and Jonathan A. Parker, 2008, Optimal beliefs, asset prices and the preference for skewed returns, Working Paper, Princeton University.

Daniel, Kent, David Hirshleifer, and Avanidhar Subrahmanyam, 1998, Investor psychology and security market under- and overreactions, *Journal of Finance* 53, 1839-1885.

Fama, Eugene F., and Kenneth French, 1992, Cross-section of expected stock returns, *Journal of Finance* 47, 427-465.

Fama, Eugene F., and Kenneth French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics* 33, 3-56.

Fama, Eugene F., and James D. MacBeth, 1973, Risk and return: some empirical tests, *Journal of Political Economy* 81, 607-636.

Friend, Irwin, and Randolph Westerfield, 1980, Co-skewness and capital asset pricing, *Journal of Finance* 35, 897-913.

Goetzmann, William N., and Alok Kumar, 2008, Equity portfolio diversification, *Review of Finance*, forthcoming.

Harvey, Campbell, and Akhtar Siddique, 1999, Autoregressive conditional skewness, *Journal of Financial and Quantitative Analysis* 34, 465-487.

Harvey, Campbell, and Akhtar Siddique, 2000, Conditional skewness in asset pricing tests, *Journal of Finance* 55, 1263-1295.

Jegadeesh, Narasimhan, 1990, Evidence of predictable behavior of security returns, *Journal of Finance* 45, 881-898.

Jegadeesh, Narasimhan, and Sheridan Titman, 1993, Returns to buying winners and selling losers: Implications for stock market efficiency, *Journal of Finance* 48, 65-91.

Kane, Alex, 1982, Skewness preference and portfolio choice, *Journal of Financial and Quantitative Analysis* 17, 15-25.

Kraus, Alan, and Robert H., Litzenberger, 1976, Skewness preference and the valuation of risk assets, *Journal of Finance* 31, 1085-1100.

Kumar, Alok, 2005, Institutional skewness preference and the idiosyncratic skewness premium, Working Paper, University of Notre Dame.

Kyle, Albert, 1985, Continuous auctions and insider trading, *Econometrica* 53, 1315-1335.

Lehman, Bruce, 1990, Fads, martingales, and market efficiency, *Quarterly Journal of Economics* 105, 1-28.

Levy, Haim, 1978, Equilibrium in an imperfect market: A constraint on the number of securities in the portfolio, *American Economic Review* 68, 643-658.

Lim, Kian-Guan, 1989, A new test of the three-moment capital asset pricing model, *Journal of Financial and Quantitative Analysis* 24, 205-216.

Lo, Andrew W., and A. Craig MacKinlay, 1990, When are contrarian profits due to stock market overreaction? *Review of Financial Studies* 3, 175-205.

Merton, Robert C., 1987, A simple model of capital market equilibrium with incomplete information, *Journal of Finance* 42, 483-510.

Mitchell, Mark, and Todd Pulvino, 2001, Characteristics of risk and return in risk arbitrage, *Journal of Finance* 56, 2135-2175.

Mitton, Todd, and Keith Vorkink, 2007, Equilibrium underdiversification and the preference for skewness, *Review of Financial Studies* 20, 1255-1288.

Odean, Terrence, 1999, Do investors trade too much? *American Economic Review*, 89, 1279-1298.

Newey, Whitney K., and Kenneth D. West, 1987, A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica* 55, 703-708.

Sears, R. Stephen, and K. C. John Wei, 1984, Asset pricing, higher moments, an the market risk premium: A note, *Journal of Finance* 40, 1251-1253.

Smith, Daniel R., 2007, Conditional coskewness and asset pricing, *Journal of Empirical Finance* 14, 91-119.

Tversky, Amos, and Daniel Kahneman, 1992, Advance in prospect theory: Cumulative representation of uncertainty, *Journal of Risk and Uncertainty* 5, 297-323.

Van Nieuwerburgh, Stijn, and Laura Veldkamp, 2008, Information acquisition and under-diversification, Working Paper, NYU.

Zhang, Yijie, 2005, Individual skewness and the cross-section of expected returns, Working Paper, Yale University.

Table I. Portfolios of NYSE/AMEX/NASDAQ Stocks Sorted by *MAX*

Decile portfolios are formed every month from July 1962 to December 2005 by sorting the NYSE, AMEX, and NASDAQ stocks based on the maximum daily returns (MAX) over the past one month. Portfolio 1 (10) is the portfolio of stocks with the lowest (highest) maximum daily returns over the past one month. Table reports the value-weighted and equal-weighted average monthly returns, alphas with respect to the 4-factor Fama-French model (FF-4 alphas), average daily maximum return of stocks within a month, and average market share of stocks in each decile. The last two rows present the differences in monthly returns and the differences in FF-4 alphas between portfolios 10 and 1. Average raw and risk-adjusted returns, average daily maximum returns, and average market shares are defined in percentage terms. Newey-West (1987) adjusted t-statistics are reported in parentheses.

Decile	**Value-Weighted Average Return**	**Equal-Weighted Average Return**	**Average MAX Return**
Low MAX	1.01	1.29	1.30
2	1.00	1.45	2.47
3	1.00	1.55	3.26
4	1.11	1.55	4.06
5	1.02	1.49	4.93
6	1.16	1.49	5.97
7	1.00	1.37	7.27
8	0.86	1.32	9.07
9	0.52	1.04	12.09
High MAX	-0.02	0.64	23.60
Return Difference	**-1.03**	**-0.65**	
	(-2.83)	**(-1.83)**	
Alpha Difference	**-1.18**	**-0.66**	
	(-4.71)	**(-2.31)**	

