The Information Effects of Financial Leverage: A Dynamic Approach

by

Catherine Anne Shenoy

B.S., University of Kansas, 1979
M.B.A., University of Kansas, 1983

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Dissertation Committee:

O. Maurice Joy .....
CHAIRPERSON

Gautam Bhattacharya .....

Steven C. Hillmer .....

Paul D. Koch .....

George E. Pinches .....

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Abstract

This dissertation is about capital structure theory under asymmetric information. In particular, I examine the relationship between cash flow and financial leverage over time. This relationship is important because signalling theory and pecking order behavior in financing seem to have opposite implications for the relationship. Further, two sets of empirical results—leverage-changing event studies and cross-sectional regression studies—also have seemingly conflicting results. I show that the apparent contradictions can be resolved be considering the dynamic aspects of the cash flow/leverage relationship.

Both signalling theory and the pecking order behavior describe the relationship between cash flow and leverage. In signalling theory, cash flow and leverage must have a monotonic relationship, and most theories predict that this relationship is positive. The relationship between cash flow and financial leverage is also important in a pecking order of financing. Pecking order behavior suggests that holding investment constant, higher cash flows are associated with lower leverage. Cross-sectional leverage studies generally support the pecking order view, while leverage-changing event studies generally support the signalling view.

I propose a model that takes into account both the simultaneous and intertemporal relationship between cash flow and leverage. Because cash flow and leverage are determined simultaneously, cross-sectional studies that ignore the simultaneity may be biased and inconsistent. Lagged cash flow is also a determinant of leverage. A pecking order suggests that firms with more slack will use less leverage, thus excess cash flow in the past may affect current decisions about how much debt to issue. Similarly, cash flow is also affected by current and lagged values of leverage.

Under the signalling hypothesis, lagged values of leverage provide information about current cash flow.

Risk is also an important element in the relationship between cash flow and leverage. It is simultaneously determined with cash flow and leverage. Thus an appropriate model to capture the simultaneous nature of risk, cash flow, and leverage is a system of pooled time series equations. These results show that lagged values of leverage tend to have more significant positive coefficients, but the contemporaneous coefficients are negative. The across-time results support the signalling hypothesis, since a signal should give information about future cash flows. The contemporaneous lag coefficients are negative. This supports the notion that pecking order behavior is a description of contemporaneous behavior.

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1. Introduction

Two asymmetric information models of capital structure that describe the relationship between leverage and cash flow have opposite implications. For both, there is a long list of empirical support. Ross's (1977) incentive signalling model implies that firm value and financial leverage should be *positively* correlated. Event studies of leverage changes have generally supported this model (see Masulis (1988) for a summary). On the other hand Myers and Majluf (1984) also use information asymmetry as an explanation for a firm following a pecking order of financing where firms use internally generated funds before issuing debt. This implies that cross-sectionally firms have a *negative* correlation between financial leverage and cash flow. Cross-sectional leverage studies generally support the pecking order explanation. These studies have all found a negative relationship between some measure of profitability or quality and leverage. For a summary see Martin, Cox, and MacMinn (1988), Titman and Wessels (1988), or Harris and Raviv (1991).

This dissertation resolves this seeming conflict by considering the dynamic relationship between a firm's capital structure and its cash flows. Asymmetric information models characterize a firm's financing choices as a resolution to the adverse selection problem. This problem arises when different individuals have different estimates of firm value. Firm value is simply the discounted sum of expected *future* cash flows. Signalling theory suggests that leverage provides information about these future cash flows. Financing decisions are immediately reflected in the level of financial leverage, but the investment payoffs for these decisions are in the future. Therefore, the interesting signalling relationship is intertemporal—between future cash flows (current firm value) and current financial leverage. Ignoring this intertemporal relationship has led to the apparent contradictions in the theory and in the empirical

results. In this dissertation, I describe this contradiction and show that by considering the dynamic aspects of leverage and cash flow, this apparent contradiction can be resolved.

Previous tests of the information content of capital structure, usually event studies or cross-sectional regressions, have focused on short time periods or on cross-sectional analysis that cannot capture dynamic relationships. When the timing of the relationship between cash flow and financial leverage is appropriately captured in a dynamic and simultaneous model, the apparent contradiction between Ross's signalling model, firm pecking order behavior, and the empirical results can be resolved. Hence this study seeks to link these different strands of the literature with a time series investigation of the direction and nature of the dynamic relationship between a firm's cash flow and its financial leverage.

The evidence presented here supports both Ross's signalling hypothesis and pecking order behavior, but Ross's model must be reinterpreted. I show that current levels of leverage are positively related to future values of cash flow, while contemporaneous levels of leverage and cash flow are negatively related. This supports the notion that signalling theory describes how investors form expectations about firm value based on something observable. In this case, financial leverage reflects these managerial expectations. However, managerial expectations relate to future cash flows, not current ones. The evidence also suggests that the pecking order is a description of the contemporaneous relationship between financial leverage and cash flow. This interpretation also reconciles the empirical results. Event studies that support Ross's hypothesis are market studies which reflect expectations, but cross-sectional studies show the contemporaneous relationship.

The first step toward specifying the dynamic cash flow/leverage relationship is a Granger test. This test provides evidence about the empirical basis of signalling by showing whether leverage can improve cash flow forecasts. For leverage to provide a basis for information about firm value, investors must use the level of financial leverage to form expectations about a firm's future cash flow. These expectations must have some empirical basis, even if realizations may be different. Since current leverage and current cash flows are not available *a priori*, a necessary condition for a signal is that previous values of leverage should improve cash flow forecasts.

Granger tests can testify about the existence of a relationship across-time, but a more general model is required to explain the discrepancy between event study results and cross-sectional regression studies. A dynamic simultaneous structural equation model provides a means to reconcile the theoretical and empirical results.

This structural model addresses some of the problems in previous empirical work. Event studies focus on a narrow time frame that disregards the magnitude and the duration of the leverage changes. An exchange offer may not constitute a large change in a firm's financial leverage, or within a relatively short time the leverage level may be readjusted. Nor do cross-sectional studies show that leverage provides information about future cash flows that cannot be obtained by simply looking at the cash flow series itself.

Another problem with many previous studies is the definition of quality. Many studies have used earnings per share, while others have used return on assets or profitability. Theoretically, a firm's market value per share is the expectation of the discounted cash flows that will accrue to a shareholder. For an all-equity firm, the idea of quality is straightforward since all cash flows ultimately will accrue to the shareholder. Abstracting from any ownership or financing decisions, a high quality

firm generates consistently higher cash flows from the same set of investment opportunities. The best measure of the quality of a firm's operating decisions then, is its cash flow from operations. Earnings per share, return on assets, and profit margins are all functions of cash flows. But they all use net income, which includes financing decisions as well as operating decision.

However, a bigger potential problem with cross-sectional leverage studies is simultaneity. The second set of tests considers the simultaneous nature of the relationship. If there is simultaneity, then ordinary least squares estimation of cross-sectional leverage models is biased and inconsistent.

Risk also may interact simultaneously with cash flow and leverage. Hull and Pinches (1991) show that risk is not constant around the event. Analytical models hold risk constant, but as leverage increases so does risk. I specify a dynamic system of simultaneous equations to show the interaction among a firm's risk, cash flow, and leverage, and to further test the signalling and the pecking order hypotheses.

In this thesis I describe the dynamic relationship between a firm's financial leverage and its quality. First, Granger causality tests show that knowledge of financial leverage improves cash flow prediction, and they show that there is some weak industry-specific support for the signalling hypothesis using a naive forecasting model. These preliminary tests lead to the specification of a simultaneous equation model. The dynamic simultaneous equation model provides even broader support for the signalling hypothesis. These results primarily show that contemporaneous cash flow and leverage are negatively related, but the lagged relationship is more often positive. This pattern supports the idea that pecking order behavior is a description of the contemporaneous relationship between cash flow and leverage, while a signal provides information about future cash flows, not contemporaneous ones.

Through these tests I show the following:

1. The nature and direction of the relationship between cash flow and leverage,
2. A reconciliation of time-series event studies and cross-sectional studies,
3. The dynamic relationship between the cash flow and leverage, and
4. The effect of risk on leverage and cash flow.

The results support both Ross's signalling hypothesis and firm pecking order behavior, when the timing of the relationship is considered. I find a negative relationship between leverage and cash flow in the same time period (pecking order), and a positive relationship between leverage and cash flow across time (signalling). Event studies are consistent with the negative across-time relationship because market value reflects expectations about future cash flows. Cross-sectional studies are consistent with the contemporaneous relationship.

