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Financial Distress, Short Sale Constraints, and Mispricing

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Keywords: Financial distress puzzle; Short sale constraints; Degree of mispricing; Asymmetric pricing effect; Benchmark-adjusted returns

JEL classification: G12; G14

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Abstract

This paper specifically examine how the extent of the distress puzzle differs according to the degree of mispricing and short sale constraints. We find that the distress puzzle observed for overpriced stocks, not for underpriced stocks, becomes insignificant after adjustment for short sale constraints due to an asymmetric pricing effect of short sale constraints only on the short-leg side of distress. However, after adjustment for arbitrage risk, the distress puzzle remains unchanged. These results indicate that the distress puzzle is mainly attributable to short sale constraints, rather than other limits-to-arbitrages such as arbitrage risk, which has a bi-lateral pricing effect on both short-leg and long-leg sides of distress. To mitigate a possible endogeneity problem relation among financial distress, mispricing, and short sale constraints, we measure these variables with different timing.

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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 principle, recent studies have showed 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 implies that investors even pay a premium for bearing distress risk, it is a challenge to standard rational asset pricing models. This negative relationship is dubbed the financial distress puzzle.[2]

One group of studies attempt to provide some rational risk-based explanations for the financial distress puzzle. Several researchers (e.g., Garlappi, Shu, and Yan, 2008; George and Hwang, 2010; Garlappi and Yan, 2011) provide theoretical rational arguments for the puzzle. The

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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. They 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] Most studies on the distress puzzle are performed only for non-financial firms. By using the default prediction models developed specifically for financial firms, Kim and Lee (2017) find that the distress puzzle is also prominent for financial firms.

other studies in this first group (e.g., Vassalou and Xing, 2004; Chava and Purnanandam, 2010; Anginer and Yildizhan, 2010) argue that the negative relationship is neither an anomaly nor a puzzle, but an outcome from using poor quality proxies for ex ante expected returns and default risk. When different proxies for ex ante expected return are used rather than ex posted realized return, a positive relationship between default risk and expected returns is found.[3] Aretz, Florackis, and Kostakis (2018) report a positive relation between distress risk and stock returns by using the systematic component of default risk.

A second group of studies suggest an explanation of mispricing by market frictions for the distress puzzle. This group hypothesizes that the puzzle is a consequence of a delayed price response or investor under-reaction to distress news. One reason for a delayed price response is market frictions or limits-to-arbitrage. They argue that among market frictions or limits-to-arbitrage, short sale constraints play an important role in incurring the distress puzzle, since they restrain rational traders from exploiting overpricing (Miller, 1977). Avramov et al. (2009) report that the negative relationship between credit ratings and future returns is prominent among stocks with severe short sale constraints, by using institutional ownership, turnover, and shares outstanding as proxies for short sale constraints.

In fact, there are only a few in the second group of studies that provide mispricing arguments by short sale constraints. Among recent studies, Campbell et al. (2008) examine the

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[3] For example, Chava and Purnanandam (2010) argue that ex post realized return is a noisy proxy to estimate ex ante expected return. 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 relationship by using a simpler approach than those used by Garlappi, Shu, and Yan (2008) 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 relationship when using bond yield spread as a proxy for default risk.

effect of arbitrage-related frictions on the distress puzzle. However, short sale constraints are not considered in their examination, despite arguably the most important friction that causes the distress puzzle. Stambaugh, Yu, and Yuan (2012) conjecture that short sale constraints could be a cause of the distress puzzle but do not perform any formal test. Avramov et al. (2009) is the only study that specifically investigates the effect of short sale constraints on the degree of the distress puzzle, by using institutional ownership, turnover, and shares outstanding as proxies for short sale constraints. However, some proxies used in their study, such as turnover and shares outstanding, are rarely used in the literature as proxies for short sale constraints because they may be inappropriate. Further, these authors do not conduct a specific investigation on the pricing effect of short sale constraints on the distress puzzle.

There are several attributes other than financial distress that incur mispricing, which is the difference between the observed price and the price that would otherwise prevail in the absence of arbitrage-related friction. If a return anomaly represents mispricing, firm characteristics related to the well-known return anomalies documented in the literature can be such attributes. Previous studies in the second group examine the effect of short sale constraints on the distress puzzle, assuming that the degree of mispricing (with respect to attributes other than financial distress) remains fixed; that is, securities are previously equally priced. It would be more reasonable, however, to assume that securities are already differently priced before the effect of short sale constraints takes place. According to the degree of mispricing status, the effect of short sale constraints on the distress puzzle would be differential. For example, if the firms are already underpriced (with respect to attributes other than financial distress), there would be little demand for selling such firms short, regardless of the extent of financial distress. Thus, short sale constraints would not play a significant role in incurring the distress puzzle for already-underpriced firms. However, if the firms are already overpriced, there would already be a strong demand for selling such firms short. Then, short sale constraints would play a significant role in incurring the distress puzzle for already-overpriced firms, and overpricing of such firms would persist. We therefore argue that the extent of the distress puzzle would differ with the degree of mispricing status (related to attributes other than financial distress).

The purpose of this study is three-fold. First, we examine how the extent of the distress puzzle differs according to the degree of mispricing. To differentiate the timing of mispricing by financial distress and by other attributes, we measure the degree of mispricing one period before measuring financial distress. Second, we specifically examine the effect of short sale constraints on the distress puzzle according to the degree of mispricing. As proxies for short sale constraints, we use stock borrowing costs, institutional ownership, exchange-traded option status, and enforcement of the uptick rule. There could be an endogenous relation between financial distress and short sale constraints, since distressed firms are costly to sell short. To mitigate this possible endogeneity problem, we measure short sale constraints one period before measuring financial distress.[4] Third, we examine an asymmetric pricing effect of short sale constraints on the distress puzzle. The 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]

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[4] To mitigate a possible endogeneity problem among short sale constraints, mispricing, and financial distress, we use lagged values of mispricing and short sale constraints in this paper, assuming that these two lagged variables are non-persistent over time.

[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 -

This asymmetric mispricing across financial distress is deepened by short-sale constraints. We attempt to *specifically* measure how much of the distress puzzle is explained by short sale constraints by constructing a factor related to short sale constraints.

We find that the distress puzzle is observed only for stocks (previously) overpriced, but not for stocks underpriced with respect to the above-mentioned attributes, regardless of the level of short sale constraints. In both univariate portfolio tests and multivariate regression tests, we show that the distress puzzle observed in overpriced stocks becomes more severe as short sales are more constrained. To measure the degree of mispricing, 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, as attributes other than financial distress.

To measure a specific pricing effect of short sale constraints on distress, we construct a factor related to short sale constraints. We find that there is a strong asymmetric pricing effect of short sale constraints on distress. That is, there is a strong unilateral pricing effect on its short-leg side, but little pricing effect on its long-leg side. After adjustment for short sale constraints, the distress puzzle becomes insignificant for overpriced stocks. However, after adjustment for the other representative limits-to-arbitrage, idiosyncratic volatility, which has a bi-lateral symmetric pricing effect on both short- and long-leg sides of distress, the distress puzzle remains unchanged. These results indicate that the distress puzzle is mainly attributable to market frictions, such as short sale constraints, which have an asymmetric pricing effect only on the short-leg side of distress.

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, Yu, and Yuan (2012).

