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TEST OF CAPITAL STRUCTURE THEORY AND CORPORATE RISK MANAGEMENT

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Abstract

This research study has attempted to indirectly test the proposition that the probability of corporate failure is mainly related to the unsystematic component of the total risk. The authors conjecture confirms that managing the total cash-flow risk of the firm significantly affects both the systematic and unsystematic components of the cash flow distribution simultaneously which ultimately shows up in a change of the systematic (beta) and unsystematic components of the total equity returns of a leveraged company.

Keywords : Corporate failure; Unsystematic component of total risk; Managing cash flow and equity returns : Leveraged company

JEL Classification : C12; G14; G34; L21

Introduction

Since the mid-1970s, capital structure theory has become even more sophisticated in its explanation of why various financing regimes exist in the corporate sector. After Miller's elegant model[1] of corporate and personal taxes in 1977, several newer balancing theories have appeared. De Angelo and Masulis[2] and Ross[3] discuss the importance of divergent tax rates in the determination of optimality in the capital structure. Kim[4] and Chen and Kim[5] analyze the impact of bankruptcy costs versus taxes in setting debt to equity relationships. The idea of agency costs as a balancing factor was introduced by Jensen and Mackling[6] and eleborated on by Myers[7]. The actions of managers for and against bondholders and stockholders added another dimension to the problem in attempting to structure the capital financing plan of the firm.

These balancing theories of capital structure suggest that the leverage of corporations depends on personal and corporate taxes, expected bankruptcy costs and the agency costs of debt and equity. While the complete dynamic form of the model which captures all the components in exactly the right way is still being developed and debated, a recent one-period model by Bradley, Jarrell, and Kim[8] incorporates these three fundamental determinants of leverage.

Direct vs. Indirect Tests of Capital Structure Theory

Simultaneous with the development of capital structure theory has been empirical testing. Such tests go back to the seminal work of Modigliani

The authors own full responsibility for the contents of the paper.

and Miller[9]. Recently, Castanias[10] has categorized the tests as direct or indirect (cross-sectional). A direct test results if the test relates to the capital structure of a specific firm*. An indirect test occurs when the business risk-leverage relationship implied by a theory is cross sectionally tested over many firms. He claims that a pure direct test is almost impossible to design because it would require market value data and a model of a firm's leverage policy along with specific information about the firm at the time a leverage decision is made. This is necessary to remove any ambiguity associated with wealth redistribution or signaling effects. Indirect tests should grow in importance because they can help identify possible new variables to include in or exclude from future models of financial economic behavior. Such tests should also promote a better understanding of how and whether certain existing proxy variables used by practicing managers are related to current theoretical retical constructs. As theory becomes more and more complex, the usefulness of carefully constructed indirect tests will increase. Indirect tests will never replace direct tests but can augment them in terms of theoretical development power. Thus, we propose a more general indirect test principle*

Empirical tests of capital structure theory have suffered from a general shortcoming. The theory models feature variables that are not readily observable, such as the probability of bankruptcy and promised debt payments. The typical solution has been to use industry dummy variables or measures of various asset returns as loose proxies for the probability of bankruplcy. Researchers also use financial ratios as surrogates for promised debt payments. This approach is used in recent studies by Marsh[11] and by Bradley, Jarrell, and Kim[8]. To some extent the work of Castanias[10] also relies on the approach, although he uses the probability of failure as a key test variable. However, he relies on historical failure rates (compiled by Dun Bradstreet) by industry or business lines estimate of the probability of failure, and he assumes these failure rates are constant over the period 1940-1977 based on a Kendall test. His test may introduce more error by classifying firms into current lines of business.

Indirect Test of Corporate Risk Management

Also appearing in the literature is the idea that corporate managers should attempt to optimize their total corporate or cash-flow risk exposure, even if security prices do not compensate for unsystematic risk. Titman[12], Myers[13], and Shapiro and Titman[14] argue that even the unsystematic component of total cash- flow risk should be managed, because these beta - associated changes can adversely affect the firm's sales and cost of doing business. Thus, these authors and others conclude that increasing total cash-flow risk leads to an increasing risk of bankruptcy and liquidation and presumably to lower firm value. Financial approaches for managing the total or unsystematic risk component include product and personal liability insurance, lowering the firm's debt-equity ratio, and hedging currency risk with futures contracts. Of course, the real costs of these approaches must be traded off against the reduced unsystematic risk which in turn leads to higher expected cash returns and value for the firm if the beta of the firm is assumed unaffected.

