The Distress Risk Puzzle in Turbulent Times
- Default risk during the financial crises

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ABSTRACT

Studies on whether risk of default is systematic or not have led to the discovery of the distress risk puzzle. It is a rather new anomaly and its implications are that empirical evidence seems to indicate that higher default risk results in lower returns. The purpose of this thesis is to clarify whether default risk is systematic, using Altman's Z-score as a proxy for default risk. We also investigate some of the possible explanations of the distress risk puzzle by applying empirical tests on the times surrounding the financial crisis. We first confirm the existence of the puzzle during a longer period; however our findings suggest that this relationship is spurious due to a leverage effect. We then find that both the puzzle and the spuriousness seem to disappear during the financial crisis. We dedicate this disappearance to a shift in the bargaining power from equity holders to debt holders or to the hypothesis that investors became more aware of the default risk during the financial turmoil.

Keywords: Distress risk puzzle, bankruptcy risk, systematic risk, asset pricing, Altman Z-score

Introduction

A. Background

The definition of default, according to the Cambridge Advanced Learner's Dictionary, is "to fail to do something, such as pay a debt, that you legally have to do". One of the most prominent risks for an individual firm is the risk of not being able to repay its debts and therefore declaring bankruptcy. According to the American Bankruptcy Institute (Annual Business Filings by Year (1980-2009)), bankruptcy filings for American businesses reached its highest level 2009 since 1993. Meaning that the risk of default has increased during the

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last couple of turbulent years. The default of an individual firm does not solely affect the firm and its employees, but it also leads to a situation where the shareholders of the firm often lose their entire investment, or at least a majority of the money invested. As an investor, the situation of default is the worst-case scenario since it often implies significant losses. Hence, when making investment decisions, the risk of default should be carefully considered.

There are two types of risks; diversifiable and systematic. Diversifiable risk is firm specific and in some cases industry specific. This risk is called diversifiable since the investor can eliminate this kind of risk by holding a diversified portfolio, consisting of stocks from various firms and industries. Since it is diversifiable the investor should not get rewarded for taking on this kind of risk. Systematic risk is news or events that affects the entire economy, for instance interest rate increases. The investor cannot protect himself from systematic risks and require higher expected return for investing in firms with high exposure to systematic risk. Hence if default risk is diversifiable, the level of default probability should not affect the expected returns. But if the risk of default is systematic, firms with a high probability of default should generate higher returns to its investors.

Consequently, it becomes quite crucial for the investor whether the risk of default is systematic or not. Several studies have been executed on the topic, with different ways of measuring the probability of default. The results and conclusions vary. Basically, the studies can be divided into two groups; those who claim that default risk is systematic and those who claim the opposite. We will start by giving an account for these two groups and then, work through those who find a negative relation between default risk and expected returns.

Shumway (1996) finds that firms listed on NYSE and AMEX with a high probability of exchange delisting generate above average returns and thus implies that the risk of bankruptcy is systematic. Vassalou and Xing (2004) is the first study that uses Merton's (1974) option pricing model to compute a default measure. They agree that risk of bankruptcy is systematic and show how their measure of default, from their sample of firms varies with the business cycle. This is in accordance with findings of Denis and Denis (1995) who argue that default risk correlates with macroeconomic factors and that it varies within the business cycle.

Others, like Opler and Titman (1994), as well as Asquith, Gertner and Sharfstein (1994), find that bankruptcy is mostly related to idiosyncratic factors and mean that there is no correlation to systematic risk. Then there are those who find that not only does a higher probability of bankruptcy not generate higher returns, it even results in lower returns. One of the first to discover this phenomenon was Dichev (1998). His study aimed to investigate

whether the risk of default was systematic or not. However he found this negative relation and that investors holding a risky portfolio were rewarded with returns below average. Several others, including Griffin and Lemmon (2002), Charitou, Lambertides and Trigeorgis (2004) and Campbell, Hilscher and Sziglayi (2008) come to the same conclusion using different measures for risk of default. Griffin and Lemmon (2002) use, like Dichev (1998), an accounting based measure called Ohlson's O presented by Ohlson (1980). Campbell et al (2008) also use accounting as well as market variables to compute their bankruptcy risk measure. Charitou et al (2004) on the other hand use option theory to construct the probability of default. In contradiction to this, Chava and Purnanandam (2010) find a positive cross-sectional relationship between probability of default and expected stock returns. But unlike prior studies, which mostly use ex post realized returns to estimate expected returns, they use ex ante estimates based on the implied cost of capital. However, the most common finding is the negative relationship, which we will try to further investigate.