A main contribution of this paper to the literature is to examine specifically how the extent of the distress puzzle differs according to the degree of mispricing and short sale constraints. To do this, we use more various, direct and indirect, proxies for short sale constraints than do any other studies. To differentiate the timing of mispricing by financial distress and by other attributes and to mitigate a possible endogeneity problem between financial distress and short sale constraints, we measure these variables with differentiated timing; that is, the degree of mispricing and short-sale constraints are measured at t-2, financial distress at t-1, and stock returns at t. To our knowledge, this attempt is the first in the literature. Another contribution of our paper is to specifically show that the distress puzzle is mainly attributable to short sale constraints, rather than other limits-to-arbitrages, such as arbitrage risk. This is the first paper to provide detailed and comprehensive empirical support for the role of short sale constraints in the distress puzzle.

The remainder of this paper proceeds as follows. Section 2 explains the proxies for financial distress risk, mispricing, and short sale constraints. Section 3 describes the data, and Section 4 reports our main empirical results. Section 5provides implications of our findings about the U.S. market for Asia-Pacific Markets, and Section 6 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 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 derived from the Black-Scholes-Merton option pricing model,[6] and the Shumway (2001) and Campbell et al. (2008) hazard models that 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.[7] The parameter estimates and the explanatory variables used in the hazard equation of (1) are

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

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[6] Garlappi, Shu, and Yan (2008) and Campbell et al. (2010) report a negative relationship between financial distress risk and subsequent returns by using Moody's KMV measure of distance-to-default, while Vassalou and Xing (2004) report a positive relationship by using a simpler approach to measure distance-to-default.

[7] Campbell et al. (2008) estimated the default prediction model of (1) by using both firms filed bankruptcy under Chapter 7 or Chapter 11 and financially-distressed firms which are delisted for financial reasons or received a D rating. It would be interesting to examine how similar the results are for bankrupt firms and for financially-distressed firms.

$$+0.075\ \text{MB}_{i,t-1} - 0.058\ \text{PRICE}_{i,t-1}. \quad (2)$$

The definitions of the explanatory variables are set forth in footnote 7, and the estimates for the parameters in equation (1), α and β, are obtained from Table IV in Campbell et al. (2008).[8]

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, such as 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, we choose nine firm characteristics used in Stambaugh, Yu, and Yuan (2015), which are related to 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-

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

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

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

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

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

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

Marx, and Zhang, 2010); and (ix) investment-to-assets (Titman, Wei, and Xie, 2004; Xing, 2008).

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, Yu, and Yuan(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 the actual mispricing that survives after arbitrage. 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 that impede the adoption of short positions. We include the following proxies: stock borrowing cost, institutional ownership, presence of exchange-traded options, and enforcement of the uptick rule governing short sale activities. 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. Stock Borrowing Costs

Lending fees charged by lenders are the direct costs of shorting stocks and are probably the most direct 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). We use the monthly average of daily DCBS's.

B. Institutional Ownership

Recently, most 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

[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.

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

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.

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.

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 stock 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. 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 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

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

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 stock borrowing costs measured by DCBS from the Markit Securities Finance Analytics Database, institutional investor holdings data from Thomson Reuters Institutional (13f) holdings S34 files, 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 January 2003 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 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. The Financial Distress Puzzle According to the Degree of Mispricing

As a preliminary step in examining the distress puzzle according to the degree of mispricing with respect to attributes other than financial distress, we form 25 portfolios in a (5×5) two-way independent sorting at the five break-points of mispricing measured at month t-2 and the five break-points of financial distress measured at month t-1 and hold the stocks in the portfolio for month t. The portfolios are monthly rebalanced with value weight. 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. The sample period is January 1981 through December 2014. As aforementioned, to differentiate the timing of mispricing by financial distress and by attributes other than financial distress, we sort stocks on mispricing (with respect to attributes other than financial distress) measured one period before measuring financial distress.

Table 2 presents average raw returns (Panel A) and abnormal returns (Panel B) of the 25 portfolios sorted on mispricing (measured at t-2) and financial distress (measured at t-1). Abnormal returns are the intercept estimates obtained from regressing the excess returns of the portfolio on the Fama and French (1993) three factors (FF3). Consistent with prior studies, the results show 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 is -0.75 percent per month, with t-statistic of -2.01, and the difference in abnormal returns between these two portfolios is -1.42 percent per month, with t-statistic of -5.00. These two zero-investment arbitrage returns are negative and statistically strongly significant at conventional levels. In particular, the distress puzzle is asymmetric. In other words, the extent to which highly distressed stocks are overpriced

($\hat{\alpha}_5 = -1.22$ percent) is much greater than the extent to which low-distressed 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, Yu, and Yuan, 2012).

We find, however, that the negative relation between financial distress and subsequent returns is strongly maintained only for (previously) overpriced stocks, but not for (previously-measured) underpriced or fairly priced stocks, when we break down the (overall) negative relation according to the degree of mispricing. Only for the most "overpriced" quintile portfolio (P5), the average raw returns monotonically decrease with financial distress, and the difference in average raw returns between high and low distress portfolios ("High−Low") is statistically significant at conventional levels; it is -1.62 percent (t-statistic of -4.07). Meanwhile, for the other mispriced (underpriced) quintile portfolios, the monotonic deceasing pattern of average raw returns across financial distress is not observed, and the difference "High−Low" is insignificantly negative or even positive. The difference in "High-Low" (in average raw return) between the most overpriced (P5) and underpriced (P1) [i.e., difference in difference (DiD) in average return] is statistically strongly significant; it is -1.52 percent (t-statistic of -4.09). These results support the argument that the distress puzzle is more severe for overpriced stocks than for underpriced stocks.

The above results are similarly observed in abnormal returns. The differences in abnormal returns between "high" and "low" distress portfolios (High−Low) are also statistically significant at conventional levels only for the most and next most "overpriced" quintile portfolios (P5 and P4). They are -2.17 percent (t-statistic of −6.40) and -1.13 percent (t-statistic of −3.09), respectively. The monotonic decreasing pattern of abnormal returns across financial distress is observed only for the most overpriced portfolio. The difference in "High-Low" (in abnormal returns) between the most overpriced (P5) and underpriced (P1) (i.e., DiD in abnormal returns) is also statistically significant; it is -1.26 percent (t-statistic of -3.36). In summary, the distress puzzle is prominent only for overpriced stocks.

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

We examine how the extent of the 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., the presence of exchange-traded stock options), and enforcement 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 three-way sorted portfolios in which the three sorting variables are measured at different periods. To differentiate the timing of mispricing by financial distress and by attributes other than financial distress, we measure the other attributes other than financial distress one period before measuring financial distress. To mitigate a possible endogenous relation between financial distress and short sale constraints (i.e., distressed firms are costly to sell short), we measure short sale constraints one period before measuring financial distress. Specifically, we first sort all stocks in a (5×5) two-way independent sorting at the break-points of the mispricing measure at month t-2 and the financial distress measured at month t-1, and then sort the stocks within each portfolio into one of two or three subgroups sorted on short sale constraints measured at month t-2. The portfolios are held for month t with value weight.

A stock is classified as more (less) short-sale constrained if its DCBS is greater than 1 (equal to 1), if it is included in the bottom (top) 30 percent group of residual institutional ownership, if it does not have (has) exchange-traded options, and if the uptick rule is enforced (eliminated) for the stock.

