FIRM MODELS OF UNHEALTHY CASH FLOWS

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This simulation study of corporporate funds flows examines the time path of balance sheet and income statement data for firms whose revenues are deteriorating. The objective is to ascertain what measures are likely to give the earliest correct signal to creditors that the firm is in trouble. A variety of firm behavioral assumptions and initial asset conditions are investigated to see how these system parameters may influence the choice of measure creditors should watch. The findings suggest that standard Balance Sheet and Income Sheet statements do not provide sufficient information to forewarn most types of creditors of impending financial crisis.

1. Introduction

Corporate creditors are increasingly concerned about the liquidity positions of client firms. This concern has developed because of the sharp rise in bankruptcies the past two years, and because of the serious financial predicament of several very large corporations, including Penn Central Transportation, Rolls-Royce Ltd., the Lockheed Corporation, and the American Motors Company. There have been a number of other large firms, particularly in the railroad, airline, and securities industries, whose financial flows have become so unhealthy that credit ratings and fund sources for these firms have been jeopardized.

In too many of the cases where a financial crisis occurred some creditors and most equity investors were caught by surprise. The question we address in this paper is "can correct signals of impending financial crisis for a firm be developed for creditors and investors who have access only to published financial statements?" The question is subject to several possible interpretations, including the following:

(1) Can corporate financial statements be used to predict firm bankruptcy?

(2) Can financial statements be used to predict serious liquidity problems?

(3) Do liquidity problems develop over a long enough period of time that annual data are sufficient to detect a forthcoming financial crisis? How much do abbreviated quarterly data help?

(4) Can liquidity measures distinguish between firms who are headed for a financial crisis and firms who are only seasonally, cyclically, or otherwise temporarily in a stringent working capital position?

(5) If financial crisis cannot be anticipated from published financial statements what data are needed by creditors, government regulators, investors, or other interested parties to ascertain firm cash flows?

In general our concern is more with answering questions (3), (4), (5) in this simulation study than with the considerably more difficult prediction problems implied by questions (1) and (2).

The issue is this. A number of studies have indicated clear differences in financial ratios of firms that eventually enter formal bankruptcy and similar ratios of healthy firms. These differences can be detected in ratios from published financial statements at least one year and often two years before formal bankruptcy. Yet in many cases, the Penn Central demise being a recent spectacular example, supposedly professional creditors and investors are caught at the point of bankruptcy with large funds invested in the firm. Why?

One hypothesis is that professionals are not exercising professional judgment in these instances. Thus some argue a careful analysis would have forewarned creditors in time to take corrective action (see Murray, (6)). But a hypothesis which requires that large numbers of competing professional analysts simultaneously make the same error in analysis (or non-analysis) does not seem tenable. An alternative hypothesis is that requisite data for analysis are not available to outside creditors. This may be because (a) financial deterioration is so rapid the crisis is revealed and occurs between points in time when statements are provided, (b) data necessary to detect cash flow crisis are not available in statements provided, (c) current analytical procedures can differentiate between healthy firms and firms with working capital problems, but these procedures cannot adequately distinguish between the relatively large number of firms who have temporary working capital problems and firms who will reach a financial crisis.

In this paper, using a simple simulation model, we explore parts (a) and (b) of the non-requisite data hypothesis. Certain implications for (c) are also discussed as well as implications for possible regulatory revisions that might be necessary in the securities field. Section 2 of the paper reviews the findings of recent bankruptcy studies. Section 3 discusses the characteristics of deteriorating cash flows. Section 4 outlines the basic assumptions made in the simulation study and Section 5 presents summary results. We conclude in Section 6 with some questions about the implications of this study.

2. Predicting Corporate Bankruptcy

In recent years a number of studies have focused on the question "can corporate financial statements be used to predict firm bankruptcy?" (see 1,2,3,6,7). These studies have consistently concluded that information from firm financial statements can be used to discriminate between a group of typical healthy firms and firms which are likely to be in a financial crisis at some point over the forecast horizon. The forecast horizon is usually one year, although there are allusions in (3) and some evidence in (1) that published data can signal a financial crisis two or more years before the event.