The phenomenon that bankruptcy is negatively related to returns is called the distress risk puzzle. There are several attempts trying to explain this. Griffin and Lemmon (2002) say that the puzzle is due to mispricing, the market underestimates the impact of default on high O-score firms. Garlappi et al (2008) points to the factor of shareholder bargaining power. They assert that the payoff to the shareholders in case of default rarely is zero and hence that the risk is overestimated. A strong shareholder bargaining power prevents inefficient liquidations when negotiating in case of default and transfers wealth from bondholders to shareholders. Thus, the risk for shareholders is smaller than anticipated, even in the worst-case scenario, default, the investor still get a return on his investments. Hence the risk is overrated and should not be rewarded with higher returns. George and Hwang (2007) say that the puzzle, and the fact that returns are negatively correlated to default risk, is spurious and assert that it disappears after controlling for leverage. Bankruptcy only relates to leverage, which in turn affects returns. The intuition behind this is that as long as managers have an optimistic view of future earnings prospects the level of leverage is likely to be high and hence the equity of the high leverage firm might be overpriced and returns abnormally low, and downwards correction will occur at earnings announcements. If this sort of mispricing is the reason for the negative relation, then more negative earnings announcements should be the case for high leverage firms compared to firms with a low level of leverage. One additional explanation of the puzzle can be derived from Fama and French's (1995) claim that the Fama and French (1992, 1993) factor book-to-market is a proxy for financial distress. If this is true, the distress risk puzzle is not really a puzzle since book-to-market is positively correlated to

returns. Dichev (1998) never calls it a distress risk puzzle but finds an explanation to his findings in time lags. Using accounting data to predict bankruptcy, at the time of the investment the investor is unable to make his decision based on updated data, which could cause a time friction.

Focusing on the mispricing and overconfidence theory as explanation for the distress risk puzzle, the overall financial environment becomes quite crucial. If the market, in general, performs well, bankruptcies will be less anticipated and investors less anxious. If defaults are infrequent it is easy to underestimate its consequences. High risk of default does not generate higher returns since investors underestimates the risk, and hence do not price it. Given this reasoning, overconfidence should decline in times when the threat of firm defaults become much more substantial and thus the risk will be priced. If this is a valid explanation for the distress risk puzzle, the puzzle should disappear when investors become more cautious. To test this theory, we choose two time periods for our regression analysis. The overall "normal" times, 1998-2010, and the turbulent years 2008-2010 in particular in a subsample. If overconfidence is the explanation, and that it disappears during the turbulent times, the return patterns should be more intuitive with a positive relation between return and default risk during the shorter period.

Besides Ohlson's O there is another widely used, accounting based, bankruptcy probability measure constructed by Altman (1968), called the Z-score. The most famous and quoted previous study using Altman's Z as proxy for financial distress is conducted by Dichev (1998). As mentioned above, he finds that higher risk of default does not imply higher expected returns and he discovers signs of the distress risk puzzle. The study was based on a sample of data from the years 1981-1995 for industrial firms with COMPUSTAT Standard Industrial Classification (SIC) codes from 1-3999 and 5000-5999. Each month the firms were divided into decile portfolios based on their Z-score. Realized stock returns were regressed monthly on the Z-score and Fama-French factors market value and book-to-market, using all individual firm observations for that month. Twice a year, the ten portfolios were redesigned and based on an updated Z-score. These portfolios were used to evaluate returns. As previously mentioned, Dichev (1998) found signs of the distress risk puzzle. However, the event window consists of a quite stable time in the manufacturing industry. For this study, we will use a similar method but with another time frame and evaluate how the results differ.

B. Motivation

The aim of this thesis is to examine whether the risk of default is systematic and to see if the distress risk puzzle holds during financially turbulent times. The key intuition behind this purpose lies in the hypothesis that the turmoil caused by the financial crisis shed a light on the possibility of a firm going bankrupt and thus made the default risk more evident to the investors. We will use an accounting based bankruptcy probability measure. Previous studies show that the distress risk puzzle seems to be more prominent when accounting based probabilities are used. For the purpose to check whether the puzzle holds in turbulent times, an accounting based measure should facilitate the study. As mentioned, the two most famous accounting based measures are Altman's Z and Ohlson's O. The Z-score is purely accounting based while Ohlson's O contains a factor such as GNP price-level index. Hamer (1983) analysis the predicting power of four default probability measures applied on industrial companies, two of them was Altman's Z and Ohlson's O. The conclusion was, disregarding analytical model, that the four measures where roughly equally successful in predicting corporate failure. Hence suggesting that the analyst should choose a measure that minimizes cost of data collection. Considering this, Altman's Z is far more simple to calculate compared to Ohlson's O and it will hence be used for this study.

To be able to investigate what happens with the relationship between default risk and returns during turbulent times, we will compare the results of two sample periods, one being the ordinary years 1998-2010 and the other being the subsample consisting of the turbulent years 2008-2010. This will give two sample periods with two overall distinctively different macroeconomic and financial environments. We will show how the puzzle disappears in the turbulent years and discuss possible explanations for this. The two prime reasons discussed will be derived from two previous explanations of the distress risk puzzle provided by Garlappi et al (2008) and Griffin and Lemmon (2002). Further we will show that the spuriousness of the relationship between default risk and returns (suggested by George and Hwang as a possible explanation of the distress risk puzzle) disappears during the turbulent years 2008-2010.

