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An Analysis of the Underreported Magnitude of the Total Indirect Costs of Financial Distress

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Abstract. In this paper we examine 1,041 *ongoing* firms over the time period 1982–92. Using quarterly data for the detection and measurement of the magnitude of the indirect costs of financial distress, we find three important explanatory factors: (a) the distinctiveness of the pattern of increasing financial distress over time, (b) the degree of leverage in the capital structure and (c) the size of the firm. For those firms with a distinctive pattern of increasing financial distress over time, the average annual losses as a percentage of market value is −10.3%. The maximum loss is −76%. Even if the firm never fails, its market value can be severely impacted by the presence of the indirect costs of bankruptcy over time. This study finds a significantly positive relationship between Altman's Z-score and the firm capital investment growth rate. This relation holds after controlling for other variables such as leverage, firm size and market/book ratio. This implies that lost investment opportunities may be also an important part of the *total* indirect costs of financial distress, which appear now to be much larger than previously recorded.

Key words: financial distress, bankruptcy, indirect cost, capital structure

Direct firm bankruptcy costs include the amounts spent on liquidation such as court and legal, auctioneer and second-hand market fees. Indirect financial distress costs are the opportunity costs suffered by the firm as the degree of solvency declines. In addition to the now widely recognized loss of customer confidence which leads to reduced customer sales, it also includes foregone profitable firm investment opportunities as well as the loss of important supplier relationships and key managers. Thus, the *total* indirect costs of financial distress have the potential to be large and occur whether or not the firm actually defaults.

In this paper, we focus on two new dimensions of the indirect costs of bankruptcy. First, expanding on the work of Altman (1984) and Opler and Titman (1994), we document that the temporal behavior of the firm prior to entering an unhealthy financial state dramatically affects the level of indirect costs imposed on the firm via the opportunity loss of sales. Second, we study the impact of increasing insolvency on the firm investment growth rate which serves as a useful proxy for lost firm investment opportunities.

Altman (1984) studies the magnitude of both direct and indirect bankruptcy costs for 19 industrial firms (12 retailers and 7 other) which went bankrupt in the 1970s. He focuses on the three years prior to and including the bankruptcy year. Altman measures the indirect costs of bankruptcy using a regression equation for sales which then translated into an expected sales or profits loss function for the years included in the analysis. He also supports his results with forecasted data provided by security analysts. Like Warner (1977), he finds an average direct cost of bankruptcy in the range of 4%–6% of firm value. However, his indirect costs are between 8%–10% of firm value for the sample.

In a more recent study, Opler and Titman (1994) relate the financial distress effects of leverage on sales for 1,363 firms by industry for the period 1972–91. They find that more highly leveraged firms lose sales market share to their more conservative financial counterparts in the same industry during periods of downturns. These results support the notion that sales losses are customer or competitor driven.

We study more closely the temporal behavior of the firm prior to possibly entering default (i.e., before entering a Chapter 7 or 11 proceeding). That is, we analyze the behavior of the rate of return on assets as the probability of bankruptcy rises. As individual firm financial distress increases, we seek a temporal explanation for the magnitude of losses in sales as well as study foregone investment opportunities and relate both of them to a reduction in firm value. Since we focus on the magnitude of the indirect costs of financial distress for *ongoing* firms which are not in Chapter 7 or 11, we include only those firms which did *not* go formally bankrupt during our sample period.

Our empirical examination of firm indirect financial distress costs uses quarterly data and is conducted by relying on three key variables: (1) the probability of bankruptcy (the degree of financial distress) as defined by Altman's Z-score (1968), (2) the level of sales (profits) loss (%) measured by a loss function L and (3) the growth rate of the amount of firm invested capital.

The paper is divided as follows. Section 1 presents the basic model. Section 2 describes the data and empirical tests with the results in Section 3. Section 4 concludes the paper.

1. The model

The probability of bankruptcy is described by Altman's Z-score (1968). The Z-score model is written as

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5 \tag{1}$$

where X_1 = Net Working Capital/Total Assets, X_2 = Cumulative Retained Earnings/Total Assets, X_3 = Earnings before Interest and Taxes/Total Assets, X_4 = market value of Equity/book value of Total Liabilities and X_5 = Sales/Total Assets.[1]

The Z-score is the overall index of a multiple discriminate function. Altman found that companies with Z-scores below 1.81 (including negative numbers) often went bankrupt. Z-scores above 2.99 represents healthy firms and between 1.81–2.99 is a gray area.

We rely on the Z-score model of Altman (1968) as our proxy for the probability of financial distress for two reasons—its parameters are publicly available *and* the interpretation of the scores are now widely known. Of course, future research can include an updating of the coefficients of the Z-model or other models on different firm samples in order to check the validity of our results.