Underlying the logic described for managing total cash-flow risk is generally the presumption that the probability of failure is. mainly related to the unsystematic component of the total risk. We choose to indirectly test this proposition by correlating the probability of bankruptcy with the systematic and unsystematic components of total equity risk. In particular, we conjecture that managing the total cash-flow risk of the firm significantly affects both the systematic and unsystematic components of the cash flow

*It is assumed that a direct test with very loose proxies for the variables will in the limit be equivalent to an indirect test of the theory model. Likewise. a pure indirect test would contain no variable or proxies for variables prescribed or derivable from a theory itself.

distribution simultaneously which ultimately shows up in a change of the systematic (beta) and unsystematic components of the total equity returns of a leveraged company. That is, as product liability changes, as debt-equity ratios change, and variable risk projects are undertaken, then two effects related to the probability of failure occur simultaneously:
The beta of the stock of the firm changes and The unsystematic risk component of the firm changes.

Theoretical Basis and Propositions for an Indirect Test of Capital Structure

Probability of Failure and Marginal Bankruptcy Cost: In almost any test of capital structure, theory, one key relation to focus on is $dF(\hat{Y})/d\hat{Y}$ where specimen $F(\hat{Y})$ is the probability of failure of bankruptcy and Y is the total promised debt payment level. Consider a single period model where the firm's gross end-of period dollar return before taxes, interest, and non-debt charges is given by the normally distributed variable X. Define $F(\hat{Y})$ as

• An empirical test is an indirect test if it is a test of a theory and/or implication of a theory which employs explanatory variables not prescribed or derived from the theory itself.

$$F(Y) = \int_{\infty}^{Y} f(\hat{X})\, d(\hat{X}) \qquad (1)$$

where

$f(\hat{X})$ = probability density of $\hat{X}$.

More importantly, since $f(\hat{X})$ is the probability density function, then $f(\hat{X})$ is everywhere non-negative. That is, if $F(\hat{Y})$ is given by **Equation 1**, then $dF(\hat{Y})/d\hat{Y}$ must be unambiguously positive (non-negative) for any level of promised debt payment in the one period framework (in a single period this payment includes interest plus principal).

It may be noted here that according to Castanias[10] $dF(\hat{Y})/d\hat{Y}$ will be strictly negative under the condition of increasing marginal bankruptcy costs. The apparent contradiction disappears if the derivative of his **Equation 1** with respect to debt properly includes the dropped term (in his notation) [-C(B)g(B,R)], where [C(B)] is his bankruptcy cost function and R is his business risk parameter of the return probability distribution. His **Equation 2** should be restated as :

$$(I + r)\, V' = T\,(I - F) - C'\,(B)\, F - C\,(B) g\,(B,R) = 0 \quad (2)$$

where :

$V' = dV\,(B,R)/dB$

$C' = dC(B)\ dB$

$F = \int_{-\infty}^{b} g\ (E,R)\ dE,$

T = corporate tax rate, and

$g(E,R) = dF(B)/dB$ = probability density function of earnings level E, given g.

Development of Testable Propositions

A more interesting problem is if $f(\hat{Y})$ (=g) (E,R) is unambiguously positive, then what are the implications for the remaining terms in **Equation 3**. To solve this problem, we resort to the model of Bradley, Jarrell and Kim (BJK)[8]. Assuming risk neutrality, marginal personal and corporate taxes, non-debt tax shields, and the non-transferability of unused tax credits, their version of **Equation 3** is

$$Vy = \frac{(1 - t_{pb})}{r_0}\,[1 - F(\hat{Y})] \qquad [1 - \frac{(1 - t_c)\ (1 - t_{ps})}{1 - t_{pb}}]$$
$$- \frac{(1 - t_{ps})\, t_c}{1 - t_{pb}}\,[F(\hat{Y} + \phi t/_c) - F(\hat{Y})\,] - k\hat{Y}f(\hat{Y}) \qquad (3)$$

where
$VY = dV/d\hat{Y}$

t_{pb}, t_{ps}, t_c = marginal tax rates of debtholders, equityholders, and the corporation, respectively;

ϕ = total after-tax value of the non-debt shields if they are fully utilized at the end of the period;

k = costs of financial distress per dollar of end-of period value of the firm;

r_0 = one plus the rate of return on default-free, tax-exempt bonds;

$F(\hat{Y}) = \int_{-\infty}^{Y} f(\hat{x})d\hat{x}$ is the probability of bankruptcy at debt level $\hat{Y}$;

$f(\hat{Y}) = dF(\hat{Y})/d(\hat{Y})$ is the probability density of evaluated at $\hat{Y}$;

$\hat{x}$ = firm's end-of-period value before taxes, debt payments, and non-debt charges.