Table 3 presents abnormal returns of 50 ($= 5 \times 5 \times 2$) portfolios sorted on mispricing (at t-2) and financial distress (at t-1) for high and low DCBS groups, respectively. In fact, the results in Table 3 are break-downs of the overall results in Table 2 regarding the distress puzzle according to the degree of short sale constraints proxied by DCBS. We present full results obtained from using the stock borrowing cost only, since it is probably the most direct measure of short sale constraints among the four proxies and the results are similar. The distress puzzle is observed only in the high DCBS group (i.e., high short-sale constrained), but not in the low DCBS group (i.e., low short-sale constrained). Specifically, using all stocks, the differences in abnormal returns between high and low distress stocks ("High−Low") are -1.59 percent (t-statistic of -2.20) and -0.31 percent (t-statistic of -0.97) for high and low DCBS groups, respectively. More importantly, the distress puzzle observed for overpriced stocks in Table 2 is statistically significant only in the high DCBS group, but not in the low DCBS group. Specifically, "High−Low" for the most overpriced portfolio (P5) are -2.36 percent (t-statistic of -2.34) and -0.31 percent (t-statistic of -0.68) for high and low DCBS groups, respectively. The difference in "High-Low" for P5 between high and low DCBS groups is statistically significant at the 10% level; it is -2.05 percent (t-statistic of -1.84). In particular, the monotonic decreasing pattern of abnormal returns across financial distress is observed only for the most overpriced portfolio in the high DCBS group.

Results obtained from using the other three proxies (institutional ownership, option status, and the enforcement of the uptick rule) are reported in Table A1 in Appendix. This table presents only the differences in abnormal returns between high and low distress stocks ("High−Low") across the five mispricing quintile portfolios for high and low short-sale constrained groups. The results are overall similar to those obtained from using DCBS.[12]

In summary, the distress puzzle is observed only for stocks that are previously overpriced with respect to attributes other than financial distress, but not for stocks that are underpriced. This distress puzzle becomes more profound 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).

The above results are obtained by using abnormal returns after adjusting for FF3. According to Novy-Marx, 2013; Chen, Novy-Marx, and Zhang, 2010; Hou, Xue, and Zhang, 2015, distress may be related to future profitability. As a robustness check, it is noteworthy to make adjustment for profitability in computing abnormal returns. To do so, we use the Fama and French (2015) five factors (FF5) in which the profitability and investment factors are added to FF3. The results are overall similar to the results obtained from using FF3-adjusted abnormal returns.[13]

4.3. Multivariate Tests

[12] "High−Low" for the most overpriced portfolio (P5) are statistically significant in the high short-sale constrained group, but not in the low short-sale constrained group. Specifically, "High−Low" in the high short-sale constrained groups are -2.67 percent (t-statistic of -6.20), -3.83 percent (t-statistic of -5.50), and -2.29 percent (t-statistic of -5.38), respectively, using institutional ownership, option status, and the enforcement of the uptick rule as proxies for short sale constraints. However, those in the low short-sale constrained groups are much smaller in magnitude and statistical significance; those are -0.92 percent (t-statistic of -2.22), -1.12 percent (t-statistic of -2.14), and -0.84 percent (t-statistic of -1.14), respectively. More importantly, the differences in "High-Low" for P5 (DiD) between high and low short-sale constrained groups are statistically significant at the conventional level for all of the three proxies; they are −1.75 percent (t-statistic of −2.92), −2.71 percent (t-statistic of −3.11), and −1.45 percent (t-statistic of −1.68), respectively.

[13] The full results using FF5 are available upon request.

The previous portfolio tests represent a univariate test on the differential effect of the extent of short sale constraints on the 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:

$$\text{Model 1: } r_{i,t} = \beta_0 + \beta_1 \text{Distress}_{i,t-1} + \beta_2 \text{Overpricing}_{i,t-2} + \gamma \left(\text{Distress}_{i,t-1} \times \text{Overpricing}_{i,t-2}\right) + \text{year dummy} + \text{industry dummy} + e_{it}, \quad (3)$$

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 $\text{Overpricing}_{i,t-2}$ is the value of the overpricing proxy variable of firm i at month t-2. The overpricing proxy variable is the indicator variable (overpricing dummy) which equals 1 if the average overpricing ranking at month t-2 is above the 50th percentile and zero otherwise.[14] 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. To be consistent with the portfolio tests in differentiating the timing of mispricing by financial distress and by other attributes, we use the distress and overpricing variables measured at t-1 and t-2, respectively.

We include year dummies in the regression model to capture contemporaneous shocks of

[14] As a proxy variable for overpricing, we also used the average of ranking percentiles produced by the nine anomaly variables (ranking percentile). The overall results are qualitatively similar to those using the ranking percentiles. The results are available upon request.

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 others, 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 of the SIC codes.

Table 4 presents the estimation results of Model 1 of equation (3) by using pooled regressions (Panel A) and the Fama-MacBeth cross-sectional regressions (Panel B). As expected, when the financial distress variable is alone in the model, the coefficient estimates on the variable are strongly negatively significant ($\hat{\beta}_1$ are -0.268 (t-statistic of -19.50) and -0.231 (t-statistic of -2.30) using pooled regressions and the Fama and MacBeth regressions, respectively, which confirms the 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. 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 is expected to have a negative sign. It measures the difference in the financial distress effect between overpriced and underpriced stocks. The estimation results show that the estimates of γ are negative and strongly statistically significant at the 1 percent level; they are $\hat{\gamma} = -0.408$ (t-statistic of -15.08) and -0.369 (t-statistic of -7.19) using pooled regressions and the Fama and MacBeth regressions, respectively. Meanwhile, the coefficient estimate on the financial distress variable, $\hat{\beta}_1$, becomes statistically insignificant or even positively significant. These results indicate that the 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 distress puzzle in a multivariate regression framework, we estimate the pooled regression model.

$$\begin{aligned}\text{Model 2:}\quad r_{it} = {} & \beta_0 + \beta_1 \text{Distress}_{it-1} + \beta_2 \text{Overpricing}_{it-2} + \gamma_1 \left(\text{Distress}_{it-1} \times \text{Overpricing}_{it-2}\right) \\ & + \gamma_2 (\text{Distress}_{it-1} \times \text{Short}_{it-2}) + \gamma_3 \left(\text{Overpricing}_{it-2} \times \text{Short}_{it-2}\right) \\ & + \gamma_4 \left(\text{Distress}_{it-1} \times \text{Overpricing}_{it-2} \times \text{Short}_{it-2}\right) + \text{Year dummy} \\ & + \text{Industry dummy} + e_{it}, \qquad (4)\end{aligned}$$

where Short_{it-2} is the proxy variable representing the severity of short sale constraints of firm i at month t-2. 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 unavailable and zero otherwise, and (4) enforcement of the uptick rule, which equals 1 for the period in which the uptick rule is enforced for all exchange-traded stocks (January 1981 to December 2004) and zero for the period in which the uptick rule is eliminated for all stocks (January 2008 to December 2014). Firms with more severe short sale constraints are assigned a higher value for the proxy variable.

Table 5 presents the estimation results of Model 2 of equation (4) by using pooled regressions (Panel A) and the Fama-MacBeth cross-sectional regressions (Panel B). The coefficient of main interest is γ_4, which is expected to have a negative sign. This is the measure of the DiD that indicates the difference in the degree of the distress puzzle observed for overpriced stocks between high and low short-sale-constrained stocks. That is, it measures the differential effect of the extent of short sale constraints on the distress puzzle. The estimation results show that the estimates of γ_4 are negative and highly statistically significant for all cases. The pooled regression estimates ($\hat{\gamma}_4$) are -0.038 (t-statistic of -8.02) using negative IO, -0.275 (t-statistic of -9.78) using DCBS, -0.820 (t-statistic of -15.26) using option status, and -0.271 (t-statistic of -5.57) using enforcement of the uptick rule as a proxy for short sale constraints. The Fama-MacBeth regression estimates of γ_4 are also similar; they are -0.039 (t-statistic of -4.03) using negative IO, -0.139 (t-statistic of -2.55) using DCBS, -0.474 (t-statistic of -3.15) using option status, and -0.115 (t-statistic of -3.69) using enforcement of the uptick rule. These results indicate that the distress puzzle observed for overpriced stocks (measured by γ in Model 1) becomes more profound as short sales are more constrained.