Table II. Time-Series Average of the MAX Transition Matrix

	Low MAX	2	3	4	5	6	7	8	9	High MAX
Low MAX	33.67	18.71	12.51	8.94	6.61	5.12	4.14	3.50	3.12	3.67
2	19.12	21.01	16.09	12.41	9.65	7.28	5.37	4.12	2.96	1.99
3	12.83	16.38	16.47	13.88	11.21	9.32	7.39	5.58	4.19	2.75
4	9.07	12.88	13.93	14.52	12.84	10.77	9.21	7.44	5.56	3.77
5	6.60	9.90	11.71	12.73	13.81	12.49	10.81	9.54	7.46	4.96
6	5.02	7.38	9.62	11.29	12.37	13.73	12.76	11.30	9.78	6.74
7	3.99	5.43	7.58	9.69	11.27	12.72	14.51	13.57	12.11	9.13
8	3.31	3.91	5.61	7.60	9.96	11.78	13.71	16.16	15.21	12.76
9	3.00	2.78	4.07	5.64	7.68	10.25	12.76	15.61	19.58	18.63
High MAX	3.61	1.73	2.45	3.32	4.82	6.66	9.42	13.49	19.93	34.57

Table III. Summary Statistics for Decile Portfolios of Stocks Sorted by *MAX*

Decile portfolios are formed every month from July 1962 to December 2005 by sorting NYSE, AMEX, and NASDAQ stocks based on the maximum (MAX) daily returns over the past one month. Portfolio 1 (10) is the portfolio of stocks with the lowest (highest) maximum daily returns over the past one month. The table reports for each decile the average across the months in the sample of the median values within each month of various characteristics for the stocks—the maximum daily return (in percent), the market beta, the market capitalization (in millions of dollars), the book-to-market (BM) ratio, our measure of illiquidity (scaled by 10^5), the price (in dollars), the return in the portfolio formation month (labeled REV), and the return over the 11 months prior to portfolio formation (labeled MOM). There are an average of 309 stocks per portfolio.

Decile	MAX	Market Beta	Size ($\$10^6$)	BM Ratio	Illiquidity (10^5)	Price ($)	REV	MOM
Low MAX	1.62	0.29	316.19	0.7259	0.2842	25.44	***	***
2	2.51	0.49	331.47	0.6809	0.1418	25.85	***	***
3	3.22	0.60	250.98	0.6657	0.1547	23.88	***	***
4	3.92	0.69	188.27	0.6563	0.1935	21.47	***	***
5	4.71	0.78	142.47	0.6605	0.2456	19.27	***	***
6	5.63	0.86	108.56	0.6636	0.3242	16.95	***	***
7	6.80	0.95	80.43	0.6738	0.4501	14.53	***	***
8	8.40	1.01	58.69	0.7013	0.7067	12.21	***	***
9	11.01	1.09	39.92	0.7487	1.3002	9.57	***	***
High MAX	17.77	1.13	21.52	0.8890	4.0015	6.47	***	***

Table IV. Value-Weighted Portfolios of NYSE/AMEX/NASDAQ Stocks Sorted by *MAX* After Controlling for SIZE, BM, MOM, REV, and ILLIQ

Double-sorted, value-weighted decile portfolios are formed every month from July 1962 to December 2005 by sorting the NYSE/AMEX/NASDAQ stocks based on the maximum daily returns after controlling for size (Panel A), book-to-market (Panel B), intermediate-term momentum (Panel C), short-term reversals (Panel D) and illiquidity (Panel E). In each case, we first sort the stocks into deciles using the control variable, then within each decile, we sort stocks into decile portfolios based on the maximum daily returns over the previous month so that decile MAX 1 (MAX 10) contains stocks with the lowest (highest) MAX. The column "Average Returns" presents average returns across the 10 control deciles to produce decile portfolios with dispersion in MAX but with similar levels of the control variable. "Return Difference" is the difference in average monthly returns between MAX 10 (high MAX) and MAX 1 (low MAX) portfolios. "Alpha Difference" is the difference in FF-4 alphas on MAX 10 (High MAX) and MAX 1 (Low MAX) portfolios. Newey-West (1987) adjusted t-statistics are also reported.

Panel A. Controlling for Size

	SIZE 1	SIZE 2	SIZE 3	SIZE 4	SIZE 5	SIZE 6	SIZE 7	SIZE 8	SIZE 9	SIZE 10	Average Returns	t-statistic
MAX 1	2.48	1.26	1.40	1.29	1.51	1.47	1.54	1.46	1.27	0.97	1.47	7.39
MAX 2	1.88	1.96	1.82	1.95	1.74	1.69	1.49	1.39	1.25	0.86	1.60	7.18
MAX 3	2.73	1.92	1.95	1.90	1.63	1.52	1.56	1.42	1.38	0.92	1.69	7.04
MAX 4	2.72	1.88	1.84	1.73	1.69	1.48	1.45	1.46	1.22	1.02	1.65	6.52
MAX 5	2.80	1.78	1.82	1.59	1.34	1.53	1.30	1.26	1.26	1.02	1.57	5.78
MAX 6	3.05	1.52	1.40	1.57	1.31	1.43	1.40	1.12	1.07	0.98	1.49	5.26
MAX 7	2.51	1.51	1.24	1.21	0.98	1.31	1.19	1.07	1.07	0.76	1.29	4.33
MAX 8	2.49	1.14	0.93	1.09	1.00	1.04	1.19	1.11	1.02	1.04	1.20	3.87
MAX 9	1.98	0.44	0.53	0.62	0.89	0.89	1.05	0.77	1.15	0.95	0.93	2.79
MAX 10	1.01	-0.37	-0.48	-0.56	-0.03	0.27	0.39	0.59	0.84	0.85	0.25	0.67
										Return Diff.	**-1.22**	**-4.49**
										Alpha Diff.	**-1.19**	**-5.98**

