Financial Distress, Short Sale Constraints, and Mispricing

Dongcheol Kim*
Inro Lee†
Haejung Na‡

This draft: November 2016

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This paper examines whether the financial distress puzzle differs across the degree of mispricing related to firm characteristics other than financial distress, and it specifically measures the asymmetric pricing effect of short sale constraints on the puzzle. The financial distress puzzle is not observed for underpriced socks, but for stocks overpriced with respect to firm characteristics other than financial distress. The puzzle observed for overpriced stocks is prominent, irrespective of the extent of short sale constraints, but becomes more severe as short sales are more constrained. We also find that after adjustment for the factor related to short sale constraints, the financial distress puzzle becomes insignificant in all mispricing groups.

Keywords: Financial distress; Short sale constraints; Asymmetric pricing effect; Mispricing; Benchmark-adjusted returns

JEL classification: G12; G14

* Korea University Business School, Anam-dong, Seongbuk-gu, Seoul 136-701, Korea. Phone: +82-2-3290-2606, Fax: +82-2-922-7220; E-mail: kimdc@korea.ac.kr.
† Korea University Business School, 145 Anam-ro, Seongbuk-gu, Seoul 136-701, Korea. E-mail: leeinro@korea.ac.kr.
‡ Department of Finance and Law, College of Business and Economics, California State University, Los Angeles. E-mail: hna5@calstatela.edu.

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Abstract

This paper examines whether the financial distress puzzle differs across the degree of mispricing related to firm characteristics other than financial distress, and it specifically measures the asymmetric pricing effect of short sale constraints on the puzzle. The financial distress puzzle is not observed for underpriced socks, but for stocks overpriced with respect to firm characteristics other than financial distress. The puzzle observed for overpriced stocks is prominent, irrespective of the extent of short sale constraints, but becomes more severe as short sales are more constrained. We also find that after adjustment for the factor related to short sale constraints, the financial distress puzzle becomes insignificant in all mispricing groups.

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1. Introduction

A fundamental principle of asset pricing is that securities with higher risk should compensate investors with higher returns for bearing higher risk that cannot be diversified. Contrary to this asset pricing principle, recent studies show that there is a negative relation between financial distress and subsequent stock returns in the cross-section. Dichev (1998), Griffin, and Lemmon (2002), Ferguson and Shockley (2003), Garlappi, Shu, and Yan (2008), Campbell, Hilscher, and Szilagyi (2008), Avramov et al. (2009), Chou, Ko, and Lin (2010) and Chen, Chollete, and Ray (2010), among many others, report that firms with higher financial distress tend to earn lower subsequent returns.[1] Since this empirical finding imply that investors even pay a premium for bearing distress risk, it is a challenge to standard rational asset pricing models. This negative relation between financial distress and subsequent returns in the cross-section is dubbed the financial distress puzzle.[2]

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[1] Using the Altman (1968) Z-score and the Ohlson (1980) O-score as proxies for financial distress risk, Dichev (1998) finds that firms with high distress risk earn lower than average returns since 1980. Griffin and Lemmon (2002) examine the relationships between book-to-market equity, distress risk (measured by the O-score), and stock returns and report that distress risk is negatively priced among low book-to-market equity stocks. Campbell, Hilscher, and Szilagyi (2008) find that distress risk, measured by the hazard rate, is also negatively priced after controlling for the Fama and French (1993) three factors (FF3), and this negative pricing effect is particularly strong among small, illiquid stocks. Avramov et al. (2009) report that the credit risk effect is concentrated in the worst-rated stocks around downgrades that experience sharply deteriorating firm fundamentals and poor price performance. Chen, Chollete, and Ray (2010) report that the quintile with the highest credit risk, measured by both Z-score and O-score, earns lower abnormal returns than the quintile with the lowest credit risk. In addition to these studies, Ferguson and Shockley (2003) and Chou, Ko, and Lin (2010) report that distress risk is significantly negatively priced in the cross-section using a relative distress risk factor constructed in a way similar to the Fama and French (1993) factors.

[2] Some studies argue that the negative relation between financial distress risk and future stock returns is neither an anomaly nor a puzzle, but an outcome from using the poor quality proxies for ex ante expected returns and default risk. For example, Chava and Purnanandam (2010) argue that ex post realized return is a noisy proxy to estimate ex ante expected returns. These authors find a positive relationship between default risk and expected returns when implied cost of capital estimates from analysts' forecasts are used to estimate ex ante expected returns. Vassalou and Xing (2004) report a positive relation by using a simpler approach than those used by

While one group of studies (e.g., Garlappi, Shu, and Yan, 2008; Chen, Chollete, and Ray, 2010; George and Hwang, 2010; Garlappi and Yan, 2011) attempts to provide rational explanations for the financial distress puzzle,[3] another group of studies (e.g., Griffin and Lemmon, 2002; Campbell et al., 2008; Avramov et al., 2009; Chen, Chollete, and Ray, 2010; Stambaugh et al. 2012) argue that market frictions, such as short sale constraints, play the important role of incurring the financial distress puzzle. For example, Avramov et al. (2009) report that the negative relation between credit ratings and future returns is prominent among stocks with severe short sale constraints. Many other studies also point out that short sale constraints cause the financial distress puzzle. However, there are few studies that specifically examine the asymmetric pricing effect of short sale constraints on the long-leg and short-leg sides of the financial distress puzzle according to the degree of mispricing with respect to firm characteristics other than financial distress.

Garlappi, Shu, and Yan (2007) and Campbell et al. (2008, 2010) in measuring the distance-to-default from the Merton option pricing model as a proxy for default risk. Anginer and Yildizhan (2010) find a positive relation when using bond yield spread as a proxy for default risk.

[3] In their theoretical model of bargaining between equity holders and debt holders in default, Garlappi, Shu, and Yan (2008) argue that firms whose shareholders have a stronger advantage in extracting rents from negotiation with other claimholders have lower risk for equity and, hence, lower expected return as the probability of default increases, which implies that distressed firms with a stronger shareholder advantage should exhibit lower expected returns in the cross section. George and Hwang (2010) argue that since firms with high distress costs tend to choose low leverage, low-leverage firms have greater exposure to systematic risk relating to distress costs; therefore, expected returns are negatively related to leverage. By choosing low leverage, high-cost firms achieve low probabilities of financial distress, and thus, expected returns are negatively related to distress measures. These authors present empirical results consistent with this explanation. Chen, Chollete, and Ray (2010) suggest a corrected single-beta CAPM to explain the financial distress puzzle and report that the spread in average return between high and low distress stocks becomes insignificantly different from zero. In their theoretical model, which includes the likelihood of shareholder recovery from firms in financial distress, Garlappi and Yan (2011) argue that while higher leverage increases equity beta at low levels of default probability, equity betas are not increased with leverage at high levels of default probability, due to the possibility of debt renegotiation and subsequent asset redistribution on financial distress, which actually de-levers equity betas and thus reduces equity risk. As a consequence, the relationship between expected returns and default probability is hump-shaped, not positive, in the presence of shareholder recovery. These authors' empirical analysis confirms this prediction.

Firms that experience deteriorating firm fundamentals gradually become distressed. Stocks of such firms are difficult to sell, unless their prices are sufficiently lowered. In the presence of market frictions such as short sale constraints hampering the prices lowered, their overpricing may persist for a significant period, which results in low subsequent returns. However, this argument of the financial distress puzzle is valid when the other firm characteristics resulting in overpricing (e.g., mispricing) remain fixed. Financial distress is not the only firm characteristic resulting in overpricing. For example, Jegadeesh and Titman (1993) argue that momentum is a consequence of mispricing that results from investor under-reaction to information about the short-term prospects of firms, such as future profitability.[4] If underpricing (overpricing) of past winners (losers) is a consequence of a delayed response to good (bad) prospects of firm future profitability, investors in overpriced past losers would react differently from investors in underpriced past winners, even though past winners and past losers are equally financially distressed. In other words, the extent of the financial distress puzzle differs across past winners and past lowers (i.e., across the degree of mispricing related to momentum). Another example of a firm characteristic related to mispricing is asset growth. According to Cooper, Gulen, and Schill (2008), firms with high (low) asset growth tend to earn low (high) subsequent returns. These authors interpret this tendency in returns as the consequence of investor overextrapolation of past gains to growth. As a result, overpricing (underpricing) of stocks with high (low) asset growth persists for a significant period. As in the above argument on momentum, the extent of the financial distress puzzle differs with the degree of mispricing related to asset growth.

[4] Several papers argue that momentum is closely related to future profitability. For example, according to Hou, Xue, and Zhang (2015), the main reason that momentum is explained by their q-factor model is that momentum profits are highly positively related to the profitability factor in their q-factor model.

The purpose of this study is three-fold. First, we examine whether the extent of the financial distress puzzle differs according to the degree of mispricing related to firm characteristics other than financial distress. As such firm characteristics, according to Stambaugh, Yu, and Yuan (2015), we select momentum, asset growth, net stock issues, composite stock issues, total accruals, net operating assets, gross profitability, return on assets, and investment-to-asset to measure the degree of mispricing. Second, we examine whether the asymmetric pricing effect of short sale constraints on the financial distress puzzle differs according to the degree of mispricing. The financial distress puzzle is asymmetric. In other words, the extent to which highly distressed stocks are overpriced is greater than the extent to which rarely distressed stocks are underpriced.[5] This asymmetric mispricing across financial distress is deepened by short sale constraints due to impediments to short selling. Third, we measure specifically how much of the financial distress puzzle, particularly overpricing of highly distressed stocks, is explained by short sale constraints, by constructing a factor related to short sale constraints.

We find that the financial distress puzzle is observed only for stocks overpriced with respect to the above-mentioned firm characteristics, not for stocks underpriced relative to such firm characteristics, irrespective of the level of short sale constraints, when using both raw returns and benchmark-adjusted returns (in terms of the Fama and French (1993) three factors). In both

[5] Stambaugh, Yu, and Yuan (2012) report that asymmetric mispricing is especially severe in the financial distress anomaly than in other well-known return anomalies. For example, these authors show in their Table 3 that the magnitude of the average abnormal returns of the long-leg and short-leg portfolios for the two financial distress anomalies (the Campbell et al. (2008) failure probability and the Ohlson (1980) O-score) are 0.29 percent and -1.02 percent, respectively. This indicates that the degree of overpricing is much greater than that of underpricing. This asymmetry in mispricing between the long-leg and short-leg portfolios in the financial distress anomalies is greatest among the 11 anomalies investigated by Stambaugh et al. (2012). The average abnormal returns for the other 9 anomalies are 0.29 percent and -0.49 percent, respectively. The magnitude of the underpricing is similar, but that of the overpricing in the financial distress anomalies is much greater than that in the other 9 anomalies.

univariate portfolio tests and multivariate regression tests, we show that the financial distress puzzle observed in overpriced stocks becomes more severe as short sales are more constrained (i.e., as institutional ownership is lower, stock borrowing cost is higher, exchange-traded stock options are unavailable, and the uptick rule governing short sale activities is enforced). By using the factor related to short sale constraints, we confirm that there is a strong asymmetric pricing effect of short sale constraints on the financial distress puzzle (i.e., a strong pricing effect on its short-leg side but little pricing effect on its long-leg side) and find this asymmetric pricing effect strong, regardless of the degree of mispricing. We also find that after adjustment for the factor related to short sale constraints, the financial distress puzzle becomes insignificant in all mispricing groups.

The remainder of this paper proceeds as follows. Section 2 explains proxies for financial distress risk, mispricing, and short sale constraints. Section 3 describes the data, and Section 4 reports our main empirical results. Section 5 sets forth our conclusions.