Overall, we confirm in a multivariate framework that the distress puzzle is prominent only in overpriced stocks and this puzzle is more profound among more short-sale constrained stocks.

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

The results described above support arguments that short sale constraints play an important role in incurring the 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 make an adjustment for short-sale constraints, we construct portfolios by first assigning all stocks each month into the portfolio of low stock borrowing costs if their DCBS, measured at month t-2, equals 1 and into the portfolio of high stock borrowing costs otherwise, and then by taking the difference between the equally weighted returns of the low and high stock borrowing cost portfolios. We regard this low-minus-high DCBS portfolio as a factor related to short sale constraints. We then estimate the following time-series regression model:

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

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, and "SS constraint factor" is the factor related to short sale constraints. Although this short sale constraint factor is not a risk factor, we employ this approach to measure specifically (in return) how much of the distress puzzle is caused by short sale constraints. The intercept term in equation (5) indicates the benchmark-adjusted return *after* adjustment for the short sale constraint factor.

Panel A of Table 6 presents FF3-adjusted abnormal returns of the 25 (= 5×5) portfolios that are formed each month in a two-way independent sorting at the break-points of mispricing (at month t-2) and financial distress (at month t-1) during the period January 2003 to December 2014 when DCBS data is available. These abnormal returns are benchmark-adjusted returns before adjustment for the short sale constraint factor. Compared to those over the full sample period from January 1981 to December 2014 (Panel B of Table 2), the distress puzzle is still significantly evident during this period, especially for overpriced stocks, although its statistical significance is weaker than in the full sample period. The differences in abnormal return between the highest and lowest distress portfolios ("High-Low") are -1.25 percent (t-statistic of -2.56) for the most overpriced stocks (P5) and -0.74 percent (t-statistic of -2.03) for all stocks.

Panel B of Table 6 presents the intercept estimates $(\hat{a}_p)$ of equation (5), which are the benchmark-adjusted return *after* adjustment for the short sale constraint factor. It shows that after adjustment for the short sale constraint factor, the distress puzzle observed for the most overpriced stocks and all stocks becomes statistically insignificant. Specifically, the "High-Lows" are -0.77 percent (t-statistic of -1.50) for the most overpriced stocks and 0.00 percent (t-statistic of 0.00) for all stocks. These results indicate that the distress puzzle is not observed after adjustment for the short sale constraint factor, which is constructed by using a direct measure of short sale constraints.

Panel C presents the difference in benchmark-adjusted return after (Panel B) and before (Panel A) adjustment for the short sale constraint factor for the 25 portfolios, which indicates the amount of the benchmark-adjusted return explained by the short sale constraint factor. It shows that the explained amount of the benchmark-adjusted return is small for low-distress stocks, but large for high-distress stocks. For example, using all stocks, the explained amount of the benchmark-adjusted return is 0.09 percent, 0.12 percent, 0.15 percent, 0.33 percent, and 0.82 percent for the five distress portfolios (from lowest to highest), respectively. Within each mispricing portfolio, the pattern in the explained amount of the benchmark-adjusted return across the five distress portfolios is also similar. We also confirm that the factor loading estimates on the short sale constraints factor $(\hat{b}_p)$ are small for low-distress portfolios, but positive and large for high-distress portfolios (not reported). These results indicate that the short sale constraint factor has little effect on the long-leg side but has a strong effect on the short-leg side of distress. In other words, short sale constraints have an *asymmetric* pricing effect on the distress puzzle. This is the main reason that distress puzzle disappears after adjustment for the short sale constraint factor.

To further examine the argument that the distress puzzle is a consequence of a delayed price response to distress news due to limits-to-arbitrage, we re-estimate equation (5) by using the factor related to another representative limits-to-arbitrage, idiosyncratic volatility (IVOL) as a proxy for arbitrage risk, and compare the estimation results with those using short sale constraints (in Table 6). The reason we choose idiosyncratic volatility as another representative limits-to-arbitrage is that it has a different pricing effect from short sale constraints. That is, it has a bi-directional pricing effect on both long-leg and short-leg sides of distress, while short sale constraints have a pricing effect only on the short-leg side. Panel A of Table 7 presents the intercept estimates in equation (5). Different from using the short sale constraint factor, the economic and statistical significance of the distress puzzle is almost unchanged (compared to the (unadjusted) results in Panel A of Table 6), when adjusting for the IVOL factor. Panel B of Table 7 presents the difference in benchmark-adjusted return after and before adjustment for the IVOL factor for the 25 portfolios. It is evident that the amount of the benchmark-adjusted returns explained by the IVOL factor 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 distress puzzle.

In summary, the above results show that the distress puzzle is mainly attributable to short sale constraints that have an asymmetric pricing effect on the distress puzzle (i.e., a strong unilateral pricing effect on the short-leg side, but little pricing effect on the long-leg side), rather than other market frictions such as arbitrage risk, which has a bi-lateral symmetric pricing effect.

5. Implications of Our Findings for Asia-Pacific Markets

Extending the literature on the distress risk puzzle in the U.S. market, many studies have shown an analogous pattern in global markets. Gao, Parsons, and Shen (2018) and Eisdorfer, Goyal, and Zhdanov (2018) report that the financial distress puzzle observed in the U.S. market is also observed in developed countries in North America and Europe.[15] These two cross-country studies also show that Asia-Pacific countries, such as Australia, New Zealand, Korea, China, Singapore, India, Malaysia, and Taiwan, exhibit a negative relation between default risk and subsequent stock returns, although their statistical significance of the negative relation is not as much strong as in the developed countries. Bissoondoyal-Bheenick and Brooks (2015) also find a similar result in Australia and Japan that there exists a negative relation between credit ratings and equity returns.

There are also several single-country studies showing the distress puzzle in Asia-Pacific markets. For example, Gharghori, Chan, and Faff (2007, 2009) report that default risk is negatively related to equity returns in the Australian market by using the Fama and MacBeth (1973) regression framework.[16] By using various default risk proxies, Kim and Lee (2015, 2016) report that the financial distress puzzle is prominent in South Korea after 2000. According to Chu, Ko, Lin and Ho (2013) and Kuo, Huang and Jhang (2015), the negative relation between credit rating and equity returns is also prevalent in Taiwan. Wang (2017) reports a similar puzzle in China where distressed firms underperform non-distressed ones.[17]

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15 For non-U.S. countries, a stronger distress puzzle is found in small firms than in large firms.

16 As a proxy for default risk, Gharghori et al. (2007, 2009) use default probabilities obtained from option-based models, as in Vassalou and Xing (2004). These authors report that the negative relation is statistically insignificant at the standard significance level. Chan, Faff, and Kofman (2011) attribute this statistical insignificance to a short sample period of just nine years (1995-2003), which is a period of expansion in the Australian business cycle. For a period of expansionary economy, any statistical significance of a default risk factor is less likely.

17 Meanwhile, the other single-country studies report that a positive relation between distress risk and stock returns is found in a few developing Asia-Pacific countries, such as Vietnam (Chaiyakul, Bangassa, and Iskandrani, 2016), Pakistan (Malik, Aftab, and Noreen, 2013; Mirza, Rahat, and Reddy, 2016), and Turkey

Many of the aforementioned studies attempt to explain the distress puzzle from a risk-based or behavioral perspective in a country-level approach. However, there are no studies to explain the distress puzzle in Asia-Pacific countries from a perspective of market frictions, such as short sale constraints, in a firm-level approach, as done in this study for the U.S. market.[18] The main reason of the lack of firm-level investigation on the effect of short sale constraints on the distress puzzle in Asia-Pacific countries may be due to firm-level data unavailability of short sale constraints. In particular, stock borrowing costs, which are the direct costs of shorting stocks and are probably the most direct measure of short sale constraints, are difficult to obtain in firm level even in developed countries except for the U.S. In this circumstance, the effect of short sale constraints on the distress puzzle in firm-level in Asia-Pacific countries can be possibly explored from our results obtained from using the U.S. data, but in a limited manner. Many studies show that short sale constraints play a similarly negative role on price discovery, market quality and efficiency in both the U.S. and Asia-Pacific markets.[19] Thus, we conjecture that short sales constraints might play a similar role in incurring the distress puzzle in Asia-Pacific markets as in the U.S. market.