Panel B. Controlling for Book-to-Market Ratio

	BM 1	BM 2	BM 3	BM 4	BM 5	BM 6	BM 7	BM 8	BM 9	BM 10	Average Returns	t-statistic
MAX 1	1.18	1.05	1.01	1.22	1.16	1.25	1.17	1.26	1.53	1.36	1.22	7.18
MAX 2	0.94	0.87	1.03	0.97	1.10	1.19	1.10	1.40	1.55	1.71	1.19	6.40
MAX 3	1.03	0.96	1.18	0.86	1.13	1.36	1.24	1.47	1.72	1.77	1.27	6.47
MAX 4	0.83	0.76	0.96	1.12	1.03	1.35	1.09	1.23	1.73	1.78	1.19	5.54
MAX 5	0.33	0.92	0.88	0.97	1.22	1.26	1.35	1.37	1.89	1.48	1.17	5.34
MAX 6	0.77	0.63	0.93	1.05	1.17	1.52	1.32	1.47	1.87	1.58	1.23	4.99
MAX 7	0.65	0.76	1.04	0.59	1.14	1.41	1.44	1.35	1.52	1.45	1.13	4.37
MAX 8	0.11	0.62	1.03	1.11	0.98	1.20	1.23	1.59	1.32	0.75	0.99	3.51
MAX 9	-0.36	0.42	0.48	1.05	0.78	1.25	1.10	1.29	1.45	1.48	0.89	2.84
MAX 10	-1.25	-0.18	0.25	0.26	0.39	0.86	0.88	1.14	0.09	0.49	0.29	0.82
										Return Difference	**-0.93**	**-3.23**
										Alpha Difference	**-1.06**	**-4.87**

Panel C. Controlling for Momentum

	MOM 1	MOM 2	MOM 3	MOM 4	MOM 5	MOM 6	MOM 7	MOM 8	MOM 9	MOM 10	Average Returns	t-statistic
MAX 1	1.44	1.17	1.22	1.06	1.07	1.24	1.29	1.30	1.51	1.94	1.32	7.46
MAX 2	0.87	1.10	1.05	0.93	1.02	0.80	1.21	1.26	1.34	1.77	1.14	5.97
MAX 3	0.75	1.02	1.25	0.89	0.91	1.03	1.20	1.33	1.41	1.94	1.17	6.03
MAX 4	0.44	1.12	0.81	0.83	0.93	0.89	1.10	1.24	1.59	1.73	1.07	5.51
MAX 5	0.17	0.70	1.13	0.87	0.96	0.99	1.02	1.20	1.27	1.99	1.03	4.92
MAX 6	0.51	0.89	0.89	0.66	0.54	0.98	1.06	1.09	1.52	2.11	1.03	4.65
MAX 7	0.22	0.58	0.89	0.59	0.86	0.98	1.07	1.10	1.54	1.76	0.96	4.04
MAX 8	-0.33	0.69	0.60	1.14	0.76	1.10	1.11	1.19	1.38	1.69	0.93	3.96
MAX 9	-0.56	0.30	0.75	0.64	1.11	1.17	1.23	1.19	1.38	1.54	0.88	3.30
MAX 10	-1.30	0.22	0.31	0.79	0.92	1.02	0.98	1.01	1.32	1.45	0.67	2.26
										Return Difference	**-0.65**	**-3.18**
										Alpha Difference	**-0.70**	**-5.30**

Panel D. Controlling for Short-Term Reversal

	REV 1	REV 2	REV 3	REV 4	REV 5	REV 6	REV 7	REV 8	REV 9	REV 10	Average Returns	t-statistic
MAX 1	2.11	2.04	1.63	1.22	0.82	0.64	0.74	0.60	0.41	0.40	1.06	6.86
MAX 2	1.98	1.48	1.35	1.18	1.12	0.94	1.21	0.79	0.83	0.88	1.18	6.67
MAX 3	1.72	1.59	1.50	1.44	1.17	1.16	0.96	0.95	0.82	0.58	1.19	6.49
MAX 4	1.28	1.51	1.27	1.46	1.40	1.01	1.06	1.05	1.05	0.69	1.18	5.54
MAX 5	1.31	1.24	1.43	1.27	1.35	0.93	0.99	1.08	1.08	0.86	1.15	4.81
MAX 6	1.24	1.69	1.28	1.31	1.23	1.20	1.10	1.14	0.96	0.42	1.15	4.34
MAX 7	1.47	1.36	1.23	1.07	1.34	1.16	1.07	0.82	0.67	0.26	1.04	3.80
MAX 8	0.86	1.14	1.35	1.81	1.16	1.06	1.21	1.29	0.59	0.21	1.07	3.18
MAX 9	0.71	0.74	1.02	0.93	1.11	0.76	1.10	1.05	0.97	0.25	0.86	1.92
MAX 10	0.09	0.24	0.18	0.37	0.53	0.47	0.41	0.47	0.27	-0.47	0.25	0.50
										Return Difference	**-0.81**	**-2.70**
										Alpha Difference	**-0.98**	**-5.37**

Panel E. Controlling for Illiquidity

	ILLIQ 1	ILLIQ 2	ILLIQ 3	ILLIQ 4	ILLIQ 5	ILLIQ 6	ILLIQ 7	ILLIQ 8	ILLIQ 9	ILLIQ 10	Average Returns	t-statistic
MAX 1	0.90	1.23	1.34	1.38	1.32	1.40	1.51	1.46	1.33	1.04	1.29	6.86
MAX 2	0.95	0.96	1.23	1.23	1.24	1.46	1.57	1.70	1.41	1.38	1.31	6.67
MAX 3	1.02	1.27	1.18	1.19	1.30	1.25	1.42	1.37	1.50	1.52	1.30	6.49
MAX 4	0.96	1.05	1.14	1.19	1.15	1.06	1.22	1.40	1.65	1.50	1.23	5.54
MAX 5	0.94	1.00	1.03	1.19	1.00	1.08	1.29	1.33	0.99	1.36	1.12	4.81
MAX 6	0.96	1.01	0.83	1.29	1.05	0.96	0.88	0.85	1.16	1.54	1.06	4.34
MAX 7	1.17	1.05	0.92	1.17	1.04	1.02	0.77	0.82	0.74	1.16	0.99	3.80
MAX 8	1.08	0.85	1.09	0.92	0.90	0.86	0.85	0.67	0.50	1.07	0.88	3.18
MAX 9	1.00	1.20	0.82	0.84	0.73	0.47	0.31	0.19	-0.06	0.52	0.60	1.92
MAX 10	0.85	0.78	0.60	0.58	0.37	0.17	0.26	-0.57	-0.73	-0.49	0.18	0.50
										Return Difference	**-1.11**	**-4.07**
										Alpha Difference	**-1.12**	**-5.74**