Sample selection, data and method

A. Data and method

The fundamental data needed for calculating the Altman Z-score was taken from firm annual filings found in the COMPUSTAT database. Stock prices, indices and similar was taken from the Centre for Research in Security Prices (CRSP) database. Since the Altman Z-score is derived for industrial firms only, all firms but industrials have been excluded from this study. This is done by only including firms with COMPUSTAT SIC codes 1 to 3999 and 5000 to 5999, the same selection frames as used by Dichev (1998) to make comparison simpler. Further, only firms listed on AMEX, NYSE and Nasdaq are used. The Z-scores for the 1998-2010 regression are calculated every second year based on numbers from the annual filings for fiscal years 1998, 2000, 2002, 2004, 2006 and 2008. The reason why the Z-score is only calculated every other year is the fact that Altman's Z measures the default risk during a two year period. The leverage factor is calculated as book value of liabilities divided by the book value of assets and is based on numbers from quarterly filings. The stock returns in the 1998-2010 regression are based on monthly stock prices. The Fama-French factor size based on fiscal-quarter end stock prices times the number of shares outstanding and is defined as the logarithm of this product. Altman's Z in the 2008-2010 regression is calculated using numbers from the annual report from fiscal year 2008. Stock returns are based on daily stock prices. The leverage factor is defined as book value of liabilities divided by book value of assets. The reason why the leverage factor is based on book values is that this captures the ex-ante decisions of the managers, plus that a market value based leverage factor might cause multicollinearity problems together with the book-to-market factor (see Welch (2004) and Penman, Richardson and Tuna (2005) for a more thorough discussion). Size and book-to-market are calculated using fiscal-quarter end numbers. Fama and French (1992) use a logarithm of this ratio but we chose to do otherwise since it is rather common for near-bankruptcy firms to have a negative book-to-market ratio and the logarithm of a negative number is not defined.

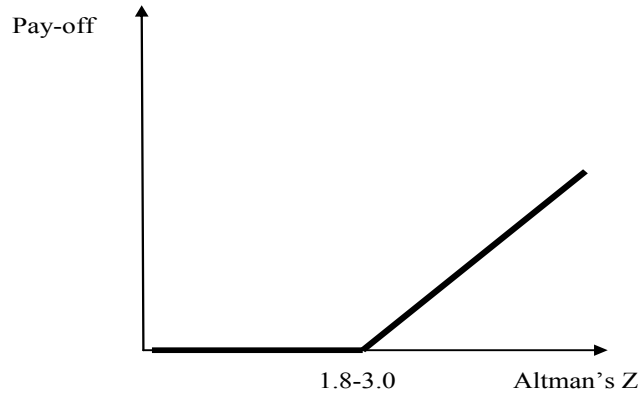
One of the main reasons why the time window for the long-term regression was set to include year 1998 through 2010 is that COMPUSTAT records seem to be larger post-1998 than pre-1998. Another reason is the fact that Dichev's (1998) study is based on a time window that ends in year 1995, why it with a comparison purpose would be interesting to use a different time period, a more recent one. The time window for the 2008-2010 subsample is

based on and motivated by the recent financial crisis. As mentioned above corporate bankruptcies spiked during 2009, which presents an excellent opportunity to study the default risk and its possible systemic nature during a time where the risk of bankruptcy should be apparent. It can also be interesting to compare the results from the long-term regression with this shorter period regression.

An issue that could be possibly devastating for this is the survivorship bias. If firms that end up bankrupt, and thus whose stock price eventually becomes zero, are not accounted for, the results would be biased. The stock returns would in such a case be higher than what they truly are, since you do not account for the default returns of zero percent. To solve this problem, the CRSP database offers one item called delisting code and one item called delisting price. The delisting code offers an explanation to a situation where a certain stock was delisted. Delisting codes 400-490 and 574 indicates a delisting due to a bankruptcy or liquidation. The item delisting price is the used to calculate the delisting return.

The method used to examine the level of systematicity in default risk is statistical tests provided by Fama and MacBeth (1973) regressions. In the 1998-2010 regression the cross-section of stock returns are regressed monthly on Altman's (1968) Z, firm size, book-to-market and leverage based on book-values of liabilities and assets. The regression coefficient reported in the results table is the average of the monthly cross-section coefficients. In the 2008-2010 regression the cross-section of stock returns are regressed daily on the same regressors and the reported coefficient is the average of the daily cross-section coefficients. The t-statistic reported in parenthesis in the results tables is equal to the coefficient divided by the time-series standard error. Presented in the results tables are both results from univariate regressions, where returns are regressed on all regressors alone, and multivariate regression results, where all regressors are included together. This provides an opportunity to compare the two specifications in order to demonstrate the interdependencies among the factors bankruptcy risk, size and book-to market in explaining stock returns. It also provides an opportunity to examine whether or not the book-to-market effect of higher stock returns is due to book-to-market being a proxy for bankruptcy. If this is the case, any significance of Altman's Z in the univariate regression should be consumed by the book-to-market factor in the multivariate regression.

Figure 1
Relationship between pay-off and default



We will also investigate if the explanatory power of default risk is higher when looking at firms that are on the limit of either prevailing or going into bankruptcy. The intuition about this can be explained by looking at the default risk and the future business of a firm as a call option in the pay-off diagram in Figure 1. Altman (1968) considers firms with a Z-score below 1.8 as risky and firms with a Z-score above 3.0 as safe. Let us hypothetically say that almost all firms in the safe group will prevail and almost all firms in the risky group will declare bankruptcy. Let us also assume that the pay-off for equity holders in case of default will be zero. In this hypothesis the Z-score of a firm will be considerably important for the future business of the firm and also for the pay-off of the investor. However the Z-score will not be nearly as important for a firm with a Z-score close to the thresholds as to a firm with either a very large or very small Z-score. We will test this hypothesis by running additional regressions which only includes firms with a Z-score in the range $-5 < Z < 5$ and compare these results with the results of the main regressions.