2. Proxies for Financial Distress Risk, Mispricing, and Short Sale Constraints

2.1. Proxy for Financial Distress Risk

There are several models widely used in empirical research and practice to predict financial failure. The most notable ones are the accounting-based Altman (1968) Z-score model and the Ohlson (1980) O-score model, the market-based distance-to-default model, which is derived from the Black-Scholes-Merton option pricing model,[6] and the Shumway (2001) and Campbell et al. (2008)

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[6] Garlappi, Shu, and Yan (2008) and Campbell et al. (2010) report a negative relation between financial distress

hazard models which use explanatory variables constructed from both observable accounting and market-based measures. Among these, we use the Campbell et al. (2008) hazard model to measure financial distress risk, since the literature reports that this model outperforms the other competing bankruptcy prediction models in terms of forecasting accuracy. For example, Shumway (2001) reports that the hazard model is more accurate than the Z-score model in out-of-sample forecasts. Hillegeist et al. (2004) report that the KMV distance-to-default model provides significantly more information in predicting bankruptcy than various modifications of the accounting-based Z-score and O-score models. Campbell et al. (2010) report that their hazard model almost doubles forecast accuracy relative to the KMV distance-to-default model.

The Campbell et al. (2008) financial distress model is a logit model, as in Shumway (2001) and Chava and Jarrow (2004). The probability of financial failure of firm i over the next period t is estimated as

$$P_{t-1}(Y_{it}=1)=\frac{1}{1+\exp\left(-\hat{\alpha}-\hat{\beta}x_{i,t-1}\right)}, \tag{1}$$

where $x_{i,t-1}$ is a vector of explanatory variables of firm i known at the previous period t-1. The parameter estimates and the explanatory variables used in the hazard equation of (1) are

$$\begin{aligned}-\hat{\alpha}-\hat{\beta}x_{i,t-1}\equiv{}&-9.16-20.26\ \mathrm{NIMTAAVG}_{i,t-1}+1.42\ \mathrm{TLMTA}_{i,t-1}-7.13\ \mathrm{EXRETAVG}_{i,t-1}\\&+1.41\ \mathrm{SIGMA}_{i,t-1}-0.045\ \mathrm{RSIZE}_{i,t-1}-2.13\ \mathrm{CASHMTA}_{i,t-1}\\&+0.075\ \mathrm{MB}_{i,t-1}-0.058\ \mathrm{PRICE}_{i,t-1}.\end{aligned} \tag{2}$$

The definitions of the explanatory variables are set forth in footnote 7,[7] and the estimates for the

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risk and subsequent returns by using Moody's KMV measure of distance-to-default, while Vassalou and Xing (2004) report a positive relation by using a simpler approach to measure distance-to-default.

[7] The definition of the variables in equation (2) are as follows.

parameters in equation (1), α and β, are obtained from Table IV in Campbell et al. (2008).

2.2. Proxy for Mispricing

Since the degree of mispricing is not directly observable, we use a proxy for mispricing. To the extent that an anomaly represents mispricing, we construct a measure of mispricing based on return anomalies that asset pricing models, say the Fama and French (1993) three-factor model, fail to explain satisfactorily for the cross-section of stock returns. To measure the degree of mispricing (i.e., overpricing), we choose nine firm characteristics used in Stambaugh, Yu, and Yuan (2015), which are related to the well-known return anomalies. These are: (i) net stock issues (Ritter, 1991; Loughran and Ritter, 1995; Fama and French, 2008), (ii) composite equity issues (Daniel and Titman, 2006), (iii) total accruals (Sloan, 1996), (iv) net operating assets (Hirshleifer et al., 2004), (v) momentum (Jegadeesh and Titman, 1993), (vi) gross profitability (Novy-Marx, 2013), (vii) asset growth (Cooper, Gulen, and Schill, 2008), (viii) return on assets (Fama and French,2006; Chen, Novy-Marx, and Zhang, 2010), and (ix) investment-to-assets (Titman, Wei, and Xie, 2004; Xing, 2008).

$$\text{NIMTA}_{it} = \frac{\text{Net Income}_{i,t}}{(\text{ME}_{i,t} + \text{Total Liabilities}_{i,t})}, \quad \text{TLMTA}_{i,t} = \frac{\text{Total Liabilities}_{i,t}}{(\text{ME}_{i,t} + \text{Total Liabilities}_{i,t})}, \quad \text{MB}_{i,t} = \frac{\text{ME}_{i,t}}{\text{BE}_{i,t}},$$

$$\text{EXRET}_{i,t} = \log(1 + R_{it}) - \log(1 + R_{\text{S\&P500},t}), \quad \text{RSIZE}_{i,t} = \log\left(\frac{\text{ME}_{i,t}}{\text{Total S\&P500 Market value}_t}\right),$$

$$\text{CASHMTA}_{i,t} = \frac{\text{Cash and Short Term Investments}_{i,t}}{(\text{ME}_{i,t} + \text{Total Liabilities}_{i,t})},$$

SIGMA is the standard deviation of each firm's daily stock return over the past three months, PRICE is the log of the stock price, which is capped at \$15, ME is market equity, BE is book equity, NIMTAAVE is (geometrically) weighted average profitability, computed as

$$\text{NIMTAAVG}_{t-1} = [(1-\phi^3)/(1-\phi^{12})](\text{NIMTA}_{t-1,t-3} + \cdots + \phi^9\, \text{NIMTA}_{t-10,t-12}), \quad \phi = 2^{-1/3},$$ and EXRETAVG is the (geometrically) weighted average return over the last two months, computed as

$$\text{EXRETAVG}_{t-1} = [(1-\phi)/(1-\phi^{12})](EXRET_{t-1} + \cdots + \phi^{11}\, EXRET_{t-12}).$$

For the anomaly related to each firm characteristic, we rank all stocks each month according to the magnitude of the anomaly variable and assign a rank percentile to each stock such that the highest (lowest) rank is assigned to the stock that has the lowest (highest) abnormal return. The higher the rank, the greater the relative degree of overpricing according to the given anomaly variable. At a given month, we then compute the cross-sectional average of its rank percentiles of the nine anomalies. Thus, the stocks with the highest (lowest) average rank percentile are referred to as arguably the most overpriced (underpriced). As noted in Stambaugh et al. (2015), this mispricing measure is cross-sectional and relative. That is, it indicates that a stock identified as the most underpriced in a month is the least overpriced within the cross-section. This stock might actually not be underpriced. It is noteworthy, therefore, that a mispricing measure based on a stock's various firm characteristics may be an imperfect proxy for mispricing, since it may be a measure of potential mispricing, possibly due to noise traders, rather than a measure of actual mispricing that survives after arbitrage.[8] Throughout this paper, we include stocks for which at least four among the nine anomaly variables are available to compute the rank percentile.

2.3. Proxies for Short Sale Constraints

Previous research suggests several proxies for short sale constraints, which impede the adoption of short positions. We include the following proxies: institutional ownership, stock borrowing cost, presence of exchange-traded options, and implementation of the uptick rule governing short sale

[8] Among the 11 anomalies used by Stambaugh, Yu, and Yuan (2015), two anomalies, the Campbell et al. (2008) financial distress and the Ohlson (1980) O-score bankruptcy probability, are not included in this study, since these are related to the financial distress puzzle on which this study focuses.

activities. Note that we do not include short interest as a proxy for short sale constraints because there is a controversy over its use as a proxy for short sale constraints.[9]

A. Institutional Ownership

Most recent literature uses institutional ownership to proxy for short sale constraints. Chen, Hong, and Stein (2002) show that short sale constraints are strongly linked to breadth of ownership, defined as the number of (institutional) investors with long positions in a particular stock, arguing that according to the increase (decrease) in the number of institutions owning a stock, short sale constraints are relaxed (tightened). Using a proprietary database from one lender, D'Avolio (2002) directly tests whether institutional ownership affects the amount of short selling. This author finds that the degree of institutional ownership explains much (55 percent) of the variation in stock loan supply across stocks and concludes that institutional investors are the main suppliers of stock loans. This indicates that stocks with low institutional ownership are more expensive to borrow and are thus more likely to be short-sale constrained.

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[9] One group of researchers argues that high (low) short interest indicates more (less) short-sale constrained, while the other group argues the opposite. The former group (e.g., Figlewski, 1981; Figlewski and Webb, 1993; Asquith and Meulbroek, 1995; Dechow, Meulbroek, and Sloan, 2001; Desai et al., 2002; Asquith, Pathak, and Ritter, 2005; Au, Doukas, and Onayev, 2009; Boehme, Danielsen, and Sorescu, 2006) argues that the high level of observed short interest for a stock indicates high demand to short the stock and thus the stock would be difficult to short. However, the latter group argues the opposite. For example, Chen, Hong, and Stein (2002) argue against using short interest as a proxy for either short sale costs or shorting demand. These authors point out that the majority of stocks have low or virtually no short interest outstanding at any given time and these stocks may simply be ones that are difficult or costly to short, not necessarily ones that are short-sale relaxed. A stock that is impossible to short has an infinite shorting cost, but the level of short interest will be zero. Jones and Lamont (2002) also point out that demand for shorting should respond to both the cost and benefit of shorting stocks, such that stocks that are very costly to short will have low short interest. D'Avolio (2002) and Nagel (2005) suggest that short selling costs are mostly related to institutional holding rather than short interest.

Nagel (2005) argues that since there is a strong cross-sectional positive relation between firm size and institutional ownership, sorting stocks on institutional ownership results in the cross-sectional return predictability of institutional ownership mixed with that of firm size, and it is therefore necessary to purge such size effects. Following Nagel (2005), we use residual institutional ownership as a proxy for short sale constraint. Residual institutional ownership (IO) is the residual obtained from the following regression: $logit(INST_{i,t}) = \beta_0 + \beta_1 \log(SZ_{i,t}) + \beta_2 \log(SZ_{i,t})^2 + \varepsilon_{it}$, where $INST_{i,t}$ is the fraction of shares outstanding of firm i at month t held by institutional investors, $\text{logit}(INST_{i,t}) = \log[INST_{i,t}/(1 - INST_{i,t})]$, and $\log(SZ_{i,t})$ denotes the log of market capitalization.

B. Stock Borrowing Costs

Lending fees charged by lenders are the direct costs of shorting stocks and are probably the best measure of short sale constraints. For such fees, we use the Daily Cost to Borrow Score (DCBS) obtained from the Markit Securities Finance Analytics Database, which covers about 80 percent of U.S. equities and 85 percent of the securities lending market.[10] DCBS is a measure of the relative cost of borrowing for each stock which is computed by Markit for each stock-day based on actual lending fees. DCBS is an integer categorization ranging from 1 (low cost; easy to borrow) to 10 (high cost; hard to borrow).

[10] The Markit database includes data from 125 large custodians and 32 prime brokers in the securities lending industry of the U.S.

C. Option Status

Investors can take short positions in stocks by buying put options and/or writing call options without selling short directly. Stocks with exchange-traded options are therefore less short-sale constrained, since investors can more easily establish short positions via options at lower cost than in the case of directly borrowing stocks. Boehme, Danielsen, and Sorescu (2006) show that stocks with listed options have lower average fee levels than non-optioned stocks after controlling for short interest. Figlewski and Webb (1993) and Danielsen and Sorescu (2001) report that short interest tends to increase with option listing, which suggests that option introduction facilitates short selling by allowing the lowest-cost trader to establish more easily the short position in the underlying market.

D. The Uptick Rule.

Since 1938, short sales had been prohibited when stock prices were declining, a regulation referred to as the uptick rule. In July 2004, however, the Securities and Exchange Commission (SEC) adopted a new regulation on short selling activities, referred to as Regulation SHO, which included a pilot program to temporarily suspend this restriction for a randomly selected sample of one-third of the Russell 3000 stocks (the pilot stocks). The pilot stocks were actually exempted from short sale price tests from May 2, 2005 to August 6, 2007. After the pilot program, the SEC completely removed short-sale price tests for all exchange-listed stocks. The purpose of the uptick rule was to limit short selling of stocks. In fact, studies report that the uptick rule impedes short-sale activities.[11] Therefore, elimination of the uptick rule relaxes short sale constraints and decreases the cost of short selling. We examine the effect of elimination of the uptick rule on the financial distress puzzle.