Table V. Firm-Level Cross-Sectional Regressions

This table presents the firm-level cross-sectional regression results for the NYSE/AMEX/NASDAQ stocks for the sample period July 1962 to December 2005. Maximum (*MAX*) and market beta (*BETA*) for each stock are computed using daily data over the previous month. ***SIZE*** is the last month's log market capitalization, ***BM*** is the last fiscal year's log book-to-market ratio. ***MOM*** is the cumulative return from month t-12 to month t-2. ***REV*** is the past 1-month return. ***ILLIQ*** is the illiquidity measure of Amihud (2002) defined in the Appendix. The time-series average slope coefficients are reported in each row. Newey-West (1987) adjusted t-statistics are given in parentheses.

MAX	*BETA*	*SIZE*	*BM*	*MOM*	*REV*	*ILLIQ*
–0.0434						
(–2.92)						
	–0.0624					
	(–1.18)					
		–0.1988				
		(–4.08)				
			0.4651			
			(6.73)			
				0.7317		
				(4.67)		
					–0.0675	
					(–11.24)	
						0.0371
						(3.87)
	***	***	***	***	***	***
–0.0857	0.0722	–0.2390	0.2944	0.6285		
(–8.32)	(1.61)	(–5.13)	(4.53)	(4.77)		
–0.0651	0.0840	–0.1473	0.3346		–0.0794	
(–6.20)	(1.78)	(–3.12)	(4.72)		(–13.08)	
–0.0903	0.1146	–0.1955	0.2811			0.0220
(–8.49)	(2.40)	(–4.21)	(4.09)			(3.62)
***	***	***	***	***	***	***

Table VI. Time-Series Average of the Cross-Sectional Correlations

This table presents the average cross-sectional correlation of maximum daily return (MAX) with the minimum daily return (MIN), total volatility, and idiosyncratic volatility for each month from July 1962 to December 2005.

	MAX	MIN	TVOL	IVOL
MAX	1	0.5491	0.7591	0.7533
MIN		1	0.7603	0.7554
TVOL			1	0.9842
IVOL				1

Table VII. Portfolios of NYSE/AMEX/NASDAQ Stocks Sorted by *IVOL*

Decile portfolios are formed every month from July 1962 to December 2005 by sorting the NYSE, AMEX, and NASDAQ stocks based on the idiosyncratic volatility (IVOL) over the past one month. Portfolio 1 (10) is the portfolio of stocks with the lowest (highest) volatility over the past one month. The table reports the value-weighted and equal-weighted average monthly returns, alphas with respect to the 4-factor Fama-French model (FF-4 alphas), and the time series average of the average IVOL and MAX within a month. The last two rows present the differences in monthly returns and the differences in FF-4 alphas between portfolios 10 and 1. Average raw and risk-adjusted returns, average daily maximum returns, and average market shares are defined in percentage terms. Newey-West (1987) adjusted t-statistics are reported in parentheses.

Decile	Value-Weighted Average Return	Equal-Weighted Average Return	Average IVOL	Average MAX
Low IVOL	0.95	1.06	0.82	1.95
2	1.05	1.21	1.16	2.84
3	1.01	1.34	1.43	3.51
4	1.05	1.39	1.71	4.15
5	1.20	1.47	2.00	4.87
6	0.97	1.42	2.34	5.70
7	0.94	1.37	2.75	6.72
8	0.76	1.37	3.31	8.15
9	0.54	1.25	4.20	10.51
High IVOL	0.02	1.43	6.40	17.31
Return Diff.	**–0.93**	**0.37**		
	(–3.23)	**(1.09)**		
Alpha Diff.	**–1.33**	**–0.14**		
	(–5.09)	**(–0.64)**		

Table VIII. Value-Weighted Portfolios of NYSE/AMEX/NASDAQ Stocks Sorted by *MAX*, MIN, and *IVOL*

Double-sorted, value-weighted decile portfolios are formed every month from July 1962 to December 2005 by sorting the NYSE/AMEX/NASDAQ stocks based on the maximum daily returns after controlling for idiosyncratic volatility (Panel A), based on idiosyncratic volatility after controlling for maximum daily returns (Panel B), based on maximum daily returns after controlling for minimum daily returns (Panel C), and based on minimum daily returns after controlling for maximum daily returns (Panel D). In each case, we first sort the stocks into deciles using the control variable, then within each decile, we sort stocks into decile portfolios based on the second variable. The column "Average Returns" presents average returns across the 10 control deciles to produce decile portfolios with dispersion in the second variable but with similar levels of the control variable. "Return Difference" is the difference in average monthly returns between decile 10 and decile 1. "Alpha Difference" is the difference in FF-4 alphas across the same portfolios. Newey-West (1987) adjusted t-statistics are also reported.