6. Conclusions

This paper examines how the distress puzzle differs according to the degree of mispricing and

(Koseoglu, 2013).

[18] In their cross-country study, Eisdorfer, Goyal, and Zhadanov (2018) investigate the effect of short-sale constraints on the distress puzzle in a country-level by including a country dummy variable in regression analyses, which equals one if short sales are allowed in the country and zero otherwise. They find an insignificant effect of short-sale constraints on the distress puzzle.

[19] See Bris, Goetzmann, and Zhu (2007), Chang, Cheng, and Yu (2007), Beber and Pagano (2013), Helmes, Henker, and Henker (2017), Chang et al. (2012), and Bai and Qin (2014).

short sales constraints. To differentiate the timing of mispricing by financial distress and by other attributes and to mitigate a possible endogeneity problem, we measure the degree of mispricing, short-sale constraints, financial distress, and stock returns with differentiated timing. We use more various, direct and indirect, proxies for short sale constraints than do any other studies in the literature. We attempt to specifically measure the asymmetric pricing effect of short sale constraints on the distress puzzle by constructing a factor related to short sale constraints.

We find that the distress puzzle is observed only for (previously) overpriced stocks, but not for underpriced stocks, regardless of the level of short sale constraints. In univariate portfolio tests and multivariate regression tests, the distress puzzle observed in overpriced stocks becomes more severe as short sales are more constrained. It is observed that there is a strong asymmetric pricing effect of short sale constraints on the distress puzzle. After adjustment for short sale constraints, the distress puzzle becomes insignificant for overpriced stocks. However, after adjustment for another representative limits-to-arbitrage, idiosyncratic volatility, which has a bi-lateral symmetric pricing effect on both long- and short-leg sides of distress, the distress puzzle remains almost unchanged. Thus, the distress puzzle is mainly attributable to market frictions, such as short sale constraints, which have an asymmetric pricing effect only on the short-leg side of distress. Our results indicate some important implications to stakeholders of the firm. Since overpricing of distressed firms is prolonged as short sales becomes more severe, investors could achieve arbitrage profits by exploiting overpricing of distressed stocks which are highly short-sale constrained. Policy-makers should focus on alleviating (if not possible to remove) impediments to short sales rather than other market frictions to remove these arbitrage opportunities.

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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. The sample periods for the stock borrowing costs and the option status data are January 2003 to December 2014 and January 1996 to August 2014, respectively. The sample period for the other variables is January 1981 to December 2014. ***, **, and * in Panel B indicate significance at the 1, 5, and 10 percent levels, respectively.

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 (%)	1.40	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	Stock borrowing costs (%)	Option status
	Panel B: Correlation coefficients				
Distress	1.00				
Overpricing	0.25***	1.00			
Institutional ownership	-0.07***	-0.05***	1.00		
Stock borrowing cost (DCBS)	0.31***	0.15***	-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	Stock borrowing cost (%)	Option status
			Panel C: Time-series average			
1 (low)	1.32	-8.62	42.61	1.46	1.12	0.61
2	1.30	-8.17	46.53	1.29	1.14	0.62
3	1.23	-7.78	49.32	1.31	1.22	0.54
4	1.15	-7.25	51.66	1.15	1.45	0.43
5 (high)	0.80	-6.10	53.41	0.79	2.19	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 and Mispricing Measures

This table presents average raw and abnormal returns for portfolios that are formed each month in a (5×5) two-way independent sorting at the beak-points of mispricing measure at month t-2 and financial distress risk measured at month t-1. The portfolios are held for month t with value-weight. 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 ($\hat{\alpha}$) obtained from time-series regressions of the Fama-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.

Sorted on mispricing measure (t-2)	Sorted on distress risk measure (t-1) 1(Low)	2	3	4	5(High)	High−Low	All stocks
	Panel A: Raw returns ($\bar{R}_p$)						
1	1.13***	1.33***	1.37***	1.84***	1.04**	-0.09	1.23***
(Under-)	(5.47)	(5.98)	(4.59)	(4.77)	(2.05)	(-0.21)	(6.01)
2	0.90***	1.13***	1.23***	1.48***	1.42***	0.52	1.03***
	(4.04)	(4.84)	(4.34)	(3.91)	(2.80)	(1.19)	(4.66)
3	1.19***	1.00***	1.02***	0.87**	1.29***	0.10	1.05***
	(4.77)	(4.02)	(3.42)	(2.39)	(2.60)	(0.26)	(4.23)
4	1.13***	0.79***	0.96***	1.05***	0.72	-0.42	0.93***
	(4.26)	(2.99)	(3.02)	(2.65)	(1.39)	(-0.99)	(3.51)
5	0.85***	0.40	0.36	0.36	-0.77	**-1.62*****	0.40
(Over-)	(2.99)	(1.37)	(1.10)	(0.88)	(-1.56)	**(-4.07)**	(1.29)
P5−P1	-0.28	-0.93***	-1.00***	-1.48***	-1.81***	**-1.52*****	-0.83***
	(-1.44)	(-4.66)	(-4.86)	(-5.46)	(-5.33)	**(-4.09)**	(-4.61)
All Stocks	1.03***	1.04***	0.97***	0.92**	0.28	**-0.75****	
	(5.01)	(4.66)	(3.50)	(2.50)	(0.60)	**(-2.01)**	
	Panel B: Abnormal returns ($\hat{\alpha}_p$)						
1	0.30***	0.41***	0.25	0.61***	-0.60**	-0.90***	0.35***
(Under-)	(3.00)	(4.05)	(1.60)	(2.76)	(-2.01)	(-2.69)	(5.13)
2	0.05	0.20**	0.12	0.17	-0.24	-0.29	0.10*
	(0.42)	(1.99)	(0.80)	(0.76)	(-0.75)	(-0.81)	(1.65)
3	0.32***	-0.01	-0.10	-0.44**	-0.22	-0.53	0.05
	(2.68)	(-0.10)	(-0.72)	(-2.25)	(-0.71)	(-1.56)	(0.75)
4	0.27*	-0.18	-0.07	-0.30	-0.86***	-1.13***	-0.07
	(1.86)	(-1.40)	(-0.46)	(-1.46)	(-2.79)	(-3.09)	(-0.90)
5	-0.05	-0.60***	-0.72***	-0.90***	-2.21***	**-2.17*****	-0.69***
(Over-)	(-0.27)	(-4.17)	(-4.80)	(-4.62)	(-8.14)	**(-6.40)**	(-6.59)
P5−P1	-0.35*	-1.01***	-0.97***	-1.51***	-1.61***	**-1.26*****	-1.04***
	(-1.82)	(-5.48)	(-4.86)	(-5.55)	(-4.75)	**(-3.36)**	(-7.22)
All stocks	0.19***	0.10*	-0.11	-0.37**	-1.22***	**-1.42*****	
	(2.70)	(1.94)	(-1.13)	(-2.36)	(-5.09)	**(-5.00)**	

