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Idiosyncratic tail risk and expected stock returns: Evidence from the Chinese stock markets☆

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ABSTRACT

We estimate idiosyncratic tail risk according to the extreme value theory. Both portfolio analyses and cross-sectional regressions suggest a significant negative relationship between the idiosyncratic tail risk and the expected returns in Chinese stock markets after controlling for other risk measures including size, book-to-market ratio, beta, momentum, short-term reversals, liquidity, idiosyncratic volatility, downside beta, co-skewness, co-kurtosis, idiosyncratic skewness, idiosyncratic kurtosis, value at risk and maximum daily returns. Turnover explains the negative effect of the idiosyncratic tail risk in Chinese stock markets where individual investors dominate the markets and short sales are constrained.

1. Introduction

Tail risk is very important in asset pricing when the returns are asymmetrically distributed and investors are averse to disasters. Menezes et al. (1980) suggested that investors tend to avoid positions that might cause enormous losses, although with low probability. Rietz (1988) and Barro (2006) demonstrate that rare disasters or tail risks are important in explaining some of the puzzles in asset pricing. Many studies have examined the relationship between systematic tail risk and expected market returns (Allen et al., 2012; DiTraglia and Gerlach, 2013; Kelly and Jiang, 2014; Chabi-Yo et al., 2015; Oordt et al., 2016). The role of idiosyncratic tail risk in affecting stock return attracted much less attention (Huang et al., 2012).

A large number of studies have shown that idiosyncratic risk affects asset prices. Merton (1987) proposed a capital market equilibrium model with incomplete information, which indicates that the idiosyncratic risk is positively correlated with expected stock returns. Ang et al. (2006) differentiated between systematic volatility and idiosyncratic volatility and studied their different roles in asset pricing empirically. By contrast, they found that the idiosyncratic risk is negatively related with expected returns, namely, the "idiosyncratic volatility puzzle". In this paper, we separate idiosyncratic tail risk from systematic tail risk and investigate how the idiosyncratic tail risk is priced in returns.

Specifically, we follow the extreme value method in Huang et al. (2012) and estimate the idiosyncratic tail risk of each stock in the Chinese market with their residual returns from the three-factor Fama–French model (Fama and French, 1992; Fama and French, 1993). We employ univariate portfolio-level analysis, bivariate portfolio-level analysis and firm-level Fama–MacBeth regressions (Fama and Macbeth, 1973) to examine the relationship between the idiosyncratic tail risk and

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cross-sectional expected returns. Our findings show that both the "idiosyncratic tail risk puzzle" and "idiosyncratic volatility puzzle" exist in the Chinese stock market. Cross-sectionally, the idiosyncratic tail risk is significantly correlated with the expected return after we control for size, book-to-market ratio, beta, momentum, reversal, liquidity, downside beta, co-skewness, co-kurtosis, idiosyncratic skewness and idiosyncratic volatility.

Our study sheds light on the empirical asset pricing research, and our findings are of great significance to portfolio construction and risk management. Our paper contributes to the literature in three ways. First, we assume that the tail of stock returns follows a generalized extreme value (GEV) distribution and uses maximum likelihood estimation (MLE) to create a left tail index to measure the idiosyncratic tail risk. Value at risk (VaR) is frequently used to measure tail risk. However, the calculation of VaR requires a subjective confidence level or higher-order moments. Since the GEV distribution is much more generalized than the other distribution assumptions, our method avoids specifying the underlying distribution of asset returns or considering the leptokurtosis and the asymmetric characteristics of stock returns. The big data in our paper also avoids the significant estimation error in estimating the tail risk in macroeconomics (Barro, 2006). The idiosyncratic tail risk we calculate differs systematically from the other common risk measures including size, book-to-market ratio, beta, momentum, reversal, liquidity, idiosyncratic volatility, co-skewness, co-kurtosis, idiosyncratic skewness, idiosyncratic kurtosis and VaR. The idiosyncratic tail risk contains important information that affects stock price.

Second, the high volatility and frequent market crash events in the Chinese stock market provide a new scenario to investigate the relationship between idiosyncratic tail risk and expected returns and compare this relationship with that in the U.S. market. Huang et al. (2012) suggested a significant positive premium on firm-specific extreme downside risk in the U.S. stock market. Our paper finds a robust, significant, negative relationship between the idiosyncratic tail risk and returns. The "idiosyncratic tail risk puzzle" and the "idiosyncratic volatility puzzle" both exist but cannot explain each other.