We focus on the **ex-post** Z-scores of our sample firms to locate possible *patterns* over time which may help explain the magnitudes of the indirect costs of financial distress due to sales losses. For example, if a firm starts off healthy $(Z > 2.99)$ and then slides monotonically into the gray and unhealthy zones, then it is shown below that the indirect costs of financial distress (i.e., lost sales and, therefore, lost profits) are heightened.

Next, the values for the sales (profit) loss function for firm j, L_j, are computed as follows:

$$L_{jt} = \frac{(S_{jt} - \hat{S}_{jt}) \cdot PM_j}{V_{jt}} \tag{2}$$

where S_{jt} is the actual sales for firm j at time t in the gray or unhealthy state, $\hat{S}_{jt}$ is the forecasted sales for firm j at time t as if the firm were still healthy, V_{jt} is the market value of the firm's assets at time t and PM_j is the average gross profit margin (before-tax% of sales) for firm j in the healthy state. Thus, L_j is measured over times spent by the firm in the gray *and* unhealthy regions and $\hat{S}_{jt}$ is calculated based on data found in the healthy zone.

1.1. Temporal stratification of firms

We categorize the sample firms into three types over the firm time horizon T as depicted in figure 1.

Set A types are characterized by a fall in Z-scores (increasing probability of financial distress) from t_0 to t_1. The fall continues from t_1 where $Z = 2.99$ to t_2 where $Z = 1.81$. From t_2 to T, the time horizon, the firm remains unhealthy.

Set C types are the opposite of Set A types. They are initially unhealthy but do not go bankrupt from t_0 to t_1, enter the gray zone and stay there until t_2 and then become healthy until T. Thus, becoming financially unhealthy does not guarantee failure.

Set B types are those firms which show no clearly discernable pattern in their Z-scores from t_0 to T. Thus, t_1 is arbitrarily defined as $T/3$ and t_2 as $2T/3$ for testing purposes.

It is emphasized that the exact values for each firm's t_1 and t_2 can be different. However, aggregations across firms can be done by time intervals. For example, two firms can have different t_1 values and yet estimation for a particular parameter can be defined over the generic interval $(t_1 - t_0)$ for each firm.

1.2. Sales loss estimation

The loss function $L(\%)$ of equation (2) depends most critically on the variable $\hat{S}_{jt}$. We specify $\hat{S}_{jt}$ by first estimating the growth rate in sales during the time in which the firm is considered healthy as measured by the Z-score. For example, the healthy growth rate in sales, g_s^A, for a Set A type firm is calculated as

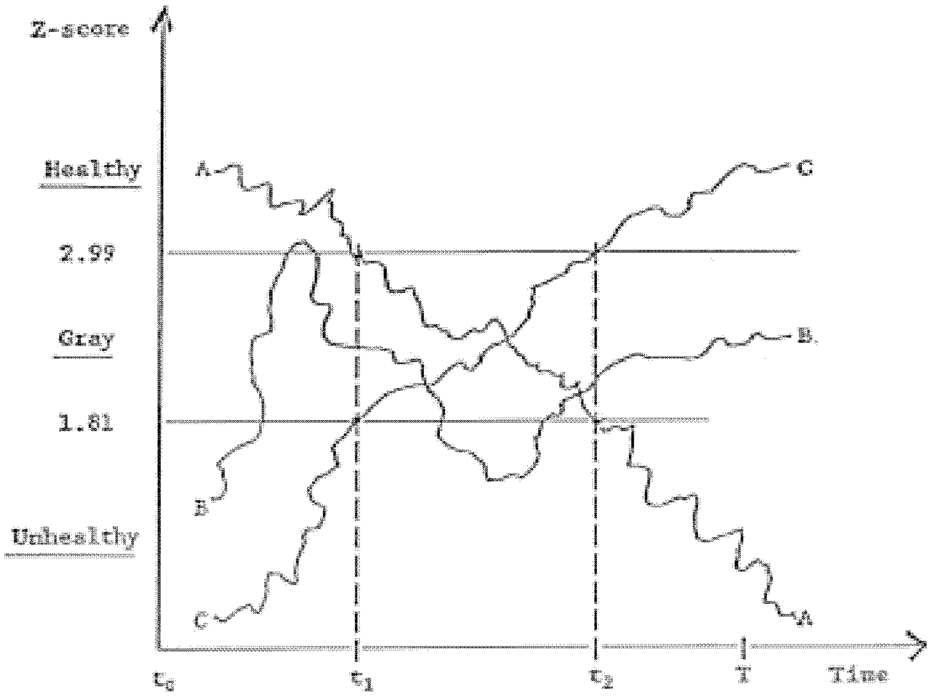

Figure 1.

$$g_s^A = \left(\frac{S_{t1}^A}{S_1{}^A}\right)^{1/(t_1-1)} - 1 \tag{3}$$

where S_1^A is sales for quarter 1 $(t_0 + 1 - t_0)$.