2. Theoretical Research in Signalling and Capital Structure

Several scholars have hypothesized that a firm's capital structure serves as a signal to investors indicating the quality of the firm. Capital structure signalling models differ in how uncertainty and quality are characterized, in their assumptions about when information is available to managers and outsiders, and in the choice of decision variables. The result is that sometimes predictions about the relationship of quality and the signal from different models is antithetical. For example, Ross (1977) predicts that higher quality is associated with higher financial leverage. Leland and Pyle (1977) predict that lower financial leverage implies higher quality. Nevertheless, all models rely on a set of signalling equilibrium conditions that provide a theoretical and empirical

research basis. No matter which model is considered, financial leverage and cash flows must have a consistent stable relationship over time in a signalling equilibrium.

In this section, I describe the imperfect information problem and relevant implications of any signalling models. Then I describe two necessary equilibrium conditions. Next I discuss the predictions and implications from specific signalling models and the problems associated with these models. To conclude this section, I mention other pertinent capital structure theory. I leave the empirical discussion to Section 3.

2.1. Signalling Equilibrium Conditions

Imperfect Information or Information Asymmetry

Capital structure signalling theory is an attempt to explain how managers communicate private information to outside shareholders. Traditional models of capital structure (Modigliani and Miller (1958), Miller and Modigliani (1963), Miller(1977), and DeAngelo and Masulis (1980)) assume that the information is the same for all decision makers. Future events are uncertain, but everyone knows the true probability distribution of the event. In other words, all parties observe and interpret events in the same way, even when the outcome is uncertain. The capital asset pricing model, arbitrage pricing theory, and net present value maximization are other models which are based upon the same assumption of uncertain, but symmetric information.

The study of imperfect information also assumes event uncertainty, but it differs because participants do not have the same information set. Managers and outside investors have different subsets of uncertain information. For example, suppose that outside investors cannot distinguish the quality of investments in two separate firms in the same industry, firm A and firm B. Outside investors form their expectations based on all publicly available information, such as past performance, press releases, or

independent security analysis. Managers of firm A have a specific idea of the probability distribution of the payoffs of the investment in their firm, but their knowledge of firm B's payoffs is less precise. They have more information about the industry than an outside investor since they are also part of the same industry, but they do not have specific knowledge of B's investments. The outside investor, firm A's management, and firm B's management each have a different information subset.

Akerlof (1970) was the first to characterize the problem of imperfect information. He showed that the imperfect information problem can lead to a breakdown of the market. He used this example:

> Suppose there is a market with products of different qualities, and buyers cannot discover the quality of the product before purchase. Akerlof's insight was that the price offered reflects the price of the average quality product. Problems can occur if sellers of high quality products do not wish to sell at the average price. If they withdraw their product from the market, then the price will drop reflecting the lower average quality. The next highest quality sellers also withdraw their product, and so on until the market disappears.

In Akerlof's example, high quality sellers clearly wish to communicate the quality of their product to buyers, but they do this in some way that is difficult or impossible for low quality sellers to imitate. Buyers would welcome a signal informing them about product quality, and be willing to pay for such information. A signalling equilibrium occurs when it is possible to find such a signal. In order for such a signalling equilibrium to hold, two necessary conditions must be met: First, There must be an unambiguous relationship between the signal that is sent and the quality of the firm, and second, the benefit derived from the signal must also be directly related to the signal.

This type of information structure may not exist in every market, but it is a necessary condition for a signalling equilibrium. All signalling models assume that

these necessary conditions are met. Therefore, empirical tests of signalling models are a test of the necessary conditions. Two signalling equilibrium conditions are discussed next.

Signal is monotonic in quality

In a signalling equilibrium the signal must unambiguously identify the quality of the firm to the investor. Since the purpose of the signal is to align the information sets of the investors and managers, the signal must provide the investors with all the relevant information needed so that investors and managers will possess equivalent sets of information.[1] Riley (1979) and Rothschild and Stiglitz (1976) show that a signalling equilibrium implies that the signal is monotonic in quality.

Not all models posit the same functional relationship between signal and quality. For example, in Ross's model the signal/quality condition requires that cross-sectionally all higher quality firms have higher levels of financial leverage. Therefore, an increase in leverage means an increase in quality. Others suggest that the quality and leverage are inversely related, but in either case, there is a monotonic relationship.

In a fully revealing (or separating) equilibrium, for each quality level there must be an associated signalling level. In this type of equilibrium all firms are instantly distinguished by the signal. Another situation that could occur is a semi-pooling equilibrium. Here the highest quality firms identify themselves by a signal, but the rest cannot. For most of the firms, the relevant price is the average for the pool, but high quality firms obtain a premium because they can identify themselves through the signal.

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[1]Investors will not have exactly the same information sets, but equivalent information sets imply that all relevant is the same.

Price reaction is monotonic

Signalling must be costly to the firm. If it were not, then every firm would send the same signal, and investors would not be able to distinguish among them. The benefit derived from signalling is an increase in stock price associated with the signal; therefore, it is a necessary condition that the price be monotonic in the signal. The higher quality firm must have a larger price increase than a lower quality firm, and the price reaction to the signal must be consistent.

These two conditions link the price reaction, firm quality, and the signal together unambiguously in a signalling equilibrium. Given a signal, the price reaction and firm quality must be consistently in the same direction.

Ambarish, John, and Williams (1987) pointed out "(a)ny model with a single costly signal must have a positive announcement effect; otherwise, insiders would never signal ... Any univariate model depends critically on the somewhat arbitrary initial selection of the signal." They develop a model with two signals where the price reaction is not required to be positive since the costs and benefits are shared between two variables.

A problem with multivariate models is that there is no end to the number of possible combinations. So far, there is no theoretical reason to prefer one type of signal or group of signals over another. When there is more than a single signal involved, much greater demands are placed on the investor's ability to interpret the event correctly.

2.2. Specific Models

Early Signalling Models

Ross (1977) and Leland and Pyle (1977) were the first to develop capital structure signalling models. Their models differ because they chose different decision variables.

In Ross's case, the decision variable is the amount of debt to issue. Managers decide whether to issue debt to undertake a project. Managerial compensation is directly related to the outcome of the project. Managers of high-quality firms issue more debt because there is a a higher expected cash flow and a lower probability of bankruptcy. Managers maximize firm value and their own compensation simultaneously. In this model the investment in the project and the amount of debt issued are directly related, so high-quality firms have higher leverage because they invest more in positive net present value projects.

Leland and Pyle (1977) use equity as the decision variable in an entrepreneurial firm. The payoffs to the entrepreneur are equivalent to Ross's condition that managerial compensation is proportional to the project outcome. In this situation, Leland and Pyle showed that an entrepreneur will retain a larger proportion of equity than the uncertain information case because the entrepreneur's compensation comes from his/her share of the firm. The result is a less highly leveraged high quality firm because entrepreneurs will retain more equity and issue less debt.

Both Ross's and Leland and Pyle's models are restricted because they limit the decision variable. There is only one way to make the investment and increase the value of the firm; with debt in Ross's model, and with equity in Leland and Pyle's. In both, leverage is a direct indication or signal of the level of investment.

Agency Problems and Signalling Models

Leland and Pyle's model can to thought of as a solution to the problem of uncertain actions (agency problem), but it is limited because the owner is the manager of the firm, and there are no outside shareholders. In an imperfect information problem (a signalling problem) managers wish to maximize shareholder wealth, but cannot. In an

agency problem there is a conflict between maximizing the manager's own wealth and shareholder wealth.

Fulghieri (1990) considers both types of problems simultaneously. He generalizes the problem proposed in Ross and Leland and Pyle. He models a firm where both the current level of investment and the quality are unknown. In this type of information environment, he shows that the quality of the firm is inversely related to leverage. This model is a combination of a signalling problem and an agency problem where the unknown level of investment is the source of hidden action, an agency problem. He defines quality as profitability.

In both models that can be described as agency/signalling models higher leverage implies lower quality, and lower leverage implies higher quality. In contrast Ross's incentive signalling model implies the opposite.

Pecking Order and Signalling

Myers and Majluf (1984) also discuss firm behavior under asymmetric information. They do not develop a signalling equilibrium model, but they do furnish insight into how information asymmetry influences firm behavior. They show that it is reasonable for a firm to follow the old idea of a pecking order of financing. In a pecking order of financing, a firm does not have a specific leverage target, but relies on retained earnings until outside financing is necessary; then a firm issues debt. Equity financing is a last resort. Over time, high quality firms, those with high cash flows, have lower leverage. Increases in leverage are not necessarily permanent or related to higher quality.