Panel A. Sorted by *MAX* Controlling for IVOL

	IVOL 1	IVOL 2	IVOL 3	IVOL 4	IVOL 5	IVOL 6	IVOL 7	IVOL 8	IVOL 9	IVOL 10	Average Returns	t-statistic
MAX 1	0.93	1.33	1.25	1.44	1.56	1.28	1.35	0.74	0.62	0.66	1.12	4.62
MAX 2	1.09	1.27	1.32	1.32	1.52	1.47	1.25	1.05	0.42	0.18	1.09	4.47
MAX 3	1.13	1.08	1.12	1.28	1.50	0.93	1.10	1.01	0.42	-0.19	0.94	3.71
MAX 4	1.06	1.08	1.15	1.08	1.39	1.01	0.97	0.88	0.50	0.16	0.93	3.62
MAX 5	0.91	1.15	0.89	1.00	1.02	1.23	1.10	0.60	0.42	-0.34	0.80	2.96
MAX 6	0.94	1.22	0.86	1.04	1.23	0.93	0.91	0.82	-0.14	-0.08	0.77	2.94
MAX 7	0.78	0.95	0.92	1.29	1.28	1.35	0.96	0.33	0.38	-0.36	0.79	3.11
MAX 8	1.04	1.17	1.12	1.22	1.08	1.04	1.01	0.73	0.34	-0.54	0.82	3.08
MAX 9	0.98	0.97	0.84	1.17	0.89	0.80	0.74	0.86	0.30	0.09	0.76	2.95
MAX 10	0.99	1.10	1.09	0.98	1.36	1.15	0.87	0.56	0.18	-0.57	0.77	2.96
										Return Diff.	**-0.35**	**-2.42**
										Alpha Diff.	**-0.34**	**-2.48**

Panel B. Sorted by IVOL Controlling for MAX

	MAX 1	MAX 2	MAX 3	MAX 4	MAX 5	MAX 6	MAX 7	MAX 8	MAX 9	MAX 10	Average Returns	t-statistic
IVOL 1	0.78	1.18	1.25	1.22	1.33	1.24	1.27	1.40	1.22	0.92	1.18	5.31
IVOL 2	1.06	1.14	1.14	1.27	1.21	1.18	1.41	1.33	1.13	0.61	1.15	4.95
IVOL 3	1.04	1.17	1.28	1.24	1.15	1.21	1.19	1.20	1.07	0.48	1.10	4.56
IVOL 4	1.11	1.19	1.25	1.36	1.51	1.34	1.24	1.19	0.88	0.64	1.17	4.56
IVOL 5	1.17	1.26	1.48	1.45	1.56	1.41	1.38	1.30	1.25	0.42	1.27	4.78
IVOL 6	1.18	1.35	1.37	1.45	1.54	1.39	1.23	1.26	0.90	0.41	1.21	4.31
IVOL 7	1.24	1.62	1.53	1.57	1.55	1.55	1.59	1.08	1.06	0.87	1.37	4.74
IVOL 8	1.31	1.58	1.94	1.74	1.41	1.49	1.24	1.40	1.33	1.38	1.48	4.91
IVOL 9	1.24	1.79	1.86	1.61	1.80	1.68	1.60	1.28	1.21	1.10	1.52	4.81
IVOL 10	2.79	2.09	2.17	1.98	2.06	2.19	2.13	2.35	2.13	1.73	2.16	6.00
										Return Diff.	**0.98**	**4.88**
										Alpha Diff.	**0.95**	**4.76**

Panel C. Sorted by *MAX* Controlling for *MIN*

	MIN 1	MIN 2	MIN 3	MIN 4	MIN 5	MIN 6	MIN 7	MIN 8	MIN 9	MIN 10	Average Returns	t-statistic
MAX 1	0.86	0.81	1.30	1.44	1.42	1.22	1.26	1.33	1.21	0.94	1.18	5.95
MAX 2	0.20	1.15	1.26	1.49	1.37	1.29	1.21	1.12	1.02	1.02	1.11	5.30
MAX 3	0.17	1.02	0.68	1.37	1.30	0.98	1.26	1.21	0.91	0.87	0.98	4.34
MAX 4	0.37	1.15	0.63	1.18	1.06	1.44	1.23	1.07	0.86	0.88	0.98	4.04
MAX 5	0.50	0.77	1.41	1.19	1.54	1.37	1.03	1.04	1.18	0.88	1.09	4.37
MAX 6	-0.07	1.15	1.00	1.24	1.24	1.26	1.15	1.19	0.85	0.88	0.99	3.78
MAX 7	-0.06	0.17	0.64	1.25	1.10	1.19	1.28	1.18	0.80	0.84	0.84	3.10
MAX 8	-0.43	0.35	0.88	0.39	1.04	0.82	1.24	1.13	0.90	0.74	0.71	2.48
MAX 9	-0.62	0.02	0.39	0.76	1.13	1.14	0.69	1.24	0.85	0.86	0.65	2.14
MAX 10	-1.84	-0.68	0.40	0.16	0.85	0.84	0.99	0.97	1.18	0.93	0.38	1.22
										Return Diff.	**-0.80**	**-3.86**
										Alpha Diff.	**-0.95**	**-5.42**

Panel D. Sorted by *MIN* Controlling for *MAX*

	MAX 1	MAX 2	MAX 3	MAX 4	MAX 5	MAX 6	MAX 7	MAX 8	MAX 9	MAX 10	Average Returns	t-statistic
MIN 1	***	***	***	***	***	***	***	***	***	***	***	***
MIN 2	***	***	***	***	***	***	***	***	***	***	***	***
MIN 3	***	***	***	***	***	***	***	***	***	***	***	***
MIN 4	***	***	***	***	***	***	***	***	***	***	***	***
MIN 5	***	***	***	***	***	***	***	***	***	***	***	***
MIN 6	***	***	***	***	***	***	***	***	***	***	***	***
MIN 7	***	***	***	***	***	***	***	***	***	***	***	***
MIN 8	***	***	***	***	***	***	***	***	***	***	***	***
MIN 9	***	***	***	***	***	***	***	***	***	***	***	***
MIN 10	***	***	***	***	***	***	***	***	***	***	***	***
										Return Diff.	***	***
										Alpha Diff.	***	***