3. Data

Stock price, return, number of shares outstanding, trading volume, and data for all NYSE, AMEX, and NASDAQ common stocks of non-financial firms are obtained from the Center for Research in Securities Prices (CRSP) monthly data file, and financial statement data are obtained from the Compustat database. Returns of delisted firms are adjusted for delisting bias using the method suggested by Shumway (1997). As a proxy for short sale constraint, we obtain institutional investor holdings data from Thomson Reuters Institutional (13f) holdings S34 files, stock borrowing costs measured by DCBS from the Markit (formerly Data Explorers) Securities Finance Analytics Database, and option status data from OptionMetrics. The full sample period for the data is January 1981 to December 2014, except for stock borrowing costs and option status data, whose sample periods are September 2004 to December 2014 and January 1996 to August 2014, respectively. We exclude stocks priced below $1 at the formation of the portfolios to mitigate biases subject to market microstructure.

Table 1 presents basic statistics of all proxy variables (financial distress measure of Campbell et al. (2008), overpricing measure in rank percentile, residual institutional ownership, stock borrowing cost by DCBS, and option status) and the correlation coefficients among these

[11] See Angel (1997), Alexander and Peterson (1999), and Chung (1991), among others.

variables. The financial distress measure is significantly positively correlated with the overpricing measure (0.25 with p-value less than 0.01) and is significantly positively correlated with the extent of short sale constraints. Table 1 also presents averages of all proxy variables across the five quintile variables sorted on the financial distress measure every month. As financial distress increases, the average raw return decreases, the measure of overpricing increases, and the extent of short sale constraints increases (i.e., residual institutional ownership decreases, stock borrowing costs increase, and the status of option presence decreases).

4. Empirical Results

4.1. Mispricing and Financial Distress

As a preliminary step in examining the financial distress puzzle according to the degree of mispricing related to firm characteristics other than financial distress, we first form 25 (5 × 5) portfolios by sorting all stocks each month on the intersection of the five financial distress risk measures and the five mispricing measure groups and holding the stocks in the portfolio for the next month over the period January 1981 through December 2014. The portfolios are monthly-rebalanced and value-weighted. Note that distress portfolio 1 (portfolio 5) includes stocks with the lowest (highest) financial distress, and mispricing portfolio 1 (portfolio 5) includes the most underpriced (overpriced) stocks.

Table 2 presents average raw returns (Panel A) and abnormal returns (Panel B) of the 25 portfolios. Abnormal returns are the intercept estimate obtained from regressing the excess returns of the portfolio on the Fama and French (1993) three factors. Consistent with prior studies, this table shows that more (less) distressed firms earn lower (higher) subsequent returns. Specifically, using all stocks, average raw returns and abnormal returns across the five quintile distress portfolios monotonically decrease with the financial distress measure. The difference in average raw returns between the highest and lowest distress portfolios ("High-Low") is -0.77 percent per month, with t-statistic of -2.06, and the difference in abnormal returns between these two portfolios is -1.43 percent per month, with t-statistic of -5.05. These two arbitrage returns are statistically strongly significant at conventional levels. In particular, the degree of mispricing across financial distress is asymmetric. In other words, the extent to which highly distressed stocks are overpriced ($\hat{\alpha}_5 = -1.24$ percent) is much greater than the extent to which low-distress stocks are underpriced ($\hat{\alpha}_1 = 0.19$ percent). These results are consistent with previous studies (e.g., Griffin and Lemmon, 2002; Campbell et al., 2008; Avramov et al., 2009; Stambaugh et al., 2012).

We find, however, that the negative relation between financial distress and subsequent returns is strongly maintained only for overpriced stocks, not for underpriced or fairly priced stocks, when we break down the (overall) negative relation according to the degree of mispricing. The difference in average raw returns between "high" and "low" distress portfolios is statistically significant at conventional levels only within the most "overpriced" quintile portfolio (P5); it is -1.56 percent (t-statistic of -3.92). Meanwhile, this difference is positive or insignificantly negative in the other mispriced (less overpriced) quintile portfolios. The differences in abnormal returns between "high" and "low" distress portfolios are statistically significant at conventional levels only within the most and next most "overpriced" quintile portfolios (P5 and P4); -2.10 percent (t-statistic of -6.11) and -1.27 percent (t-statistic of -3.59), respectively. However, the differences are negative but statistically insignificant within the other mispriced quintile portfolios.

In summary, the financial distress puzzle is prominent only for stocks overpriced with respect to firm characteristics other than financial distress.

4.2. Effect of Short Sale Constraints on the Financial Distress Puzzle; Portfolio Tests

We examine how the extent of the financial distress puzzle observed in overpriced stocks differs according to the extent of short sale constraints. Again, as proxy variables for short sale constraints, we use residual institutional ownership, stock borrowing cost by DCBS, option status (i.e., presence of exchange-traded stock options), and elimination of the uptick rule. Among these proxies, institutional ownership, stock borrowing cost, and option status may affect activities of short sales cross-sectionally as well as intertemporally, while the uptick rule may affect activities of short sales only intertemporally.

To carry out our portfolio tests, we construct portfolios by first assigning stocks into one of five mispricing quintile portfolios, and then within each mispricing quintile portfolio, by sorting stocks on the intersection of the Campbell et al. (2008) financial distress measure and the proxy variable for short sale constraints. The high (low) financial distress subsample consists of the top (bottom) 20 percent of stocks sorted on the financial distress measure. A stock is classified as more (less) short-sale constrained if it is included in the low (high) 30 percent group of residual institutional ownership, if its DCBS is greater than 1 (equal to 1), if it has not (has) exchange-traded options, and if the uptick rule is enforced (eliminated) for the stock.

Tables 3, 4, 5, and 6 present abnormal returns of the low and high distress portfolios across the degree of mispricing for each of the cases of short sale constraints proxied by residual institutional ownership, stock borrowing cost, option status, and the elimination of the uptick rule, respectively.

When residual institutional ownership is used as a proxy variable for short sale constraints (Table 3), the negative relation between financial distress and subsequent returns found in overpriced stocks is more severe for low institutional ownership than for high institutional ownership. In other words, there is an apparent differential effect of "low" (more short-sale constrained) and "high" (less short-sale constrained) institutional ownership on the negative relation. Specifically, the differences in abnormal return between high and low-distress stocks ("High-Low") using all stocks are -2.01 percent per month (t-statistic of -6.29) and -1.08 percent per month (t-statistic of -3.63) for low and high IO groups, respectively. The difference in "High-Low" between the low and high IO groups (i.e., difference in difference; DiD) is statistically significant at the 5 percent level; it is -0.93 (t-statistic of -2.14).

However, the above-mentioned differential effect differs across the degree of mispricing. This differential effect is prominent only for overpriced stocks. Specifically, within the most overpriced quintile portfolio (P5), the differences in abnormal return between high and low-distress stocks ("High-Low") are -2.61 percent (t-statistic of -5.65) and -0.92 percent (t-statistic of -2.19) for low and high IO groups, respectively. The difference in High-Low between these two low and high IO groups (i.e., DiD) in P5 is -1.69 (t-statistic of -2.69), which is statistically significant at the 1 percent level. However, this differential effect is not found in the underpriced quintile portfolios (P1, P2, and P3). The DiDs in these underpriced portfolios are much smaller in magnitude than the case of P5 and are statistically insignificant at the conventional significance levels.

When stock borrowing cost is used as the proxy for short sale constraints (Table 4), we obtain similar results. That is, the distress puzzle found only for overpriced stocks is more severe when stock borrowing cost is higher (DCBS greater than 1). Specifically, within the most overpriced portfolio (P5), the differences in abnormal return between high and low-distress stocks ("High-Low") are -3.56 percent (t-statistic of -2.24) and -0.60 percent (t-statistic of -1.05) for high and low stock borrowing cost groups, respectively. Thus, the difference in High-Low between these two high and low stock borrowing cost groups (i.e., DiD) in P5 is -2.95 (t-statistic of -1.75), which is statistically significant at the 10 percent level. However, this differential effect is not found for the underpriced portfolios. Note that although the differences in abnormal return (i.e., High-Low and DiD) in this case are similar in magnitude to the cases of using the other proxy variables, their statistical significance is weaker than those cases. The reason for the weaker statistical significance may be the smaller sample size in time-series.[12]

When option status and the elimination of the uptick rule are used as proxies for short sale constraints (Table 5), similar results are obtained for the differential effect of the extent of short

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[12] Since the DCBS data is unavailable for the period prior to September 2004, we attempt to estimate loan fees for the full sample period from January 1981 to December 2014 by using the logit model estimated by D'Avolio (2002) to match with the sample period of institutional ownership. According to the D'Avolio logit model, the stock loan fee for firm i at time t is computed as Loan $\text{Fee}_{it} = exp(\hat{y}_{it})/[1 + exp(\hat{y}_{it})]$, where

$$\hat{y}_{it} = -0.46\, Size_{it} - 2.80\, IO_{it} + 1.59\, TURN_{it} - 0.09\, CF_{it} + 0.86\, IPO_{it} + 0.41\, Glam_{it},$$

$Size$ is the log of market equity value, IO is the number of shares held by 13F filing institutional investors as a percentage of shares outstanding for the quarter to which the given month belongs, $TURN$ is monthly turnover, calculated by scaling CRSP monthly trading volume by shares outstanding, CF is cash flows scaled by total book assets, IPO is an indicator set to 1 for stocks within 1 year of their issue date as provided by the Securities Data Company (SDC), and $Glamour$ is an indicator set to 1 for stocks in the bottom three deciles of book-to-market (See also Ali and Trombley, 2006 for the use this logit model).

Using these loan fee estimates, we have obtained the results with a much stronger statistical significance than in the case of using DCBS. Specifically, the High-Low's for high and low loan fee groups using all stocks are -1.86 percent (t-statistic of -5.01) and -0.71 percent (t-statistic of -2.86), respectively, and thus, the DiD is -1.15 (t-statistic of -2.57). However, this differential effect is more prominent only for overpriced stocks. The difference in "High-Low" between the two high and low loan fee groups (DiD) for P5 is -1.31 percent (t-statistic of -2.06). However, the DiD for the underpriced portfolio (P1) is statistically insignificant; it is -0.60 percent (t-statistic of -0.99). The detailed results are available upon request.

sale constraints on the financial distress puzzle. The differential effect of the presence of exchange-traded stock options on the financial distress puzzle is also found only for overpriced stocks. Specifically, within the most overpriced portfolio (P5), the differences in abnormal return between high and low-distress stocks ("High-Low") are -3.68 percent (t-statistic of −5.24) and −1.13 percent (t-statistic of −2.18) for "No" (absence of exchange-traded options; more short-sale constrained) and "Yes" (presence of exchange-traded options; less short-sale constrained) groups, respectively. Thus, the difference in High-Low between the "No" and "Yes" groups (i.e., DiD) in P5 is -2.55 (t-statistic of -2.92). A similar pattern is found in the next-most overpriced portfolio (P4). However, this differential effect is hardly found in the underpriced portfolios.

Table 6 reports abnormal returns of the portfolios for the "Yes" period (in which the uptick rule is enforced from January 1981 to December 2004) and the "No" period (in which the uptick rule is eliminated for all exchanged-traded stocks from January 2008 to December 2014). The High-Low's (between high and low-distress stocks) using all stocks are −1.57 percent (t-statistic of −4.96) for the "Yes" period (more short-sale constrained) and− 0.55 percent (t-statistic of −1.01) for the "No" period (less short-sale constrained). Thus, the difference in High-Low between the "Yes" and "No" periods using all stocks is negative but barely statistically significant at conventional levels; it is −1.02 (t-statistic of −1.41), which indicates a meager differential effect. However, this differential effect of the uptick rule differs according to the degree of mispricing. Specifically, within P5, the High-Low for the "Yes" period is −2.26 percent (t-statistic of −5.23), while that for the "No" period is -0.53 percent (t-statistic of −0.73). Thus, the difference in High-Low between the "Yes" and "No" periods in P5 is −1.73 percent (t-statistic of −1.98). However, this differential effect is not found in the underpriced portfolios.