The relationship between quality and leverage may also be monotonic in a pecking order. The progression of events would be low leverage to higher leverage to lower leverage as the firms relies on retained earnings, issues debt, and finally issues

equity. Issuing equity is not a common occurrence. In Myer's and Majluf's framework, a firm issues equity, not because it needs operating cash, but because it is a good enough investment opportunity to overcome the cost of issuing equity. Therefore, an equity issue may indicate increased future cash flow from the investment opportunity; that is, increased quality. To summarize, holding the investment level constant, in the first stage of the pecking order, quality (cash flow) is high, and the firm relies primarily on retained earnings. In the next stage, a firm issues debt, leverage increases and quality decrease. Finally, a firm will issue equity when additional investment is needed, which indicates an increase in quality (cash flow). The total market value of the firm may increase, while share price and leverage decrease. In all cases leverage is inversely related to quality.

John and Ronen (1989) show that timing of the investment and the timing of the information about the investment determine whether a pecking order of financing results. When managers know the quality of the firm but have not yet invested in a project, then a pecking order results. In this framework the investment opportunities of the firm and timing determine the information asymmetry and, in turn, a firm's optimal capital structure.

Different technologies mean differences in the amount and type of information available. For example, novel technology, which makes it difficult for outsiders to relate cash flow and investment, implies more equity financing. The longer the lag between investment and the resolution of the cash flows, the more equity will be used. Their analysis implies that signalling results vary across industries or technologies, and that the dynamic relationship between the signal and quality is important in determining a signalling equilibrium

2.3. Criticisms of Signalling Models

Signalling models indicate that the assumption of perfect information is costly, but the different models lack a unifying framework. The choice of a signal or combination of signals is arbitrary. In univariate signalling models, the market price reaction, the benefit of signalling, must always be positive in a fully revealing equilibrium. With multivariate models, the information processing capabilities of investors is taxed as they consider all the implications of all possible signal combinations.

Signalling models are also criticized because the conditions that lead to a signalling equilibrium are not well-defined. All signalling models assume that the conditions for equilibrium are met and describe what happens after that point. It is more instructive and much more difficult to start with a set of plausible market and firm conditions and derive the existence of equilibrium. John and Ronen and Myers and Majluf do approach the problem from this direction.

Finally the idea of quality is problematic. What is a high-quality firm? In some models (Ross and Leland and Pyle) the issue is not addressed, except that for a given level of risk, higher cash flows are generated by a high quality firm, or the expected value of a high quality firm is greater than the expected value of a low quality firm. In others it is defined in terms of a firm's higher marginal productivity. Quality may also depend on macro-economic conditions. For example, a firm that employs a specific, undiversified strategy may do very well under certain market conditions. A well-diversified firm may never perform spectacularly, but it may exceed the average performance of the other firm over time. Although signalling models incorporate temporal elements, the notion of quality is still static.

2.4. Other Relevant Theory

Fischer, Heinkel, and Zechner (1989) hypothesize that firms have relevant ranges of leverage, instead of a single static target. In their model variations in asset value, transaction costs, tax advantages, and the riskless interest rate all affect the decision to recapitalize. In a signalling context this means that capital structure decisions that are not related to investment decisions convey a different type of information. It also indicates that for certain industries with wide leverage ranges, leverage changes convey little information and are only weakly related to any idea of quality.

3. Empirical Research in Signalling and Capital Structure

There are two main types of empirical capital structure research: time-series studies of leverage changing events and cross-sectional regression leverage studies. Event studies that test the capital structure signalling hypothesis rely upon the price/signal condition. Researchers find leverage increasing or decreasing events and then observe the stock price reaction to the event. Cross-sectional leverage studies can be considered a test of the quality/signal relationship.

Leverage changing event studies have generally found that price decreases with leverage decreasing events, and price increases with leverage increasing events. These results have widely been interpreted as support for Ross's signalling model which associates higher leverage with higher quality. Recent empirical work also extends the event studies and examines earnings' surprises after a leverage changing event (Cornett and Travlos (1989), Dann, Masulis, and Mayer (1989), and Vermaelon (1981)). They conclude that leverage-increasing events are positively associated with increasing quality.

Yet all cross-sectional studies of leverage find an inverse relationship between leverage and any variable that is used as a proxy for quality. Both results are robust

and both fit some type of signalling model or information model. However, they cannot be reconciled with current information models. What differs in the two types of studies is the timing of the information. Event studies relate to future cash flow, while cross-sectional regression studies relate to current cash flow or current quality.

3.1. Event Studies

The first ten studies in Table 1, exchange offers and repurchases, have large statistically significant abnormal returns upon announcement. These are leverage-increasing events with a positive stock price reaction. These events also are called "pure" leverage increases since there is no impact on the firm's assets or investments. Recall that a necessary condition for a signalling equilibrium is a positive stock price reaction to the announcement. This has been interpreted as a release of new information that is consistent with price/signal equilibrium condition.

Table 1. Average Stock price Reactions to Leverage-increasing Announcements for U. S. Firms

Study	Type of Announcement	Sample Size	Two-day Mean Annual Return
Masulis[33]	Exchange offers of debt for common stock	52	14.0+*
Masulis[33]	Exchange offers of debt for preferred stock	24	3.5+*
Pinegar and Lease[40]	Exchange offers of preferred for common stock	15	8.1*
Masulis[34]	Exchange offers of preferred for common stock	9	8.3+*
McConnell and Schlarbaum[36]	Exchange offers of income bonds for preferred stock	24	2.2*
Masulis[34]	Repurchase of common stock by tender offer	199	16.4*
Masulis[34]	Debt-financed repurchase of common stock by tender offer	45	21.9*
Dann[8]	Repurchase of common stock by tender offer	142	15.4*
Vermaelen[46]	Repurchase of common stock by tender offer	131	14.1*
Vermaelen[46]	Secondary market repurchases of common stock	243	3.4*
DeAngelo et al[11]	"Going-private" transactions	72	28.3*
Linn and Pinegar[29]	Public offerings of nonconvertible preferred stock	294	0.8
Dann and Mikkelson[10]	Public offerings of nonconvertible debt	150	-0.4
Mikkelson and Partch[37]	Public offerings of nonconvertible debt (IND)	171	-0.2
Eckbo[12]	Public offerings of nonconvertible nonmortgage debt	459	-0.1
Eckbo[12]	Public offerings of nonconvertible mortgage debt	189	-0.2
Mikkelson and Partch[37]	Private placement of debt (IND)	80	-0.6
Mikkelson and Partch[37]	Bank debt borrowings (IND)	61	-0.2
Mikkelson and Partch[37]	Initiation of credit agreements (IND)	155	0.9*
Officer and Smith[33]	Withdrawal of common stock offering	31	2.4*

IND = Industrial firms only. *Significant at the 5 percent level.

+Includes two-day returns on initial announcement and in 40% of the sample a second return representing a clarifying announcement.

Source: Masulis, *The Debt/Equity Choice*, (1988) p.16.

Other leverage-increasing event studies do not find significant, positive abnormal returns. In Table 1, the second ten studies do not show positive abnormal returns. Eckbo's (1986) comprehensive study of large corporate debt issues shows that for the most common type of leverage-increasing event, new debt issues, there is no new information revealed to investors.

3.2. After the Event: Relating Quality to the Event

To test whether the positive abnormal return associated with the leverage-increasing events is a signal of increasing quality, the abnormal return is regressed on some quality variable. Most previous research has used unexpected earnings per share (EPS) as an indicator of quality change. Dividend signalling studies also used a similar approach. Usually the unexpected EPS is the standardized forecast error from an earnings' time-series model (Cornett and Travlos (1989), Vermaelon (1981), Eckbo (1986), Dann, Masulis and Mayer (1989), Healy and Palepu (1988), among others). But Lang and Litzenberger (1989) and Copeland and Lee (1988) use standardized analysts' EPS forecast errors. Dann, Masulis, and Mayer also use unexpected earnings before interest and taxes. Conceptually earnings before interest and taxes (EBIT) is a better indication of the quality of a firm's operations (as discussed in Section 4.1). EPS forecast errors are biased upward in repurchase and exchange studies if an adjustment is not made for the decrease in the number of shares outstanding.

Vermaelon (1981) and Dann, Masulis, and Mayer (1989) use a sample of equity repurchases and examine subsequent earnings. Both use an OLS regression with abnormal returns as the dependent variable and the forecast error as the independent variable. Vermaelon does not adjust the denominator for the decreased number of shares in the EPS forecasts, but Dann, Masulis, and Mayer do. Both find some weak support for the idea that there are positive forecast errors after the repurchase. Dann, Masulis and Mayer also use unexpected EBIT with no change in results.

Eckbo (1986) examines corporate debt offerings with a similar methodology. He finds no significant positive abnormal returns, nor does he find subsequent earnings increases.