Finally, we find that turnover explains the "idiosyncratic tail risk puzzle" in the Chinese stock market. Our findings are consistent with the main findings in bubble and crash research (Miller, 1977; Harrison and Kreps, 1978; Scheinkman and Xiong, 2003; Chen et al., 2001; Hong and Stein, 2003). Stocks with more heterogeneous beliefs tend to have higher turnover. Hong and Stein (2003) suggested that heterogeneous opinions and short sale constraints tend to cause market crashes and negative returns in the futures. Zhang and Ikeda (2016) found that investor' fresh disagreement negatively correlates with returns of stocks under the short sale ban in the Hong Kong Stock Exchange. Individual investors dominate the Chinese stock markets. Heterogeneous opinions and high turnover are more likely to happen. The constraints on short sales dramatically increase the idiosyncratic tail risk and the probability of a stock price crash, leading to negative future returns.

The paper is organized as follows. Section 2 presents the data and methodology. Section 3 presents the empirical results and robustness test. Section 4 contains a conclusion.

2. Data and methodology

2.1. Data

We collect daily and monthly returns of all stocks in Chinese A-share markets between January 1997 and December 2015 from the CSMAR (China Securities Market & Accounting Research) database in WRDS (Wharton Research Data Service). The 10% price limit policy took effect at the beginning of 1997. We exclude stocks that have been listed for less than one year and returns on the first day after the initial public offering. We use the value-weighted market return from CSMAR database. We use the one-year deposit rate as the risk-free rate. We also obtain the turnover, total market capitalization, book-to-market ratio, risk-free rate, and the daily and monthly Fama–French three-factor data from the CSMAR database.

2.2. Estimation of the idiosyncratic tail risk

According to Huang et al. (2012), we take the following steps to estimate the idiosyncratic tail risk.

First, for each stock i in each month, we run the time-series three-factor models in Eq. (1), with their daily returns in the month. The regression residuals $\varepsilon_{i,t}$are the idiosyncratic returns on stock i at time t.

$$\mathrm{R}_{i,t} - r_{f,t} = \alpha_i + \beta_i^{MKT}(MKT_t - r_{f,t}) + \beta_i^{SMB} SMB_t + \beta_i^{HML} HML_t + \varepsilon_{i,t} \tag{1}$$

where $R_{i,t}$ is the return on stock i at day t, MKT_t is the market return on day t, and $r_{f,t}$ is the risk-free rate at day t. SMB_t and HML_t represent daily Fama–French risk factors of size and book-to-market ratio, respectively.

Second, for each stock i in each month, we use the idiosyncratic returns of the past 250 days before the last day of the month to estimate the idiosyncratic tail risk. According to the block minima method, we choose the minimum idiosyncratic returns in every block of 20 days and denote them as X_1,X_2,..., X_n. These minimum values form an extreme sample.

Last, for each stock i in each month, with the extreme sample formed in the last step, we use the maximum likelihood estimation to compute the tail index based on the GEV distribution. We choose the ξ to maximize the following logarithmic likelihood function of GEV distribution:

$$l(\mu, \sigma, \xi) = -n \log \sigma - \left(\frac{1}{\xi} + 1\right) \sum_{i=1}^{n} \log\left(1 + \xi \frac{x_i - \mu}{\sigma}\right) - \sum_{i=1}^{n} \left(1 + \xi \frac{x_i - \mu}{\sigma}\right)^{-\frac{1}{\xi}} \tag{2}$$

where $1 + \xi \frac{x_i - \mu}{\sigma} > 0$. We denote the idiosyncratic tail risk on stock i for each month t as ITR_{it}. We have $ITR_{it} = \hat{\xi}$.

Table 1
Summary statistics.

Variable	# of obs	Minimum	Maximum	Mean	Median	Std	Skewness	Kurtosis
RET	299,780	−1.4236	3.0949	0.0155	0.0104	0.1422	0.3069	5.1851
ITR	299,780	−1.9157	7.9221	0.0773	0.0816	0.4174	0.6863	10.114
IV	299,780	0.0010	0.1305	0.0187	0.0183	0.0057	1.6902	21.7825
BETA	299,780	−1.2268	2.1844	1.0921	1.1062	0.2404	−0.3467	0.92030
SIZE	299,780	1.4100	24,200.0	86.300	30.300	454.00	26.636	948.81
BM	299,780	−4.8947	2.0267	0.3686	0.3216	0.2677	−0.66790	22.440

Note: The value −1.4236 of RET represents stock monthly minimum return is −142.36%. The unit of SIZE is 100 million RMB.