Virtually all of the studies use financial ratios in their analysis in order to make cross-firm and inter-temporal studies of the data on a "scale free" basis. Ratios that turn out to be important in this type of discrimination analysis include (a) debt/equity measures (6), (b) relations between cash flow and debt (3), and the variables earnings before interest and taxes over total assets and sales/total assets (1). In one of the more careful studies to date Altman not only looks at the ability of individual variables to predict bankruptcy, he also examines selected combinations of variables through the statistical procedure of discriminant analysis. Altman also tests the ability of his model to discriminate between firms who become bankrupt and unhealthy firms who continue to survive. Although the results are mixed (his unhealthy sample of firms was based primarily on the fact that the firms had a net income loss, not that they had a tight working capital position), this is an important step in posing the question creditors actually face.

Creditors seldom have trouble distinguishing between healthy and very unhealthy corporations on the basis of financial statements. Insofar as this is the only differentiation the findings of existing studies can offer, we have made little real progress. Creditors do have trouble distinguishing between firms who are unhealthy in the sense that they have temporary cash flow problems and firms which are headed for a financial crisis. This distinction and a sharp estimate of the point in time when the financial crisis is most likely to occur are the critical issues once credit has been given (see Johnson (6) for another statement of this viewpoint).

3. Characteristics of Deteriorating Cash Flows

What do we mean by a firm with an unhealthy financial profile? a company with deteriorating cash flows? a firm in a financial crisis? We do not mean a firm that has been put in legal bankruptcy, for at that point a creditor has little possibility of taking independent action. Nor do we necessarily mean a firm that has reached a point where total debt is greater than total equity. While such leverage is not typical for large industrial corporations it is not a rare phenomenon either, and it is typical that most financial firms have debt/equity ratios considerably in excess of one.

To better understand the impact of a deteriorating cash flow on a firm we will develop a simplified analytical framework. Exhibit I defines the financial statement variables that will be used. In this initial illustration we will assume that the corporation is making no current capital investments and that a non-seasonal simple production cycle exists. Goods manufactured any month are equal to goods sold, so that unit inventories remain constant. Revenues are collected without problem in the month sales occur and manufacturing costs (primarily wages and materials) must be paid

in the month incurred (other costs are paid when due). Even in this highly simplified abstraction non-trivial working capital problems exist so long as all expenses are not homogeneous with revenues. And it is certain that some expenses, such as wages or electricity or administrative costs, will not vary in a simple proportionate way with revenues; thus working capital needs will change as the level of sales changes. These assumptions can be summarized by the following algebraic relations:

$$OCF(t) = RV(t) - CGM(t) - OE(t) \qquad (1)$$
$$NI(t) = RV(t) - CGS(t) - OE(t) \qquad (2)$$
$$\text{and if } CGS = CGM + DP$$
$$= OCF(t) - DP$$
$$CA(t) = CA(t-1) + OCF(t) \qquad (3a)$$
$$= K \qquad \text{if (3a) is less than k}$$

$$P(t) = P(t-1) - DP \qquad (4)$$
$$CL(t) = CL(t-1) \qquad (5)$$
$$= CL(t-1) + K - (3a) \text{ if (3a) is less than K}$$
$$NW(t) = NW(t-1) + NI(t) \qquad (6)$$

It is interesting to see what this set of relations would imply under conditions of declining revenues for the trends in the financial ratio measures of liquidity and health mentioned in Section 2. As Exhibit II suggests, ratio variables in financial statement analysis must be used with extreme caution. In five of the six ratios it is not possible to state with certainty what the direction of ratio change will be for a decline in revenues, let alone the magnitude of the change. In the sixth ratio, $(NI + DP)/NW$, direction can be predicted but not the order of magnitude as things go from bad to worse in terms of current cash flows. With increased knowledge about the cost functions for a firm and the liquidity of components of the firm's balance sheet some of the uncertainty about these ratios could be resolved. It still remains true, however, that there are too many degrees of freedom in a firm's financial statements for simple financial ratios to be highly dependable as indicators of approaching financial crisis.