If $dF(\hat{Y})/d\hat{Y}$, the change in the probability of bankruptcy with respect to the change in the level of debt promises, is substituted for $f(\hat{Y})$ and if Vy is equal to zero at the optimal capital structure, then the following equation yields the sensitivity of bankruptcy probability to level of debt payments :

$$\frac{dF(\hat{Y})}{dY} = \frac{A[1 - F(\hat{Y})]}{C} - \frac{B(F\hat{Y} + \frac{\phi}{t_c})}{C} - F(\hat{Y}) \qquad (4)$$

where

$$A = [1 - \frac{(1 - t_c)\ (1 - t_{ps})}{1 - t_{pb}}];$$

$$B = \frac{(1 - t_{ps})\, t_c}{1 - t_{pb}}; \text{ and}$$

$$C = k\hat{Y}$$

Equation 4 implies that if $dF(\hat{Y})/d\hat{Y}$ is strictly positive for reasonable debt levels and assuming C is greater than zero, then at the optimal capital structure point

$$A[1 - F(\hat{Y})] > B[F(\hat{Y} + \frac{\phi}{t_c})] - F(\hat{Y}) \qquad (5)$$

since $(1 - F(\hat{Y})] > 0$, $[F(\hat{Y} + \phi/t_c) - F(\hat{Y}) > 0$ and B > 0, then A > 0. **Equation 5** rules out negative values for A at the optimal capital structure point for all firms in this model.

Since a firm's optimal capital structure involves a tradeoff between the tax advantage of debt and non-debt tax shields in performing our indirect tests of **Equation 4**, it is useful to create extreme positions in the two variables (debt and non-debt charges for a given sample of firms. In the chart is a matrix representation of our indirect tests.

In constructing the matrix we assume that in the first quartile, while $(\hat{Y})$ and ϕ/t_c are both low the bankruptcy probabilities given by $F(\hat{Y})$ and $F(\hat{Y} + \phi/t_c)$ are both very small and approximately equal. Similarly in the fourth quartile $F(\hat{Y} + \phi/t_c)$ is very large and approximately equal to 1. Similar arguments provide a set of assumptions for each quartile. Under the stated assumptions and the general argument that $F(\hat{Y})/D\hat{Y} > 0$, the implication is that in all the quar tiles A > 0, and additionally in quartile 4, A > B. Further, the implications of A > 0 and A > B are noted. They will be used in interpreting the results of the indirect tests of capital structure theory. The indirect tests are created by selecting variables related to the probability of bankruptcy (F) and the promised debt payments $(\hat{Y})$. In particular, we study two proxy variables for the probability of bankruptcy (F) and a set of four indirect variables for promised debt payments $(\hat{Y})$. The sample firms are divided into high and low debt categories.

Objectives of the Empirical Tests

The purpose of the capital structure indirect tests is three-fold:

- to test the hypothesis that $dF(\hat{Y})/d\hat{Y}$ remains positive when indirect variables are used for $\hat{Y}$;
- to test for the consistency of the results of part (1) across time when the sample is selected from firms having extreme positions of debt and non-debt charges; and
- to test additional proxies for the probability of bankruptcy variable which may be used in capital structure decisions.
- finally, within our indirect capital structure tests may be implications relating to possible tax clientele effects fostered by the marginal personal and corporate tax rate trade-offs on the right-hand side of **Equation 4**.

Capital Structure Test and Design

Bankruptcy Forecasting Model

Since the exact form of F used by the capital markets in a multi period setting may differ from **Equation 1**, we choose as our reference F a probability of bankruptcy forecasting model in the belief that it will be a very close proxy for F given by **Equation 1** as well as a good substitute for the form actually used by the markets. Of course, we have no reason to believe that changes in F with changes in promised debt payments are not unambiguously positive in other settings, too. We have used a cash flow-based bankruptcy prediction model[15]*. This was developed using data from 1973-1981. Since this timespan bounds the period of our study (1976-1981) it is expected that the bankruptcy probability estimates generated by this model will be good predictors of the implicit bankruptcy probabilities forecast by the capital markets.

To determine if the forecasted probabilities of bankruptcy are positively or negatively related to existing debt payment promises ($\hat{Y}$ in **Equation 2**), we chose to replace $\hat{Y}$ by four different indirect measures:
1) long-tern debt/net worth,
2) long-term debt/total assets.
3) total liabilities/net worth, and
4) cash flow/long-term debt. The sign of the correlation tests will indicate whether $dF/d\hat{Y}$ is positively or negatively related for each sample cell in chart. It is our contention that the above indirect measures of promised debt payments are related to the probability of failure as prescribed by the BJK Model which uses $\hat{Y}$ measured by the sum of interest and principal payments.