In summary, we find the differential effect of the extent of short sale constraints on the financial distress puzzle. In other words, the financial distress puzzle becomes more profound as short sales are more constrained. This differential effect is found only for stocks that are overpriced, but not for stocks that are underpriced with respect to firm characteristics other than financial distress.

4.3. Multivariate Tests

The previous portfolio tests represent a univariate test on the differential effect of the extent of short sale constraints on the financial distress puzzle. In this section, we examine this differential effect at the individual stock level within a multivariate regression framework using pooled regression tests and the Fama and MacBeth (1973) type cross-sectional regression (CSR) tests. To do this, we first estimate the following pooled regression model:

Model 1:

$$r_{i,t} = \beta_0 + \beta_1 \text{Distress}_{i,t-1} + \beta_2 \text{Overpricing}_{i,t-1} + \gamma \left(\text{Distress}_{i,t-1} \times \text{Overpricing}_{i,t-1}\right) + year\text{ dummy} + \text{industry dummy} + e_{it}, \quad (3)$$

where $r_{i,t}$ is benchmark-adjusted returns of firm i at month t, calculated as the sum of the intercept estimate and the residuals obtained from regressing the excess returns of firm i at month t on the Fama and French (1993) three factors; $\text{Distress}_{i,t-1}$ is the Campbell et al. (2008) financial distress measure of firm i at month t-1; and $\text{Overpricing}_{i,t-1}$ is the value of the overpricing proxy variable of firm i at month t-1. The overpricing proxy variable is either the average of ranking percentiles produced by the nine anomaly variables (ranking percentile) or the dummy variable (overpricing dummy), which equals 1 if the average overpricing ranking is above the 50th percentile, and zero otherwise. In fact, use of the overpricing proxy variable in the regression model is equivalent to controlling for firm characteristic variables associated with the nine return anomalies that are used in constructing the overpricing ranking.

We include year dummies in the regression model to capture contemporaneous shocks of market-wide credit conditions on financial distress possibly due to macroeconomic environments. Improving (deteriorating) market-wide credit conditions could ease (worsen) financial distress on individual stocks and thus reduce (magnify) the financial distress effect. We also include industry dummies in the regression model to capture industry-related fixed effects, since firms in different industries may face different degrees of financial distress. Different industries face different levels of competition and may have different accounting conventions, implying different likelihood of bankruptcy, albeit identical balance sheets. Prior studies also empirically support the importance of industry effects in financial distress. Among other recent studies, Opler and Titman (1994) show that the adverse consequences of leverage on bankruptcy differ across industries, Chava and Jarrow (2004) demonstrate the importance of including industry effects in measuring the forecasting accuracy of bankruptcy prediction models, and Acharya, Bharath, and Srinivasan (2007) find that industry conditions are an important determinant of credit recovery rates. We define a set of industry dummy variables based on the first digit SIC codes.

Table 7 presents the estimation results of Model 1 of equation (3). As expected, when the financial distress variable is alone in the model, the coefficient estimate on the variable is strongly negatively significant ($\hat{\beta}_1$ is -0.268, with t-statistic of -19.50), which confirms the financial distress puzzle. When overpricing alone is controlled, the coefficient estimate on the financial distress variable is still negative and significant, although its magnitude in negative value is decreased; $\hat{\beta}_1$ is -0.193 (t-statistic of -13.76) using the overpricing dummy variable and -0.118 (t-statistic of -8.31) using the overpricing ranking percentile for a proxy variable for overpricing. These results indicate that overpricing alone is not sufficient to explain the financial distress effects. The coefficient of main interest in Model 1 is γ, which measures the difference in the financial distress effect between overpriced and underpriced stocks. Its estimate is negative and strongly statistically significant at the 1 percent level; it is $\hat{\gamma}$ = -0.426 (t-statistic of -15.80) using the overpricing dummy variable and -0.018 (t-statistic of -18.68) using the overpricing ranking percentile. Meanwhile, the coefficient estimate on the financial distress variable, $\hat{\beta}_1$, becomes statistically insignificant or even positively significant. These results indicate that the financial distress puzzle is prominent only in overpriced stocks, while this puzzle disappears among underpriced stocks. These results are consistent with the portfolio tests described in Section 4.2.

To examine the differential effect of the extent of short sale constraints on the financial distress puzzle in a multivariate regression framework, we estimate the pooled regression model.

Model 2:

$$
\begin{aligned}
r_{it} = \ & \beta_0 + \beta_1 \text{Distress}_{it-1} + \beta_2 \text{Overpricing}_{it-1} + \gamma_1 \left(\text{Distress}_{it-1} \times \text{Overpricing}_{it-1}\right) \\
& + \gamma_2 (\text{Distress}_{it-1} \times \text{Short}_{it-1}) + \gamma_3 \left(\text{Overpricing}_{it-1} \times \text{Short}_{it-1}\right) \\
& + \gamma_4 \left(\text{Distress}_{it-1} \times \text{Overpricing}_{it-1} \times \text{Short}_{it-1}\right) + \text{Year dummy} \\
& + \text{Industry dummy} + e_{it}, \qquad (4)
\end{aligned}
$$

where Short_{it-1} is the proxy variable representing the severity of short sale constraints of firm i at month t-1. Each of the four proxy variables is used in the above model. These are (1) negative institutional ownership (NegIO), (2) DCBS for stock borrowing cost (ranging from 1 to 10), (3) option status (OS), which equals 1 if exchange-traded options of the stock are available and zero otherwise, and (4) elimination of the uptick rule (NoUptick), which equals 1 for the period in which the uptick rule is eliminated for all exchange-traded stocks (January 2008 to December 2014) and zero for the period in which the uptick rule is enforced for all stocks (January 1981 to December 2004). Firms with more severe short sale constraints are assigned a higher value for the proxy variable.

Table 8 presents the estimation results of Model 2 of equation (4). The coefficient of main interest is γ_4. This is the measure of the DiD, which indicates the difference in the degree of the financial distress puzzle observed in overpriced stocks between more and less short-sale-constrained stocks. That is, it measures the differential effect of the extent of short sale constraints on the financial distress puzzle. The estimates of γ_4 are negative and statistically significant for most cases. When the overpricing dummy variable is used, the estimates ($\hat{\gamma}_4$) are -0.031 (t-statistic of -6.52) using negative IO, -0.261 (t-statistic of -9.62) using DCBS, -0.819 (t-statistic of -15.16) using OS, and -0.251 (t-statistic of -5.14) using elimination of the uptick rule (NoUptick) as a proxy for short sale constraints. When the overpricing ranking percentile is used, similar results are obtained. These results indicate that the financial distress puzzle observed in overpriced stocks (measured by γ in Model 1) becomes more profound as short sales are more constrained. Note that since the coefficient estimate on the interaction term $\mathrm{Distres} \times \mathrm{Overpricing}$, $\hat{\gamma}_1$, is still negative in most cases and statistically significant, it may be said that the financial distress puzzle found in overpriced stocks remains prominent even among less short-sale-constrained stocks.

Next, we estimate the coefficients of Models 1 and 2 within the Fama and MacBeth (1973) CSR framework. In this framework, we allow the coefficients to vary each month and estimate them in month-by-month CSR. Tables 9 and 10 report time-series averages of the coefficient estimates of Models 1 and 2 obtained from the Fama and MacBeth (1973) month-by-month CSRs, respectively. The estimate of γ, which is the coefficient of main interest in Model 1, is also negative and strongly statistically significant at the 1 percent level; it is $\bar{\hat{\gamma}}$ = -0.386 (t-statistic of -7.67) using the overpricing dummy variable and -0.016 (t-statistic of -8.28) using the overpricing ranking percentile. Meanwhile, the coefficient estimate on the financial distress variable, $\bar{\hat{\beta}}_1$, becomes statistically insignificant or even positively significant. The estimates of γ_4 in Model 2 are also negative and all statistically significant. They are $\bar{\hat{\gamma}}_4$= -0.038 (t-statistic of -3.94) using negative IO, -0.141 (t-statistic of -2.65) using DCBS, -0.450 (t-statistic of -2.94) using OS, and -0.161 (t-statistic of -4.89) using elimination of the uptick rule (NoUptick) as a proxy for short sale constraints. When the overpricing ranking percentile is used, similar results are obtained.

In summary, we confirm in a multivariate framework that the financial distress puzzle is prominent only in overpriced stocks and this puzzle is more profound among stocks with more short sale constraints.

4.4. Asymmetric Pricing Effect of Short Sale Constraints on the Financial Distress Puzzle

The results described above support arguments that short sale constraints play the important role of incurring the financial distress puzzle, particularly incurring overpricing of highly distressed firms. In this section, we attempt to *specifically* measure the extent to which overpricing of such firms is attributed to short sale constraints. We use DCBS as a representative proxy for short sale constraints, since this is the most direct measure of short sale constraints among the four proxies used in this study. To adjust returns for short-sale constraints, we construct the portfolio by first assigning all firms each month into the portfolio of low stock borrowing costs if their DCBS equals

1 and into the portfolio of high stock borrowing costs otherwise, and then by taking the difference between the equally weighted return of the low stock borrowing cost portfolio and the equally weighted return of the high stock borrowing cost portfolio (i.e., Low-High). We regard this portfolio as a factor related to short sale constraints. We then estimate the following time-series regression model:

$$(\text{Benchmark\_adjusted return})_{pt} = a_p + b_p(\text{SS constraint factor})_t + e_{pt}, \quad (5)$$

where "Benchmark_adjusted return" is the sum of the intercept estimate and the residuals from regressing excess raw returns of portfolio p on the Fama and French (1993) three factors (FF3), and "SS constraint factor" is the factor related to short sale constraints. This is the FF3-benchmark-adjusted (abnormal) return *before* controlling for the short sale constraint factor. Although this short sale constraint factor is not a risk factor, we employ this approach to measure specifically (in return) how much of the financial distress puzzle is caused by short sale constraints. The intercept term in equation (5) indicates the benchmark-adjusted return *after* controlling for the short sale constraint factor.

Table 11 presents the estimation results of equation (5) for the 25 (= 5×5) portfolios sorted on the financial distress and mispricing measures during the period September 2004 to December 2014 when DCBS is available. Before presenting the estimation results of equation (5), we first present the benchmark-adjusted returns of the 25 portfolios before controlling for the short sale constraint factor in Panel A. Compared to those over the full sample period from January 1981 to December 2014 (Panel B of Table 2), the financial distress puzzle is still significantly evident, especially for overpriced stocks, although its statistical significance is weaker than in the full sample period, possibly due to a smaller sample size. That is, the differences in benchmark-adjusted return between the highest and lowest distress portfolios ("High-Low") are -1.18 percent per month (t-statistic of -2.19) for the most overpriced stocks and -0.79 percent per month (t-statistic of -1.97) for all stocks.