Table IX. Firm-Level Cross-Sectional Regressions with MAX, MIN and IVOL

This table presents the firm-level cross-sectional regression results with MAX, MIN and IVOL for the NYSE, AMEX, and NASDAQ stocks over the sample July 1962 to December 2005. Maximum (*MAX*), Minimum (*MIN*), market beta (***BETA***), and idiosyncratic volatility (***IVOL***) of each stock are computed using daily data over the previous month. ***SIZE*** is the last month's log market capitalization, ***BM*** is the last fiscal year's log book-to-market ratio. ***MOM*** is the cumulative return from month t-12 to month t-2. ***REV*** is the past 1-month return. ***ILLIQ*** is the illiquidity measure of Amihud (2002) defined in equation (2). The time-series average slope coefficients are reported in each row. Newey-West (1987) adjusted t-statistics are given in parentheses.

MAX	*MIN*	*BETA*	*SIZE*	*BM*	*MOM*	*REV*	*ILLIQ*	*IVOL*
–0.0434								
(–2.92)								
	0.0593							
	(2.41)							
								–0.0530
								(–0.97)
–0.0900	0.1280							
(–7.84)	(6.21)							
–0.1103	0.1029							0.0840
(–6.90)	(5.43)							(0.94)
–0.0901	0.0174	0.0320	–0.1071	0.3261	0.7100	–0.0709	0.0238	0.0649
(–6.22)	(1.12)	(0.71)	(–2.75)	(4.93)	(5.31)	(–14.70)	(3.92)	(0.83)

Table X. Value-Weighted Portfolios of NYSE/AMEX/NASDAQ Stocks Sorted by *MAX* After Controlling for SKEWNESS (TSKEW, SSKEW, ISKEW)

Value-weighted decile portfolios are formed every month from July 1962 to December 2005 by sorting the NYSE/AMEX/NASDAQ stocks based on the maximum daily returns after controlling for total, systematic, and idiosyncratic skewness. Portfolio 1 (10) is the portfolio of stocks with the lowest (highest) maximum daily returns over the past one month. This table reports the value-weighted average returns in monthly percentage terms. The column "Average Returns" refers to the average monthly returns after controlling for total skewness (Panel A), systematic skewness (Panel B), and idiosyncratic skewness (Panel C). The row "Return Difference" reports the difference in average monthly returns between MAX 10 (High MAX) and MAX 1 (Low MAX) portfolios. The row "Alpha Difference" reports the difference in FF-4 alphas on MAX 10 (High MAX) and MAX 1 (Low MAX) portfolios. Newey-West (1987) adjusted t-statistics are reported in the last column.

Panel A. Controlling for Total Skewness

In Panel A, we first form decile portfolios of NYSE/AMEX/NASDAQ stocks ranked based on their total skewness measure. Then, within each TSKEW decile, we sort stocks into decile portfolios ranked based on the maximum daily returns over the previous month so that decile 1 (10) contains stocks with the lowest (highest) MAX. The raw labeled "Average Return" averages across the 10 TSKEW deciles to produce decile portfolios with dispersion in MAX and with near-identical levels of total skewness and thus these decile MAX portfolios control for differences in total skewness.

	TSKEW1	TSKEW2	TSKEW3	TSKEW4	TSKEW5	TSKEW6	TSKEW7	TSKEW8	TSKEW9	TSKEW10	Average Returns	t-statistic
MAX 1	0.79	1.25	1.04	1.28	0.87	1.06	0.95	1.31	1.29	1.16	1.10	6.90
MAX 2	0.51	1.11	1.11	1.08	1.09	1.11	1.18	1.10	1.15	1.20	1.07	6.04
MAX 3	0.55	1.11	0.97	1.08	1.16	1.04	1.02	0.91	1.16	1.43	1.04	5.39
MAX 4	0.72	1.11	0.85	1.12	1.07	1.15	1.20	1.28	1.27	1.28	1.11	5.45
MAX 5	0.99	0.97	0.93	0.99	1.11	1.30	1.20	0.90	1.17	1.05	1.06	4.85
MAX 6	1.03	1.41	0.99	1.21	1.34	1.17	0.75	0.87	1.08	0.95	1.08	4.14
MAX 7	0.84	1.09	0.76	0.79	1.00	1.13	0.92	0.94	0.78	0.60	0.88	2.99
MAX 8	0.56	0.86	0.70	1.26	0.62	0.66	0.73	0.95	0.33	0.62	0.73	2.25
MAX 9	0.56	0.45	0.80	0.88	0.94	0.42	0.34	0.29	0.39	0.14	0.52	1.47
MAX 10	0.33	-0.04	0.17	0.39	0.24	-0.15	0.13	-0.29	0.14	-0.19	0.07	0.18
										Return Difference	**-1.03**	**-2.99**
										Alpha Difference	**-1.01**	**-4.06**

Panel B. Controlling for Systematic Skewness

In Panel B, we first form decile portfolios of NYSE/AMEX/NASDAQ stocks ranked based on their systematic skewness measure. Then, within each SSKEW decile, we sort stocks into decile portfolios ranked based on the maximum daily returns over the previous month so that decile 1 (10) contains stocks with the lowest (highest) MAX. The raw labeled "Average Return" averages across the 10 SSKEW deciles to produce decile portfolios with dispersion in MAX and with near-identical levels of systematic skewness and thus these decile MAX portfolios control for differences in systematic skewness.