The tests specified in chart also require that our sample firms be separated by debt and non-debt payments. To accomplish this, for each year of the test we first scaled the variables by sales and then rank ordered all the firms in our total population from highest to lowest in debt payment (as measured by (interest + principal due/sales). Then we rank

EXHIBIT
CAPITAL STRUCTURE TESTABLE PROPOSITIONS MATRIX WITH IMPLICATIONS AND ASSUMPTIONS

Debt payments ($\hat{Y}$) \ Non-Debt payments ($\frac{\Phi}{t_c}$)	Low (Bottom Quartile)	High (Low Quartile)
Low (Bottom Quartile)	1 $^*dF(\hat{Y})/d\hat{Y} > 0$ $^{**}A > 0$ *** $F(\hat{Y} + \frac{\Phi}{t_c}) - F(\hat{Y}) = 0$ $1 - F(\hat{Y})] >> F(\hat{Y} + \frac{\Phi}{t_c}) - F(\hat{Y})$	2 $^*dF(\hat{Y})/d\hat{Y} > 0$ $^{**}A > 0$ *** $1 - F(\hat{Y})] > F(\hat{Y} + \frac{\Phi}{t_c}) - F(\hat{Y})$
High (Top Quartile)	3 $^*dF(\hat{Y})/d\hat{Y} > 0$ $^{**}A > 0$ *** $F(\hat{Y} + \frac{\Phi}{t_c} F) - F(\hat{Y}) = 0$	4 $^*dF(\hat{Y})/d\hat{Y} > 0$ $^{**}A > B \geq 0$ *** $1 - F(\hat{Y})] = F(\hat{Y} + \frac{\Phi}{t_c}) - F(\hat{Y})$

Notes :
a) $A > 0 \Rightarrow t_{pb} < t_{ps} + t_c - t_{pstc}$; b) $A > B \Rightarrow t_{pb} < t_{ps}$; c) *Testible proposition : d) **Implication of the proposition $dF(\hat{Y})/d\hat{Y} > 0$ e) ***Assumption used in **Equation 5**

*Mathematical proof of our assertion using the Generalized Lcibnitz Formula in available on request.

ordered all the firms from highest to lowest in non-debt charges (as measured by (depreciation + depletion, etc.)/ sales. Next,each firm's two measures were plotted on a debt payment vs. non-debt payment diagram broken down by quartiles along each axis. The sample firms for each cell in chart were selected from the diagram based on whether or not they appeared in the top or bottom quartile along each axis as described in the matrix of chart. For example, cell (4) consists of firms which are in both the top quartile along the debt payment axis and the top quartile along the non-debt payment axis. The population of firms consisted of all firms appearing on the 1982 **Compustat** industrial file, except for utilities and financial institutions which were excluded from the data set. The actual number of firms used as a sample in each cell is shown in **Tables 1-4**. Once the probability of bankruptcy is calculated for each firm for each year, it is related to the four debt payment indirect variables for each firm for each year using a bivariate test over the period 1977-1981 for the sample firms.

Our final set of tests was run to determine how well our measure of the probability of bankruptcy is related to the more conventional measure of failure — the variance of after-tax cash flows. Before testing this, we need a measure of firm size, since the proposition to be tested is that small-firm variances are more highly correlated with the probability of bankruptcy than are large-firm variances. We chose to measure firm size by the sum of the values of total debt and equity. The large firm and small firm samples each consisted of the top and bottom twenty-five per cent, respectively, of the total sample population. The variances were calculated by using the operating cash flows of each firm (net operating income plus

TABLE 1
BIVARIATE CORRELATIONS OF PROBABILITY OF BANKRUPTCY AND DEBT PAYMENT MEASURES
(A) Using Pearson Product Moment (Cell 1 Chart)
(B) Using Kendall Tau B (Cell 2 Chart)

Year (Number of firms*)		F vs. LTD/NW	F vs. LTD/TA	F vs. TL/NW	F vs. CF/LTD
1977 (248/201)	A	+0.2848 (.0001)	+0.1861 (.0033)	+0.3330 (.0001)	-0.1153 (.1032)
	B	+0.2316 (.0000)	+0.2173 (.0000)	+0.2710 (.0001)	-0.2359 (.0000)
1978 (101/75)	A	+0.1762 (.0780)	+0.0993 (.3231)	+0.3797 (.0008)	-0.1050 (.2961)
	B	+0.1783 (.0101)	+0.1487 (.0318)	+0.2721 (.0006)	-0.0276 (.6833)
1979 (234/183)	A	+0.2068 (.0015)	+0.1686 (.0096)	+0.3556 (.0001)	-0.1464 (.0481)
	B	+0.2404 (.0000)	+0.2137 (.0000)	+0.2564 (.0000)	-0.2706 (.0000)
1980 (211/174)	A	+0.1428 (.0383)	+0.1415 (.0400)	+0.1357 (.0490)	+0.0530 (.4876)
	B	+0.0929 (0.0473)	+0.1279 (.0064)	+0.0637 (.1684)	-0.1078 (.0347)
1981 (213/171)	A	+0.1446 (.0349)	+0.0457 (.5068)	+0.1658 (.0154)	+0.0646 (.0646)
	B	+0.12094 (.0097)	+0.1125 (.0162)	+0.1576 (.0006)	-0.1408 (.0062)