Copeland and Lee (1988) and Cornett and Travlos (1989) look at exchange offers and subsequent earning. They use a similar regression, but also include other independent variables such as the percent of insider ownership, and they control for the type of leverage change. When these other variables are included, the support for positive unexpected earnings after the event is very weak. In Cornett and Travlos's analysis the change in insider ownership appears to be driving the results. Copeland and Lee find almost no significant results for any of their variables.

Despite the generally weak relationship between subsequent unexpected earnings and the abnormal returns from these leverage-increasing events, these authors interpret their results as support for a signalling hypothesis. Not all of them rely exclusively on the leverage signalling argument. For example, Copeland and Lee discuss the increase in inside ownership as being consistent with Leland and Pyle's signalling model. Another argument is that a stock repurchase can be viewed as a dividend signal; but whatever the type of signalling model, the relationship between quality and the signal should be monotonic.

Other Concerns

In these studies earnings are the main focus. But what happens to leverage after the event is not considered. Is this a temporary or a permanent change in leverage? For example, many LBO firms were very highly leveraged but subsequently reduced leverage fairly quickly. It is possible also that these leverage changes are within the expected leverage range for this type of firm. In event studies the dynamic interactive nature of the relationship between earnings and financial leverage is not considered.

3.3. Cross-sectional Studies

Generally cross-sectional financial leverage studies find that financial leverage is negatively related to profitability or return on assets. This result is in contrast to the

event study interpretation that increasing leverage signals future unexpected profitability. Cross-sectionally Ross (1977) also predicts that higher quality firms have higher leverage, and Fulghieri's and Leland and Pyle's models predict that higher quality firms have lower leverage.

Titman and Wessels (1989) list other factors that also affect capital structure. They include the collateral value of assets, non-debt tax shields, growth, uniqueness, industry classification, size, and risk. They find that uniqueness, size, and to some extent profitability are significant determinants. Profitability is significantly negatively related to financial leverage when the market value of equity is used in the denominator, but not when book value is used. Friend and Lang (1988) find that return on assets, the standard deviation of the return on assets, and collateral value of assets (as measured by the ratio of property, plant and equipment to total assets) are significant. Friend and Lang also consider the effect of ownership structure. There are changes in the size of the coefficients, but not in the sign or significance.

Fischer, Heinkel, and Zechner (1989) use the range of leverage as the dependent variable. They find that size, risk, and industry are significant, although their primary interest is in tax shields, and they do not include any other variables. See Martin, Cox, and MacMinn (1988) for a summary of earlier work with the same basic findings.

What is common in these studies and others is that profitability or return on assets, the industry, and size are always significant, risk is sometimes, but tax variables do not seem to matter. Further, there is usually a significant negative coefficient for profitability.

None of these studies had a primary interest in signalling or in how the information structure affects the financial leverage of a firm. John and Ronen (1989)

hypothesize that the timing of information and the firm's technology determine the structure of financing. Cross sectional studies generally find that technological variables are important, but the timing has been ignored.

4. Sample Selection and Variable Definitions

In this section, first the sample selection is described, then the variables are defined. The models that relate these variables to each other are defined in the following sections (sections 5 and 6). The most important idea in this section is the definition of firm quality and how it relates to firm value. Without this connection, which is described in the first part of this section, the models would make little sense. The next part of this section defines two other key variables: financial leverage and risk. There are other variables that were discussed in the literature review that may also be important determinants of leverage. These are defined in this section as well.

4.1. Sample Selection

The sample consists of a stratified random selection of firms from all those industries that have at least eighteen firms per industry with sufficient Compustat and CRSP data. Only those firms with a full 44 quarters of the cash flow, leverage, and risk variables were used in the analysis. The sample period covered the first quarter of 1979 through the last quarter of 1989.

Eight firms were eliminated because they used no long-term debt. Their inclusion would influence the cash flow and risk relationship, but since the leverage variable would always be zero, the corresponding leverage variables would not be estimated. This results in 7,084 observations from 161 firms.

Table 2 shows the number of firms from which industries that were selected for this study. Three are manufacturing industries; three, non-manufacturing. Industries were defined by two-digit SIC codes with the exception of retail sales which includes SIC 5200 through 5900.

Harris and Raviv (1991) show the industry leverage rankings. Three of these industries, 20, 27, and 36 were ranked as low leverage. The other three were in the

medium to high range. For this sample 33 and 52 have the highest leverage, with 20 the next highest. Appendix B reports the mean leverage for each industry, as well as other descriptive statistics.

Table 2. Industries used In the Analysis

Industry Number	Industry Name	Number of firms with 44 quarters of data	Number of observations
20	Food and Kindred Products	25	1,100
27	Printing, Publishing and Allied Products	22	968
29	Petroleum Refining & Related	19	836
33	Primary Metal Industries	22	968
36	Electrical Equipment	36	1,584
52	Retail Sales (all retail sales SIC 5200-5900)	37	1,628
Total		161	7,084

Appendix C contains a list of the firms used in the analysis with their Compustat company numbers. It also contains a list of the other industries that had sufficient data but were not used in the analysis.

Analysis of more industries is beyond the scope of this study and must be left as the subject of future research. This is a sample of firms that may be representative of all firms. It is necessary to restrict this study to a sample rather than considering all possible firms because of the intensive computing requirements. Since each firm's data is a time series, many diagnostic checks are performed on each individual time series.

4.2. Variable Definitions

An Empirical Definition of Quality

Theoretically, a firm's market value per share is the expectation of the discounted cash flows that will accrue to a shareholder. For an all-equity firm, the idea of quality is straightforward since all cash flows ultimately will accrue to the shareholder. Abstracting from any ownership or financing decisions, a high quality firm generates consistently higher cash flows from the same set of investment opportunities.

Therefore, the best measure of the quality of a firm's operating decisions is its cash flow from operations.

All firms do not face the same set of investment opportunities. John and Ronen (1989) also show that a signalling equilibrium depends upon the type of technological environment or investment opportunities. Controlling the investment opportunity set is not a problem if a firm's current and past performance is being compared to itself, but measurement across firms complicates matters. To help remedy this problem, I group firms by industry. When pooling by industry I implicitly assume that firms in the same industry face the same investment opportunity schedule.

Most previous work that considers the relationship between leverage or leverage changes and quality relies on subsequent unexpected earnings per share as a test of the signalling hypothesis. (Dann, Masulis, and Mayer (1989) and others). Other studies use the return on assets or profitability as a quality measure. The problem with these measures is that they rely on net income. Net income reflects not only operating decisions, but also financing decisions. Israel, Ofer, and Siegel (1989) use earnings before interest and taxes and depreciation. I use this same variable scaled by total assets $\frac{\text{cash flow from operations}}{\text{total assets}}$ as a measure of quality. Cash flow from operations is defined as income before interest, taxes, and depreciation as reported by Compustat.[1] This variable is denoted by CF.

Other measures of quality are also defined so that these results can be compared to previous work, and to determine the robustness of the results. The other quality variables are: earnings per share, free cash flow, and return on assets. They will be discussed further in section 6.7.

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[1] An attempt was made to adjust for changes in accruals; however, not all companies reported quarterly current assets and current liabilities consistently.

Leverage Definitions

Financial leverage, using Compustat data, is measured in two ways. One uses the market value of equity in the denominator; and the other, book value. Theoretically, from an information perspective, it is the current value of the firm that is important. This is reflected in the market value of the firm, not the book value, so a market value definition of leverage is a preferred measure. It more closely reflects the current value of the firm. Empirically, Titman and Wessels (1988) and others (see Harris and Raviv (1991)) find no relationship between quality measures and a book value definition of leverage. But both measures are used here in the Granger tests to see if there are different effects. Since the Granger tests show that there is only a weak relationship between cash flow and a book value definition of leverage and since it is the theoretically preferred measure, only the market value definition of leverage is used in the simultaneous equations model.

Leverage Variables

Market Value Leverage MVL	$\frac{\text{book value of long-term debt}}{\text{book value of long-term debt+market value of equity}}$
Book Value Leverage BVL	$\frac{\text{book value of long-term debt}}{\text{total assets}}$

Risk

Risk is measured in two ways. A firm's non-diversifiable risk is measured by its beta, and total risk is a firm's standard deviation of daily returns. Weekly betas are calculated for each firm using a two year moving window for each quarter. For example, the beta calculated for the first quarter of 1986 was calculated over the period starting with the second quarter of 1984 and ending March 31, 1986, the end of that quarter. The standard deviation of daily returns is computed quarterly using daily returns from the CRSP return tapes.