	SSKEW1	SSKEW2	SSKEW3	SSKEW4	SSKEW5	SSKEW6	SSKEW7	SSKEW8	SSKEW9	SSKEW10	Average Returns	t-statistic
MAX 1	0.98	1.18	1.18	1.34	1.19	1.04	1.01	1.19	1.31	0.95	1.14	6.54
MAX 2	1.27	1.35	1.19	1.01	1.02	1.15	1.01	0.96	1.02	0.97	1.10	5.96
MAX 3	1.33	1.10	0.98	1.24	0.89	0.90	1.25	1.25	1.12	1.27	1.13	5.72
MAX 4	1.08	1.31	1.16	1.04	0.89	0.99	0.85	0.93	1.02	0.78	1.01	4.77
MAX 5	1.32	1.13	1.28	0.97	1.14	1.12	1.12	1.04	1.15	1.02	1.13	5.05
MAX 6	0.50	0.94	1.14	1.16	1.11	0.92	1.05	1.17	1.07	0.96	1.00	4.12
MAX 7	0.29	0.94	1.06	1.16	0.88	1.25	1.01	1.10	1.08	0.74	0.95	3.67
MAX 8	0.13	1.02	0.96	1.07	1.22	0.90	1.03	0.86	0.96	0.19	0.83	2.99
MAX 9	-0.27	0.52	1.07	0.84	1.11	1.19	0.99	0.96	0.76	0.53	0.77	2.42
MAX 10	-0.49	0.53	0.40	1.00	0.75	0.85	0.91	0.61	0.49	-0.08	0.50	1.40
										Return Difference	**-0.64**	**-2.46**
										Alpha Difference	**-0.70**	**-3.87**

Panel C. Controlling for Idiosyncratic Skewness

In Panel B, we first form decile portfolios of NYSE/AMEX/NASDAQ stocks ranked based on their idiosyncratic skewness measure. Then, within each ISKEW decile, we sort stocks into decile portfolios ranked based on the maximum daily returns over the previous month so that decile 1 (10) contains stocks with the lowest (highest) MAX. The raw labeled "Average Return" averages across the 10 ISKEW deciles to produce decile portfolios with dispersion in MAX and with near-identical levels of idiosyncratic skewness and thus these decile MAX portfolios control for differences in idiosyncratic skewness.

	ISKEW1	ISKEW2	ISKEW3	ISKEW4	ISKEW5	ISKEW6	ISKEW7	ISKEW8	ISKEW9	ISKEW10	Average Returns	t-statistic
MAX 1	0.76	1.03	1.22	1.22	1.16	1.17	0.98	1.28	1.20	1.24	1.12	6.96
MAX 2	0.62	0.88	1.06	0.98	1.09	0.99	1.19	1.11	1.05	1.21	1.02	5.97
MAX 3	0.70	1.22	1.03	1.01	1.10	0.86	1.17	1.20	0.99	1.41	1.07	5.81
MAX 4	1.01	1.14	1.12	1.10	1.12	1.15	1.26	1.24	1.39	1.31	1.18	5.66
MAX 5	1.06	0.81	1.21	1.22	1.20	1.14	1.02	1.17	0.77	0.84	1.04	4.73
MAX 6	0.74	1.09	0.91	1.00	0.92	1.17	1.13	1.05	1.06	1.15	1.02	4.10
MAX 7	0.83	0.87	1.21	0.99	1.10	0.87	1.13	1.12	0.98	0.68	0.98	3.62
MAX 8	0.67	1.13	0.82	1.23	0.59	0.69	0.87	0.96	0.72	0.41	0.81	2.58
MAX 9	0.57	0.64	1.16	0.91	0.95	0.67	0.77	0.34	0.25	0.37	0.66	1.88
MAX 10	0.02	0.52	0.38	0.79	-0.08	0.16	0.05	0.15	-0.34	-0.12	0.15	0.38
										Return Difference	**-0.97**	**-2.86**
										Alpha Difference	**-1.02**	**-4.61**

Table XI. Firm-Level Cross-Sectional Regressions with MAX and Skewness
NYSE/AMEX/NASDAQ Stocks

This table presents the firm-level cross-sectional regression results for the NYSE/AMEX/NASDAQ stocks. Maximum (*MAX*), market beta (*BETA*), total skewness (*TSKEW*), systematic skewness (*SSKEW*), and idiosyncratic skewness (*ISKEW*) of each stock are computed using daily data over the previous month. *SIZE* is the last month's log market capitalization, and *BM* is the last fiscal year's log book-to-market ratio. The time-series average slope coefficients are reported in each row. Newey-West (1987) adjusted t-statistics are given in parentheses.

MAX	*BETA*	*SIZE*	*BM*	*TSKEW*	*SSKEW*	*ISKEW*
–0.0368				–0.1121		
(–2.14)				(–2.89)		
–0.0413					0.0143	
(–2.81)					(0.32)	
–0.0388						–0.0854
(–2.35)						(–2.47)
–0.0397					–0.0248	–0.0791
(–2.39)					(–0.42)	(–2.23)
–0.0815	0.0900	–0.2234	0.2942	–0.0467		
(–6.93)	(2.00)	(–4.77)	(4.51)	(–1.57)		
–0.0799	0.0926	–0.2255	0.2915		0.0297	
(–7.75)	(2.07)	(–4.71)	(4.48)		(0.75)	
–0.0811	0.0895	–0.2235	0.2944			–0.0473
(–7.09)	(1.98)	(–4.76)	(4.50)			(–1.70)
–0.0819	0.0894	–0.2252	0.2910		–0.0104	–0.0393
(–7.10)	(2.01)	(–4.79)	(4.48)		(–0.21)	(–1.38)

Table XII. Equal-Weighted Portfolios of NYSE/AMEX/NASDAQ Stocks Sorted by *MAX* After Controlling for SIZE, BM, MOM, REV, ILLIQ, and IVOL

This table presents the equal-weighted average returns, 10-1 differences in average returns between High MAX and Low MAX portfolios, and 10-1 differences in 4-factor alphas between High MAX and Low MAX portfolios after controlling for size, book-to-market, momentum, short-term reversal, illiquidity, and idiosyncratic volatility. We first form decile portfolios of NYSE/AMEX/NASDAQ stocks ranked based on their size, book-to-market, past 12-month return, past 1-month return, illiquidity, and idiosyncratic volatility. Then, within each size, book-to-market, momentum, short-term reversal, illiquidity, and idiosyncratic volatility decile, we sort stocks into decile portfolios ranked based on the maximum daily returns so that decile 1 (10) contains stocks with the lowest (highest) MAX. The average returns reported below are the averages across the 10 size, book-to-market, momentum, short-term reversal, illiquidity, and idiosyncratic volatility deciles to produce decile portfolios with dispersion in MAX and with near-identical levels of size, book-to-market, momentum, short-term reversal, illiquidity and idiosyncratic volatility. Newey-West adjusted (1987) t-statistics are reported in parentheses.