This growth rate is then used to estimated $\hat{S}_{jt}^A$ as follows

$$\hat{S}_{jt}^A = S_{jt_1}^A (1 + g_s^A)^{t-t_1} \tag{4}$$

where $t = t_1 + 1, \ldots, T$. A similar process is used for Set B but a reverse time procedure is used for Set C types. That is, the loss function L is calculated from $t_1 + 1$ to T for Sets A and B but from t_0 to t_1 for Set C.

1.3. Invested capital growth rate: IC_p

According to financial distress theory, a financially distressed firm might forego profitable investment opportunities due to financial difficulties. This opportunity loss should be treated as part of the total indirect costs of financial distress.

Let $IC_p(j, t)$ denote the **ex-post** geometric average quarterly *change* in invested capital at time t for firm j, which is expressed as:

$$IC_p(j,t) = \left[\frac{IC(j,t+4)}{IC(j,t)}\right]^{1/4} - 1 \tag{5}$$

where $IC(j,t)$ is the amount of invested capital for firm j at quarter t.

2. Data and tests

The initial data consists of all firms on the 1992 Compustat Quarterly Tapes except for regulated utilities and financial institutions. The time period runs from the first quarter of 1982 through the second quarter of 1992 resulting in 42 possible quarters of data for each firm. After considering missing data and data required for Z-score, loss function L and invested capital changes IC_p calculations and reserving quarters for other possible estimation purposes, the maximum effective testing period is set between 1982–92 using 31 quarters and the full sample size reduces to 1,041 firms.

Again, figure 1 is a visual depiction of the methodology used to create the three sample sets: A, B, and C. Set A contains those firms which start the sample period as healthy, according to the Z-score and then decline into the gray and unhealthy zones by the end of the sample period T. Set C firms are the opposite of Set A firms. Set B firms are firms which have no clear-cut Z-score pattern over the horizon T, sometimes healthy and sometimes gray or unhealthy. The total number of firms by set type are:

Set A: *113 firms*;

Set B: *890 firms*; and

Set C: *38 firms*.

For each firm in each set, the Z-score is computed at each quarterly date in time. The Z-scores are then analyzed over three points in time: t_1, t_2 and T. Time t_1 is the point where firms in Set A enter the gray zone while for firms in Set C it is the point t_2. Time t_2 for Set A firms is the point where the firm enters the unhealthy zone which is time t_1 for firms in Set C. T is the actual size of the testing period for a given firm. The times t_1, t_2 and T may all be different for different firms in each set. The points t_1 and t_2 for firms in Set B are arbitrarily set at $t_1 = T/3$ and $t_2 = 2T/3$ since these firms have no clear-cut Z-score pattern over T.

2.1. Sales (profits) loss function tests

The loss function L values are calculated for each firm in Sets A, B and C as follows: For Set A, the healthy growth rate g_s is calculated as defined in equation (3) and $\hat{S}^A_{jt}$ for firm j is computed according to equation (4). For Set C, the g_s is calculated from t_2 to T and $\hat{S}^C_{jt}$ ranges over t_0 to t_2. The g_s for firms in Set B are calculated from t_0 to t_1 with $\hat{S}^B_{jt}$ used between t_1 and T.

After calculating $\hat{S}^i_{jt}$ for each firm j in set $I(i = \text{A, B or C})$, the loss L^i_{jt} is computed according to equation (2) for each quarter t over the appropriate firm set range. The L^i_{jt}s for each subset are then averaged and annualized as

$$\bar{L}^i_j \left(= \sum_{t_1+1}^{T} \frac{L^A_{jt}}{T - t_1} * 4 \text{ for set A, for example} \right)$$

for comparison purposes.

2.2. *Investment opportunity loss tests*

We attempt to examine the relation between financial condition and firm investment growth. If a firm's financial condition has a positive effect on its investment growth, i.e., a financially-distressed firm should reduce or cut its investment budget, it can be argued that financial distress is also costly to a firm that foregoes good investment opportunities.

In our regression tests, the above **ex-post** quarterly change in invested capital is the dependent variable. For independent variables, the direct indicator of financial condition, Z-score, is the most important one. However, we also want to know how the change in financial condition will affect investment growth. The variable for the change in Z-score is one of the independent variables, that is:

$$Z_p(j,t) = \left[\frac{Z(j,t)}{Z(j,t-4)} \right]^{1/4} - 1 \tag{6}$$

where $Z(j,t)$ is Z-score for firm j at quarter t while $Z_p(j,t)$ is the **ex-ante** quarterly geometric average Z-score percentage change rate.