B. Altman's Z-score

Altman (1968) presented a measure that could forecast the probability of bankruptcy within two years. The formula was derived using multiple discriminant analysis (MDA) on a sample of 66 manufacturing corporations. The firms were divided into two groups;

> Group 1 – The bankrupt group: 33 firms that filed for bankruptcy petition under Chapter X of the National bankruptcy Act from 1946 to 1965.
> Group 2 – Non-bankrupt group: A random sample of 33 manufacturing firms that were still in existence at the time of the analysis.

From a first selection of 22 variables, which were likely to explain probability of default, five was chosen on basis of doing the best job in overall predicting corporate bankruptcy together. Generating the following formula

$$Z = 0.012X_1 + 0.014X_2 + 0.033X_3 + 0.006X_4 + 0.999X_5$$

Where

X_1=working capital/total assets
X_2=retained earnings/total assets
X_3=earnings before interest and taxes/total assets
X_4=market value equity/book value of total liabilities
X_5=sales/total assets

The original 22 variables belonged to five different groups from which one measure was chosen to the formula.

> X_1 is a liquidity measure, a firm that suffers from constant operating losses will soon have liquidity problems and further on problems paying their current liabilities and keeping the business going.

> X_2 belongs to the group of leverage ratios but is also an age indicator. If retained earnings are high compared to total assets, the firm is financed with previous profits

rather than debts, which can be seen as more stable financing. This measure benefits older firms that have built their retained earnings during a long time period. One can argue that those firms are more stable and this agrees to the real world. According to Dun & Bradstreet (1994), approximately 50% of all firms that failed in 1993 were younger than five years. This justifies the fact that older firms are favored by the second variable.

X_3 measures profitability or the earning power of the firm's assets. When it comes to prediction corporate defaults it is essential to look at profitability, which is the key for a firm to live further.

X_4 is a ratio of solvency. One can argue that it is an indicator of a firm's perseverance, how much the assets can decline in value before the firm becomes insolvent. It also adds an otherwise rarely, when it comes to these types of measures, seen market dimension since it is the market value of equity that is used.

X_5 is the measure with the highest weight to in the formula. It is a productivity measure and a standard financial turnover ratio. The activity, or the ability to use the assets to generate sales, is one of the most crucial factors for a firm to live on.

High values in each of the five variables are good for a firm and hence a high Z-score means a lower probability of bankruptcy and vice verse. Altman (1968) sets the cut-off points to 1.8 and 3.0 Firms with z-scores higher than 3.0 are believed to have a low probability of going bankrupt and the opposite for firms below 1.8. All in between are hard to evaluate and that interval is considered to be a grey area.

Later studies have investigated the ability of the Z-score to predict bankruptcy. Altman (1993) himself comes to the conclusion that his model correctly predicted 24 out of 25 bankrupt firms and 52 out of 66 being the corresponding numbers for the non-bankrupt firms. Begley, Ming and Watts (1997) confirm this using COMPUSTAT data for firms during the 1980's. They also made an attempt to improve the predicting power of the model by a reestimation. The reestimation was done using more recent data than Altman (1968) did, however their attempts were unsuccessful which strengthens the credibility of the original Z-score model. Our sample shows a significant difference between the high and low Z groups. Of 1268 firms with a Z lower than 1.8, implying that the risk of default is high, 221 (17.43%)

actually went bankrupt. The corresponding numbers for the low risk group, Z above 3.0, was 56 out of 1053 (5.31%).

Empirical Results and Discussion

Table 1
Descriptive Statistics and Correlation Matrix for the Test Variables in 1998-2010 Regression

Panel A shows descriptive statistics that illustrate the empirical distributions of the test variables from the 1998-2010 regression and Panel B shows the corresponding statistics for the 2008-2010 regression.. Returns are monthly returns for the entire sample of firms in Panel A and daily returns in Panel B. Z is from Altman (1968) and measures default risk. A higher Z means a lower risk for default. The Z-score is based on fiscal years 1998, 2000, 2002, 2004, 2006, 2008 in Panel A and on fiscal year 2008 in Panel B. Panel C shows Pearson correlation coefficients between the variables from the 1998-2010 regression and Panel B shows the corresponding coefficients for the 2008-2010 regression. Size is the logarithm of fiscal-quarter-end stock price times the number of shares outstanding. BtM is common equity divided by fiscal-quarter-end stock price times the number of shares outstanding. Leverage is book value of total liabilities to book value of total assets and is calculated quarterly.