The best measure of operating risk would be the standard deviation of cash flow from operations, but like other measures of risk used in cross-sectional studies, such as the standard deviation of total assets or net income, these cannot be computed quarterly since these time series data are not available.

Exogenous Variables

A set of exogenous variables is included to control other influences on leverage, cash flow, and risk. These variables include those discussed in the literature review of cross-sectional leverage studies: size, the ratio of net property, plant and equipment to total assets, non-debt tax shields, and the uniqueness of a firm's assets. For a size variable, Titman and Wessels (1988) use the natural logarithm of sales, but report that their results are not sensitive to the choice between sales or total assets. Therefore, I use the logarithm of total assets since cash flow and book value of debt are also scaled by total assets. The non-debt tax shield is defined as $\frac{\text{depreciation}}{\text{total assets}}$. These variables are computed from quarterly Compustat information.

Because of the limitations of quarterly data the investment tax credits are not included in the tax shield variable. Investment tax credits are typically included in one quarter only. This reporting practice creates false seasonality in the estimation. All four of these variables are included in the leverage equation.

Table 3 summarizes the variables definitions, their abbreviations, and summary statistics. Appendix B has the same information for each industry.

Table 3. Variable Definitions and Descriptive Statistics for All Industries (1979-1989)

(n=161)

Variable	Symbol	Mean	Std. Dev.	Median	Minimum	Maximum
cash flow / total assets	CF	0.038	0.030	0.037	-0.303	0.385
LT Debt / Mkt Value	MVL	0.238	0.204	0.185	0.000	0.962
LT Debt / Book Value	BVL	0.182	0.137	0.166	0.000	1.274
ln(total assets)	SIZE	5.889	1.924	5.802	0.960	11.762
Net PPE / total assets	TGAST	0.367	0.172	0.348	0.000	0.906
Depreciation / total assets	TAX	0.009	0.007	0.009	0.000	0.119
R&D Exp / total assets	UNIQ	0.0003	0.003	0.000	0.000	0.113
σ(daily return)	σ	0.023	0.013	0.020	0.001	0.516
Beta	β	0.983	0.428	0.962	-0.843	2.659

5. Granger Causality

Signals are information about firm value. Since firm value is the sum of discounted expected future cash flows, a signal simply provides information about those future cash flows. In testing whether leverage is a signal, the dynamic process determining leverage and cash flow should be considered. It is the intertemporal relationship that is important. The first model, a Granger causality model, focuses on this aspect of the cash flow/leverage relationship. In the next section a simultaneous equation model takes into account not only the intertemporal relationship, but also the simultaneous relationship.

5.1. Methodology

If the information contained in lagged values of a variable, y, improves the forecasts of another variable, x, then y is said to Granger-cause x. Similarly, if knowledge of

leverage in time t-n, Y_{t-n}, improves predictions of cash flow at time t, X_t, then leverage Granger-causes cash flow, or leverage leads cash flow. Signalling theory suggests a similar idea of incremental predictability. A signal must provide additional or incremental information to outsiders about future values of cash flow. Granger-causality might be thought of as a necessary signalling condition.

The Granger tests have two purposes. First, they provide a simple test of leverage and cash flow cross-correlation . The second, more important purpose is to provide a preliminary specification for a full simultaneous equation model. This simpler model is an appropriate way to examine such issues as the nature of the lead/lag relationship. Still the results from this section must be interpreted cautiously since the model does not include risk or other control variables. It is a preliminary test of the predictive power of leverage.

The signs of the coefficients of the lagged values of the leverage variable also provide a clue about which signalling model is supported by the data. Positive coefficients imply that higher leverage in time t-n is associated with higher quality in time t. This is consistent with Ross's (1977) model of signalling, although Ross's model does not consider the timing of the information. Negative coefficients of the lagged leverage variables in the cash flow equation imply an alternative signalling model such as that of Leland and Pyle (1977) or Fulghieri (1990).

The lag relationship from cash flow to subsequent values of leverage is also interesting. Firms that follow a pecking order of financing may exhibit behavior consistent with Granger-causality from cash flow to leverage. Cash generated in one period may lead to lower leverage in the future, since investments could be financed from internal sources as slack is increased. For at least one lagged value, the coefficient should be negative in order to support pecking order behavior.

Model Specification

Suppose that a simple autoregressive model provides a forecast for both leverage and cash flow. Let Y_{it} be leverage for firm i in time t, and let X_{it} be cash flow for firm i in time t. a(B) and c(B) are finite polynomial lag operators. The forecast equations for leverage and cash flow are:

$$Y_{it} = a(B)Y_{it} + \varepsilon_{1it} \qquad X_{it} = c(B)X_{it} + \varepsilon_{2it}, \text{ or equivalently,}$$

$$Y_{it} = \sum_{n=1}^{M1} a_{it-n}Y_{it-n} + \varepsilon_{1it} \qquad X_{it} = \sum_{n=1}^{M1} c_{it-n}X_{it-n} + \varepsilon_{2it}.$$

ε_{1it} and ε_{2it} denote the error terms for firm i in time t, for forecasts of leverage and cash flow, respectively.

Granger causality results if the addition of previous values of cash flow to the leverage equation results in better forecasts of cash flow (1). The forecast equation for leverage then becomes:

$$Y_{it} = a(B)Y_{it} + b(B)X_{it} + \varepsilon_{1it}, \qquad (1)$$

where b(B) is a finite polynomial lag operator for cash flow. If b(B) is not equal to zero then we say that cash flow provides additional information about leverage.

If previous values of leverage improve the forecasts of cash flow, then Granger causality results in the opposite direction. Leverage is said to improve cash flow forecasts, or leverage signal cash flow. The following model tests this direction of Granger causality:

$$X_{it} = c(B)X_{it} + d(B)Y_{it} + \varepsilon_{2it}, \qquad (2)$$

where d(B) is a finite polynomial lag operator for leverage. If d(B) is not equal to zero then we say that leverage provides additional information about cash flow.

It is possible that ε_{1it} and ε_{2it} may be contemporaneously correlated. If so, and if the degree of a(B), b(B), c(B), and d(B) are not all the same, then a seemingly

unrelated regressions model will result in more efficient estimates than ordinary least squares estimation. Thus we combine equations (1) and (2) into the following system:

$$\mathbf{Z} = \mathbf{A}\,\mathbf{Z} + \varepsilon. \tag{3}$$

ε_{1it} and ε_{2it} are serially uncorrelated disturbance terms with mean zero;

$E(\varepsilon_{1it}\varepsilon_{1jt}) = \sigma^2$, for i = j; $E(\varepsilon_{1it}\varepsilon_{1jt}) = 0$, for i ≠ j, for firm i = 1, ... , N;

j = 1, ... , N; for some time t = 1, ... , T. ε_{1it} may be correlated with ε_{2it}, that is $E(\varepsilon_{1it}\varepsilon_{2it}) = \sigma_{12}$. $\mathbf{Z}$ is a 2NT × 1 vector which contains the leverage and cash flow variables; $\mathbf{Z} = \begin{bmatrix} Y \\ X \end{bmatrix}$. $\mathbf{A}$ is a matrix containing polynomials in the lag operator; $\mathbf{A} = \begin{bmatrix} a(B) & b(B) \\ c(B) & d(B) \end{bmatrix}$.

The degree of a(B) need not equal the degree of d(B), and the degree of b(B) need not equal the degree of c(B). For simplicity the degree of a(B) and c(B), the lagged values of the dependent variable, are assumed to be both of degree M1, and the degree of b(B) and d(B) is M2. Thus M1 is not equal to M2.

Hypotheses

A series of F-statistics tests whether the forecasts of X_{it} and Y_{it} improve when additional variables are added to the forecast equations. If leverage leads cash flow, a result consistent with signalling theory, then Y_{it-n} Granger-causes X_{it}. Let $d_t, \ldots, d_{t-M2}$ be the coefficients in d(B), then the null hypothesis is:

$$H_1: d_{t-1} = \ldots = d_{t-M2} = 0.$$

If H_1 is rejected, then the results are consistent with the notion that leverage is a signal.

In the other direction, if cash flow provides some predictive information about leverage, that is, if cash flow leads leverage, then X_{it-n} Granger-causes Y_{it}. Let $b_t, \ldots, b_{t-M2}$ be the coefficients in b(B), then the associated null hypothesis is:

$$H_2: b_{t-1} = \ldots = b_{t-M2} = 0.$$

If H_2 is rejected, then cash flow leads leverage.

Again, the signs of the coefficients are important in distinguishing among the different asymmetric information hypotheses. Support for the pecking order hypothesis would be a one-sided test that at least one cash flow coefficient in equation (1) is less than zero. The null hypothesis is:

$$H_3: b_{t-n} \geq 0 \qquad \text{for some } n = 1, \ldots, M2.$$

If H_3 is rejected, then pecking order behavior is supported.