Panel B of Table 11 presents the intercept estimates $(\hat{a}_p)$ of equation (5). It shows that after controlling for the short sale constraint factor, the financial distress puzzle observed for overpriced stocks and all stocks becomes statistically insignificant. Specifically, the "High-Lows" are -0.86 percent per month (t-statistic of -1.59) for the most overpriced stocks and -0.44 percent per month (t-statistic of -1.15) for all stocks. Panel C presents the difference in benchmark-adjusted return after and before controlling for the short sale constraint factor for the 25 portfolios, which indicates the amount of reduction in benchmark-adjusted return after adjustment for short sale constraints. Panel C shows that the amount of reduced benchmark-adjusted return is very small for low-distress stocks but large for high-distress stocks. For example, the average amount of reduction in benchmark-adjusted return is -0.02 percent, 0.00 percent, 0.01 percent, 0.07 percent, and 0.33 percent for the five (from lowest to highest) financial distress quintile portfolios, respectively. These results indicate that the short sale constraint factor has almost no effect on the long-leg side but has a strong effect on the short-leg side in the financial distress puzzle. In other words, short sale constraints have an asymmetric and unilateral pricing effect on the financial distress puzzle. This statement is confirmed by the factor loading estimates $(\hat{b}_p)$ on the short sale constraint factor (Panel B). The factor loading estimates for low-distress stocks are small in size, while those for high-distress stocks are positive and large. This is the main reason for a large (small) reduction in benchmark-adjusted returns in high (low) distress stocks, which induces the financial distress puzzle becoming insignificant after controlling for short sale constraints.

Another interesting feature of the above results is that the extent of the financial distress puzzle alleviated by the short sale constraint factor, which is measured by "High-Low" in the amount of reduction in benchmark-adjusted return, is unrelated to the degree of mispricing. That is, the "High-Lows" across the five mispricing quintile portfolios from P1 (mots underpriced) to P5 (most overpriced) are 0.41 percent, 0.15 percent, 0.31 percent, 0.29 percent, and 0.32 percent, respectively. There is no particular trend in the factor loading estimates on the short sale constraint factor for the five "High-Low" portfolios across the mispricing measure.

To examine further the argument that the financial distress puzzle is attributable mainly to its short-leg side rather than long-leg side, we estimate equation (5) including the idiosyncratic volatility factor instead of the short sale constraint factor.[13] Idiosyncratic volatility (IVOL) is a well-known proxy for arbitrage risk that has a bi-directional pricing effect on both long-leg and short-leg sides. Panel A of Table 12 presents the intercept estimates in equation (5). Different from adjusting for the short sale constraint factor, the economic and statistical significance of the financial distress puzzle is almost unchanged (compared to the (unadjusted) results in Panel A of Table 11) when adjusting for the IVOL factor. Panel B of Table 12 presents the difference in benchmark-adjusted return after and before adjusting for the IVOL factor for the 25 portfolios. It is evident that the amount of reduction in benchmark-adjusted returns is not only very small for all portfolios but there is also no particular pattern in the reduction across the short-leg and long-leg sides of the financial distress puzzle.

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[13] The IVOL factor is constructed by first assigning all stocks into one of the three IVOL portfolios based on their IVOL (high 30 percent, middle 40 percent, and low 30 percent of stocks), and then by taking the difference between the equally weighted returns of the low and high IVOL portfolios. IVOL is calculated as the standard deviation of the residuals obtained from regressing stock returns on the Fama and French (1993) three factors by using 36-month return observations available up to the portfolio formation month (i.e., t-36, t-1).

In summary, the above results show specifically that the financial distress puzzle is mainly attributable to short sale constraints that have an asymmetric pricing effect on the financial distress puzzle (i.e., a strong pricing effect on the short-leg side but little pricing effect on the long-leg side), rather than to arbitrage risk that could have a symmetric pricing effect.

5. Conclusions

This paper examines whether the financial distress puzzle, which is the negative relation between financial distress and subsequent returns, differs across the degree of mispricing related to firm characteristics other than financial distress, and whether the financial distress puzzle becomes more profound as short sales are more constrained. We use several proxies for short sale constraints: residual institutional ownership, stock borrowing costs, presence of exchange-traded stock options, and elimination of the uptick rule governing short sale activities. We attempt to specifically measure the asymmetric pricing effect of short sale constraints on the financial distress puzzle.

We find that the financial distress puzzle is observed only for stocks overpriced with respect to firm characteristics other than financial distress (such as net stock issues, composite equity issues, total accruals, net operating assets, momentum, gross profitability, asset growth, return on assets, and investment-to-assets), not for underpriced stocks, irrespective of the level of short sale constraints. In univariate portfolio tests and multivariate regression tests, we find that the financial distress puzzle observed in overpriced stocks becomes more severe as short sales are more constrained (i.e., as institutional ownership is lower, stock borrowing cost is higher, exchange-traded stocks options are unavailable, and the uptick rule is enforced).

By constructing the factor related to short sale constraints, we specifically measure the asymmetric pricing effect of short sale constraints on the financial distress puzzle. This asymmetric pricing effect is observed, irrespective of the degree of mispricing. We also find that after adjustment for this short-sale constraint factor to the FF3-benchmark-adjusted returns, the financial distress puzzle becomes insignificant in all mispricing groups.

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Table 1. Summary Statistics of Proxy Variables

This table presents basic characteristics of the proxy variables for financial distress risk, overpricing, and short sale constraints. Financial distress risk is measured by the Campbell et al. (2008) financial distress measure, and the mispricing measure is the average of ranking percentiles based on the characteristics of the nine anomalies. Institutional ownership is the Nagel (2005) residual institutional ownership, stock borrowing cost is the daily costs to borrow score (DCBS) computed by Markit, and option status is a dichotomy variable that equals 1 if the stock has exchange-traded options and zero if the stock does not. ***, **, and * in Panel B indicate significance at the 1, 5, and 10 percent levels, respectively. The sample periods for the stock borrowing costs and the option status data are September 2004 to December 2014 and January 1996 to August 2014, respectively. The sample period for the other variables is January 1981 to December 2014.

Proxy variables	Mean	Min	Q1	Median	Q3	Max
			Panel A: Basic statistics of the proxy variables			
Financial distress risk:						
Campbell et al. measure	-7.53	-10.09	-8.26	-7.76	-7.01	-2.87
Overpricing:						
Rank percentile	48.82	0.80	39.11	48.11	57.89	98.14
Short sale constraints:						
Institutional ownership	1.27	-9.37	0.42	2.52	3.58	15.58
Stock borrowing cost	1.32	1.00	1.00	1.00	1.00	10.00
Option status	0.47	0.00	0.00	0.00	1.00	1.00

	Financial Distress	Overpricing	Institutional ownership	DCBS	Option status
		Panel B: Correlation coefficients			
Distress	1.00				
Overpricing	0.25***	1.00			
Institutional ownership	-0.07***	-0.05***	1.00		
DCBS	0.30***	0.14***	-0.11***	1.00	
Option status	-0.27***	0.03***	0.10***	-0.11***	1.00

Portfolios sorted on financial distress	Ave return	Financial distress	Overpricing	Institutional ownership	DCBS	Option status
			Panel C: Time-series average			
1 (low)	1.32	-8.62	42.61	1.46	1.09	0.61
2	1.30	-8.17	46.53	1.29	1.11	0.62
3	1.23	-7.78	49.32	1.31	1.17	0.54
4	1.15	-7.25	51.66	1.15	1.39	0.43
5 (high)	0.80	-6.10	53.41	0.79	2.06	0.30
P5-P1	-0.52	2.52	10.80	-0.67	0.97	-0.31

Table 2. Average Raw and Abnormal Returns of Portfolios Sorted on Distress Risk Measure and Mispricing Measure

This table presents average raw and abnormal returns for portfolios that are formed each month by sorting stocks independently on the financial distress risk measure and the mispricing measure. The portfolios are value-weighted. Financial distress risk is measured by the Campbell et al. (2008) financial distress measure, and the mispricing measure is the average of ranking percentiles based on the characteristics of the nine anomalies. Abnormal returns are calculated as the intercept estimate $(\hat{\alpha})$ in the regression, $R_{i,t} = \alpha + bMKT_t + cSMB_t + dHML_t + \epsilon_{i,t}$, where $R_{i,t}$ is the excess return in month t, and MKT_t, SMB_t, and HML_t are the Fama and French (1993) three factors. The sample period is from January 1981 to December 2014. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

		Distress risk measure					High-	All
		1(Low)	2	3	4	5(High)	Low	stocks
		Panel A: Raw returns						
	1	1.15***	1.36***	1.35***	1.99***	1.65***	0.50	1.26***
	(Under-)	(5.59)	(6.13)	(4.53)	(5.26)	(3.27)	(1.14)	(6.18)
	2	0.89***	1.26***	1.12***	1.32***	1.09**	0.20	1.04***
		(3.95)	(5.51)	(3.94)	(3.49)	(2.21)	(0.47)	(4.73)
Mispricing measure	3	1.11***	0.86***	1.13***	0.85**	1.44***	0.33	0.99***
		(4.46)	(3.42)	(3.78)	(2.31)	(2.84)	(0.82)	(3.99)
	4	1.08***	0.88***	0.87***	1.06***	0.56	-0.53	0.97***
		(4.03)	(3.32)	(2.76)	(2.69)	(1.09)	(-1.28)	(3.66)
	5	0.78***	0.30	0.44	0.48	-0.78	-1.56***	0.41
	(Over-)	(2.71)	(1.02)	(1.33)	(1.15)	(-1.58)	(-3.92)	(1.31)
	P5-P1	-0.37*	-1.06***	-0.90***	-1.51***	-2.42***		-0.85***
		(-1.85)	(-5.26)	(-4.26)	(-5.42)	(-6.87)		(-4.64)
	All Stocks	1.04*** (5.01)	1.03*** (4.63)	0.97*** (3.50)	0.93** (2.53)	0.27 (0.57)	-0.77** (-2.06)	
		Panel B: Abnormal returns						
	1	0.33***	0.45***	0.26	0.76***	-0.01	-0.34	0.38***
	(Under-)	(3.24)	(4.53)	(1.58)	(3.44)	(-0.04)	(-0.99)	(5.58)
	2	0.04	0.34***	-0.01	-0.02	-0.47*	-0.51	0.11*
		(0.33)	(3.50)	(-0.05)	(-0.11)	(-1.64)	(-1.52)	(1.69)
Mispricing measure	3	0.24**	-0.14	0.03	-0.53***	-0.07	-0.32	-0.01
		(2.10)	(-1.28)	(0.18)	(-2.88)	(-0.23)	(-0.92)	(-0.09)
	4	0.23	-0.12	-0.21	-0.21	-1.04***	-1.27***	-0.04
		(1.63)	(-0.98)	(-1.34)	(-0.99)	(-3.40)	(-3.59)	(-0.50)
	5	-0.14	-0.71***	-0.62***	-0.81***	-2.24***	-2.10***	-0.68***
	(Over-)	(-0.75)	(-4.90)	(-4.11)	(-3.98)	(-8.23)	(-6.11)	(-6.42)
	P5-P1	-0.47**	-1.16***	-0.88***	-1.57***	-2.23***		-1.06***
		(-2.38)	(-6.27)	(-4.28)	(-5.66)	(-6.34)		(-7.32)
	All Stocks	0.19*** (2.73)	0.10* (1.82)	-0.11 (-1.14)	-0.36** (-2.29)	-1.24*** (-5.14)	-1.43*** (-5.05)	

Table 3. Distress Anomaly in Subsamples of High versus Low Institutional Ownership

This table presents abnormal returns of portfolios that are formed by first assigning stocks into one of five quintile portfolios based on the mispricing measure and then by sorting stocks on the intersection of the financial distress measure by the Campbell et al. (2008) and institutional ownership (IO) within each quintile portfolio of the mispricing measure. The low (high) distress risk subsample consists of the top (bottom) 20 percent of stocks sorted on the financial distress measure, and the high IO (low IO) subsample consists of the top (bottom) 30 percent of stocks sorted on institutional ownership. Following Nagel (2005), IO refers to residual institutional ownership, which is the residual obtained from the following regression: $logit(INST_{i,t}) = \beta_0 + \beta_1 \log(SZ_{i,t}) + \beta_2 \log(SZ_{i,t})^2 + \varepsilon_{it}$, where $INST_{i,t}$ is the fraction of shares outstanding of firm i at month t held by institutional investors, and $\log(SZ_{i,t})$ denotes the log of market capitalization. Abnormal returns are calculated as the intercept estimate ($\hat{\alpha}$) in the regression, $R_{i,t} = \alpha + bMKT_t + cSMB_t + dHML_t + \epsilon_{i,t}$, where $R_{i,t}$ is the excess return in month t, and MKT_t, SMB_t, and HML_t are the Fama and French (1993) three factors. The sample period is January 1981 to December 2014. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