2.3. Control variables

To control the influence of the other factors on the relationship between the idiosyncratic tail risk and cross-sectional expected returns, we consider the following commonly used control variables:

Market beta (BETA): the proxy of systematic risk suggested in CAPM.
Market capitalization (SIZE): the logarithm of the market capitalization of the previous June.
Book-to-market ratio (BM): the logarithm of the book-to-market ratio at the end of the last fiscal year.
Momentum (MOM): the stock return of the previous year excluding the most recent month.
Short-term reversals (REV): the stock return of the previous month.
Illiquidity (Amihud): the absolute monthly stock return over monthly trading volume.
Turnover (Turnover): the number of shares traded in the last month over total number of outstanding shares.
Idiosyncratic volatility (IV): the standard deviation of the residual returns from the three-factor Fama–French model.
Downside beta (Beta_down): the covariance between individual stock returns and market index returns when the market is going down.
Co-skewness (Coskew): the third standardized cross central moment between the individual stock return and the market return.
Co-kurtosis (Cokurt): the fourth standardized cross central moment between individual stock return and market return.
Idiosyncratic skewness (Iskew): skewness of the residual returns from the three-factor Fama–French model.
Idiosyncratic kurtosis (Ikurt): kurtosis of the residual returns from the three-factor Fama–French model.
Value at risk (VaR): the value at risk at 5% confidence level.
Maximum daily return (MAX): the maximum daily return during the last month.

2.4. Research methods

We employ univariate portfolio-level analysis, bivariate portfolio-level analysis and firm-level cross-sectional regressions. These methods are commonly used in the empirical asset pricing literature. We follow Fama and Macbeth (1973) to run the following firm-level regressions with monthly data:

$$R_{i,t+1} = \lambda_{0,t} + \lambda_{1,t} ITR_{i,t} + \lambda_{2,t} BETA_{i,t} + \lambda_{3,t} SIZE_{i,t} + \lambda_{4,t} BM_{i,t} + \lambda_{k,t} Control_{k,t} + \varepsilon_{i,t} \tag{3}$$

where $R_{i,t+1}$ represents the realized return of stock i in month $t+1$. The independent variables are the one-month lagged values of ITR, BETA, SIZE, BM, and other control variables.

3. Empirical results

3.1. Summary statistic and correlations

Table 1 reports the summary statistics for monthly stock returns (RET) and risk measures including ITR, IV, BETA, SIZE, and BM across 299,780 firm-month observations. The kurtosis of RET is 5.1851. The mean and median of ITR are 0.0773 and 0.0816, respectively. These figures suggest that the sample stocks have tail risk on average.

Table 2 provides the average cross-sectional correlations between ITR and the other risk measures. The correlation coefficient between ITR and Iskew (Ikurt) is −0.15 (0.24). The three variables all measure the higher-order risk and have high correlations. However, we do not expect the correlations to cause a multi-collinearity problem. ITR still captures some information beyond the Iskew and Ikurt variables. The correlations between ITR and the rest of the risk measures are all economically small. Interestingly, we find a significant positive correlation between ITR and turnover.

There is a statistically significant, although economically small, correlation between ITR and IV. ITR exploits the tail information of data while IV considers the complete information. The latter has been widely studied by scholars. In the following sections, we will compare the different roles of ITR and IV in pricing stocks.

Table 2
Cross-sectional average correlations between TR and other risk measures.

Variable	Correlation	Newey–West *t* statistic
BETA	0.0178	1.5824
SIZE	0.0102	1.0455
BM	0.0547	6.0752
MOM	−0.0177	−1.4235
REV	0.0005	0.0916
Amihud	−0.0381	−6.0821
Turnover	0.0367	6.0496
Beta_down	0.0027	0.3465
Coskew	0.0372	3.4763
Cokurt	0.0125	1.0316
IV	0.0360	2.2187
Iskew	−0.1536	−4.3579
Ikurt	0.2418	18.4300
VaR	−0.0133	−0.8123
Max	0.0344	7.0683

Note: We compute cross-sectional correlation coefficients between ITR and other risk measures each month from January 1997 to December 2015. The monthly averaged correlation coefficients and the corresponding Newey-West (1987) robust t-statistics are reported.