The analysis in this section suggests that if we do not know firm cost functions w must look directly to cash flows rather than summary balance sheet and income statement statistics to get a clear indication of current creditor risks. In the next section we turn to the question of whether cash flow surrogate variables can be constructed from published financial statements in more complex situations, or whether information not ordinarily available to outsiders is required.

4. A Simple Cash-flow, Financial Statements Simulator

In order to test hypotheses about the information content of financial statements a simple cash flow simulation model was developed. The model is basically an open-ended elaboration of equations (1) - (6). As currently constructed the model framework allows the investigator to incorporate the following features. (1) From one to three product groups are permitted. Each product group has its own finished inventory level and its own production cost equation specified in terms of labor costs and direct material costs. (2) Demand functions for a 50 period horizon must be specified. Since the interest in this study is on the impact of specific types of revenue changes on a firm's cash flows, our runs did not incorporate stochastic elements.

(3) Certain working capital policies must be set. These include an inventory policy (level in relation to unit demand and targets), a minimum cash level policy, an accounts receivable policy (rate of collection and

level relative to sales), an accounts payable policy. These policies are set at run time by inserting appropriate algebraic relations (usually linear equations or first difference relations) and parameter magnitudes. Good managers, with quick reaction time and sharp feedback controls do not get into financial crises. Therefore, to simplify the testing most of the simulations made certain assumptions that seemed to be typical of poor management groups: (a) direct labor expenses and administrative overhead decline slowly as revenues deteriorate; (b) dollar inventories decline slowly as sales deteriorate, or if they do decline much it is not because the product is sold but because obsolete goods are written down in value; (c) accounts payable will not decline in proportion to revenue changes. In addition we also assume that companies paying dividends are reluctant to reduce them and that firms with deteriorating revenues must still pay for some ongoing capital investments, although there probably will be no significant net new investment.

(4) The initial balance sheet structure of the firm must be specified. We have, in most simulations assumed an initial position where the firm would be considered below average in terms of financial health, but is perfectly viable so long as revenues do not decline more than 15%. In addition to operating expenses there is provision (5) for periodic cash outlays the firm must make. These include interest payments, role-over of bank loans or other debt, capital investments beyond replacement decisions, or any other event causing cash outflows at some point in time. We assumed in all our runs that the firm faced such outlays every few months. For large firms, this might be analogous to replacing commercial paper as it is due with new paper. For small firms it would mean re-negotiating a bank loan or getting additional funds.

We did not introduce increasing labor or material costs over time (inflation effects for example) although it would be very easy to do so. Nor did we consider the impact of interest rate shifts on the desired level of cash, accounts, receivable, or accounts payable. It was not the intent of these simulations to find the optimal balance sheet structure period by period as the firm approaches bankruptcy.

5. A Summary of Some Results

The out put of the simulation runs consisted of period by period cash flow statements, income statements, and balance sheet statements. In addition balance sheet and income statements were available for quarterly and yearly intervals (each period is considered a month of firm operations). Selected financial ratios were also tabulated.

The basic revenue patterns were (a) a linear sales decline over a one year interval, stabilizing at the new lower level, (b) an immediate sales drop to the lower level, (c) a smoothed cycle declining to the lower level and then increasing to the original level. Sales deteriorations were usually 15%, 20%, or 25% from the original level to the new lower level. These basic patterns bracket most of the types of revenue deterioration experienced by industrial corporations. Each simulation went through 24 iterations (two years) before any sales level change occurred to establish the fact that the firm was viable, given the parameters and relations inserted, in the absence of a sales decline.

A critical question in interpreting the output is "when does the firm reach a financial crisis?" This is a matter of judgement and the following criteria were selected: (a) cash flows have been negative for at least nine months; (b) net income has been negative for three quarters; (c) bank loans or other borrowings in the financial markets have doubled in the past year and are significant. If these conditions occur we assume that a _moderate financial crisis_ will occur within three months. That is, the firm will have trouble renewing or increasing a bank loan, or will have to find new customers for commercial paper, or will come under close supervision or review by some creditor groups. If conditions (a), (b), (c) prevail for 18 months we assume a major financial crisis will occur with the firm either on the edge of bankruptcy or under active creditor control. (See Walter (9) for another measure of financial crisis.)