Sorted on mispricing	Low Institutional Ownership			High Institutional Ownership			Low IO-High IO		
	Low distress	High distress	H-L	Low distress	High distress	H-L	Low distress	High distress	H-L
1	0.38***	-0.34	-0.72	0.45***	0.05	-0.40	-0.07	-0.39	-0.33
(Under-)	(3.44)	(-0.72)	(-1.46)	(3.12)	(0.13)	(-0.87)	(-0.36)	(-0.62)	(-0.48)
2	0.01	-0.89**	-0.91*	0.28	-0.34	-0.62*	-0.26	-0.56	-0.29
	(0.12)	(-2.03)	(-1.91)	(1.62)	(-1.06)	(-1.67)	(-1.26)	(-1.02)	(-0.49)
3	0.29**	-0.48	-0.77*	0.20	-0.44	-0.63*	0.10	-0.04	-0.14
	(2.14)	(-1.09)	(-1.66)	(1.08)	(-1.35)	(-1.67)	(0.44)	(-0.08)	(-0.24)
4	0.34*	-1.49***	-1.83***	-0.09	-0.83**	-0.74*	0.43	-0.66	-1.09*
	(1.75)	(-3.73)	(-3.93)	(-0.49)	(-2.47)	(-1.82)	(1.60)	(-1.27)	(-1.77)
5	-0.24	-2.84***	-2.61***	-0.68***	-1.59***	-0.92**	0.43	-1.25***	-1.69***
(Over-)	(-0.89)	(-8.39)	(-5.65)	(-2.86)	(-4.70)	(-2.19)	(1.19)	(-2.62)	(-2.69)
P5-P1	-0.63**	-2.50***	-1.88***	-1.14***	-1.64***	-0.53	0.51	-0.86	-1.35*
	(-2.15)	(-4.78)	(-3.15)	(-4.73)	(-3.62)	(-1.05)	(1.34)	(-1.24)	(-1.74)
All stocks	0.21***	-1.80***	-2.01***	0.16	-0.91***	-1.08***	0.05	-0.88**	-0.93**
	(3.05)	(-6.20)	(-6.29)	(1.30)	(-3.83)	(-3.63)	(0.35)	(-2.35)	(-2.14)

Table 4. Distress Anomaly in Subsamples of High versus Low Stock Borrowing Costs

This table presents abnormal returns of portfolios that are formed by first assigning stocks into one of five quintile portfolios based on the mispricing measure and then by sorting stocks on the intersection of the Campbell et al. (2008) financial distress measure and stock borrowing costs measured by Daily Costs of Borrowing Score (DCBS) within each quintile portfolio of the mispricing measure. The low (high) distress risk subsample consists of the top (bottom) 20 percent of stocks sorted on the financial distress measure, and the high (low) stock borrowing costs subsample consists of stocks with DCBS greater than 1 (equal to 1). Abnormal returns are calculated as the intercept estimate ($\hat{\alpha}$) in the regression, $R_{i,t} = \alpha + bMKT_t + cSMB_t + dHML_t + \epsilon_{i,t}$, where $R_{i,t}$ is the excess return in month t, and MKT_t, SMB_t, and HML_t are the Fama and French (1993) three factors. The sample period is September 2004 to December 2014. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

Sorted on mispricing	High Stock Borrowing Costs			Low Stock Borrowing Costs			High -Low		
	Low distress	High distress	H-L	Low distress	High distress	H-L	Low distress	High distress	H-L
1	0.34	-1.42	-1.76	0.17	0.10	-0.07	0.17	-1.52	-1.69
(Under-)	(0.75)	(-1.25)	(-1.51)	(0.93)	(0.20)	(-0.12)	(0.34)	(-1.22)	(-1.29)
2	-0.09	-1.11	-1.02	0.19	0.15	-0.05	-0.29	-1.26	-0.97
	(-0.21)	(-0.76)	(-0.66)	(1.39)	(0.31)	(-0.10)	(-0.61)	(-0.82)	(-0.60)
3	0.87	-1.51	-2.39	-0.06	0.37	0.43	0.93	-1.88	-2.81*
	(1.26)	(-1.14)	(-1.63)	(-0.21)	(0.86)	(0.84)	(1.25)	(-1.35)	(-1.82)
4	-0.72	-0.27	0.45	0.44	0.15	-0.29	-1.15	-0.41	0.74
	(-0.92)	(-0.24)	(0.34)	(1.74)	(0.33)	(-0.55)	(-1.41)	(-0.35)	(0.52)
5	-0.41	-4.04***	-3.56**	0.03	-0.57	-0.60	-0.45	-3.48***	-2.95*
(Over-)	(-0.45)	(-3.58)	(-2.24)	(0.09)	(-1.39)	(-1.05)	(-0.45)	(-2.89)	(-1.75)
P5-P1	-0.65	-2.62	-1.80	-0.14	-0.67	-0.53	-0.51	-1.96	-1.27
	(-0.63)	(-1.49)	(-0.86)	(-0.34)	(-1.46)	(-0.87)	(-0.46)	(-1.08)	(-0.58)
All stocks	-0.39	-1.96**	-1.57*	0.19	-0.02	-0.21	-0.58*	-1.94**	-1.37
	(-1.23)	(-2.44)	(-1.88)	(1.59)	(-0.07)	(-0.55)	(-1.71)	(-2.26)	(-1.49)

Table 5. Distress Anomaly in Subsamples of Option Status

This table presents abnormal returns of portfolios that are formed by first assigning stocks into one of five quintile portfolios based on the mispricing measure and then by sorting stocks on the intersection of the financial distress measure by the Campbell et al. (2008) and option status (OS) within each quintile portfolio of the mispricing measure. The low (high) distress risk subsample consists of the top (bottom) 20 percent of stocks sorted on the financial distress measure. Option status indicates whether the firm has exchange-traded options trading prior to the first day of the month. Abnormal returns are calculated as the intercept estimate ($\hat{\alpha}$) in the regression, $R_{i,t} = \alpha + bMKT_t + cSMB_t + dHML_t + \epsilon_{i,t}$, where $R_{i,t}$ is the excess return in month t, and MKT_t, SMB_t, and HML_t are the Fama and French (1993) three factors. The sample period is February 1996 to September 2014. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

Sorted on mispricing	Option Status: No			Option Status: Yes			No-Yes		
	Low distress	High distress	H-L	Low distress	High distress	H-L	Low distress	High distress	H-L
1	0.55***	-0.81	-1.37**	0.31*	0.48	0.17	0.24	-1.30	-1.54*
(Under-)	(2.98)	(-1.25)	(-1.98)	(1.83)	(1.02)	(0.32)	(0.97)	(-1.61)	(-1.76)
2	0.30	-1.34**	-1.64**	-0.02	-0.29	-0.28	0.32	-1.05	-1.36
	(1.30)	(-2.16)	(-2.46)	(-0.08)	(-0.67)	(-0.51)	(1.01)	(-1.38)	(-1.60)
3	0.29	-0.81	-1.10*	0.48**	0.41	-0.07	-0.19	-1.22*	-1.03
	(1.14)	(-1.51)	(-1.83)	(2.38)	(0.95)	(-0.13)	(-0.58)	(-1.77)	(-1.30)
4	0.64*	-2.44***	-3.08***	0.30	-1.03**	-1.33**	0.34	-1.41**	-1.75**
	(1.84)	(-5.30)	(-5.04)	(1.22)	(-2.35)	(-2.40)	(0.80)	(-2.21)	(-2.11)
5	0.71*	-2.97***	-3.68***	-0.47	-1.60***	-1.13**	1.18**	-1.37*	-2.55***
(Over-)	(1.95)	(-4.90)	(-5.24)	(-1.43)	(-4.42)	(-2.18)	(2.41)	(-1.94)	(-2.92)
P5-P1	0.16	-2.15***	-2.31***	-0.78**	-2.08***	-1.30**	0.93*	-0.08	-1.01
	(0.39)	(-2.72)	(-2.69)	(-2.18)	(-4.23)	(-2.23)	(1.75)	(-0.08)	(-0.97)
All stocks	0.36**	-2.20***	-2.56***	0.22	-0.93**	-1.14**	0.14	-1.27*	-1.42*
	(2.05)	(-4.71)	(-4.96)	(1.30)	(-2.27)	(-2.16)	(0.57)	(-1.93)	(-1.85)

Table 6. Distress Anomaly in Subsamples by the Uptick Rule

This table presents abnormal returns of portfolios that are formed by first assigning stocks into one of five quintile portfolios based on the mispricing measure and then by sorting stocks on the intersection of the Campbell et al. (2008) financial distress measure and the application of the uptick rule (UR) within each quintile portfolio of the mispricing measure. The low (high) distress risk subsample consists of the top (bottom) 20 percent of stocks sorted on the financial distress measure. The uptick rule 'YES' indicates the period that the uptick rule is applied to all trading in the stock markets (from January 1981 to December 2004), and the uptick rule 'NO' indicates the period that the uptick rule is removed in trading stocks (from January 2008 to December 2014). Abnormal returns are calculated as the intercept estimate ($\hat{\alpha}$) in the regression, $R_{i,t} = \alpha + bMKT_t + cSMB_t + dHML_t + \epsilon_{i,t}$, where $R_{i,t}$ is the excess return in month t, and MKT_t, SMB_t, and HML_t are the Fama and French (1993) three factors. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

Sorted on mispricing	Uptick Rule: Yes			Uptick Rule: No			Yes-No		
	Low distress risk	High distress risk	H-L	Low distress risk	High distress risk	H-L	Low distress risk	High distress risk	H-L
1	0.41***	0.46	0.05	0.13	-0.73	-0.86	0.28	1.19	0.91
(Under-)	(3.05)	(1.30)	(0.12)	(0.78)	(-0.87)	(-0.96)	(1.08)	(1.53)	(1.05)
2	-0.06	-0.52	-0.46	0.18	0.11	-0.07	-0.24	-0.62	-0.39
	(-0.35)	(-1.38)	(-1.03)	(1.17)	(0.20)	(-0.12)	(-0.74)	(-0.85)	(-0.45)
3	0.26*	-0.26	-0.51	0.06	0.84	0.78	0.19	-1.10	-1.29
	(1.83)	(-0.65)	(-1.15)	(0.25)	(1.33)	(1.20)	(0.66)	(-1.38)	(-1.47)
4	0.11	-1.16***	-1.27***	0.36	-0.32	-0.68	-0.25	-0.84	-0.59
	(0.62)	(-2.92)	(-2.77)	(1.27)	(-0.55)	(-1.01)	(-0.70)	(-1.07)	(-0.65)
5	-0.24	-2.51***	-2.26***	-0.47	-1.00*	-0.53	0.23	-1.50**	-1.73**
(Over-)	(-1.04)	(-7.26)	(-5.23)	(-1.18)	(-1.71)	(-0.73)	(0.49)	(-2.15)	(-1.98)
P5-P1	-0.65***	-2.96***	-2.31***	-0.60	-0.27	0.33	-0.05	-2.69***	-2.64***
	(-2.67)	(-6.77)	(-4.80)	(-1.36)	(-0.36)	(0.41)	(-0.09)	(-3.03)	(-2.71)
All stocks	0.16*	-1.41***	-1.57***	0.20*	-0.34	-0.55	-0.04	-1.07*	-1.02
	(1.75)	(-4.49)	(-4.26)	(1.77)	(-0.75)	(-1.01)	(-0.21)	(-1.72)	(-1.41)