Table 3
Returns and alphas on portfolios sorted by ITR and IV respectively.

	Low 1	2	3	4	5 High	H-L difference
Panel A: for portfolios sorted by ITR						
Equally-weighted returns	1.43%	1.28%	1.39%	1.37%	1.13%	−0.30%
	(1.89)	(1.72)	(1.84)	(1.85)	(1.50)	(−3.55)
CAPM alpha	1.28%	1.14%	1.26%	1.25%	1.00%	−0.28%
	(1.90)	(1.70)	(1.84)	(1.85)	(1.46)	(−3.51)
FF3 alpha	1.53%	1.38%	1.49%	1.47%	1.24%	−0.28%
	(2.37)	(2.17)	(2.28)	(2.28)	(1.92)	(−3.41)
Panel B: for portfolios sorted by IV						
Equally-weighted returns	1.59%	1.51%	1.40%	1.24%	0.86%	−0.74%
	(2.21)	(2.02)	(1.88)	(1.59)	(1.09)	(−2.69)
CAPM alpha	1.45%	1.36%	1.26%	1.10%	0.75%	−0.69%
	(2.29)	(2.05)	(1.88)	(1.55)	(1.02)	(−2.48)
FF3 alpha	1.63%	1.58%	1.48%	1.35%	1.07%	−0.55%
	(2.75)	(2.53)	(2.32)	(2.01)	(1.47)	(−1.85)

Note: Panel A presents quintile portfolios formed in every month from January 1997 to December 2015 by sorting stocks on the basis of the idiosyncratic tail risk (ITR) of the previous month. Portfolio 1 (5) is concerned with stocks with the lowest (highest) ITR. The table illustrates the average equal-weighted monthly returns, the CAPM alphas and the three-factor Fama–French alphas of each portfolio. The last column demonstrates the differences both in monthly returns and in alphas with respect to the CAPM model and three-factor Fama–French model between portfolios 5 and 1. In the brackets the *t*-statistics adjusted according to Newey-West (1987) are reported. Panel B is similar to Panel A but with quintile portfolios formed based on the idiosyncratic volatility (IV).

3.2. Univariate portfolio-level analysis

Table 3 presents the average equal-weighted monthly returns and alphas of quintile portfolios that are formed by sorting all stocks based on the ITR (Panel A) or IV (Panel B) of the previous month. We calculate alphas from both the Capital Asset Pricing Model (CAPM alpha) and the three-factor Fama–French model (FF3 alpha). From panel A, we can see that the average portfolio returns R_{ITR} decline as ITR increases. The average return difference between the portfolios with highest and lowest ITRs is −0.30%, which is significant at the 1% significance level. All the *t* statistics in our paper are adjusted according to Newey-West (1987). Both the average differences in CAPM alpha and FF3 alpha between the portfolios with highest and lowest ITRs are −0.28%, which are both significant at the 1% significance level. These results show that there is a significantly negative relationship between idiosyncratic tail risk and cross-sectional expected returns. We call it “idiosyncratic tail risk puzzle”. Consistent with Ang et al. (2006), Panel B shows that the “idiosyncratic volatility puzzle” also exists in Chinese stock markets.

Table 4
Bivariate analysis on the relationship between ITR and expected returns.