To better understand the relation between financial condition and investment growth, we include the variables which also may have an impact on investment growth. The first such variable is leverage, measured by the debt/equity ratio, where debt is defined as the sum of Current Debt, Long-Term Debt and the redeemable Preferred Stock, and equity is equal to the market value of Common Stock outstanding plus the unredeemable Preferred Stock.[2] Cantor (1990), Whited (1992), Kopcke and Howrey (1994) show that leverage has an important implication to investment decisions. Furthermore, Lang, Ofek, and Stulz (1996) find a negative relation between leverage and investment growth at the firm level. The leverage is measured one quarter prior to the base quarter.

The second added variable is firm size, measured by the (quasi) market value of the firm, i.e., the sum of the market value of Common Equity, book values of Long-Term Debt, Preferred Stock and Net Working Capital. There is no direct empirical evidence for the relation between size and investment growth. However, in view of the size effect in capital markets, it is reasonable to include this variable in the regression models. In addition, Novaes and Zingales (1993) show that contracting problems in periods of financial distress are more severe in large firms because of the larger number of layers in managerial hierarchies and larger number of operating units. On the other hand, small firms may have more difficulty in accessing needed capital during a period of financial distress because of their heightened informational asymmetry.

The market/book ratio or Tobin's q is the third added variable. Firm market value is estimated as the sum of the market value of equity and the book value of Preferred Stock, the book value of Long-Term Debt, and Net Working Capital. We include the firm's market/book ratio in the regression tests since firms with high market/book ratio may have more valuable growth opportunities.

Since we are interested in the effects of leverage, firm size and market/book ratio on investment growth for financially-distressed firms, a financial distress dummy variable, D_{LZ}, is introduced into the equation, where D_{LZ} is defined as $D_{LZ}(i,t) = 1$ if $Z(i,t) < 1.81$, and $D_{LZ} = 0$ if $Z(i,t) \geq 1.81$. Following Altman's (1968) finding that firms with a Z-score below 1.81 are financially unhealthy, we use a Z-score value of 1.81 as our benchmark for financial distress.

All the independent variables above are measured one quarter prior to the base quarter except for Z_p which is measured as the Z-score geometric average percentage change over four quarters prior to the base quarter. In addition, by conducting a correlation analysis, it is found that the Z-score has a high correlation with the variable, market/book ratio.[3] To avoid a potential multicollinearity problem, these two variables are not put into the same regression equation. Therefore, we have two separate regression models which have the following forms:

$$\begin{aligned}\text{Investment Growth Rate } = {} & \gamma_0 + \gamma_1 \text{ Z-score} \\ & + \gamma_2 \text{ Debt/Equity Ratio} \\ & + \gamma_3 \text{ Log of Firm Size} \\ & + \gamma_4 \text{ Financial distress dummy variable} \\ & + \gamma_5 \text{ Distressed dummy variable } \times \text{ Debt/Equity Ratio} \\ & + \gamma_6 \text{ Distressed dummy variable } \times \text{ Log of Firm Size } + \varepsilon, \quad (7)\end{aligned}$$

$$\begin{aligned}\text{Investment Growth Rate } = {} & \gamma_0 + \gamma_1 \text{ Z-score percentage change } + \gamma_2 \text{ Debt/Equity Ratio} \\ & + \gamma_3 \text{ Log of Firm Size } + \gamma_4 \text{ Market/Book Ratio} \\ & + \gamma_5 \text{ Financial distress dummy variable} \\ & + \gamma_6 \text{ Distressed dummy variable } \times \text{ Debt/Equity Ratio} \\ & + \gamma_7 \text{ Distressed dummy variable } \times \text{ Log of Firm Size} \\ & + \gamma_8 \text{ Distressed dummy variable } \times \text{ Market/Book Ratio } + \varepsilon. \quad (8)\end{aligned}$$

Considering there are time-series elements in our data sample, we note that serial correlation can potentially cause a bias in our research results. The presence of a significant trend in the time series data introduces dependence between successive observations and tends to produce serially correlated regression residuals. For example, the fourth quarter's Z-score will be much related to the third quarter's Z-score, quite likely still related to the second quarter's Z-score, and somewhat related to the first quarter's data. To address this concern, we divide the base or full sample (FULL) into four sub-

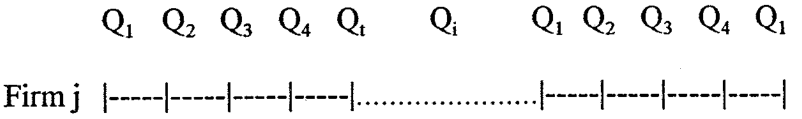

Figure 2. An illustration of quarters in detrended samples.

samples, which contain *detrended* data only. The first detrended sub-sample is all observations with the first quarter period and the second sub-sample with all observations of the second quarter period, and so on. The number of observations in each sub-sample is almost equal. Figure 2 shows that sub-sample i ($\text{DTS}_i, i = 1, 2, 3, 4$) will include all the quarter i (Q_is) observations for all firms over the test period.