Table 7. Pooled Regression Estimates for Model 1

This table presents the coefficient estimates of the following pooled regression:

$$r_{i,t} = \beta_0 + \beta_1 \text{Distress}_{i,t-1} + \beta_2 \text{Overpricing}_{i,t-1} + \gamma \left(\text{Distress}_{i,t-1} \times \text{Overpricing}_{i,t-1}\right) + year\ \text{dummy} + \text{industry dummy} + e_{it},$$

where $r_{i,t}$ is benchmark-adjusted return of firm i at month t, which is the sum of the intercept estimate and the residual obtained from regressing the excess returns of firm i at month t on the Fama and French (1993) three factors; $\text{Distress}_{i,t-1}$ is the Campbell et al. (2008) financial distress measure of firm i at month t-1; and $\text{Overpricing}_{i,t-1}$ is the value of the overpricing proxy variable of firm i at month t-1. The industry dummy variables are defined based on the first digit SIC codes. The overpricing proxy variable is either the average of ranking percentiles produced by the nine anomaly variables (ranking percentile) or the dummy variable (overpricing dummy) which equals 1 if the average overpricing ranking is above the 50th percentile and zero otherwise. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

Explanatory variable	Dependent variable: FF3-adjusted return						
	(1)	(2)	(3)	(4)	(2)′	(3)′	(4)′
		Overpricing = Overpricing dummy			Overpricing = Ranking percentile		
Distress	-0.268***		-0.193***	0.028		-0.118***	0.766***
	(-19.50)		(-13.76)	(1.40)		(-8.31)	(15.50)
Overpricing		-0.795***	-0.727***	-3.925***	-0.044***	-0.042***	-0.172***
		(-31.48)	(-28.26)	(-19.24)	(-45.47)	(-41.91)	(-24.40)
Distress×Overpricing				-0.426***			-0.018***
				(-15.80)			(-18.68)
Intercept	-2.240***	0.261*	-1.250***	0.418*	2.061***		7.624***
	(-12.23)	(1.73)	(-6.70)	(1.95)	(13.05)		(18.85)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,476,825	1,476,825	1,476,825	1,476,825	1,476,825	1,476,825	1,476,825
Adj R-square	0.001	0.002	0.002	0.002	0.002	0.002	0.003

Table 8. Pooled Regression Estimates for Model 2

This table presents the coefficient estimates of the following pooled regression:

$$r_{it} = \beta_0 + \beta_1 \text{Distress}_{it-1} + \beta_2 \text{Overpricing}_{it-1} + \gamma_1(\text{Distress}_{it-1} \times \text{Overpricing}_{it-1}) + \gamma_2(\text{Distress}_{it-1} \times \text{Short}_{it-1}) + \gamma_3(\text{Overpricing}_{it-1} \times \text{Short}_{it-1}) + \gamma_4(\text{Distress}_{it-1} \times \text{Overpricing}_{it-1} \times \text{Short}_{it-1}) + \text{Year dummy} + \text{Industry dummy} + e_{it},$$

where $r_{i,t}$ is the benchmark-adjusted return of firm i at month t, which is the sum of the intercept estimate and the residual obtained from regressing the excess returns of firm i at month t on the Fama and French (1993) three factors; $\text{Distress}_{i,t-1}$ is the Campbell et al. (2008) financial distress measure of firm i at month t-1; and $\text{Overpricing}_{i,t-1}$ is the value of the overpricing proxy variable of firm i at month t-1. The overpricing proxy variable is either the average of ranking percentiles produced by the nine anomaly variables (ranking percentile) or the dummy variable (overpricing dummy) which equals 1 if the average overpricing ranking at month t-1 is above the 50th percentile and zero otherwise. Short_{it-1} is the proxy variable representing the severity of short sale constraints. The proxy variables are negative institutional ownership (NegIO), stock borrowing cost measured by DCBS, option status (OS), which equals 1 if exchange-traded options of the stock are available and zero otherwise, and the elimination of the uptick rule (NoUptick) which equals 1 for the period that the uptick rule is eliminated for all exchange-traded stocks (January 2008 through December 2014) and zero for the period that the uptick rule is enforced for all stocks (January 1981 through December 2004). Firms with more severe short sale constraints are assigned a higher value of the proxy variable. The sample periods for the models including DCBS and the option status (OS) variable are September 2004 to December 2014 and January 1996 to September 2014, respectively, and the sample period for the other models is January 1981 through December 2014. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

	Model				Model			
	(1)	(2)	(3)	(4)	(1)′	(2)′	(3)′	(4)′
	Overpricing = Overpricing dummy				Overpricing = Ranking perentile			
Distress	0.038*	0.267***	0.125***	0.126***	0.727***	0.343***	1.067***	0.903***
	(1.91)	(5.95)	(4.58)	(6.02)	(14.59)	(2.90)	(15.57)	(16.94)
Overpricing	-4.075***	0.708	-0.052	-1.895***	-0.168***	0.023	-0.128***	-0.142***
	(-19.78)	(1.26)	(-0.13)	(-5.33)	(-23.71)	(1.22)	(-12.46)	(-16.74)
Distress×Overpricing	-0.445***	0.126*	0.051	-0.198***	-0.017***	0.004	-0.012***	-0.016***
	(-16.25)	(1.72)	(1.01)	(-4.15)	(-17.96)	(1.63)	(-9.13)	(-13.19)
Distress×Overpricing×NegIO	-0.031***				-0.001***			
	(-6.52)				(-4.99)			
Distress×Overpricing×DCBS		-0.261***				-0.004***		
		(-9.62)				(-9.51)		
Distress×Overpricing×OS			-0.819***				-0.014***	
			(-15.16)				(-14.98)	
Distress×Overpricing×NoUptick				-0.251***				-0.001
				(-5.14)				(-1.23)
Distress×NegIO	0.004***				-0.000			

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(5.81)				(-0.04)			
Distress×DCBS		0.035***				-0.007		
		(6.62)				(-0.53)		
Distress×OS			-0.058***				-0.070***	
			(-8.73)				(-3.64)	
Distress×NoUptick				-0.047***				-0.154***
				(-7.84)				(-8.68)
Overpricing×NegIO	-0.256***				-0.004***			
	(-7.25)				(-7.54)			
Overpricing×DCBS		-1.936***				-0.038***		
		(-10.68)				(-14.45)		
Overpricing×OS			-6.425***				-0.111***	
			(-16.13)				(-19.48)	
Overpricing×NoUptick				-2.359***				-0.029***
				(-6.57)				(-5.73)
Intercept	0.400*	2.419***	0.980***	0.932***	7.236***	3.220***	9.709***	7.876***
	(1.87)	(5.72)	(3.22)	(4.42)	(17.78)	(3.29)	(16.97)	(18.80)
Year dummy	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,472,453	276.605	929,869	1,333,447	1,472,453	276,605	929,869	1,333,447
Adj R-square	0.002	0.003	0.002	0.001	0.003	0.003	0.003	0.002

Table 9. Fama-MacBeth Regression Estimates for Model 1

This table reports time-series averages of the coefficient estimates of the cross-sectional regression at month *t*: $r_{i,t} = \beta_{0t} + \beta_{1t}\text{Distress}_{i,t-1} + \beta_{2t}\text{Overpricing}_{i,t-1} + \gamma_t\left(\text{Distress}_{i,t-1} \times \text{Overpricing}_{i,t-1}\right) + \text{industry dummy} + e_{it}$, where $r_{i,t}$ is benchmark-adjusted return of firm i at month t, which is the sum of the intercept estimate and the residual obtained from regressing the excess returns of firm i at month t on the Fama and French (1993) three factors; $\text{Distress}_{i,t-1}$ is the Campbell et al. (2008) financial distress measure of firm i at month t-1; and $\text{Overpricing}_{i,t-1}$ is the value of the overpricing proxy variable of firm i at month t-1. The industry dummy variables are defined based on the first digit SIC codes. The overpricing proxy variable is either the average of ranking percentiles produced by the nine anomaly variables (ranking percentile) or the dummy variable (overpricing dummy) which equals 1 if the average overpricing ranking is above the 50^{th} percentile and zero otherwise. "$\overline{\text{Adj}}\ R^2$" is the time-series average of the R-squares of the cross-sectional regressions. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

Explanatory variable	Dependent variable: FF3-adjusted return						
	(1)	(2)	(3)	(4)	(2)′	(3)′	(4)′
		Overpricing = Overpricing dummy			Overpricing = Ranking percentile		
Distress	-0.231**		-0.166*	0.030		-0.095	0.691***
	(-2.30)		(-1.66)	(0.30)		(-0.96)	(5.660)
Overpricing		-0.709***	-0.663***	-3.559***	-0.039***	-0.037***	-0.154***
		(-9.25)	(-11.76)	(-8.84)	(-10.30)	(-13.58)	(-10.05)
Distress×Overpricing				-0.386***			-0.016***
				(-7.67)			(-8.28)
Intercept	-2.020***	0.122	-1.153	0.346	1.697***	0.910	6.780***
	(-2.67)	(0.57)	(-1.53)	(0.46)	(5.69)	(1.20)	(7.00)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-series Obs.	408	408	408	408	408	408	408
$\overline{\text{Adj}}\ R^2$	0.036	0.026	0.038	0.039	0.028	0.040	0.041

Table 10. Fama-MacBeth Regression Estimates for Model 2

This table presents time-series averages of the coefficient estimates of the following regression at month t:

$$r_{it} = \beta_{0t} + \beta_{1t}\text{Distress}_{it-1} + \beta_{2t}\text{Overpricing}_{it-1} + \gamma_{1t}(\text{Distress}_{it-1} \times \text{Overpricing}_{it-1}) + \gamma_{2t}(\text{Distress}_{it-1} \times \text{Short}_{it-1}) + \gamma_{3t}(\text{Overpricing}_{it-1} \times \text{Short}_{it-1}) + \gamma_{4t}(\text{Distress}_{it-1} \times \text{Overpricing}_{it-1} \times \text{Short}_{it-1}) + \text{Industry dummy} + e_{it},$$

where $r_{i,t}$ is the benchmark-adjusted return of firm i at month t, which is the sum of the intercept estimate and the residual obtained from regressing the excess returns of firm i at month t on the Fama and French (1993) three factors; $\text{Distress}_{i,t-1}$ is the Campbell et al. (2008) financial distress measure of firm i at month t-1; and $\text{Overpricing}_{i,t-1}$ is the value of the overpricing proxy variable of firm i at month t-1. The overpricing proxy variable is either the average of ranking percentiles produced by the nine anomaly variables (ranking percentile) or the dummy variable (overpricing dummy) which equals 1 if the average overpricing ranking at month t-1 is above the 50th percentile and zero otherwise. Short_{it-1} is the proxy variable representing the severity of short sale constraints. The proxy variables are negative institutional ownership (NegIO), stock borrowing costs measured by DCBS, option status (OS), which equals 1 if exchange-traded options of the stock are available and zero otherwise, and the elimination of the uptick rule (NoUptick) which equals 1 for the period that the uptick rule is eliminated for all exchange-traded stocks (January 2008 through December 2014) and zero for the period that the uptick rule is enforced for all stocks (January 1981 through December 2004). Firms with more severe short sale constraints are assigned a higher value of the proxy variable. The sample periods for the models including DCBS and the option status (OS) variable are September 2004 to December 2014 and January 1996 to September 2014, respectively, and the sample period for the other models is January 1981 through December 2014. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