	TR						
Control	Low 1	2	3	4	5 High	H-L Return difference	H-L FF3 alpha
Panel A: Returns on portfolios sorted by ITR after controlling for the other risk measures							
SIZE	1.41%	1.32%	1.38%	1.31%	1.17%	−0.25%	−0.23%
	(1.88)	(1.75)	(1.86)	(1.75)	(1.55)	(−3.18)	(−2.86)
BM	1.42%	1.35%	1.33%	1.34%	1.15%	−0.27%	-0.21%
	(1.89)	(1.80)	(1.77)	(1.80)	(1.54)	(−3.13)	(−2.59)
Beta	1.39%	1.35%	1.37%	1.35%	1.14%	−0.24%	-0.18%
	(1.85)	(1.80)	(1.82)	(1.81)	(1.52)	(−2.70)	(−1.97)
MOM	1.46%	1.27%	1.36%	1.39%	1.12%	−0.34%	-0.30%
	(1.93)	(1.70)	(1.81)	(1.87)	(1.49)	(−3.98)	(−3.77)
REV	1.41%	1.33%	1.32%	1.42%	1.12%	−0.28%	-0.23%
	(1.86)	(1.77)	(1.77)	(1.89)	(1.50)	(−3.35)	(−2.95)
Turnover	1.38%	1.30%	1.39%	1.35%	1.18%	−0.20%	-0.13%
	(1.83)	(1.74)	(1.85)	(1.80)	(1.58)	(−2.68)	(−1.90)
Amihud	1.36%	1.31%	1.39%	1.38%	1.16%	−0.20%	-0.18%
	(1.81)	(1.75)	(1.85)	(1.84)	(1.55)	(−2.56)	(−2.31)
IV	1.40%	1.29%	1.37%	1.39%	1.15%	−0.26%	-0.89%
	(1.81)	(1.75)	(1.85)	(1.84)	(1.55)	(−2.86)	(−3.77)

	IV						
Control	Low 1	2	3	4	5 High	H-L Return difference	H-L FF3 alpha
Panel B: Returns on portfolios sorted by IV after controlling for ITR							
ITR	1.60%	1.53%	1.37%	1.26%	0.84%	−0.76%	−0.89%
	(1.70)	(1.54)	(1.67)	(1.62)	(1.37)	(−2.82)	(−3.77)

Note: In Panel A, we sort all firms into quintile portfolios based on each controlling risk factor. Then, we sort all firms within each portfolio into quintile portfolios based on the ITR of each stock. We get 25 portfolios in each bivariate sort. We compute the average equal-weighted returns of each of the 5 quintile portfolios by ITR across 5 quintile portfolios by each of the other risk factors. Quintile 1 (5) includes stocks with the lowest (highest) ITR. We also report the differences in returns and FF3 alphas between portfolios with highest and lowest ITR. In Panel B, we present the differences in returns and FF3 alphas between the portfolios with highest and lowest IV after controlling for ITR. We report in brackets the *t*-statistics adjusted according to Newey-West (1987).

3.3. Bivariate portfolio-level analysis

In this section, we use bivariate sort method to examine the relationship between ITR and the future stock returns after controlling for the other common risk factors. We take the SIZE factor for example. First, we sort all firms into quintile portfolios based on the size of each firm. Then, we sort all firms within each size portfolio into quintile portfolios based on the ITR of each stock. We get 25 portfolios. Second, we calculate the average equal-weighted return of each of these 25 portfolios in the next month across all months. Last, we calculate the average equal-weighted returns of each of the 5 quintile portfolios by ITR across 5 quintile portfolios by SIZE. We present these average returns in the first row of the Panel A of Table 4. The last two columns present the differences in returns and FF3 alphas between the portfolios with the highest and lowest ITRs. We report t statistics to test the significance of the difference. We implement similar studies on the interaction between the ITR and the other risk factors. In panel B of Table 4, we present the differences in returns and FF3 alphas between the portfolios with highest and lowest IV after controlling for ITR.

From Panel A of Table 4, we can see that there is a significantly negative relationship between ITR and the expected return after we control for the effect of SIZE, BETA, BM, MOM, REV, Turnover, Amihud and IV. These factors cannot fully explain the negative effect of ITR, i.e., the “idiosyncratic tail risk puzzle” in Chinese stock markets. From Panel B of Table 4, we can see that the significant negative relationship between IV and the expected return still exists after we control for the level of ITR. Both the “idiosyncratic volatility puzzle” and “idiosyncratic tail risk puzzle” exist in Chinese stock markets. They can both help price stocks but cannot fully explain each other.

3.4. Firm-level cross-sectional regressions

In this section, we examine the role of ITR on stock pricing by running regressions according to Fama and MacBeth (1973). We include BETA, SIZE and BM in all models except model 1. We classify all the rest of the control risk factors into categories that measure trading characteristics, systematic risk and idiosyncratic risk. Panel A, B and C of Table 5 present the results for regressions including ITR and the three categories of risk measures.

In all the models, the coefficients of ITR are significantly negative. Consistent with our portfolio analyses, the results further indicate a significantly negative relationship between the idiosyncratic tail risk and cross-sectional stock returns.