Panel A: Descriptive Statistics for the Test Variables in 1998-2010 Regression

Variables	Mean	StdD	P25	P50	P75
Returns	1.01	13.78	-9.88	2.11	11.98
Z	4.77	8.23	-1.55	5.20	9.14
Size	4.80	1.97	2.91	5.09	7.22
BtM	0.91	4.91	0.33	0.97	1.99
Leverage	0.78	1.45	0.34	0.80	1.33

Panel B: Descriptive Statistics for the Test Variables in 2008-2010 Regression

Variables	Mean	StdD	P25	P50	P75
Returns	-0.4	2.54	-0.02	0.21	0.77
Z	1.61	6.83	0.21	2.20	4.14
Size	5.58	2.37	3.91	5.64	7.72
BtM	2.21	7.91	0.33	0.57	0.94
Leverage	0.65	1.19	0.27	0.57	1.12

Panel C: Pearson Correlation Coefficients for the Test Variables in 1998-2010 Regression

	Returns	Z	Size	BtM	Leverage
Returns	1.0000				
Z	0.0012	1.0000			
Size	-0.0215	0.0042	1.0000		
BtM	0.0022	-0.0012	-0.0666	1.0000	
Leverage	-0.0043	-0.0023	0.0045	-0.0091	1.0000

Panel D: Pearson Correlation Coefficients for the Test Variables in 2008-2010 Regression

	Returns	Z	Size	BtM	Leverage
Returns	1.0000				
Z	0.0024	1.0000			
Size	-0.0126	0.0001	1.0000		
BtM	0.0029	0.0027	-0.0718	1.0000	
Leverage	-0.0006	-0.0031	0.0098	-0.0004	1.0000

Table 1 includes descriptive statistics and correlation matrices for both the 1998-2010 regression and the 2008-2010 regression. Comparing the descriptive statistics for the two different regression one can find that Altman's Z seems to be higher in the long-term regression than in the short-term regression. Both the mean and median value of the Z-score is larger in the first regression. This indicates that firms on average had a lower default risk in the period 1998-2010 than in the period 2008-2010. This is certainly not an unexpected observation and can most probably be explained by the financial crisis of 2008. Another observation is that the Z-scores are more widely dispersed in the long-term regression; the standard deviation is larger in this regression. This is also quite comprehensible, since this regression includes more observed Z-scores and ranges over a longer time-period. Further interesting remarks can be done by looking at the correlation matrices; the matrices give the first evidence of how the different factors are related and can thus give a hint of how the regression results will look like. In the 1998-2010 regression the correlation between Altman's Z and returns is positive. This means that firms with a lower risk of default (higher Z-score) seem to have higher realized return. The 2008-2010 regression shows the opposite, i.e. the correlation between the Z-score and return is negative and thus a higher risk (lower Z-score) seem to indicate a higher return. The correlation between size and returns is negative and the correlation between book-to-market and return is positive, which means that smaller firms and firms with higher book-to-market ratios seem to earn higher returns than their counterparties. This goes for both the 1998-2010 and the 2008-2010 regression. Both of these findings are consistent with the logic behind the Fama-French three factor model. Looking at the correlation between Z-score and the book-to-market ratio, the results are different between the two regressions. In the long-term regression the correlation is negative, which indicates that firms with a high default risk (low Z-score) seem to have a high book-to-market ratio. In the short-term regression the correlation is instead negative, which indicates that firms with a high default risk seem to have a low book-to-market ratio. The negative correlation in the long-term regression is consistent with the idea that the book-to-market ratio can be seen as a proxy for bankruptcy risk. The correlation between Altman's Z and size is positive in the long-term regression and insignificant in the short-term regression. This indicates that the default risk seems to be higher among larger firms. The correlation between size and book-to-market is negative in both regressions. This result means that larger firms seem to have a lower book-to-market ratio, which is consistent with previous studies (Fama and French, 1995). Leverage seems to be negatively correlated with returns. This would indicate that firms with higher leverage will have a lower realized return. This is consistent with previous

literature (George and Hwang 2007) and gives another perspective on the distress risk puzzle. Intuitively a firm with higher leverage should have a higher default risk and thus a higher return. The first part of the intuition holds since the correlation between leverage and Z is negative, but as mentioned recently the positive correlation between return and Z is puzzling.

Table 2

Regression Results for the Relation between Altman's Z, Market Value, Book-to-Market, Market Return and Subsequent Realized Returns during the period 1998-2010

Z is calculated according to Altman (1968), where a higher Z signify a lower probability of default and vice versa. Z-scores are calculated on values from fiscal years 1998, 2000, 2002, 2004, 2006 and 2008 for the 1998-2010 regression. Returns are monthly stock returns in percent, starting one month after fiscal-year-end. Size is the logarithm of fiscal-quarter-end stock price times the number of shares outstanding. BtM is common equity divided by fiscal-quarter-end stock price times the number of shares outstanding. Leverage is book value of liabilities to book value of assets and is calculated quarterly. The sample contains 84 523 observations of monthly returns for stocks traded on NYSE, AMEX and NASDAQ. T-statistics in parenthesis.

Regression results					
Returns =	β_0 +	β_1*Z +	β_2*Size +	β_3 * BtM +	β_4* Lev
Pred. sign of coeff.:		(-)	(-)	(+)	(+)
	0.91***	**0.02****			
	(.75)	**(1.65)**			
	0.56***		-0.04***		
	(12.70)		(-5.78)		
	0.67***			0.09***	
	(6.78)			(7.89)	
	0.45***				-0.01***
	(8.01)				(-4.78)
	0.68***	**0.02****	-0.05***	0.08***	
	(5.88)	**(2.12)**	(-6.12)	(6.45)	
	0.54***	**0.001**	-0.05***	0.08***	-0.01***
	(4.66)	**(0.99)**	(-6.03)	(6.66)	(-7.87)