TABLE 2
BIVARIATE CORRELATIONS OF PROBABILITY OF BANKRUPTCY AND DEBT PAYMENT MEASURES
A Using Pearson Product Moment (Cell 1 - - Chart)
B Using Kendal Tau (Cell 2 - Chart)

Year (Number of firms*)		F vs. LTD/NW	F vs. LTD/TA	F vs. TL/NW	F vs. CF/LTD
1977	A	+0.4417	+0.1924	+0.3385	+.0730
(38/28)		(.0055)	(.2471)	(.0376)	(.7119)
	B	+0.0999	+0.0853	-0.0726	-0.1956
		(.3879)	(.4614)	(.5214)	(.1437)
1978	A	-0·9830	-0.0262	-0.1506	+0.2780
(33/24)		(.6461)	(.8849)	(.4029)	(.1885)
	B	-0.1060	-0.0667	-0.3258	-0.0507
		(.3975)	(.5942)	(.0077)	(.7284)
1979	A	-0.0861	-0.0848	-0.1502	+0.0411
(38/29)		(.6072)	(.6129)	(.3682)	(.8323)
	B	-0.1650	-0.0891	-0.1892	+0.0690
		(.1524)	(.4398)	(.0945)	(.5994)
1980	A	+0.2543	+0.2939	+0.1675	-0.3561
(39/35)		(.1183)	(.0694)	(.3080)	(.0358)
	B	+0.1748	+0.2100	+0.1336	-0.3647
		(.1184)	(.0606)	(.2311)	(.0021)
1981	A	+0.1790	+0.0627	+0.2786	-0.2286
(37/35)		(.2892)	(.7124)	(.0950)	(.1866)
	B	+0.1668	+0.0316	+0.2012	-0.2168
		(.1465)	(.7836)	(.0797)	(.0670)

non-cash charges minus taxes) for the prior five-year period beginning in 1977 and ending in 1981. Each year a cross-sectional test was run by correlating the variances with the probabilities of bankruptcy for the sample for that year. We also tested to see if the probability of bankruptcy is related to firm size across the period 1977-1981.

Results and Analysis of Capital Structure Tests

In each year of the period 1977-81 the sample firms were selected using the plotting technique described above. The first set of indirect capital structure tests were performed by correlating the measure of probability of bankruptcy (F) against he four indirect measures of debt payment ($\hat{Y}$), that is,

F vs. long-term debt/net worth (LTD/NW);
F vs.long-tenn debt/total assets (LTD/TA);
F vs. total liabilities/net worth (TL/NW);
F vs. cash flow-long-term debt (CF/LTD).

If $dF/d\hat{Y} > 0$, then the signs of the first three tests above should be positive while the last test should be negative. If $dF/d\hat{Y} > 0$, then F correlated with (CF/LTD) should be negative since debt payment ability is inversely related to the ratio of cash flows divided by long-term debt. The correlation tests were performed using three tests:

1) Pearson product moment,
2) Spearman rank order, and
3) Kendall Tau

B. Since all three measures give the same basic information, we report only the Pearson and Kendal Tau B test results.

Analysis of Data (Tables 1-4 & Exhibit)

In **Tables 1-4** are the 1977-81 period correlation results for each cell in chart for both the Pearson and Kendall Tau B methods. Based on the signs

TABLE 3
BIVARIATE CORRELATIONS OF PROBABILITY OF BANKRUPTCY AND DEBT PAYMENT MEASURES
A. USING PEARSON PRODUCT MOMENT (CELL 3 - - EXHIBIT) B, KENDALL TAU B (CELL 3 - EXHIBIT)

Year (Number of Firms)		F vs LTD / NW	F vs LTD / TA	F vs TL / NW	F vs CF / LTD
1977	A	+0.3024	+0.4329	+0.4572	-0.4419
(35/35)		(.0775)	(.0094)	(.7943)	(.0079)
	B	+0.2538	+0.4050	+0.0420	-0.3714
		(.0032)	(.0006)	(.7226)	(.0017)
1978	A	+0.2917	+0.2643	-0.1001	-0.4499
(29/29)		(.1248)	(.1659)	(.6054)	(.0143)
	B	+0.2315	+0.2217	+0.0197	-0.2709
		(.0779)	(.0914)	(.8807)	(.0391)
1979	A	+0.2136	+0.1334	+0.3379	+0.1969
(45/42)		(.1590)	(.3824)	(.0232)	(.2112)
	B	+0.0658	+0.0010	+0.2202	-0.1800
		(.5248)	(.9922)	(.0330)	(.0932)
1980	A	+0.0462	+0.1306	+0.1321	-0.1226
(80/79)		(.6844)	(.2483)	(.2428)	(.2819)
	B	+0.0152	+0.0766	-0.0873	-0.0790
		(.8419)	(.3147)	(.2515)	(.3036)
1981	A	-0.1156	+0.0129	-0.2582	+0.0629
(31/27)		(.5357)	(.9450)	(.1608)	(.7550)
	B	-0.0931	+0.0065	-0.1742	-0.0541
		(.4643)	(.9593)	(.1686)	(.6920)

and significances of the numbers of **Tables 1-4** and the summary in **Table 5**, it is reasonable to draw the following conclusions:

- The signs of the statistically significant correlations, 0.10, and below, support the hypothesis that $dF(\hat{Y})/d\hat{Y} > 0$ across broad ranges of debt and non-debt charges over time when indirect vairables are used for Y.
- For firms with low debt and low non-debt charges [cell (1)], the traditional measures of debt payments (LTD/NW, LTD/TA, TL/NW, and CF/Ltd) should serve as useful measures of debt payments in tests of theoretical models of capital structure behavior.
- For firms with either low debt and high non-debt charges or high debt and low no debt charges [cells (2) and (3)], the indire debt payment measures must be careful selected in any meaningful test of capital structure theory. None of the measures, except Ltd. TA using Kendall Tau B, retain their same sig over the entire period 1977-81 as predicted by the single period theory. However, the encouraging aspect of the results is that when the correlations are significant at any reasonable level the signs almost always support the contention that $dF/dY > 0$.
- For firms with high debt and high non debt charges, [cell (4)] the indirect variables regain their consistency as predictors of capital structure behavior. As in cell (1), with one or two insignificant exceptions, the signs on the variables are consistent with the proposition that $dF/d\hat{Y} > 0$. The main difference between cell (1)

TABLE 4
BIVARIATE CORRELATIONS OF PROBABILITY OF BANKRUPTCY AND DEBT PAYMENT MEASURES

Year (Number of Firms)		F vs LTD / NW	F vs LTD / TA	F vs TL / NW	F vs CF / LTD
1977 (204/203)	A	+0.0091 (.8975)	+0.1749 (.0126)	+0.1089 (.1210)	-0.1274 (.0701)
	B	+0.1113 (0.181)	+01031 (.0290)	+0.1082 (.0216)	-0.2492 (.0000)
1978 (175/174)	A	+0.1507 (.0465)	+0.0863 (.2574)	+0.1740 (.213)	-0.0729 (.3391)
	B	+0.0516 (.3111)	+0.0510 (.3182)	+0.0542 (.2871)	-0.1578 (.0020)
1979 (327/326)	A	+0.3209 (.0001)	+0.1492 (.0070)	-0.0074 (.8945)	-0.0920 (.0972)
	B	+0.1211 (.0011)	+0.1023 (.0058)	+0.0830 (.02511)	-0.2775 (.0001)
1980 (112/112)	A	+0.0323 (.7352)	+0.0038 (.9686)	+0.0828 (.3853)	-0.1276 (.1800)
	B	-0.0608 (.3419)	-0.0132 (.8366)	-0.0528 (.4095)	-0.1493 (.0196)
1981 (197/197)	A	+0.2692 (.7073)	+0.0392 (.5840)	+0.0345 (.6303)	0.0598 (.4307)
	B	-0.1402 (.0034)	-0.0345 (.4716)	-0.1641 (.0006)	-0.1366 (.0044)

Abbreviations : F + Probability of Bankruptcy (Appendix) : LTD = Total Long Term Debt
NW = Net Worth (Equity + Pf Stock): TL = Total Liabilities
CF = Net Cash Flow (Earnings before depreciation minus taxes); () = Significance Probability
*Number of Firms in First Three Columns / Number of Firms in Last Column

and cell (4) is that the Kendall Tau B offers less supporting evidence in cell (4) than in cell (1).

One possible explanation for the relatively larger sign variability results in cells (2) and (3) of chart is a tax clientele effect. In cell (4) it is argued that $dF/d\hat{Y} > 0$ implies A > B which implies $t_{ph} < t_{ps}$. However, in cell (1), it is argued that $dF/d\hat{Y} > 0$ implies that t pb < tps + tc.tpstc which may mean that tpb > tps for reasonable levels of corporate tax rates. Thus, cells (2) and (3) may contain a mixture of investors whose tpb < tps and tpb > tps which gives the mixed signs to the correlation tests in **Tables 2 and 3**.

In **Table 6** are the results examining asset Size (A) and business risk (σ) as proxies for our measure of the probability of bankruptcy. In the case of small firms o appears to be a useful proxy for the probability-of bankruptcy. The asset size appears to be a better proxy in the case of large firms. However, in both cases, the level of correlation between our F and the other two proxies is low enough to cautior against using either A or σ in any rigorous test of capital structure theory.