Table 5
Firm-level cross-sectional return regressions results controlling series other risk measures.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Panel A: Trading characteristic measures						
ITR	−0.0020***	−0.0018***	−0.0019***	−0.0016***	−0.0016***	−0.0015**
	(−2.92)	(−2.88)	(−3.13)	(−2.58)	(−2.44)	(−2.30)
BETA		−0.0036	−0.0041	−0.0042	−0.0026	−0.0032
		(−1.14)	(−1.39)	(−1.36)	(−0.82)	(−1.06)
SIZE		−0.0063***	−0.0063***	−0.0062***	−0.0053***	−0.0054***
		(−3.81)	(−3.67)	(−3.35)	(−3.36)	(−3.03)
BM		0.0045***	0.0034**	0.0046***	0.0048***	0.0044***
		(2.65)	(2.29)	(2.68)	(2.85)	(2.79)
MOM			−0.0114***			−0.0041
			(−3.23)			(−1.26)
Rev				−0.0510***		−0.0500***
				(−6.17)		(−7.19)
Amihud					1.6903***	1.6495***
					(3.92)	(4.25)
Adj R^2	0.0016	0.0681	0.09017	0.08837	0.07741	0.1114

	Model 7	Model 8	Model 9	Model 10
Panel B: Systematic risk measures				
ITR	−0.0019***	−0.0018***	−0.0016***	−0.0017***
	(−2.97)	(−2.95)	(−2.65)	(−2.76)
BETA	−0.0108**	−0.0051	−0.0090**	−0.0137***
	(−2.27)	(−1.61)	(−2.30)	(−2.58)
SIZE	−0.0060***	−0.0063***	−0.0066***	−0.0064***
	(−3.67)	(−3.91)	(−4.07)	(−4.07)
BM	0.0044***	0.0041***	0.0037**	0.0036**
	(2.66)	(2.46)	(2.22)	(2.24)
Beta_down	0.0068***			0.0045
	(2.47)			(1.30)
Coskew		−0.0766		−0.0070
		(−1.17)		(−0.06)
Cokurt			1.0086***	1.0964**
			(2.49)	(2.31)
Adj R^2	0.0725	0.0749	0.0812	0.0885

	Model 11	Model 12	Model 13	Model 14	Model 15	Model 16
Panel C: Idiosyncratic risk measures						
ITR	−0.0013**	−0.0019***	−0.0016***	−0.0019***	−0.0014**	−0.0010*
	(−2.04)	(−2.99)	(−2.63)	(−3.07)	(−2.28)	(−1.69)
BETA	−0.0011	−0.0034	−0.0037	0.0001	0.0001	−0.0024
	(−0.38)	(−1.09)	(−1.20)	(0.02)	(0.04)	(−0.68)
SIZE	−0.0070***	−0.0064***	−0.0063***	−0.0068***	−0.0067***	−0.0068***
	(−4.30)	(−3.88)	(−3.84)	(−4.29)	(−3.96)	(−4.19)
BM	0.0026	0.0044***	0.0045***	0.0039**	0.0039**	0.0025
	(1.57)	(2.67)	(2.69)	(2.23)	(2.30)	(1.64)
IV	−0.8909***					−0.8241***
	(−4.44)					(−3.83)
Iskew		0.0001				0.0002
		(0.13)				(0.24)
Ikurt			−0.0001			−0.0001
			(−0.90)			(−0.73)
VaR				−0.2348**		0.1401
				(−2.07)		(1.05)
Max					−0.2017***	−0.1744***
					(−6.69)	(−6.51)
Adj R^2	0.0811	0.0708	0.0705	0.0837	0.0776	0.1011

Note: For each month from January 1997 to December 2015, we run a firm-level cross-sectional regression according the Eq. (3). In each column, the time-series averages of the cross-sectional regression slope coefficients and their associated Newey-West (1987) adjusted *t*-statistics (in brackets) are reported. The last row reports each regression Adj R^2. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Table 6
An explanation of "the idiosyncratic tail risk puzzle".