Decile	SIZE	BM	MOM	REV	ILLIQ	IVOL
Low MAX	1.52	1.37	1.47	1.25	1.40	2.01
	(7.55)	(6.79)	(7.59)	(6.49)	(7.12)	(7.05)
2	1.63	1.50	1.45	1.46	1.59	1.65
	(7.28)	(7.14)	(7.09)	(7.07)	(7.38)	(5.98)
3	1.73	1.53	1.38	1.51	1.60	1.54
	(7.13)	(6.69)	(6.60)	(6.97)	(7.17)	(5.65)
4	1.70	1.54	1.32	1.52	1.58	1.41
	(6.63)	(6.25)	(6.08)	(6.30)	(6.28)	(5.15)
5	1.62	1.48	1.29	1.55	1.52	1.34
	(5.93)	(5.70)	(5.61)	(5.90)	(5.84)	(4.88)
6	1.54	1.52	1.20	1.55	1.52	1.22
	(5.44)	(5.36)	(5.07)	(5.57)	(5.50)	(4.42)
7	1.38	1.45	1.15	1.41	1.40	1.19
	(4.56)	(4.83)	(4.62)	(4.68)	(4.71)	(4.38)
8	1.27	1.33	1.08	1.38	1.32	1.23
	(4.06)	(4.05)	(4.28)	(4.18)	(4.18)	(4.42)
9	1.04	1.19	1.03	1.22	1.05	1.04
	(3.10)	(3.29)	(3.64)	(3.38)	(3.02)	(3.78)
High MAX	0.41	0.78	0.71	0.82	0.59	1.10
	(1.09)	(1.89)	(2.24)	(1.95)	(1.46)	(4.00)
Return	**-1.11**	**-0.59**	**-0.76**	**-0.43**	**-0.81**	**-0.91**
Difference	**(-4.05)**	**(-2.00)**	**(-3.70)**	**(-1.42)**	**(-2.68)**	**(-7.86)**
Alpha	**-1.06**	**-0.54**	**-0.88**	**-0.58**	**-0.79**	**-0.92**
Difference	**(-5.18)**	**(-1.96)**	**(-7.62)**	**(-2.79)**	**(-3.40)**	**(-7.96)**

Table XIII. Firm-Level Cross-Sectional Regressions with MAX
NYSE Stocks

This table presents the firm-level cross-sectional regression results for the NYSE stocks. Maximum (*MAX*), market beta (*BETA*), and idiosyncratic volatility (*IVOL*) of each stock are computed using daily data over the previous month. ***SIZE*** is the last month's log market capitalization, ***BM*** is the last fiscal year's log book-to-market ratio. ***MOM*** is the cumulative return from month t-12 to month t-2. ***REV*** is the past 1-month return. ***ILLIQ*** is the illiquidity measure of Amihud (2002) defined in equation (2). The time-series average slope coefficients are reported in each row. Newey-West (1987) adjusted t-statistics are given in parentheses.

MAX	*BETA*	*SIZE*	*BM*	*MOM*	*REV*	*ILLIQ*	*IVOL*
–0.0635							
(–3.54)							
	0.0103						
	(0.16)						
		–0.1136					
		(–2.44)					
			0.2766				
			(3.59)				
				0.9093			
				(4.70)			
					–0.0517		
					(–8.09)		
						0.1089	
						(2.44)	
							–0.1557
							(–2.47)
–0.0687	0.0777						
(–2.45)	(1.41)						
–0.0910		–0.1629					
(–5.90)		(–3.80)					
–0.0747			0.2821				
(–4.30)			(3.83)				
–0.0614				0.8612			
(–3.67)				(4.79)			
–0.0558					–0.0507		
(–3.32)					(–8.02)		
–0.0785						0.1255	
(–4.58)						(2.66)	
–0.0840							0.0695
(–4.02)							(0.77)
–0.1008	0.1294	–0.1736					
(–7.65)	(2.22)	(–3.87)					
–0.0827	0.1084		0.2901				
(–5.29)	(2.10)		(4.01)				
–0.1022	0.1398	–0.1334	0.1798				
(–7.77)	(2.48)	(–3.02)	(2.69)				

Table XIII (continued)

MAX	*BETA*	*SIZE*	*BM*	*MOM*	*REV*	*ILLIQ*	*IVOL*
–0.0985	0.1014	–0.1535	0.1774	0.7947			
(–7.73)	(1.89)	(–3.67)	(2.83)	(4.85)			
–0.0821	0.1273	–0.0868	0.1942		–0.0533		
(–6.26)	(2.22)	(–2.01)	(2.82)		(–9.26)		
–0.1099	0.1394	–0.1348	0.1765			0.0422	
(–9.28)	(2.49)	(–2.93)	(2.63)			(1.05)	
–0.0819	0.1494	–0.1344	0.1817				–0.0818
(–4.21)	(2.60)	(–3.43)	(2.76)				(–1.15)
–0.0770	0.1083	–0.1580	0.1709	0.8241	–0.0584	0.0746	–0.1188
(–4.18)	(2.00)	(–4.04)	(2.74)	(5.21)	(–10.90)	(1.72)	(–1.64)