While it is not possible to reproduce the output results of several dozen different simulation runs here, we have tabulated in Exhibit III a few of the results from a typical run batch. For that particular example a 15% decline in revenues did not produce a financial crisis. A 20% or 25% decline produced a moderate financial crisis by month 40 and a major crisis by month 48. The critical question then is could the changes in financial ratios from months 24 to 36 indicate a near term financial crisis?

The answer is "no" for two reasons. First, the difference between a revenue decline that does not produce a financial crisis and one that does is not known to an outside creditor. For example, for any given firm is a 20% decline enough to produce a crisis or would a 30% decline be needed? Second, a financial crisis does not produce an absolute, consistent set of ratios. At the point of crisis, for example, the CA/CL ratio for different firms would be different. The ratio levels (and rate of financial deterioration) depend on firm cost functions and required (institutional-technological) asset-liability portfolio structures. These are unique for each firm, so that the determination of a set of crisis ratio levels would require a separate model for every firm with whom the creditor had relations.

There are several generalizations that at least tentatively seem warranted as a result of a study of the simulation output.

(1) Whenever deteriorating firm revenues produce a financial crisis we can assert (a) that the firm's financial statements or specified ratios derived from these statements are significantly different from corresponding statements when the firm was healthy, (b) but that it seems impossible without firm-specific knowledge to distinguish financial statements of a firm headed for a financial crisis from statements of the same firm with temporary (but solvable without creditor intervention) working capital problems due to the revenue decline, (c) and that in any event financial ratios and balance sheet structures at the point of crisis are not absolute but differ from firm to firm.

(2) The rate of financial deterioration depends on the rate of revenue deterioration and the rate of change in cash expenses as revenues decline. For most firms material expenses can be cut as production declines. The critical element seems to be how fast wages, salaries, and administrative overhead can be reduced to match the reduced revenue inflows (or more that match the percentage reduction if there are obligatory lease-type cash payments). In our simulations firms that had high wage bills, typical administrative ex-

penses, periodic obligatory payments -- and did not immediately adjust these outflows once a sales decline started -- usually had a moderate financial crisis within 18 months of the time the revenue declines started.

(3) The rate of financial deterioration is not very sensitive to initial balance sheet structure in these simulations. But the point of financial crisis is partly determined by initial levels of cash and bank loans. Repayment schedules for loans or refinancing plans for other debt obligations are important factors in determining the pattern of deterioration, but these data are not usually available to most creditors.

(4) As creditors have known for many years, the critical elements in assessing financial deterioration are the current trends and projections in monthly cash flows together with the arrangements made to finance any negative flows. Monthly cash flows cannot be reconstructed from periodic income and balance sheet statements. Only some of the borrowing implications of a series of negative flows are revealed in typical periodic balance sheet statements.

6. Concluding Comments

Unlike most firm simulation models our analysis was not designed to trace through the implications of management strategies or specific complex programs. Rather we were interested in the differences in information available through periodic income and balance sheet statements as compared to monthly cash flow statements. This made the development of a simulation framework somewhat easier, for while there are uncountable combinations of production-marketing decisions that could produce different financial patterns, the types of decisions that lead to deteriorating cash flows are fewer and fairly well known. Since the analysis was not firm specific, most of the time in preparing the simulations was spent in revising parameters and changing the algebraic relations that specify lead-lag and inter-relationships among the more than 60 variables used in this study. An important unanswered question is whether more detailed, firm specific models would change the point of financial crisis under a specified type of revenue deterioration by more than two or three months from the results of our simple model. If the point of crisis were delayed, but the balance sheet ratios or relative structure did not change from our simpler model, the conclusions would be modified.