Probability of Failure and Corporate Risk Management

we will investigate the relationship between the management of total cash flow risk and the changes in systematic and unsystematic risk components. To conduct indirect tests, we correlate the probability of failure with proxies for systematic risk and unsystematic risk across the same sample

TABLE 5
STATISTICAL SUMMARY OF TABLES 1-4 BY CELL TYPE : 1977 - 1981

	Expected F vs. Ratios	Actual F vs.	Ratios	As expected & significant @ 5 %	10 %	Not as expected & significant @ 5 %	10 %
1.	(+)	(+)	30/30	26/30	1/30	—	—
		(-)	0/30				
2.	(-)	(-)	8/10	5/8	1/8	—	1/2
	(+)	(+)	17/30	2/17	4/17	1/13	1/13
	(-)	(-)	13/30				
3.	(-)	(-)	6/10	2/10	1/10	0/4	0/4
		(+)	4/10				
	(+)	(+)	24/30	5/24	3/24	0/6	0/6
		(-)	(-)	6/30			
	(-)	(-)	8/10	. 4/8	1/8	0/2	0/2
		(+)	2/10				
4.	(+)	(+)	23/30	10/23	0/23	2/7	0/7
		(-)	7130				
	(-)	(-)	10/10	5/10	2/10	—	—
		(+)	0/10				

NOTES 1. Total number of signs = 160. 2. Number of signs as expected = 126. 3. Number of signs as expected and significant = 45 4. Number of signs not as expected and significant = 5

of firms used in the capital structure tests: approximately 1500 firms from the **1984 Annual Industrial Compustat** file for the period 1976-1981. The issue to be studied is whether or not change in the probability of failure is primarily captured in the unsystematic risk component of the total risk, or is it a joint effect on systematic and unsystematic risk. Looking over the prior sixty months τ, we ran the following market model regression for each stock j at year t:

$$\bar{R}_{jt-\tau} = Y_0 + B_{jt} R_{mt-\tau} + \varepsilon_{jt-\tau} \qquad t = 1976\text{ -81} \qquad (6)$$

where

$$\bar{R}_{jt-\tau} = Y_0 + B_{jt} R_{mt-\tau} + \varepsilon_{jt-\tau} \qquad t = 1976\text{ -81}$$

$\bar{R}_{jt}$ = return on security j at time t;

$\bar{R}_{mt}$ = return on market proxy, S&P 400 at time t;

$B_{jt} = COV(\bar{R}_{jt}, \bar{R}_{mt}) / \sigma(^2\bar{R}_{mt})$;

$Y_0 = R_F(1 - \bar{B}_j)$ where R_F is risk-free rates; and

ε_{jt} = error term at time t

Defining the systematic risks at time t as :

$SYS_{jt} = B_{jt}$

$$USYS_{jt} = \sqrt{\frac{\sigma^2(_{jt})}{\sigma^2(\bar{R}_{jt})}} = \frac{\sigma(\bar{\varepsilon}_j)}{\sigma(\bar{R}_m)} \qquad (7)$$

we then calculate them each year for each firm j over the period 1977-81 and cross sectionally correlate them with the probability of bankuptcy for each firm (Fj) which is calculated as before by the model.

Research Findings

The cash flow based model[15] estimates the probability of a firm going bankrupt in a certain period. It is based on cash-flow ratios instead of financial ratios computed using accrual accounting.

TABLE 6
BIVARIATE CORRELATIONS OF PROBABILITY OF BANKRUPTCY WITH ASSET SIZE (A) BUSINESS RISK (σ) B = SMALL FIRM

Year (Number of firms)		Average assets ($ mil)	Average Business risk σ (X) ($ million)	Pearson Product Moment		Kendall Tau B	
				F vs A.	F vs. σ	F vs. A	F vs. σ
1977	A	15.011	0.691	+0.0297	+0.1585	+0.0387	+0.1052
(472)		-		(.5202)	(.0005)	(.2090)	(.0006)
	B	2.560.1	45.4	-0.0862	-0.1140	+0.0311	+0.0235
				(.0612)	(.0132)	(.3/25)	(.4455)
1978	A	17.147	0.774	+0.0238	+0.1465	+0.0766	+0.0349
(475)				(.6055)	(.0005)	(.0126)	(.2615)
	B	2.575.9	45.6	-0.0560	-0.0537	+0.0227	-0.0070
				(.2234)	(.2426)	(.4594)	(.8/81)
1979	A	19.919	0.852	-0.0296	+0.0584	+0.0021	+0.0312
(477)				(.5193)	(.2028)	(.9443)	(.3082)
	B	2.854.6	54.2	-0.1034	-0.0738	-0.0004	-0.0511
				(.0240)	(.1076)	(.9904)	(.0954)
1980	A	24.572	1.028	+0.0821	+0.0008	+0.0624	+0.0073
(484)				(0.711)	(.9861)	(.0403)	(.8104)
	B	3.361.5	78.6	-0.0989	-0.0752	-0.0034	-0.0398
				(.0295)	(.0983)	(.9/17)	(.19/2)
1981	A	28.216	1.120	+0.0779	+0.0324	+0.0635	+0.0304
(491)				(0847)	(.4739)	(.0354)	(.3139)
	B	4.1229	95.0	-0./529	-0./52/	-0.0748	-0.0983
				(.0007)	(.0007)	(.0/32)	(.0011)