Support for Ross's signalling model implies that there are positive lagged leverage coefficients in equation (2). The null hypothesis is:

$$H_4: d_{t-n} \leq 0\,, \qquad \text{for some } n = 1,\ldots,M2.$$

5.2. Granger Causality Results

Estimated Model

Seemingly unrelated regression is used to estimate equations (1) and (2), but ordinary least squares estimation also produced similar results. For estimation, the equations were pooled by firms within an industry and across time. Quarterly (zero/one) indicator variables, firm indicator variables, and a time trend were included in each equation. The estimated equations are:

$$LEV_{it} = a_{it-1}LEV_{it-1} + \ldots + a_{it-8}LEV_{it-8} + b_{it-1}CF_{it-1} + \ldots + b_{it-4}CF_{it-4} + \lambda \mathbf{D} + u_{1it} \qquad (4)$$

$$CF_{it} = c_{it-1}CF_{it-1} + \ldots + c_{it-8}CF_{it-8} + d_{it-1}LEV_{it-1} + \ldots + d_{it-4}LEV_{it-4} + \lambda \mathbf{D} + u_{2it}; \qquad (5)$$

where LEV is either financial leverage using the market value of equity (MVL) or the book value of equity (BVL) in the denominator. **D** is a N+3 x NT matrix containing the indicator variables and the time trend. The indicator variable for firm i is one when i=i for the variables in (4) and (5), and zero otherwise. There are N-1 firm indicator variables. The first quarter indicator variable equals 1 for first quarter, and zero otherwise. There are indicator variables for the first three quarters of each year. The trend equals one for the first quarter of 1979; two for the second quarter of 1979, and

so on, until the trend equals 44 for the last quarter of 1989. λ is an NT $\times$ N+3 matrix that contains the coefficients of D.

Since each leverage and cash flow observation for a given firm represents a different point in time, it is a reasonable assumption that shocks in the economy at a particular point in time will introduce some contemporaneous correlation across firms and across equations for a given time, t. In this case, the error terms, u_{1it} and u_{2it} may reflect some common omitted factors which would lead to a non-zero correlation for u_{1it} and u_{2it}. Since contemporaneous correlation may exist and the independent variables in equations (4) and (5) are not the same, a seemingly unrelated regressions model is used to estimate the system of equations.

Following Geweke (1978) the lags for the dependent variable are always longer than the lags for the independent variable. This serves two purposes. First and most importantly, a longer lag length on the dependent variable may help to ensure that no timing effects are falsely associated with the lagged values of the independent variables. Second, a longer lag on the dependent variable is more likely to ensure that the error terms are not autocorrelated. The shorter lag length of the right hand side variable also results in a more powerful hypothesis test.

Two sets of lags were used initially: 12 quarters for the dependent variable and 8 quarters for the independent variable, and then, 8 quarters and 4 quarters, respectively. The second set of 8 and 4 quarter lags (two years and one year) produced errors that are not autocorrelated, so lags of eight quarters for the dependent variable and lags of four quarters for the independent variables are used throughout the analysis. In other words this means that M1 is equal to eight, and M2 is equal to four.

Only a few specifications tests are performed to test the appropriateness of the Granger-causality model. Many more specification checks are made for the

simultaneous equation model in the next section. Those that are performed for this model are checks for autocorrelation in the disturbance term. These checks help determine the appropriate lag lengths. Appendix A presents the results from the primary metals industry (33). Out of 22 firms in the industry, two firms had residuals from the cash flow equation that were not white noise. Across all firms, approximately 8% of the firms' residuals were not white noise. This is slightly higher than would be expected at the 5% level, but in the interest of parsimony this was judged to be acceptable.[1]

Results of Tests of Hypotheses

Recall that we wish to test signalling by determining whether the addition of lagged values of leverage in the cash flow forecast equation results in better cash flow forecasts. For equation (2) an F-statistic tests the following hypothesis:

$$\text{Signalling:} \quad H_1: d_{t-1} = d_{t-2} = d_{t-3} = d_{t-4} = 0.$$

If all of the lagged coefficients are jointly equal to zero, then leverage provides no information about future cash flows. The results of this F-test are in column 5 of Table 4. They show that knowledge of previous values of leverage results in better cash flow predictions. H_1 is rejected in three of six industries using a market-value leverage definition. Using a book-value definition of leverage, H_1 is rejected only for the petroleum refining industry (29), where a market value definition is not significant. Thus, market-value leverage seems to lead cash flow though not in all industries. The signalling results are sensitive to the leverage definition, and they are industry-specific.

[1]When the model is estimated on a firm basis using lags of 12 and 8 quarters, there are very few remaining degrees of freedom, and only 3% of the residuals were not white noise. However, in the trade-off between degrees of freedom and the improved error structure, degrees of freedom were thought to be more important.

Table 4. F-test for Granger Causality

$$LEV_{it} = a_{it-1}LEV_{it-1} + \ldots + a_{it-8}LEV_{it-8} + b_{it-1}CF_{it-1} + \ldots + b_{it-4}CF_{it-4} + \lambda D + \varepsilon_{1ti}$$
$$CF_{it} = c_{it-1}CF_{it-1} + \ldots + c_{it-8}CF_{it-8} + d_{it-1}LEV_{it-1} + \ldots + d_{it-4}LEV_{it-4} + \lambda D + \varepsilon_{2ti}$$

Panel A: Market Value Definition of Leverage (LEV=MVL)

(1) Industry	(2) Cross-model Correlation $\rho_{\varepsilon 1,\varepsilon 2}$	(3) System r^2	(4) Degrees of Freedom[a]	(5) H_1 Signalling $F_{d1=\ldots=d4=0}$ (P-value)	(6) H_2 CF→MVL $F_{b1=\ldots=b4=0}$ (P-value)
20	-0.16	0.92	4, 1718	1.62	2.33
				(0.17)	(0.05)
27	-0.10	0.89	4, 1508	2.08	0.40
				(0.08)	(0.81)
29	-0.13	0.80	4, 1298	0.81	2.62
				(0.52)	(0.03)
33	-0.15	0.86	4, 1508	4.37	5.51
				(0.00)	(0.00)
36	-0.09	0.85	4, 2488	2.29	0.16
				(0.06)	(0.96)
52	-0.13	0.89	4, 2536	1.04	4.15
				(0.38)	(0.00)

Panel B: Book Value Definition of Leverage (LEV=BVL)

(1) Industry	(2) Cross-model Correlation $\rho_{\varepsilon 1,\varepsilon 2}$	(3) System r^2	(4) Degrees of Freedom[a]	(5) H_1 Signalling $F_{d1=\ldots=d4=0}$ (P-value)	(6) H_2 CF→BVL $F_{b1=\ldots=b4=0}$ (P-value)
20	-0.10	0.89	4, 1718	0.41	0.87
				(0.80)	(0.48)
27	-0.09	0.88	4, 1508	1.61	0.88
				(0.17)	(0.47)
29	-0.11	0.83	4, 1298	3.07	3.19
				(0.02)	(0.01)
33	-0.17	0.84	4, 1508	0.24	4.36
				(0.92)	(0.00)
36	-0.07	0.86	4, 2488	1.25	0.12
				(0.29)	(0.98)
52	-0.10	0.86	4, 2536	1.52	2.95
				(0.19)	(0.02)

[a]the first number is the degrees of freedom for the numerator; the second is for the denominator.

$$MVL_{it} = \frac{\text{Long-term Debt}_{it}}{LTD_{it}+\text{Mkt of Equity}_{it}} \qquad BVL_{it} = \frac{\text{Long-term Debt}_{it}}{\text{Total Assets}_{it}}$$

$$CF_{it} = \frac{CFFO_{it}}{\text{Total Assets}_{it}}$$

λ = vector of indicator and time trend coefficients

D = vector of indicator variables and time trend

It is not surprising that signalling results depend upon the leverage definition. The results should be stronger for market-value definitions of leverage because market values include expectations of future information, while book values reflect historical decisions. Titman and Wessels (1988) found a similar dichotomy in their cross-sectional analysis. They show a relationship between profitability and a market value definition of leverage, but they did not find one when they used book-value leverage.

Cash flow may lead leverage. This related hypothesis is also tested with an F-statistic.

Cash Flow leads Leverage: H_2: $b_{t-1} = b_{t-2} = b_{t-3} = b_{t-4} = 0$.

These results are in column 6 of Table 4. This hypothesis, H_2, does not seem to depend upon the leverage definition. It is rejected for four of the six industries using a market-value definition, and for three of the six for book-value.