Table 3. Distress Anomaly in Subsamples of High versus Low Stock Borrowing Costs

This table presents abnormal returns of portfolios formed in a (5×5×2) three-way sorting. That is, all stocks are sorted first in a (5×5) independent two-way at the beak-points of the mispricing measure at month t-2 and the financial distress at month t-1 and then the stocks within each portfolio are sorted into one of two subgroups on stock borrowing costs measured at t-2. The portfolios are held for month t with value-weight. Stock borrowing costs are the daily costs to borrow score (DCBS) by Markit. The high (low) stock borrowing costs subgroup consists of stocks with DCBS greater than 1 (equal to 1). The mispricing measure is the average of ranking percentiles based on the characteristics of the nine anomalies. Financial distress risk is measured by the Campbell et al. (2008) financial distress measure. Abnormal returns are calculated as the intercept estimate $(\hat{\alpha})$ obtained from time-series regressions of the Fama-French (1993) three factors. The sample period is January 2003 to December 2014. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

Sorted on mis-pricing (t-2)	HIGH stock borrowing costs (t-2): Sorted on distress measure (t-1)						LOW stock borrowing costs (t-2): Sorted on distress measure (t-1)						HIGH costs –LOW costs: Sorted on distress measure (t-1)					
	Low	2	3	4	High	H−L	Low	2	3	4	High	H−L	Low	2	3	4	High	H−L
1	-0.49	-0.31	-1.12*	0.06	-0.90	-0.41	0.11	0.24*	0.10	-0.11	-0.18	-0.30	-0.60	-0.55	-1.23*	0.17	-0.71	-0.11
(Under)	(-1.19)	(-0.67)	(-1.80)	(0.06)	(-0.75)	(-0.33)	(0.65)	(1.83)	(0.60)	(-0.48)	(-0.34)	(-0.50)	(-1.35)	(-1.14)	(-1.90)	(0.17)	(-0.54)	(-0.08)
2	-0.28	0.14	-0.85	-1.48*	-1.66	-1.38	0.07	0.09	0.12	0.00	0.15	0.08	-0.36	0.05	-0.97	-1.48*	-1.82	-1.46
	(-0.64)	(0.24)	(-1.16)	(-1.76)	(-1.20)	(-1.00)	(0.55)	(0.68)	(0.59)	(0.00)	(0.43)	(0.19)	(-0.77)	(0.08)	(-1.28)	(-1.69)	(-1.26)	(-1.01)
3	0.37	-0.43	-1.37**	-0.37	-1.79*	-2.16**	0.32	0.06	-0.04	0.05	0.29	-0.03	0.05	-0.49	-1.33**	-0.42	-2.08**	-2.13*
	(0.77)	(-0.73)	(-2.23)	(-0.50)	(-1.88)	(-1.99)	(1.44)	(0.33)	(-0.22)	(0.19)	(0.84)	(-0.07)	(0.09)	(-0.80)	(-2.05)	(-0.54)	(-2.06)	(-1.83)
4	0.19	0.09	-0.36	0.13	-0.55	-0.74	0.31	0.30	-0.09	-0.05	-0.09	-0.41	-0.13	-0.21	-0.27	0.18	-0.46	-0.33
	(0.38)	(0.16)	(-0.45)	(0.13)	(-0.56)	(-0.69)	(1.31)	(1.36)	(-0.46)	(-0.22)	(-0.27)	(-0.92)	(-0.23)	(-0.35)	(-0.33)	(0.18)	(-0.44)	(-0.29)
5	-0.43	-0.49	-1.80***	-2.08***	-2.79***	**-2.36****	-0.10	0.07	-0.17	0.13	-0.41	**-0.31**	-0.34	-0.55	-1.63***	-2.21***	-2.38***	**-2.05***
(Over-)	(-0.73)	(-1.03)	(-3.31)	(-3.35)	(-3.69)	**(-2.34)**	(-0.29)	(0.28)	(-0.67)	(0.41)	(-1.26)	**(-0.68)**	(-0.50)	(-1.04)	(-2.72)	(-3.18)	(-2.89)	**(-1.84)**
P5−P1	0.06	-0.18	-0.67	-2.14*	-1.90	**-1.96**	-0.21	-0.17	-0.27	0.24	-0.23	**-0.02**	0.27	-0.01	-0.40	-2.38**	-1.67	**-1.94**
	(0.09)	(-0.28)	(-0.82)	(-1.88)	(-1.28)	**(-1.21)**	(-0.56)	(-0.62)	(-0.99)	(0.68)	(-0.45)	**(-0.03)**	(0.34)	(-0.01)	(-0.46)	(-2.00)	(-1.07)	**(-1.12)**
All	-0.45	-0.04	-1.57***	-1.06*	-2.04***	**-1.59****	0.18*	0.18**	0.04	-0.06	-0.13	**-0.31**	-0.63**	-0.22	-1.61***	-1.00	-1.91***	**-1.28**
stocks	(-1.61)	(-0.15)	(-4.35)	(-1.76)	(-3.12)	**(-2.20)**	(1.69)	(2.29)	(0.29)	(-0.39)	(-0.51)	**(-0.97)**	(-2.11)	(-0.74)	(-4.19)	(-1.60)	(-2.73)	**(-1.62)**

Table 4. Pooled and Fama-MacBeth Regression Estimates for Model 1

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

$$r_{i,t} = \beta_0 + \beta_1 \text{Distress}_{i,t-1} + \beta_2 \text{Overpricing}_{i,t-2} + \gamma \left(\text{Distress}_{i,t-1} \times \text{Overpricing}_{i,t-2}\right) + year\ \text{dummy} + \text{industry dummy} + e_{it},$$

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+1 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 $\text{Overpricing}_{i,t-2}$ is the value of the overpricing proxy variable of firm i at month t-2. The industry dummy variables are defined based on the first digit SIC codes. The overpricing proxy variable is the dummy variable (overpricing dummy) which equals 1 if the average overpricing ranking at month t-2 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.

	Model				Model			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	Panel A: Pooled regression				Panel B: Fama-MacBeth regression			
Distress	-0.268***		-0.194***	0.020	-0.231**		-0.167*	0.023
	(-19.50)		(-13.82)	(1.00)	(-2.30)		(-1.68)	(0.24)
Overpricing		-0.745***	-0.675***	-3.736***		-0.665***	-0.613***	-3.378***
		(-29.49)	(-26.21)	(-18.26)		(-8.80)	(-10.97)	(-8.23)
Distress×Overpricing				-0.408***				-0.369***
				(-15.08)				(-7.19)
Intercept	-2.240***	0.227	-1.295***	0.328	-2.020***	0.090	-1.198	0.270
	(-12.23)	(1.49)	(-6.92)	(1.51)	(-2.67)	(0.41)	(-1.58)	(0.36)
Year dummy	Yes	Yes	Yes	Yes	.	.	.	.
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,476,825	1,473,292	1,473,292	1,473,292	408	408	408	408
Adj R-square	0.001	0.002	0.002	0.002	0.036	0.026	0.038	0.039