We will conduct our tests on the base sample (FULL) as well as on all the four detrended sub-samples (DTS_i).

3. Empirical results

3.1. Sales (profits) loss function

The loss function L and data sets are summarized in Panels A and B of Table 1. In Panel A of Table 1 is a description of the data by firm set type. Listed are average Z-scores, volatility of Z-scores, leverage ratio and size (Total Assets) as well as the number of firms in each set.[4] As expected, larger firms and higher leverage ratios are found in Set B versus Sets A and C. In Panel B of Table 1, it is seen that the average annualized profit losses (% of market value) are largest for firms in Set A. In particular, $\bar{L}^A = -10.3\%, \bar{L}^B = -4.3\%$, and $\bar{L}^C = -6.4\%$.

These results support the notion that as a firm enters into a distinctive pattern of increasing financial distress, then its opportunity losses rise dramatically. For example, the average losses for Set A firms are nearly 150% greater than for Set B while Set C firm losses are approximately 50% times greater than for Set B. Also, the maximum annualized profit loss for a firm in Set A in the gray and unhealthy states can range as high as almost −80% of the market value of the same firm when in the healthy state. However, it is noted that complete symmetry does not seem to hold between Sets A and C. That is, the growth rates for sales of firms in Set C in the healthy state are much lower than that of firms in Set A in the healthy zone. Perhaps, customers go (back) more slowly to a firm after it has experienced severe financial distress than they do prior to such an experience.

3.2. Investment opportunity losses

Table 2 reports the empirical results of our regression tests based on the full sample (FULL). We find that the coefficient for Z-score in equation (7) is positive and statistically significant at the level of one percent while that for Z_p in equation (8) is also positive

Table 1. Panel A describes the number of firms, average Z-scores, volatility, leverage and asset size. Panel B contains the average sales, sales losses and profit losses. Both panels are for set types A, B and C

Panel A. Data Description

Set Type	# Firms	$\bar{Z}^{(a)}$	$\bar{\sigma}(z)^{(b)}$	$L\bar{E}V^{(c)}$	$S\bar{I}ZE^{(d)}$ ($000,000)
A	113	7.02	3.70	0.16	750.42
B	890	3.18	0.98	0.25	1,888.00
C	38	5.22	2.42	0.15	322.15

Notes: [(a)]Average $\bar{Z}$-score in healthy state for set type (I). [(b)]Average volatility in healthy state for set type (I). [(c)]Average debt divided by total assets in healthy state for set type (I). [(d)]Average book value of total assets in healthy state for set type (I).

Panel B. Average Annualized Losses ($\bar{L}$)

Set Type	$\bar{S}^{(a)}$ ($000,000)	$\bar{L}_S(\%)^{(b)}$	$\bar{V}^{(c)}$ ($000,000)	$\bar{L}_P(\%)^{(d)}$	$L_p^{\text{MAX}}(\%)^{(e)}$
A	193.32	– 90.10	1,322.02	– 10.26	– 75.80
B	536.84	– 45.86	1,664.55	– 4.26	– 79.80
C	101.69	– 42.32	740.19	– 6.39	– 77.70

Notes: [(a)]Average sales (quarterly) for firms for set type (I). [(b)]Average annualized sales loss as% of Market Value where $L_{jt} = (S_{jt} - \hat{S}_{jt})/V_{jt}$ for set type (I). [(c)]Average market value of firms in set type (I). (d) Average profit loss as % of market value where $L_{jt} = ((S_{jt} - \hat{S}_{jt}) - Pm_j)/V_{jt}$ for set type (I). [(e)]Maximum profit loss as % of market value for set type (I).

though not statistically significant. The findings confirm that when a firm's Z-score is low, or the firm is in financial distress, the firm will typically cut invested capital, or become more cautious about planned investment opportunities.[5]

The other interesting things in Table 2 include the roles of the Debt/Equity Ratio, Market-to-Book Ratio (MBR) and Firm Size in the regression models. In Table 2, the interactive term, **Debt/Equity Ratio × Financial Distress Dummy Variable**, has a negative and large statistically significant coefficient in both equations (7) and (8). This evidence implies that asset investment growth for the firm depends on the debt carried by the firm conditioned on the level of financial distress with a lower growth rate evidenced by a higher Debt/Equity ratio. The high Debt/Equity ratio firms will be more active (or desperate) in restricting cash outflows with the onset of financial distress. Therefore, good investment opportunities might be foregone by a high debt type of firm which could be interpreted as another indirect cost of financial distress for such firms.