*p<0.1 **p<0.05 ***p<0.001

Presented in Table 2 is the result of the 1998-2010 regressions of realized return on Altman's Z, size, book-to-market and leverage. The results from the univariate regressions indicate that Altman's Z is significant in explaining raw returns. The coefficient on Z is however positive, which means that a lower default risk (higher Z-score) gives higher returns. This result is consistent with previous evidence of the distress risk puzzle. The coefficient on size is significantly negative, which is consistent with the idea that the returns of smaller firms outperform the returns of larger firms. Book-to-market is significant in explaining raw returns and the coefficient is positive, i.e. firms with a higher book-to-market ratio earn greater

returns on their stock. The results further indicate that leverage is significant in explaining raw returns and that the coefficient on leverage is negative. This means that higher leverage gives lower returns. This result confirms the evidence of previous studies. The multivariate regression gives an opportunity to examine a couple of things. Firstly it sheds light on whether the book-to-market effect can be explained as it being a proxy for default risk and whether this is an explanation to the distress risk puzzle. Secondly the multivariate regression will test the findings of George and Hwang (2007) that the distress risk puzzle can be explained by a spurious relationship between default risk and returns caused by leverage. The first multivariate regression, in which return is regressed on Altman's Z, size and book-to-market, disproves the idea of book-to-market being a proxy for default risk. If the idea were to be true, the significance of Altman's Z would be disappearing when controlled for book-to-market but the result of the regression indicates that the significance of Altman's Z in fact increases after including book-to-market. The second multivariate regression, which adds leverage as an explaining variable, confirms the idea that the relationship between default risk as measured by Altman's Z and return is spurious, since the significance of Altman's Z disappears in this regression when controlling for leverage.

Table 3

Regression Results for the Relation between Altman's Z, Market Value, Book-to-Market and Subsequent Realized Returns during 2009 and 2010

Z is calculated according to Altman (1968), where a higher Z signifies a lower probability of default and vice versa. Z-scores are calculated for fiscal year 2008 for the 2008-2010 regression Returns are daily stock returns in percent, starting one day after fiscal-year-end. Size is the logarithm of fiscal-quarter-end stock price times number of shares outstanding. BtM is common equity divided by fiscal-quarter-end stock price times the number of shares outstanding. Leverage is book value of liabilities to book value of assets and is calculated quarterly. Panel A contains regression results for the entire sample of 1 417 971 observation of daily returns for stocks traded on NYSE, AMEX and NASDAQ. Panel B contains regression results for firms with Z-values closer to the thresholds of 1.8 and 3.0.Number of observations is 765 234 T-statistics in parenthesis.

Panel A: Regression results for all firms

Returns =	β_0 +	β_1*Z +	β_2*Size +	β_3 * BtM+	β_4* Lev
Pred. sign of coeff.:		(-)	(-)	(+)	(+)
	2.29***	**-0.004****			
	(-115.07)	**(-2.04)**			
	-1.99***		-0.06***		
	(-39.70)		(-6.32)		
	2.29***			0.0006***	
	(-117.78)			(11.26)	
	-2.29***				-0.09***
	(-117.94)				(6.11)
	-0.036***	**-0.003***	-0.05***	0.0004***	-0.09***
	(-63.68)	**(-1.69)**	(-6.05)	(8.66)	(6.41)

Panel B: Regression results for firms with Z-values: -5 < Z < 5

Returns =	β_0 +	β_1*Z +	β_2*Size +	β_3 * BtM +	β_4* Lev
Pred. sign of coeff.:		(-)	(-)	(+)	(+)
	-0.45***	**-0.01*****			
	(-17.07)	**(-3.5)**			
	-0.87***		-0.08***		
	(-11.11)		(-4.88)		
	-0.76***			0.0006***	
	(-21.09)			(13.43)	
	-1.32***				-0.12***
	(-18.90)				(6.88)
	-0.036***	**-0.009****	-0.07***	0.0004***	-0.10***
	(-63.68)	**(-2.91)**	(-5.54)	(7.98)	(5.98)

*p<0.1 **p<0.05 ***p<0.001

The results of the 2008-2010 regression are found in Table 3. Panel A includes observations for all sample firms, whereas panel B only includes observations for firms with a Z in the range -5 < Z < 5. The implications of size, book-to-market and leverage in the univariate regressions are the same in these couple of two-year period regression as in the previous regression. That is, size and leverage have a significant negative effect on realized returns and

book-to-market has a significant positive effect on realized return. On the contrary, when looking at Altman's Z, and its effect on realized returns during these two years, the findings are the opposite of the findings in the previous regression. Altman's Z is significant in both the univariate and the multivariate regressions and further has a negative sign in both cases. This implies that during the period 2008-2010, a higher default risk did lead to higher realized returns. These findings contradict both the findings of the previous long period regression and the "distressed risk puzzle". Also contrary to the 1998-2010 regression, the significance of Altman's Z does not disappear when controlling for leverage in this short-term regression. The implication of these findings is primarily that the distress risk puzzle seems to disappear during the period 2008-2010. The same goes for the spurious relationship between default risk and realized returns. Of course this time period is special due to the financial crisis starting in 2008 and we will begin with exploring a couple of explanations to the results which are related to the financial crisis, but first we will connect the regression results to the initial discussion of systematic versus idiosyncratic risk

Concluding from the regression results you can say that default risk was not a systematic risk during the period 1998-2010. This conclusion is quite obvious since there is a negative relationship between default risk and raw returns and that this relationship disappears when controlling for leverage, i.e. it is spurious. However during the period 2008-2010 we conclude that default risk has to be somewhat systematic, since the correlation with returns is significantly positive and that this correlation does not seem to be spurious.