Table 5. Pooled and Fama-MacBeth Regression Estimates for Model 2

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

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

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 $\text{Overpricing}_{i,t-2}$ is the value of the overpricing proxy variable of firm i at month t-2. The overpricing proxy variable is the dummy variable (overpricing dummy) which equals 1 if the average overpricing ranking at month t-2 is above the 50th percentile and zero otherwise. Short_{it-2} is the proxy variable representing the severity of short sale constraints. The proxy variables are negative institutional ownership (NegIO), daily costs to borrow score (DCBS), option status (OS), which equals 1 if exchange-traded options of the stock are unavailable and zero otherwise, and enforcement of the uptick rule (Uptick), which equals 1 for the period that the uptick rule is enforced for all exchange-traded stocks (January 1981 through December 2004) and zero for the period that the uptick rule is eliminated for all stocks (January 2008 through December 2014). 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 January 2003 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)
	Panel A: Pooled regression				Panel B: Fama-MacBeth regression			
Distress	0.029	0.139***	0.115***	0.117***	0.041	0.009	0.075	-0.015
	(1.46)	(3.81)	(4.15)	(5.52)	(0.41)	(0.05)	(0.48)	(-0.17)
Overpricing	-3.905***	-0.999***	-6.371***	-1.609***	-3.508***	-1.191*	-5.379***	-3.184***
	(-18.89)	(-2.61)	(-20.26)	(-4.53)	(-8.20)	(-1.69)	(-7.94)	(-7.61)
Distress×Overpricing	-0.430***	-0.105**	0.060	-0.162***	-0.386***	-0.133	-0.170	-0.242***
	(-15.68)	(-2.12)	(1.18)	(-3.40)	(-7.19)	(-1.53)	(-1.21)	(-5.32)
Distress×Overpricing×NegIO	-0.038***				-0.039***			
	(-8.02)				(-4.03)			
Distress×Overpricing×DCBS		-0.275***				-0.139**		
		(-9.78)				(-2.55)		
Distress×Overpricing×OS			-0.820***				-0.474***	
			(-15.26)				(-3.15)	
Distress×Overpricing×Uptick				-0.271***				-0.115***
				(-5.57)				(-3.69)

Distress×NegIO	0.004***				0.005***			
	(6.63)				(5.78)			
Distress×DCBS		0.041***				0.018***		
		(9.93)				(1.80)		
Distress×OS			-0.058***				-0.045**	
			(-8.64)				(-2.20)	
Distress×Uptick				-0.044***				0.089
				(-7.42)				(1.39)
Overpricing×NegIO	-0.305***				-0.308***			
	(-8.73)				(-4.08)			
Overpricing×DCBS		-2.046***				-1.139**		
		(-15.06)				(-2.91)		
Overpricing×OS			6.460***				3.783***	
			(16.33)				(3.29)	
Overpricing×Uptick				-2.469***				-0.139
				(-6.90)				(-1.29)
Intercept	0.297	1.122***	0.836***	0.841***	0.345	0.024	0.308	0.648
	(1.37)	(3.33)	(2.73)	(3.95)	(0.46)	(0.02)	(0.28)	(0.81)
Year dummy	Yes	Yes	Yes	No	.	.	.	.
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-series Obs.	1,468,961	426,893	923,788	1,330,061	408	132	223	372
Adj R^2	0.002	0.003	0.002	0.001	0.042	0.044	0.048	0.040

Table 6. Financial Distress After Adjustment for Short Sale Constraints

This table compares the Fama and French (1993) three-factor (FF3)-adjusted abnormal returns before (Panel A) and after (Panel B) adjustment for short sale constraints for portfolios that are formed each month in a (5×5) two-way independent sorting at the beak-points of mispricing measured at month t-2 and financial distress measured at month t-1. Adjustment for short sale constraints is performed by first constructing a factor related to short sale constraints and then estimating the intercept from regressing FF3-adjusted abnormal returns of each portfolio on the short-sale-constraint factor. The short-sale-constraint factor is constructed by taking the difference between the equal-weighted returns of the low and high stock borrowing cost portfolios. Stocks with DCBS of 1 (greater than 1) are assigned to the low (high) stock borrowing cost portfolio. DCBS is measured at month t-2. The sample period is from January 2003 to December 2014. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

Sorted on mispricing measure (t-2)	Sorted on distress risk measure (t-1) Low	2	3	4	High	High−Low	All stocks
			Panel A: FF3-adjusted abnormal returns				
1	0.03	0.26**	-0.02	0.13	-0.98*	-1.01*	0.11
(Under-)	(0.21)	(2.38)	(-0.10)	(0.42)	(-1.89)	(-1.80)	(1.22)
2	0.04	0.16	0.21	-0.08	-0.38	-0.42	0.07
	(0.33)	(1.17)	(1.00)	(-0.31)	(-0.85)	(-0.88)	(1.00)
3	0.38*	-0.04	0.17	-0.08	0.22	-0.16	0.08
	(1.91)	(-0.21)	(0.93)	(-0.35)	(0.52)	(-0.33)	(0.66)
4	0.30	0.16	0.14	-0.42*	-0.23	-0.52	0.08
	(1.55)	(0.81)	(0.67)	(-1.74)	(-0.53)	(-1.04)	(0.68)
5	-0.00	-0.18	-0.19	-0.21	-1.25***	-1.25**	-0.25
(Over-)	(-0.01)	(-0.79)	(-0.82)	(-0.73)	(-3.20)	(-2.56)	(-1.38)
P5−P1	-0.03	-0.44	-0.17	-0.33	-0.27	-0.23	-0.36
	(-0.11)	(-1.60)	(-0.61)	(-0.89)	(-0.51)	(-0.40)	(-1.52)
All Stocks	0.15*	0.14*	0.06	-0.27	-0.58*	-0.74**	
	(1.71)	(1.91)	(0.45)	(-1.52)	(-1.91)	(-2.03)	
			Panel B: Intercept estimates ($\hat{a}_p$) from (FF3-adjusted abnormal return)$_t = a_p + b_p$(short-sale constraint factor)$_t + e_t$				
1	0.04	0.40***	0.13	0.58*	-0.24	-0.28	0.18*
(Under-)	(0.28)	(3.22)	(0.69)	(1.83)	(-0.43)	(-0.47)	(1.83)
2	0.19	0.19	0.18	0.12	0.09	-0.10	0.16**
	(1.48)	(1.21)	(0.81)	(0.44)	(0.20)	(-0.21)	(2.09)
3	0.60***	0.24	0.29	0.30	1.00**	0.40	0.27**
	(2.66)	(1.33)	(1.44)	(1.15)	(2.37)	(0.82)	(2.12)
4	0.43**	0.27	0.53**	0.07	0.76*	0.33	0.25*
	(2.01)	(1.25)	(2.30)	(0.28)	(1.79)	(0.64)	(1.92)
5	0.25	0.19	0.07	0.27	-0.52	-0.77	0.01
(Over-)	(0.83)	(0.79)	(0.29)	(0.88)	(-1.36)	(-1.50)	(0.05)
P5−P1	0.21	-0.21	-0.06	-0.31	-0.28	-0.49	-0.17
	(0.63)	(-0.70)	(-0.19)	(-0.75)	(-0.50)	(-0.78)	(-0.67)
All Stocks	0.24**	0.26***	0.21	0.06	0.24	0.00	
	(2.39)	(3.11)	(1.43)	(0.33)	(0.81)	(0.00)	

Sorted on mispricing measure (t-2)	Low	2	3	4	High	High− Low	All stocks
	Panel C: Amount of the abnormal return explained by the short sale constraint factor (= Panel B – Panel A)						
1 (Under-)	0.01	0.14	0.15	0.45	0.74	0.73	0.07
2	0.15	0.03	-0.03	0.20	0.47	0.32	0.09
3	0.22	0.28	0.12	0.38	0.78	0.56	0.19
4	0.13	0.11	0.39	0.49	0.99	0.85	0.17
5 (Over-)	0.25	0.37	0.26	0.48	0.73	0.48	0.26
P5−P1	0.24	0.23	0.11	0.02	-0.01	-0.26	0.19
All stocks	0.09	0.12	0.15	0.33	0.82	0.74	

The columns Low, 2, 3, 4 and High are sorted on distress risk measure (t-1).