It is also noteworthy to observe in Table 2 the effects of Size and MBR (Market/Book Ratio) on Invested Capital. The coefficient estimates on **Size × Financial Distress Dummy Variable** are negative and statistically significant in the equations (7) and (8) while those on **Market – to–Book Ratio × Financial Distress Dummy Variable** are positive and statistically significant.[6] These results suggest that large firms and those with low asset intangibilities tend to slow down their investment activities more quickly during periods of financial distress. This is because there usually exist more severe incentive problems in large firms than in small ones. That is, the management of large

Table 2. Regressions of investment growth rate on Z-score, debt/equity ratio, firm size and market/book ratio based on full sample

	IC_p equation (7)	IC_p equation (8)
Intercept	0.03118	0.00571
	(4.41)*	(0.82)
Z-score	0.00427	
	(5.14)*	
Ex-ante Z-score percentage change (Z_p)		0.01569
		(1.04)
Debt/equity ratio	0.00633	0.00563
	(5.57)*	(4.94)*
Firm size	− 0.00233	− 0.00118
	(− 2.43)†	(− 1.22)
Market/book ratio		0.01905
		(10.56)*
Financial distress dummy variable (FD)	0.03802	0.00636
	(5.71)*	(8.67)*
Deet/Equiry Ratio × dD dummy	− 0.01276	− 0.01287
	(− 12.85)*	(− 13.00)*
Firm size × FD dummy	− 0.00377	− 0.00643
	(− 5.48)*	(− 8.63)*
Market/book ratio × FD dummy		0.00795
		(11.69)*
R^2	0.01	0.02
D-W statistic	1.11	1.12
Serial correlation	0.44	0.44

Notes: *Significant at the 0.01 level. †Significant at the 0.05 level. ‡Significant at the 0.10 level.

firms often have more incentives to send a better signal to their shareholders by cutting investment opportunities to make the short-run financial condition better looking without considering long-term benefits. In addition, low MBR firms usually are those in old and traditional industries. Their investment opportunities are relatively non-attractive. When facing financial distress, it is much easier for such firms to give up projects which are originally planned to be invested in.

Table 2 also demonstrates that there exists a high serial correlation of the testing results based on the full sample. The reported serial correlations are measured by manually computing Durbin-Waston d-statistics in order to avoid possible data bias. Most of Durbin-Waston d-statistics are less than one while the values of serial correlations are above 0.5. The existence of high serial correlations makes the conclusions drawn less than robust. In order to make the research results more robust, we have specially designed four detrended samples, DTS1-4, which possess very low serial correlations. The results for testing all the previous hypotheses based on DTS1 to DTS4 are presented in Tables 3–6.

The results based on DTS1 are shown in Table 3. The serial correlations are − 0.06 for the IC_p regression models. The serial correlations have been significantly reduced compared to the FULL Sample. The following is a summary of all the results: (1) The

Table 3. Regressions of investment growth rate on Z-score, debt/equity ratio, firm size and market/book ratio based on DTS1

	IC_p equation (7)	IC_p equation (8)
Intercept	0.02135	– 0.00050
	(1.32)	(– 0.03)
Z-score	0.00468	
	(2.48)†	
Ex-ante Z-score percentage change (Z_p)		0.14512
		(4.06)*
Debt/equity ratio	0.00621	0.00624
	(3.06)*	(3.08)*
Firm size	– 0.00084	0.00014
	(– 0.39)	(0.06)
Market/book ratio		0.01788
		(4.64)*
Financial distress dummy variable (FD)	0.05943	0.07555
	(3.90)*	(5.26)*
Debt/equity ratio × FD dummy	– 0.00593	– 0.00556
	(– 4.12)*	(– 3.87)*
Firm size × FD dummy	– 0.00711	– 0.00963
	(– 4.50)*	(– 5.73)*
Market/book ratio × FD dummy		0.00791
		(4.33)*
R^2	0.01	0.02
D-W statistic	2.12	2.12
Serial correlation	– 0.06	– 0.06

Notes: *Significant at the 0.01 level. †Significant at the 0.05 level.

serial correlations are low for all the IC_p regressions, (2) The coefficient estimates on the Z-score and Z_p are positive and statistically significant while leverage and size are documented to be negatively related to the invested capital growth rate during periods of financial distress and (3) We find that all the conclusions made from the Full sample are supported by the additional tests based on the four detrended samples.