Column 2 of Table 4 shows the correlation between the errors of the two equations. For all industries the correlation is negative and significant although the values are not very large in magnitude. This provides a measure of the benefit of using seemingly unrelated regression (SUR) over ordinary least squares, and suggests that some efficiency is gained through using SUR. However, none of the coefficients signs or level of significance change using OLS. Any change in the coefficients is usually in the third decimal place, so OLS estimation and SUR results are essentially the same.

The system r^2 measures the fit of the system of equations. They are relatively high as would be expected since the lagged values of the dependent variable are included in both equations.

Table 5 reports the coefficients from b(B) and d(B) using the market value definition of leverage. The top portion (rows 1-4) show the lagged cash flow coefficients from the leverage equation, and the bottom portion (rows 5-8) shows the

lagged leverage coefficients from the cash flow equation. The lower panel summarizes the signs of the significant coefficients by showing the percentage of significant positive and negative coefficients for each lag.[1]

First consider the leverage coefficients in rows 5-8. The pecking order null hypothesis is:

$$\text{Pecking Order:} \quad H_3: b_{t-n} \geq 0, \qquad \text{for some } n = 1, 2, 3, 4.$$

The pecking order hypothesis is accepted for four industries. Industries 20, 29, 33, and 52 have significant negative coefficients at t-1. Cash flow leads leverage and the relationship is generally negative. In the other direction (leverage leading cash flow) there are also more negative coefficients then positive.

The significant positive leverage coefficients from the fourth lag (one year previous) lend some tentative support to Ross's signalling hypothesis, although the coefficients in each case are only significant for two industries.

[1]When the equations are estimated for individual firms, the percentage of positive and negative coefficients for each lag are approximately the same as the percentages shown here.

Table 5. Coefficients from Granger Causality Equations

Equation	Variable	Industry 20	27	29	33	36	52
Leverage	CF_{t-1}	-0.14*	0.03	-0.35*	-0.84**	0.01	-0.17**
CF→MVL	CF_{t-2}	0.19**	-0.01	0.22	0.52**	0.03	0.05
	CF_{t-3}	-0.03	-0.03	0.14	-0.26	0.00	-0.02
	CF_{t-4}	0.09	0.07	-0.20	0.12	-0.02	-0.09*
Cash Flow	MVL_{t-1}	-0.02*	-0.02	0.00	-0.02**	0.00	0.00
(Signalling)	MVL_{t-2}	0.02	0.03	0.02	-0.01	-0.02	0.01
	MVL_{t-3}	-0.01	-0.04**	-0.02	0.00	0.00	0.00
	MVL_{t-4}	0.02	0.02	0.01	0.01*	0.02**	-0.01

*Significant at 10% level **Significant at 5% level

Equation	Variable	Significant Negative Coefficients	Significant Positive Coefficients
Leverage	CF_{t-1}	67%	0%
CF→MVL	CF_{t-2}	0%	33%
	CF_{t-3}	0%	0%
	CF_{t-4}	17%	0%
Cash Flow	MVL_{t-1}	33%	0%
(Signalling)	MVL_{t-2}	0%	0%
	MVL_{t-3}	17%	0%
	MVL_{t-4}	0%	33%

This section provides some evidence through Granger-causality tests that leverage provides some weak incremental predictive power. For half of the industries leverage improved the predictions of cash flow. However, it is difficult to discriminate which hypothesis is supported based on these tests. There are more significant negative coefficients for shorter lags (t-1 and t-3), while the lags at t-4 are positive. Fortunately in the next section the results augment, amplify, and help clarify the economic intuition behind these preliminary findings.

6. A Dynamic Model of Cash Flow, Leverage, and Risk

This section introduces a more general model that takes into account both the lagged and contemporaneous relationship of cash flow, leverage, and risk. This model builds on previous cross-sectional regression models of leverage, but relaxes some of the strong assumptions about the processes that generate leverage. One such assumption is that each leverage observation represents an independent drawing from a random sample. Financing decisions may be independent, but the cumulative effect of these decisions, leverage, is not. Nor may cash flow and risk be independent of previous leverage decisions. Current values of cash flow and a firm's current level of risk may be explained by previous financing decisions.

This model also builds on the information provided by the Granger tests. There we find that the Granger causality results show that there is some weak industry-specific support for the signalling hypothesis. However, this forecasting model isolates only part of the process that determines leverage and cash flow. In this section we show that a more general dynamic simultaneous equation model provides broader support for the signalling hypothesis. These results in this section show that contemporaneous cash flow and leverage are negatively related, but the lagged relationship is more often positive. These results also show that pecking order behavior is a description of the contemporaneous relationship between cash flow and leverage, while signalling information concerns future cash flows, not contemporaneous ones.

Risk is also an important element in the the leverage and cash flow process, and the relationships among risk, quality, and financial leverage may be both simultaneous and lagged. Cross-sectional leverage regressions usually include risk, some type of

quality variable, and other variables, but simultaneity and any lagged effects are ignored.

Simultaneity is potentially the more serious problem. This problem arises in cross-sectional regression studies because cash flow, risk and leverage may be jointly determined. With simultaneity, the error term from the leverage regression equation is not independent of the risk or cash flow variable because both are functions of leverage. This violates a basic assumption of OLS, that of independent residuals. When this assumption is violated, OLS cross-sectional leverage studies produce estimates that are biased and inconsistent because the regressors are correlated with the error term (see Judge et al (1988)). Under these conditions, ordinary least squares regression is no longer appropriate.

Event studies generate another type of problem. They look at the dynamic relationship between leverage and expected quality, but they assume that risk is constant over the event period. This is a especially troublesome for leverage changing events because a change in leverage presumably implies a change in risk. In a leverage-increasing event, there is reason to believe that bankruptcy risk increases. When risk increases, the expected return should also increase. The expected returns are typically calculated for a period before the event, that is, before leverage and systematic risk have increased. Therefore, the expected returns would be biased downward, and the abnormal returns after the event period would be biased upward. When risk is held constant as leverage changes, one would expect higher abnormal returns for leverage increases and lower abnormal returns for leverage decreases because of change in risk. Without controlling for risk, it is impossible to separate the effect of risk changes from information effect of leverage changes.

Predetermined Variables and the Dynamic Relationships Among Endogenous Variables

Cash flow and leverage may have a simultaneous relationship, whether cash flow is measured in book or market value terms. For book value leverage, retained earnings are a function of the firm's cash flow, and cash flow is calculated from changes in book value. For market value leverage, current cash flow is reflected in the market price of equity. Current cash flow also affects expectations of future cash flows, which in turn is reflected in the equity price.

Cash flow and risk are contemporaneously related if the market for investment opportunities is mean-variance efficient. Mean-variance efficiency implies that higher risk as measured by standard deviation or variance is positively correlated with a higher cash flow level.

As noted before, leverage and risk have a contemporaneous relationship, but if risk changes over time, leverage and risk may also have a lagged relationship. Current levels of leverage reflect incremental decisions made in the past. Those decisions accumulate so that current risk may be influenced by past leverage decisions.

There is no theoretical or empirical evidence about the lagged relationship between cash flow and risk. But if previous investments were riskier than current ones, then current cash flows should be more volatile. If the level of risk is not stationary, then it is important to consider both the past and present.

Theoretical results and cross-sectional leverage studies provide information about other factors that influence leverage. These were discussed in previous sections. They are: the collateral value of a firm's assets (TGAST), the tax depreciation shield (TAX), uniqueness of a firm's assets as measured by research and development expense (UNIQ), and size (SIZE).

In the quality equation (equation 5) the only predetermined variables are lagged values of the jointly determined variables. Current cash flows reflect previous operating and investment decisions. Since the goal of this paper is to find whether financial leverage reflects the quality of those decisions, no other exogenous factors for cash flow are considered. Operating cash flow might be completely determined by including all current revenues and expenses, but then no inferences could be drawn between previous leverage decisions and cash flows.

In the risk equation (equation 6), the determinants of risk are a firm's previous investment and financing decisions. Previous investment decisions are reflected in the level of cash flow, and previous financing decisions are reflected in financial leverage. Size and the proportion of tangible assets may affect the riskiness of a firm. Size, the proportion of tangible assets, and the lagged values of the jointly determined variables are the predetermined variables in the risk equation.

An appropriate model to describe these contemporaneous and lagged relationships is a set of three simultaneous equations. The endogenous variables are current risk, scaled cash flow, and financial leverage. The exogenous variables include the lags of these variables and those variables discussed previously: TGAST, TAX, UNIQ, and SIZE.