Table 7. Financial Distress After Adjustment for Idiosyncratic Volatility

This table presents abnormal returns after adjustment for idiosyncratic volatility (IVOL) for portfolios that are formed each month in a (5×5) two-way independent sorting at the beak-points of mispricing measured at month t-2 and financial distress measured at month t-1. Adjustment for IVOL is performed by first constructing a factor related to IVOL and then estimating the intercept from regressing the Fama and French (1993) three-factor (FF3)-adjusted abnormal returns of each portfolio on the IVOL factor. The IVOL factor is constructed by taking the difference between the equal-weighted returns of the low (bottom 30%) and high (top 30%) IVOL portfolios. The sample period is from January 2003 to December 2014. Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

Sorted on mispricing measure (t-2)	Sorted on distress risk measure (t-1) Low	2	3	4	High	High−Low	All stocks
	Panel A: Intercept estimates ($\hat{a}_p$) from (FF3-adjusted abnormal return)$_t = a_p + b_p$(IVOL factor)$_t + e_t$						
1	0.17	0.39***	0.10	0.15	-1.01**	-1.18**	0.11
(Under-)	(1.17)	(3.53)	(0.57)	(0.52)	(-2.00)	(-2.16)	(1.21)
2	0.18	0.29**	0.31	0.01	-0.40	-0.58	0.08
	(1.53)	(2.09)	(1.49)	(0.04)	(-0.94)	(-1.27)	(1.13)
3	0.47**	0.06	0.28	0.00	0.15	-0.32	0.11
	(2.42)	(0.37)	(1.50)	(0.02)	(0.37)	(-0.70)	(0.90)
4	0.39**	0.27	0.21	-0.35	-0.31	-0.70	0.06
	(2.05)	(1.40)	(0.98)	(-1.51)	(-0.77)	(-1.45)	(0.50)
5	0.07	-0.10	-0.11	-0.20	-1.32***	-1.39***	-0.26
(Over-)	(0.26)	(-0.44)	(-0.48)	(-0.75)	(-3.58)	(-2.93)	(-1.43)
P5−P1	-0.10	-0.48*	-0.21	-0.35	-0.31	-0.21	-0.37
	(-0.34)	(-1.79)	(-0.76)	(-0.96)	(-0.59)	(-0.36)	(-1.54)
All Stocks	0.28***	0.26***	0.16	-0.20	-0.64**	-0.92***	
	(3.21)	(3.48)	(1.24)	(-1.19)	(-2.25)	(-2.72)	
	Panel B: Amount of the abnormal return explained by the short sale constraint factor						
1 (Under-)	0.14	0.13	0.12	0.02	-0.03	-0.17	0.00
2	0.14	0.13	0.10	0.09	-0.02	-0.16	0.01
3	0.09	0.1	0.11	0.08	-0.07	-0.16	0.03
4	0.09	0.11	0.07	0.07	-0.08	-0.18	-0.02
5 (Over-)	0.07	0.08	0.08	0.01	-0.07	-0.14	-0.01
P5−P1	-0.07	-0.04	-0.04	-0.02	-0.04	0.02	-0.01
All stocks	0.13	0.12	0.1	0.07	-0.06	-0.18	

Table A1. Distress Anomaly According to the Degree of Short Sale Constraints

This table presents the differences in the Fama and French (1993) three-factor (FF3)-adjusted abnormal returns between high and low distress quintile portfolios ("High−Low") across the five mispricing portfolios in high and low short sale constrained groups. All stocks are sorted in a three-way (5×5×3 or 5×5×2) on the degree of mispricing measured at month t-2, financial distress measured at month t-1, and short sale constraints measured at t-2, and then the stocks in the portfolio are held for month t with value weight. Abnormal returns are calculated as the intercept estimate $(\hat{\alpha})$ obtained from time-series regressions of the Fama-French (2015) five factors. The mispricing measure is the average of ranking percentiles based on the characteristics of the nine anomalies. Financial distress risk is measured by the Campbell et al. (2008) financial distress measure. Stock borrowing costs are the daily costs to borrow score (DCBS) computed by Markit. The high (low) stock borrowing costs subsample consists of stocks with DCBS greater than 1 (equal to 1). The low (high) institutional ownership subsamples consist of stocks with bottom (top) 30% of the residual institutional ownership by Nagel (2005). Numbers in parentheses indicate t-statistics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

Sorted on mispricing at t-2	All stocks	Proxies for short sale constraints measured at t-2: Stock borrowing costs (DCBS)			Institutional ownership (IO)			Option status			Uptick rule enforcement		
		High	Low	H−L	Low IO	High IO	L−H	No	Yes	No−Yes	Yes	No	Yes−No
1	0.35^{***}	-0.41	-0.30	-0.11	-1.17^{***}	-0.77^{*}	-0.40	-1.56^{**}	-0.15	-1.41	-0.59	-1.33	0.74
(Under)	(5.13)	(-0.33)	(-0.50)	(-0.08)	(-2.68)	(-1.75)	(-0.65)	(-2.09)	(-0.27)	(-1.52)	(-1.48)	(-1.58)	(0.88)
2	0.10^{*}	-1.38	0.08	-1.46	-0.39	-0.73^{**}	0.33	-1.39^{**}	-0.38	-1.01	-0.18	-0.25	0.08
	(1.65)	(-1.00)	(0.19)	(-1.01)	(-0.74)	(-2.05)	(0.52)	(-2.09)	(-0.73)	(-1.20)	(-0.38)	(-0.39)	(0.08)
3	0.05	-2.16^{**}	-0.03	-2.13^{*}	-0.83^{*}	-0.43	-0.40	-1.77^{***}	-0.43	-1.34	-0.53	0.16	-0.70
	(0.75)	(-1.99)	(-0.07)	(-1.83)	(-1.76)	(-1.13)	(-0.67)	(-2.64)	(-0.77)	(-1.53)	(-1.21)	(0.26)	(-0.80)
4	-0.07	-0.74	-0.41	-0.33	-1.82^{***}	-0.45	-1.37^{**}	-2.49^{***}	-0.96^{*}	-1.53^{*}	-1.31^{***}	0.01	-1.32
	(-0.90)	(-0.69)	(-0.92)	(-0.29)	(-4.13)	(-1.12)	(-2.31)	(-4.07)	(-1.73)	(-1.85)	(-2.77)	(0.02)	(-1.41)
5	-0.69^{***}	-2.36^{**}	-0.31	-2.05^{*}	-2.67^{***}	-0.92^{**}	-1.75^{***}	-3.83^{***}	-1.12^{**}	-2.71^{***}	-2.29^{***}	-0.84	-1.45^{*}
(Over-)	(-6.59)	(-2.34)	(-0.68)	(-1.84)	(-6.20)	(-2.22)	(-2.92)	(-5.50)	(-2.14)	(-3.11)	(-5.38)	(-1.14)	(-1.68)
P5−P1	-1.04^{***}	-1.96	-0.02	-1.94	-1.50^{***}	-0.15	-1.35^{*}	-2.27^{***}	-0.97	-1.30	-1.70^{***}	0.49	-2.20^{**}
	(-7.22)	(-1.21)	(-0.03)	(-1.12)	(-2.81)	(-0.31)	(-1.86)	(-2.65)	(-1.63)	(-1.25)	(-3.61)	(0.65)	(-2.32)
All		-1.59^{**}	-0.31	-1.28	-1.89^{***}	-1.04^{***}	-0.85^{**}	-2.62^{***}	-1.03^{**}	-1.59^{**}	-1.55^{***}	-0.55	-1.00
stocks		(-2.20)	(-0.97)	(-1.62)	(-5.78)	(-3.62)	(-1.96)	(-4.90)	(-2.50)	(-2.35)	(-4.19)	(-1.03)	(-1.37)