4. Summary and conclusions

In this paper we have expanded the study of the magnitude of the indirect costs of financial distress. Using Altman's Z-score (1968) as our proxy for the probability of bankruptcy (financial distress), we first calculate the sales (profit) losses for three types of firms. The first type contains those firms which start off financially healthy during the sample period and then lapse uniformly into a gray or unhealthy state. The second type are those firms

Table 4. Regressions of investment growth rate on Z-score, debt/equity ratio, firm size and market/book ratio based on DTS2

	IC_p equation (7)	IC_p equation (8)
Intercept	0.02528	−0.03035
	(1.63)	(−1.99)†
Z-score	0.00558	
	(3.07)*	
Ex-ante Z-score percentage change (Z_p)		−0.04513
		(−1.34)
Debt/equity ratio	0.03110	0.03115
	(8.96)*	(9.01)*
Firm size	−0.00293	−0.00201
	(−1.37)	(−0.94)
Market/book ratio (MBR)		0.03928
		(10.13)*
Financial distress dummy variable (FD)	0.08453	0.10975
	(5.54)*	(7.48)*
Debt/equity ratio × FD dummy	−0.09464	−0.09540
	(−21.13)*	(−21.54)*
Firm size × FD dummy	−0.00108	−0.00364
	(−0.67)	(−2.11)†
Market book ratio × FD dummy		0.01068
		(8.37)*
R^2	0.08	0.10
D-W Statistic	2.13	2.02
Serial Correlation	−0.07	−0.01

Notes: *Significant at the 1% level. †Significant at the 5% level.

which show no discernible pattern to their Z-scores over the total sample period. The third type are those firms with a Z-score pattern opposite of those of the first type.

Our results indicate that when ongoing firms exhibit a marked temporal pattern of increasing probability of failure (declining Z-scores), then later average sales and profit losses are much larger than when there is no clearly discernable pattern. Additional explanatory variables for this sales (profit) loss include the firm's leverage ratio and size. The higher the leverage ratio and smaller the firm, the larger the average percentage loss. While the average profit loss of all firms in financial trouble in our sales loss sample is on the order of −8% per annum as a percentage of firm market value, the maximum losses can range as high as −80% of market value.

The empirical results of this study also validate that there is a statistically significant positive relation between financial condition and the firm investment capital growth rate. This relation strongly holds even after controlling for serial correlation and multicollinearity problems. The finding of this relation suggests that financial distress can be costly to firms if they forego positive NPV projects due to experiencing financial

Table 5. Regressions of investment growth rate on Z-score, debt/equity ratio, firm size and market/book ratio based on DTS3

	C_p equation (7)	C_p equation (8)
Intercept	0.04069	0.03129
	(3.24)*	(2.53)†
Z-score	0.00382	
	(2.57)*	
Ex-ante Z-score percentage change (Z_p)		− 0.05293
		(− 1.99)†
Debt/equity ratio	0.00303	0.00177
	(1.34)	(0.78)
Firm size	− 0.00364	− 0.00265
	(− 2.14)†	(− 1.54)
Market/book ratio		0.00997
		(2.99)*
Financial distress dummy variable (FD)	0.02728	0.03468
	(2.27)†	(3.01)*
Debt/equity ratio × FD dummy	− 0.00355	− 0.00428
	(− 1.71)‡	(− 2.06)†
Firm size × FD dummy	− 0.00307	− 0.00509
	(− 2.50)†	(− 3.78)*
Market/book ratio × FD dummy		0.00598
		(5.10)*
R^2	0.01	0.01
D-W statistic	1.67	1.67
Serial correlation	0.17	0.17

Notes: *Significant at the 0.01 level. †Significant at the 0.05 level. ‡Significant at the 0.10 level.

difficulties. Documenting such a relation has an important additional implication for the capital structure decision. We find that leverage has a negative effect on the investment capital growth rate for financially-distressed firms, but not for financially-healthy ones, which is consistent with Lang, Ofek, and Stulz (1996)'s finding that there is a negative relation between leverage and investment growth for firms with a low Tobin's q ratio, but not for high-q ratio firms.

Heretofore, it has been accepted that the direct costs of financial failure are on the order of 5% (Warner (1977)) and indirect costs around 8–10% (Altman (1984)). In this study we show that the indirect costs are significantly understated if the effects of the temporal pattern (a type of signal) and foregone investment opportunities are both included in the calculation costs. Firm value can drop dramatically based on the pattern of financial decay plus missed capital opportunities.

It is recommended that a renewed effort of research be focused on the individual pieces of the *total* indirect costs of financial distress on firm value. They now appear to be more significant in magnitude and scope than previously believed.

Table 6. Regressions of investment growth rate on Z-score, debt/equity ratio, firm size and market/book ratio based on DTS4

	C_p equation (7)	C_p equation (8)
Intercept	0.04917	0.03509
	(4.10)*	(2.92)*
Z-score	0.00451	
	(3.17)*	
Ex-ante Z-score percentage change (Z_p)		0.02336
		(0.95)
Debt/equity ratio	0.01337	0.01223
	(6.48)*	(5.90)*
Firm size	− 0.00574	− 0.00428
	(− 3.54)*	(− 2.61)*
Market/book ratio		0.01214
		(3.65)*
Financial distress dummy variable (FD)	− 0.00061	0.01442
	(− 0.06)	(1.36)
Debt/equity ratio × FD dummy	− 0.02156	− 0.02197
	(− 9.34)*	(− 9.54)*
Firm size × FD dummy	0.00160	− 0.00164
	(1.39)	(− 1.27)
Market/book ratio × FD dummy		0.00860
		(6.47)*
R^2	0.02	0.02
D-W statistic	1.91	1.91
Serial correlation	0.04	0.04

Notes: *Significant at the 0.01 level. †Significant at the 0.05 level. ‡Significant at the 0.10 level.