	Model				Model			
	(1)	(2)	(3)	(4)	(1)′	(2)′	(3)′	(4)′
	Overpricing = Overpricing dummy				Overpricing = Ranking perentile			
Distress	0.045	0.082	0.076	-0.040	0.650***	0.347	0.894***	0.344***
	(0.46)	(0.44)	(0.50)	(-0.57)	(5.34)	(1.34)	(4.56)	(3.80)
Overpricing	-3.647***	-0.296	-1.888*	-3.155***	-0.148***	-0.022	-0.137***	-0.067***
	(-8.72)	(-0.30)	(-1.70)	(-8.16)	(-9.75)	(-0.65)	(-4.88)	(-5.69)
Distress×Overpricing	-0.396***	-0.019	-0.198	-0.225***	-0.015***	-0.002	-0.015***	-0.009***
	(-7.54)	(-0.15)	(-1.43)	(-5.58)	(-7.91)	(-0.46)	(-4.25)	(-6.51)
Distress×Overpricing×NegIO	-0.038***				-0.001***			
	(-3.94)				(-3.83)			
Distress×Overpricing×DCBS		-0.141***				-0.003***		
		(-2.65)				(-3.00)		
Distress×Overpricing×OS			-0.450***				-0.008***	
			(-2.94)				(-2.93)	
Distress×Overpricing×NoUptick				-0.161***				-0.007***
				(-4.89)				(-4.82)

Distress×NegIO	0.004^{***}				0.004^{***}			
	(5.29)				(2.27)			
Distress×DCBS		0.028^{***}				-0.001		
		(2.93)				(-0.00)		
Distress×OS			-0.045^{**}				-0.074^{**}	
			(-2.23)				(-2.27)	
Distress×NoUptick				0.069				0.346^{***}
				(0.99)				(4.06)
Overpricing×NegIO	-0.301^{***}				-0.004^{***}			
	(-4.05)				(-4.25)			
Overpricing×DCBS		-1.143^{***}				-0.026^{***}		
		(-2.98)				(-4.43)		
Overpricing×OS			-3.560^{***}				-0.064^{***}	
			(-3.03)				(-3.49)	
Overpricing×NoUptick				-0.404^{***}				-0.087^{***}
				(-2.93)				(-7.78)
Intercept	0.404	0.966	0.384	0.346	6.434^{***}	3.120	7.744^{***}	6.780^{***}
	(0.54)	(0.44)	(0.35)	(0.46)	(6.66)	(1.54)	(5.31)	(7.00)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-series Obs.	408	408	223	124	408	124	223	372
$\overline{\text{Adj}}\ R^2$	0.041	0.043	0.048	0.048	0.043	0.044	0.050	0.041

Table 11. Estimation Results After Adjusting for Short Sale Constraints

This table presents the estimation results from regressing benchmark-adjusted returns of each portfolio on the factor related to short sale constraints. Portfolios are formed as in Table 2. Benchmark-adjusted returns are calculated as the sum of the intercept estimate and the residuals from regressing the excess portfolio returns on the Fama and French (1993) three factors. The factor related to short sale constraints (or the SS constraint factor) is constructed by first assigning all firms each month into high or low stock borrowing cost portfolios according to the value of Markit's Daily Costs to Borrow Score (DCBS), and then by taking the difference between the equally weighted returns of the low and high stock borrowing cost portfolios. Stocks with DCBS equal to 1 (greater than 1) are assigned to the low (high) stock borrowing cost portfolio. The sample period is from September 2004 to December 2014. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

		Distress risk measure					High-	All
		1(Low)	2	3	4	5(High)	Low	stocks
		Panel A: Benchmark-adjusted returns						
	1	0.10	0.34***	0.27	0.35	-0.73	-0.83	0.21**
	(Under-)	(0.71)	(2.95)	(1.54)	(1.22)	(-1.20)	(-1.25)	(2.23)
	2	0.18	0.07	-0.21	-0.31	-0.37	-0.55	0.03
		(1.54)	(0.47)	(-1.00)	(-1.17)	(-0.88)	(-1.24)	(0.35)
Mispricing measure	3	0.16	0.03	0.36*	-0.25	0.57	0.41	0.06
		(0.74)	(0.16)	(1.79)	(-0.97)	(1.19)	(0.81)	(0.51)
	4	0.50**	0.16	0.06	-0.34	-0.53	-1.03*	0.17
		(2.12)	(0.84)	(0.22)	(-1.23)	(-1.22)	(-1.95)	(1.24)
	5	-0.14	-0.22	-0.21	-0.25	-1.32***	-1.18**	-0.30
	(Over-)	(-0.47)	(-0.87)	(-0.81)	(-0.80)	(-3.12)	(-2.19)	(-1.44)
	P5-P1	-0.24	-0.56*	-0.48*	-0.60	-0.59		-0.50*
		(-0.73)	(-1.85)	(-1.69)	(-1.65)	(-1.02)		(-1.89)
	All Stocks	0.21**	0.14*	0.04	-0.27	-0.58*	-0.79**	
		(2.11)	(1.79)	(0.25)	(-1.35)	(-1.73)	(-1.97)	
		Panel B: $(\text{Benchmark adjusted return})_{pt} = a_p + b_p(\text{SS constraint factor})_t + e_{pt}$						
		Intercept estimates $(\hat{a}_p)$						
	1	0.09	0.33***	0.23	0.42	-0.33	-0.42	0.19*
	(Under-)	(0.61)	(2.67)	(1.28)	(1.46)	(-0.55)	(-0.64)	(1.95)
	2	0.14	0.05	-0.28	-0.25	-0.26	-0.40	-0.00
		(1.20)	(0.35)	(-1.33)	(-0.93)	(-0.62)	(-0.91)	(-0.04)
Mispricing measure	3	0.27	0.07	0.39*	-0.27	0.99**	0.72	0.14
		(1.26)	(0.36)	(1.91)	(-1.02)	(2.07)	(1.40)	(1.08)
	4	0.48**	0.17	0.19	-0.11	-0.26	-0.74	0.23*
		(2.04)	(0.86)	(0.76)	(-0.38)	(-0.60)	(-1.42)	(1.70)
	5	-0.09	-0.08	-0.10	-0.07	-0.95**	-0.86	-0.16
	(Over-)	(-0.30)	(-0.33)	(-0.40)	(-0.22)	(-2.37)	(-1.59)	(-0.80)
	P5-P1	-0.18	-0.41	-0.33	-0.49	-0.62		-0.35
		(-0.53)	(-1.34)	(-1.18)	(-1.33)	(-1.07)		(-1.33)
	All Stocks	0.19*	0.14*	0.05	-0.20	-0.25	-0.44	
		(1.95)	(1.72)	(0.36)	(-0.96)	(-0.79)	(-1.15)	

		Factor loading on the SS constraint factor $(\hat{b}_p)$						
Mispricing measure	1 (Under-)	-0.06	-0.02	-0.14**	0.12	0.51**	0.57**	-0.06
		(-1.23)	(-0.38)	(-2.15)	(1.14)	(2.28)	(2.36)	(-1.58)
	2	-0.05	-0.10*	-0.09	0.05	0.22	0.27*	-0.07**
		(-1.24)	(-1.85)	(-1.18)	(0.49)	(1.43)	(1.68)	(-2.45)
	3	0.14*	-0.02	0.04	-0.03	0.58***	0.44**	0.06
		(1.73)	(-0.34)	(0.57)	(-0.28)	(3.30)	(2.34)	(1.40)
	4	0.03	0.01	0.15*	0.31***	0.49***	0.46**	0.07
		(0.32)	(0.13)	(1.68)	(3.05)	(3.12)	(2.41)	(1.35)
	5 (Over-)	0.20*	0.21**	0.13	0.30***	0.60***	0.39**	0.21***
		(1.81)	(2.37)	(1.37)	(2.66)	(4.05)	(1.98)	(2.76)
	P5-P1	0.27**	0.23**	0.27**	0.18	0.09		0.26***
		(2.20)	(2.08)	(2.61)	(1.33)	(0.42)		(2.71)
	All Stocks	-0.02	-0.03	0.00	0.11	0.51***	0.53***	
		(-0.65)	(-1.01)	(0.01)	(1.43)	(4.39)	(3.78)	
		Panel C: Amount of reduction in benchmark-adjusted return after controlling for the short sale constraint factor						
Mispricing measure	1	-0.01	-0.01	-0.04	0.07	0.40	0.41	-0.02
	2	-0.04	-0.02	-0.07	0.06	0.11	0.15	-0.03
	3	0.11	0.04	0.03	-0.02	0.42	0.31	0.08
	4	-0.02	0.01	0.13	0.23	0.27	0.29	0.06
	5	0.05	0.14	0.11	0.18	0.37	0.32	0.14
	P5-P1	0.06	0.15	0.15	0.11	-0.03		0.15
	All stocks	-0.02	0.00	0.01	0.07	0.33	0.35	

Table 12. Estimation Results After Adjusting for Idiosyncratic Volatility

This table presents the estimation results from regressing benchmark-adjusted returns of each of the portfolios on the factor related to idiosyncratic volatility (IVOL). Portfolios are formed as in Table 2. Benchmark-adjusted returns are calculated as the sum of the intercept estimate and the residuals from regressing excess portfolio returns on the Fama and French (1993) three factors. The IVOL factor is constructed by first assigning all stocks into one of the three IVOL portfolios based on their IVOL (high 30 percent, middle 40 percent, and low 30 percent of stocks), and then by taking the difference between the equally weighted returns of the low and high IVOL portfolios. IVOL is calculated as the standard deviation of the residuals obtained from regressing stock returns on the Fama and French (1993) three factors by using 36-month return observations prior to the portfolio formation month. The sample period is from September 2004 to December 2014. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

		Distress risk measure					High-	All
		1(Low)	2	3	4	5(High)	Low	stocks
		Panel A: $(\text{Benchmark adjusted return})_{pt} = a_p + b_p(\text{IVOL factor})_t + e_{pt}$						
		Intercept estimates $(\hat{a}_p)$						
Mispricing measure	1	0.13	0.34***	0.31*	0.35	-0.64	-0.77	0.22**
	(Under-)	(0.91)	(2.82)	(1.76)	(1.24)	(-1.10)	(-1.20)	(2.36)
	2	0.18	0.11	-0.23	-0.28	-0.39	-0.57	0.04
		(1.52)	(0.76)	(-1.10)	(-1.07)	(-0.96)	(-1.31)	(0.49)
	3	0.19	0.08	0.36*	-0.25	0.64	0.45	0.10
		(0.90)	(0.44)	(1.85)	(-0.99)	(1.40)	(0.91)	(0.81)
	4	0.46**	0.16	0.09	-0.29	-0.55	-1.01**	0.19
		(2.01)	(0.85)	(0.40)	(-1.11)	(-1.33)	(-2.00)	(1.47)
	5	-0.21	-0.21	-0.18	-0.25	-1.32***	-1.11**	-0.29
	(Over-)	(-0.70)	(-0.87)	(-0.75)	(-0.86)	(-3.49)	(-2.16)	(-1.49)
	P5-P1	-0.34	-0.55*	-0.49*	-0.60*	-0.67		-0.51**
		(-1.02)	(-1.85)	(-1.79)	(-1.69)	(-1.19)		(-2.03)
	All Stocks	0.21**	0.16*	0.05	-0.26	-0.56*	-0.77**	
		(2.16)	(1.97)	(0.36)	(-1.32)	(-1.88)	(-2.11)	
		Panel B: Amount of reduction in benchmark-adjusted return after controlling for the IVOL factor						
Mispricing measure	1	0.03	0.00	0.04	0.00	0.09	0.06	0.01
	2	0.00	0.04	-0.02	0.03	-0.02	-0.02	0.01
	3	0.03	0.05	0.00	0.00	0.07	0.04	0.04
	4	-0.04	0.00	0.03	0.05	-0.02	0.02	0.02
	5	-0.07	0.01	0.03	0.00	0.00	0.07	0.01
	P5-P1	-0.10	0.01	-0.01	0.00	-0.08		-0.01
	All stocks	0.00	0.02	0.01	0.01	0.02	0.02	0.00