The risk of default should probably have increased during the years following the financial crisis outburst. Evidence of this is found in the fact that the Z-score during the period 2008-2010 was on average lower than the Z-score during the period 1998-2010. This could be a possible explanation to the disappearance of the distress risk puzzle. This would mean that when the bankruptcy rick becomes more prominent, the investors start getting rewarded for investing in high default risk stocks. An analogy can be made to the disappearance of the size effect during the 1980s, which is found and debated, by Fama and French (1992) and Roll (1995). In the 1980s the returns of large stocks outperformed the returns of small stocks. However if the explanation of the distress risk puzzle lies in different levels of prominence of the default risk, previous studies which also includes times of recessions should not have obtained results which are justifying the puzzle, which is the case in many studies. This means that this explanation of the distress risk puzzle probably does not hold.

One possible explanation to the disappearance is based on the overconfidence mispricing theory of the distress risk puzzle, which says that investors are overconfident in their valuation of high default risk stocks. The explanation is based on the hypothesis that the 2008 financial crisis caused investors to be more cautious in their expectations of the performance of distressed firms which makes the overpricing disappear. This explanation makes sense since the financial markets saw some major bankruptcies caused by the financial crisis. These bankruptcies might have acted as an eye-opener for investors, which caused the overconfident behavior to cease. This hypothesis could explain the negative coefficient on Altman's Z in the 2008-2010 regression, and would then also imply the correctness of the overconfidence mispricing theory of Griffin and Lemmon (2002).

Another explanation to the disappearance of the distress risk puzzle is that the bargaining power of the debt holders might have increased during the years of the latest financial crisis. This explanation leads to a discussion about shareholder bargaining power initiated by Garlappi et al (2008). The reason for this possible increase in bargaining power might have to do with an increasing selectiveness among financial institutions and other lenders. Due to the unstable climate of the financial markets, it is probable that the debt holders was more careful in their selection of which firm's debt they were willing to hold and thus they obtained a bargaining power over the equity holders. It is also probable that the increasing number of bankruptcies during the financial crisis forced the debt holders to fight harder for their claims in every single bankruptcy. This eventually led to a higher risk for the equity holders and thus the distress premium appeared. This hypothesis can definitely explain the results of this thesis.

The finding that the spuriousness of default risk also seems to disappear during the financial crisis is another interesting discovery of the regression results. Similarly to George and Hwang (2007) the results of our 1998-2010 regression indicate that the relationship between default risk and realized return is spurious and the actual effect on returns is caused by leverage, but during the period 2008-2010 both default risk and leverage are significant in explaining returns. Perhaps this finding might shed some light on the distress risk puzzle. George and Hwang (2007) assign the leverage effect to a mispricing due to overconfidence from both investors and managers of high leverage firms. Both managers and investors are excessive in their expectations of future earnings prospect, which causes investors to overprice the stock and managers to take on too much risk; this behavior eventually causes returns to fall. It might be the case that during the financial crisis the leverage effect and default risk got separated due to the macroeconomic shock, which caused the spuriousness to

cease. Perhaps investors became more informed about the risk of bankruptcy, but did not connect this risk with leverage. The negative effect of leverage is however still a puzzle.

Comparing Panel A and Panel B in Table 3 one can observe that meanwhile Z is fairly significant in both cases; the significance is higher in Panel B. Thus the significance of Altman's Z is higher when the sample is consisted of firms with a Z that lies close to the thresholds 1.8 and 3.0. This observation was not made in the long-term regression. The intuition behind can, as mentioned previously, be explained by observing the firm and its prevalence or default as a call option in a pay-off diagram (See Figure 1) with Z-score on the x-axis and the pay-off to equity holders on the y-axis. We also assumed that the pay-off to equity would be zero in the event of a default and that almost all firms with a Z-score below 1.8 would be declared bankrupt; meanwhile almost all firms with a Z-score above 3.0 would prevail. In this hypothetical world the Z-score of a firm would be crucial for the firm's future business. However it would be considerably more important for a firm with a Z-score closer to the thresholds of 1.8 and 3.0, since a small shift of the Z-score could mean a significant change of the survival probability of the particular firm. The fact that the significance of Altman's Z increases when only including firms with a Z-score closely to the thresholds could indicate that there is some truth behind the mentioned hypothetical world. One implication of this is that the explanatory power of Altman's Z in predicting bankruptcies seems to be high. Another implication is that the pay-off to equity in case of default seems to be small. The latter implication suggests that the explanation of the distress risk puzzle found in Garlappi et al (2008), which suggests that the high level of shareholder bargaining power in case of a default eliminates the default risk, since the risk of investors losing money is small even in case of a default. Since the significance of Altman's Z does not show any signs of strengthening when observing firms closely to the thresholds, one could assume a situation where it does not matter whether a firm has a Z-score which is above 3.0 or below 1.8, i.e. it does not matter if the firm is considered risky or safe, since investors know that they will be able to extract a majority of their investment from the bankrupt estate. However during the years of the financial crisis the significance of Altman's Z increases among firms around the thresholds, which could indicate that investors are more observant of the default risk, since they risk losing money in the event of a default due to a shift of the bargaining power in a default from equity holders towards debt holders.