Appendix

A. Calculation of Z-scores is

$$Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 1.0X5$$

where

X1 = Net Working Capital/Total Assets
= (Current Assets − Current Liabilities)/Total Assets
= (#40 − #49)/(#44)
X2 = Cumulative Retained Earnings/Total Assets
= (#58)/(#44)

$$
\begin{aligned}
X3 &= \text{EBIT/Total Assets} \\
&= (\text{Net Income} + \text{Interest Expense} + \text{Income Tax})/\text{Total Assets} \\
&= (\#69 + \#22 + \#6)/(\#44) \\
X4 &= \text{Market Value of Equity/Book Value of Total Liabilities} \\
&= (\text{Share Price} \times \text{Common Shares Outstanding} + \text{Preferred} \\
&\quad \text{Stock} - -carrying\ value) \\
&= (\#14 \times \#61 + \#55)/(\#54) \\
X5 &= \text{Sales/Total Assets} \\
&= (\#2)/(\#44)
\end{aligned}
$$

and

Data Item	Quarterly (Restated)#
Sales	#2
Income tax	#6
Share price (QTR or Year End)	#14
Operating income	#21
Interest expense	#22
Current assets	#40
Total assets	#44
Current debt	#45
Current liabilities	#49
Long-term debt—total	#51
Total liabilities	#54
Preferred stock—carrying value	#55
Retained earnings	#58
Common shares outstanding	#61
Net income	#69
Preferred stock—redeemable	#71.

B. Calculation of losses-L is

(1) $$\text{PM (Gross)} = \frac{\text{Operating Income}}{\text{Sales}} = \frac{(\#21)}{(\#2)}$$

(2) $$
\begin{aligned}
\text{V (size)} &= \text{Long-Term Debt} + \text{Preferred Stock} + \text{Market Value of Common} \\
&\quad \text{Stock (Common Stock Outstanding} \times \text{Current Stock Price)} \\
&\quad + \text{Net Working Capital (Current Assets} - \text{Current Liabilities)} \\
&= (\#51) + (\#55) + (\#14) \times (\#61) + ((\#40) - (\#49))
\end{aligned}
$$
and

$$(3) \qquad \text{Leverage} = \frac{\text{Long-Term Debt} + \text{Debt in Current Liabilities}}{\text{Total Assets}}$$
$$= \frac{(\#51) + (\#45)}{(\#44)}$$

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Notes

1. For a more detailed explanation of the calculation of the Z-score using Compustat data items, see the Appendix. The average percentages of financial ratios in forming Z-scores are 12.65% for Net Working Capital/Total Assets, 3.86% for Cumulative Retained Earnings/Total Assets, 3.16% for Earnings before Interest and Taxes/Total Assets, 58.85% for Market Value of Equity/Book Value of Total Liabilities, and 21.48% for Sales/Total Assets, respectively. The financial ratio of Market Value of Equity/Book Value of Total Liabilities has the highest contribution to the Z-scores, responsible for more than half of the Z-score value. This finding is consistent with the theory that the market does foresee the firm's future earning ability. It might suggest that the Market/Book Ratio is a good proxy for firm financial condition. As we see, the least contributional components are Cumulative Retained Earnings/Total Assets and Earnings before Interest and Taxes/Total Assets, only between 3% and 4%.
2. The reason for dividing the total preferred stock into two parts—redeemable and unredeemable preferred stock is that the former contains more debt characteristics while the latter has more equity characteristics.
3. We conduct a correlation test among the independent variables. The results show that the correlation between Z-score and Market/Book Ratio is as high as over 0.70. All other correlations are trivial. According to econometric theory, a low degree of multicollinearity has little damaging results on regression studies but a high degree of multicollinearity can be serious.
4. The Z-score parameters, LEV ratio and SIZE variables for each firm j are computed by averaging the values found in the quarters during which the firm is in the healthy state or zone. For Sets A and C, this occurs when $Z > 2.99$. For Set B, it is artificially specified as (t_0, t_1). However, for this temporal averaging process a bar is not placed above the firm variable except for the average Z-score $(\bar{Z}_j)$ in order to minimize symbol confusion.
5. Though the change of investment behavior could forego some good investment opportunities which should be regarded as part of indirect costs of financial distress, it can sometimes be a good thing if management avoids some bad investment decisions.
6. The variable MBR is not included in equation (7) since MBR is highly correlated with the explanatory variable Z-score.

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