	Model 1	Model 2	Model 3	Model 4	Model 5
ITR	−0.0011	−0.0009	−0.0009	−0.0007	−0.0006
	(−1.62)	(−1.40)	(−1.51)	(−1.09)	(−0.91)
BETA	0.0008	0.0004	−0.0076	−0.0015	−0.0017
	(0.26)	(0.15)	(−1.52)	(−0.42)	(−0.35)
SIZE	−0.0071***	−0.0062***	−0.0069***	−0.0071***	−0.0060***
	(−4.20)	(−3.51)	(−4.28)	(−4.33)	(−3.79)
BM	0.0039***	0.0039***	0.0038***	0.0030**	0.0031**
	(2.36)	(2.57)	(2.43)	(2.03)	(2.16)
MOM		−0.0022			0.0012
		(−0.67)			(0.42)
REV		−0.0411***			−0.0373***
		(−5.86)			(−5.47)
Amihud		1.1346***			1.1776***
		(3.76)			(4.20)
Beta_down			0.0057*		0.0075***
			(1.76)		(2.42)
Coskew			0.0081		0.0193
			(0.08)		(0.18)
Cokurt			0.3320		−0.3640
			(0.72)		(−0.81)
IV				−0.5783***	−0.7371***
				(−2.7)	(−3.29)
Iskew				0.0001	−0.0005
				(0.07)	(−0.54)
Ikurt				−0.0001	−0.0000
				(−0.8)	(−0.32)
VaR				0.1756	−0.0236
				(1.31)	(−0.27)
Max				−0.1196***	−0.0660***
				(−4.61)	(−2.91)
Turnover	−0.0124***	−0.0113***	−0.0126***	−0.0107***	−0.0100***
	(−7.85)	(−7.06)	(−9.47)	(−8.72)	(−8.51)
Adj R^2	0.0801	0.1202	0.0978	0.1079	0.1460

*, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

The common Fama-French factors and the other risk measures cannot fully account for the "idiosyncratic tail risk puzzle". Our finding in the Chinese stock markets is different from the finding of Huang et al. (2012) in the U.S. stock markets.

3.5. Turnover and the "idiosyncratic tail risk puzzle"

In this section, we include the turnover variable in our main models and again run regressions according to Fama and MacBeth (1973). Table 6 presents the results. We can see that the coefficients on ITR in all the models are no longer significant, while the coefficients on Turnover are all significantly negative at the 1% level. Interestingly, the variable of Turnover explains the "idiosyncratic tail risk puzzle" in Chinese stock markets.

Turnover is frequently used to represent heterogeneous beliefs and speculative trading in empirical research papers (Zhang and Ikeda, 2016; Chen et al., 2001; Scheinkman and Xiong, 2003). Miller (1977) and Hong and Stein (2003) argued that heterogeneous beliefs and short sale constraints may cause a crash. By the end of year 2015, individual investors held approximately 85% of all the public shares. Individual investors are more likely to have heterogeneous beliefs about stock valuation. Although China reduced the short sale constraint in March 2010, the constraint is still considerably large in the whole stock market. We expect that heterogeneous opinions generate high turnover in Chinese stock markets. The heterogeneous opinions and short sale constraints form a bubble, dramatically increasing the idiosyncratic tail risk and the probability of a stock price crash, thus leading to negative future returns. Our findings are consistent with the main findings in bubble and crash research.

3.6. Robustness check

We do a robustness check in three ways. First, we delete ST (i.e., special treatment) firms and firms in the financial industry. Second, we divide the full sample period into different subsamples. They are subsamples before and after December 2006, subsamples with returns higher and lower than the median index return, and subsamples before and after March 2010 when Chinese stock markets partially allowed short sales. Third, we calculate portfolio returns with different holding periods of 2, 6, and 12 months. All the results are similar to our previous findings. The tables can be provided upon request.

4. Conclusions

This paper studies the relationship between the idiosyncratic tail risk and the cross-sectional expected return in Chinese stock markets. The empirical results suggest that the idiosyncratic tail risk is significantly negatively associated with the cross-sectional expected return after we control for other risk measures including size, book-to-market ratio, beta, momentum, short-term reversals, liquidity, idiosyncratic volatility, downside beta, co-skewness, co-kurtosis, idiosyncratic skewness, idiosyncratic kurtosis, VaR and maximum daily return. The "idiosyncratic tail risk puzzle" and the "idiosyncratic volatility puzzle" both exist in Chinese stock markets. Turnover is highly related to the idiosyncratic tail risk and can explain its effect on the expected returns. The conclusion of this paper is of great significance to the portfolio construction and risk management of investors.

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