Abbreviations : X = Earnings before depreciation less taxes ($ million),F = Probability of bankruptcy: ( ) = Significance probability

The cash-flow measures used are the components of Lawson's identity[16] to estimate the market value of a firm. The identity consists of six components -- operating cash flow (OCF), net investment in fixed assets cash flow (ICF), taxes actually assessed and paid (TCF), cash flow for liquidity change (CFL), shareholder cash flow (SCF) and lender cash flow (LCF). The identity is stated as:

(1a) OCF - ICF - TCF - CFL = SCF + LCF

The model, expressed in linear form $\beta_0 + \sum_{i<1}^{N} \beta_i x_i$ is estimated using these six components (N=6) and a scale measure, the book value of the firm, by employing a logistic regression technique. The probability of failure or bankruptcy (F) is computed by the relationship:

$$(2a)\ F = \frac{\exp(\beta_0 + \sum_{i=1}^{N} B_i x_i)}{1 + \exp(\beta_0 + \sum_{i=1}^{N} B_i x_i)}$$

In **Table 7** are our results. Inspection of these results support the following contentions:

1. The probability of bankruptcy is positively and significantly correlated with both systematic risk (Bj) and unsystematic risk $[\sigma(\varepsilon_j) / \sigma(R_m)]$ across a large sample of firms over time.
2. The level of correlation and degree of

TABLE 7
BIVARIATE CORRELATIONS OF PROBABILITY OF BANKRUPTCY WITH MEASURES OF SYSTEMATIC AND FIRM-SPECIFIC (UNSYSTEMATIC) RISK

Year	F vs. SYS		F vs. USYS	
(Number of Firms)	P	K	P	K
1977	.17081	.11264	.29572	.21268
(1062)	(.0001)	(.0001)	(.0001)	(.0001)
1978	.05277	.03526	.05428	.21265
(1071)	(.0843)	(.0840)	(.0758)	(.0001)
1979	-0.04279	.01711	.04807	.23194
(1094)	(.1573)	(.3968)	(.1120)	(.0001)
1980	.09761	.0553	.35133	.24916
(1115)	(.0011)	(.0057)	(.0001)	(.0001)
1981	.19529	.12559	.35456	.25434
(1114)	(.0001)	(.0001)	(.0001)	(.0001)

Abbreviations F: Probability bankruptcy;
$SYS = \beta_j$
$USYS + a (\varepsilon_j)\sigma/R_m)$,
$\sigma(\varepsilon_j)$ + Standard deviation of firm specific return
$\sigma(R_m)$ + standard deviation of market return

P Pearson Product Moment
K - Kendall Tau B
() = Significant probability

significance of the probability of failure with systematic or unsystematic risk is almost equivalent using either the Pearson test or the Kendall test.

3. Changes in the probability of bankruptcy impact both the systematic and unsystematic components of total (equity) risk. If the total risks of the firm is to be managed, then two effects occur simultaneously: the beta changes and the firm specific risk changes. Thus, the manager cannot assume that the beta of the equity security or of the assets of the firm is a constant while manipulating the sales or cash flow distribution.

Conclusions

In the testing of many theoretical models of capital structure theory, proxy variables are used as substitutes for model variables. Our major conclusions are;

- Almost all of our statistically significant indirect tests support the hypothesis that changes in the probability of bankruptcy with changes in debt payments across firms is unambiguously positive as predicted by theory.
- For firms with either low debt and low non-debt charges or high debt and high non-debt charges, the traditional measures of capital structure (long-term debt/ net worth, long-term debt/total assets, total liabilities/net worth, and cash flow / long-term debt) are related as anticipated to the debt payment variables in models of capital structure theory.
- Assets size (A) and business risk (σ) can be useful proxies for the probability of bankruptcy with good for small firms and 'A' good for large firms.
- For firms with intermediate positions in debt and/ or non-debt charges, the traditional measures of capital structure lose a good deal of their power to proxy for debt payments in direct or indirect tests of capital structure theory.
- The concept of total corporate risk management can be misapplied if it is automatically assumed

that changes in the sales or cash flow distribution of the firm only impact the firm-specific (unsystematic) risk component of total risk, and not the beta too.

Future empirical research in capital structure theory can proceed along lines of direct and indirect tests. Direct tests should rely on estimates of variables actually called for by the model while indirect tests can aid in the development of theoretical models as well as attempt to explain some of the implications of theoretical results with respect to actual variables used by practicing managers.

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