Table 4

Performance of Z Measure of Default Risk in Predicting Bankruptcy Delistings

This table demonstrates the accuracy of Z in predicting bankruptcies. The sample is divided into two parts according to Altman (1968). Firms with a Z lower than 1.8 should have a potentially high risk of default, whereas the default risk for firms with a Z higher than 3.0 should have a low risk. The table indicates the number of delistings due to bankruptcy in each group of firms. The cause for delisting is found in the CRSP database.

Group:	Number of Bankruptcy delistings 1998-2010
Low Risk (Z > 3.0)	56
High Risk (Z < 1.8)	221
Group:	**Number of Bankruptcy delistings**
Low Risk (Z > 3.0)	7
High Risk (Z < 1.8)	45

Presented in Table 4 is a performance measure of Altman's Z as a proxy for default risk during the period 1998-2010. The table shows the number of delistings due to default in two groups. The first group includes firms with a Z lower than 1.8 and the second group includes firms with a Z higher than 3.0. The reason behind this dividing is the fact that Altman (1968) regards a firm as safe if the firm Z is higher than 3.0, and risky if Z is lower than 1.8. The reason for delisting is taken from the COMPUSTAT "Delisting code" item. A delisting code of 400-490 and 574 indicates a delisting due to bankruptcy or insolvency. The number of bankruptcy related delistings in the low-risk group was 56 and the corresponding number in the high-risk group was 221. During the period 2008-2010 the number of bankruptcy delistings in the low-risk group was 7 and in the high risk group the number was 45. This result coincides with a number of previous studies which all suggests that Altman's Z is highly significant in explaining bankruptcy. It is however difficult to claim causation since the delisting rarely happen at the same time as the bankruptcy event, but it still gives some justification to the use of Altman's Z as the default risk proxy in this thesis.

Even though the survivorship bias is accounted for, it can still pose a threat to the validity of our results. This is due to a potential problem with the delisting codes and delisting returns from CRSP. In some of the later bankruptcy delistings it is still not certain what stake the shareholders will get in the bankrupt estate, since the matter is yet to be resolved. It has also been shown that there exists a bias in the delisting returns from CRSP, due to omitted

delisting returns (Shumway, 1997). This bias could certainly have led to bias also in the results of this thesis.

It certainly would have been motivated to have made the time-span for the long-term regression even longer. The main reason behind the decision to only include year 1998-2010 is the fact that a number of previous studies already have examined years previous to 1998 and almost all of these studies have unanimous results. Since the result from the regression in this study also consists with the previous results, the decision to include only the later years could be seen as justified.

In order to validate the results a discussion about Altman's Z also has to be made. There are a number of different ways to measure the default risk, e.g. CDS spreads, Merton's option pricing model, implied volatility, credit ratings. The authors of previous studies have different opinions of which of these measures that has the best ability to capture the default risk and each argue for their point of view. The fact that the distress risk puzzle is most evident in studies which make use of an accounting based default risk measure such as Altman's Z, of course the explanation for the default risk puzzle could be as simple as the fact that accounting based risk measures does not capture default risk in an adequate way. If this is the case the results of this thesis is probably biased due to using only Altman's Z as a default risk measure. On the other hand many accounting based measures, especially Altman's Z, have been proven highly significant in predicting bankruptcies. This means that Altman's Z has to capture at least some risk. One must also consider that this thesis, along with a number of previous studies, get rather highly significant results using Altman's Z and other accounting based measures, which could certainly be due to some endogeneity problem. It is however unlikely that this endogeneity would be apparent in all studies, since the studies use different types of accounting based measures. To resolve this issue we encourage future research of the distress risk puzzle during the recent financial crisis that uses other types of risk measures.

One must also consider that this study only includes industrial firms and thus excludes many companies, such as start-up IT-firms, which in many cases have high default risks. If one were to apply the default risk as an investment strategy one would probably want to include high-risk firms and thus a different default risk measure has to be used. A highly interesting measure is CDS-spreads. The main reason why this thesis does not apply CDS-spreads as a default risk measure is the unavailability of data.

Conclusion

This thesis confirms the existence of the default risk puzzle in the long term. It also confirms the previous findings of the relationship between default risk and returns as being spurious, where the effect instead is attributed to leverage. However the most remarking result of this thesis is the fact that both the distress risk puzzle and the spuriousness disappear during the turbulent times following the financial crisis. During the period 2008-2010 the relationship between default risk and returns is significantly positive, also after controlling for size, book-to-market and leverage. Possible explanations of this disappearance are that investors became more informed of and aware of the risk of bankruptcy, which erased the investor's previous overconfidence in high-risk and high-leverage stocks. It can also be assigned to a shift in the bargaining power in the event of a bankruptcy, from the shareholders to the debt holders. This might have caused shareholders to receive less from the bankrupt estate, which enhanced the default risk since investors now risked losing a larger sum of their investment in the event of a bankruptcy. However we must mention that previous studies have argued that the use of an accounting based default risk measure, such as the one we use, is inaccurate and that this might possibly cause bias to our results. It can therefore be interesting to conduct future studies of the distress risk puzzle during the financial crisis using a different kind of default risk measure.

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