We have omitted discussion of the most powerful signal of deteriorating financial position, namely a decline in the price of a firm's traded debt and equity securities. Studies and theory suggest that in efficient capital markets this should be as good a signal as any of impending financial trouble (see (1), (5)). Security prices in efficient markets incorporate all the information that is publicly available that may influence the value of the security. If, as we have concluded, the point in time of financial crisis cannot be accurately anticipated from examining published financial statements, insiders with access to detailed firm cash flow information will have a possible economic advantage. One of the questions in the Penn Central bankruptcy is whether or not such inside information was used by certain banks and other groups to sell Penn Central stock before bankruptcy was declared. The issue could be resolved, of course, by requiring firms to make available upon request to all investors or creditors whatever detailed cash flow information is supplied to any outside creditor. But that type of information dissemination raises a number of questions about proprietary firm data, efficient communication, and the effects on firm credit of anticipated financial crisis that must be carefully studied before such an information dissemination rule is implemented.

In this paper we conclude from the analysis of our simulations only that financial crisis cannot be accurately predicted without detailed insider information on cash flows. We reach no conclusions about what creditors can do about it.

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EXHIBIT I

CA	current assets	NI	net income
P	net plant and equipment	DP	depreciation on plant and equipment
TA	total assets	RV	revenues from sales
CL	current liabilities	OCF	cash flows from operations
NW	stockholder net worth	CGM	cash cost of goods manufactured
TC	total claims = TA	CGS	costs of goods sold
K	minimum desired cash level	OE	operating expenses

EXHIBIT II

Impact of a decline in revenues on selected ratios
if during period (t):

		NI ≥ 0	NI < 0 OCF ≥ 0	NI < 0 OCF < 0
RV/TA	n.	d	d	d
	d.	i	d	?
	r.	d	?	?
NI/RV		d	d	d
		d	d	d
		?	?	?
CL/NW		0 or d	0 or d	0 or d
		i	d	d
		d	?	i
(NI + DP)/CL		d	d	d
		0 or d	0 or d	0 or d
		?	?	d
(OCF - LD)/CL		?	?	d
		0 or d	0 or d	0 or d
		?	?	d
(NI + DP)/NW		d	d	d
		i	d	d
		d	d	d

Notes: n. = the numerator of the ratio
d. = the denominator of the ratio
r. = the ratio
d = this variable decreases as a result of the revenue decline
i = this variable increases
LD = bank loans due this period (in this simplified model it
is assumed that some CL may not have to be rolled over--
that is paid--during the current period)
? = it is not certain what the direction of change will be
during the period as a result of the revenue decline

EXHIBIT III

Selected Financial Ratios for Various Revenue Declines

		Period				
		0	12	24	36	48
CA/CL	a.	1.60	1.97	2.28	2.19	1.88
	b.	1.60	1.97	2.28	2.08	1.47
	c.	1.60	1.97	2.28	2.06	1.25
(CH+AR)/CL		.96	1.07	1.24	1.15	.99
		.96	1.07	1.24	1.06	.75
		.96	1.07	1.24	1.04	.62
RV/TA		1.08	1.14	1.14	.98	.94
		1.08	1.14	1.14	.98	.88
		1.08	1.14	1.14	.97	.75
NI/RV		.056	.056	.056	.025	.012
		.056	.056	.056	.010	(.030)
		.056	.056	.056	.008	(.097)
TD/NW		1.00	.82	.75	.76	.84
		1.00	.82	.75	.78	1.04
		1.00	.82	.75	.78	1.20
(NI+DP)/TD		.25	.29	.31	.22	.18
		.25	.29	.31	.17	.07
		.25	.29	.31	.18	(.01)
(NI+DP)/NW		.25	.24	.23	.17	.15
		.25	.24	.23	.14	.07
		.25	.24	.23	.14	(.01)

Notes:

The revenue declines were linear over one year to the new lower level. Declines from original base were a. = -15%, b. = -20% and c. = -25%.

Financial variables not defined in Exhibit I are CH = cash, AR = accounts receivable, and TD = total firm debt.

In this particular simulation a moderate financial crisis, as defined, occurred in month 40 for the 20 and 25 percent revenue declines.