6.1. Simultaneous Equation Model

To examine the dynamic relationships among quality, leverage, and risk, define a system of three simultaneous equations. Let X_{it} denote the cash flow of firm i at time t, let Y_{it} denote financial leverage for firm i at time t, and let σ_{it} denote the risk of firm i at time t. The three structural simultaneous equations are:

$$\text{Leverage: } Y_{it} = \nu(B)Y_{it} + \beta(B)X_{it} + A(B)\sigma_{it} + \gamma_{1it}v_{1it} + \ldots + \gamma_{jit}v_{jit} + \varepsilon_{1it} \quad (6)$$

$$\text{Quality: } X_{it} = \eta(B)Y_{it} + \phi(B)X_{it} + C(B)\sigma_{it} + \varepsilon_{2it}, \quad (7)$$

$$\text{Risk: } \sigma_{it} = \alpha(B)Y_{it} + \pi(B)X_{it} + D(B)\sigma_{it} + \gamma_{xit}v_{xit} + \ldots + \gamma_{kit}v_{kit} + \varepsilon_{3it}, \quad (8)$$

where $\nu(B), \ldots, D(B)$ are polynomials in the lag operator of finite degree. v_{jit} denotes exogenous variable j for firm i at time t, and γ_{jit} denotes the coefficient of v_{jit}. ε_{1it}, ε_{2it}, and ε_{3it} denote the random error terms for firm i in time t for equations 1, 2, and 3, respectively. Y_{it}, X_{it}, and σ_{it} are the endogenous variables.

Since X_{it} may affect Y_{it} and σ_{it} and vice versa, contemporaneous coefficients are nonzero for $\beta(B)$ and $A(B)$ in equation (6), for $\eta(B)$ and $C(B)$ in equation (7), and for $\pi(B)$ and $\alpha(B)$ in equation (8). For the operators $\nu(B)$, $\phi(B)$, and $D(B)$, the coefficient for lag zero is constrained to zero. The degree of $\nu(B)$, $\phi(B)$, and $D(B)$ is M1, and the degree of $\beta(B)$, $A(B)$, $\eta(B)$, $C(B)$, $\alpha(B)$, and $\pi(B)$ is M2.

Rewriting equations (6), (7) and (8) in matrix notation obtains:

$$\begin{bmatrix} Y \\ X \\ \sigma \end{bmatrix} = \begin{bmatrix} \nu(B) & \beta(B) & A(B) \\ \eta(B) & \phi(B) & C(B) \\ \alpha(B) & \pi(B) & D(B) \end{bmatrix} \begin{bmatrix} Y \\ X \\ \sigma \end{bmatrix} + \begin{bmatrix} \gamma_t \\ 0 \\ \gamma_\kappa \end{bmatrix} \begin{bmatrix} v_i & 0 & v_\kappa \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \end{bmatrix} \quad (9)$$

or simply,

$$Z = AZ + \Gamma V + \varepsilon. \quad (10)$$

The matrix A contains the polynomials in lag coefficients, Z is a $3NT \times 1$ vector that contains the endogenous variables, leverage, cash flow and risk. V

contains the set of exogenous variables, Γ contains the coefficients of the exogenous variables, and ε is a $3NT \times 1$ vector which contains the error terms. For each equation, $E(\varepsilon_{rit}) = 0$, where r = 1, 2, 3 equations; i =1, ... , N firms; and t = 1, ... , 36 quarterly time periods. The covariance between firms in each equation, r, is

$$E(\varepsilon_{rit}\varepsilon_{rjt}) = \sigma_r^2 \text{ for } i=j, \text{ and}$$

$$E(\varepsilon_{rit}\varepsilon_{rjt}) = 0 \text{ for } i \neq j.$$

The error terms in any equation are not autocorrelated; $E(\varepsilon_{rit}\varepsilon_{rit-n}) = 0$. However, across equations, some ε_{rit} and ε_{sit} may be contemporaneously correlated, and $E(\varepsilon_{rit}\varepsilon_{sit}) = \sigma_{rs}$, for r,s = 1, 2, 3; and $r \neq s$.

Note that this structural model differs from the Granger causality model in two ways. First, the simultaneous values of X_{it} and Y_{it} are used in equations (6) and (7), in addition to the lagged values of X and Y. Second, additional dependent variables are included so that other effects can be controlled.

Hypotheses

F statistics test whether an intertemporal relationship between cash flow and financial leverage exists. For this relationship we examine the lag coefficients of $\beta(B)$ and $\eta(B)$. Let $b_t, \ldots, b_{t-M2}$ be the cash flow coefficients in the distributed lag $\beta(B)$, and $n_t, \ldots, n_{t-M2}$ be the leverage coefficients in the distributed lag $\eta(B)$. The null hypotheses consider the possibility of a dynamic relationship between cash flow and leverage . We test the relationship in two directions by considering only the lagged coefficients, and allowing the contemporaneous coefficients, b_t and n_t to remain unconstrained. The null hypotheses is:

$$H_5: b_{t-1} = b_{t-2} = \ldots = b_{t-M2} = 0.$$

If cash flow leads leverage, then this hypothesis is not accepted. A significant F-test for H_5 indicates that previous values of cash flow influence current leverage.

In the other direction the null hypothesis is:

$$H_6: n_{t-1} = n_{t-2} = \ldots = n_{t-M2} = 0.$$

If leverage leads cash flow, then lagged values of leverage have an effect on current cash flow, and they can be considered a signal. In this case the H_6 is rejected.

The further relationships with risk are tested with similar F statistics. Let $a_t, \ldots, a_{t-M2}$, be the coefficients in the distributed lag A(B); $\boldsymbol{a}_t, \ldots, \boldsymbol{a}_{t-M2}$ be the coefficients in $\alpha(B)$; $c_t, \ldots, c_{t-M2}$ be the coefficients in C(B), and $p_t, \ldots, p_{t-M2}$ be the coefficients in $\pi(B)$. Risk and leverage, and risk and cash flow lags are tested with the following F-tests:

Leverage/risk: $H_7: a_{t-1} = a_{t-2} = \ldots = a_{t-M2} = 0$, and

$H_8: \boldsymbol{a}_{t-1} = \boldsymbol{a}_{t-2} = \ldots = \boldsymbol{a}_{t-M2} = 0.$

Cash flow/risk: $H_9: c_{t-1} = c_{t-2} = \ldots = c_{t-M2} = 0$, and

$H_{10}: p_{t-1} = p_{t-2} = \ldots = p_{t-M2} = 0.$

There is no theoretical reason to believe that risk leads leverage (H_7), but leverage changes may precede risk changes. From a market efficiency perspective, however, the market's evaluation of risk should be concurrent with any changes due to leverage.

For cash flow and risk, there is no theory to suggest that risk leads cash flow, or vice versa. However, there is reason to expect a simultaneous relationship. If the market for investment opportunities is mean/variance efficient, then higher risk should be associated with higher returns. Therefore, cash flows should be increasing at a higher rate in riskier firms.

The signs of the contemporaneous and lagged coefficients provide information about which asymmetric information model characterizes the data. Signalling models suggest that the relationship between cash flow and leverage is positive. However, leverage is supposed to provided information about future cash flows, and event study

results would suggest that the leverage/cash flow signalling relationship is across time, not contemporaneous. It follows from this argument, that the null hypothesis for signalling is:

Signalling Hypothesis: H_{11}: some $n_{t-n} \leq 0$, for n = 0, ... , M2.

In a pecking order the relationship between leverage and cash flow is not necessarily monotonic. High quality firms will have low leverage because more internally generated funds are produced with less reliance on outside financing. Very low quality firms may have lower leverage than medium quality firms since they must resort to issuing equity. However, until the point that the firm issues equity, the relationship between cash flow and leverage is negative. Pecking order behavior would be consistent with a negative relationship between cash flow and leverage. The null hypothesis is:

Pecking Order: H_{12}: some $n_{t-n} \geq 0$ or some $b_{t-n} \geq 0$, for n = 0, ... , M2.

6.2. Simultaneous Model Results

The Granger causality results show that there is some weak industry-specific support for the signalling hypothesis using a naive forecasting model. This naive model isolates only part of the process that determines leverage and cash flow. This more general dynamic simultaneous equation model provides broader support for the signalling hypothesis. These results primarily show that contemporaneous cash flow and leverage are negatively related, but the lagged relationship is more often positive. This supports the idea that pecking order behavior is a description of the contemporaneous relationship between cash flow and leverage, while signalling information is about future cash flows, not contemporaneous ones.

Estimation

Three-stage least squares is used to estimate the simultaneous equation model.[1] The model is estimated over eleven years for each industry. Each equation in the model includes indicator variables for each firm except one in each industry, an indicator variable for the first three quarters of each year, and a time trend in addition to the other exogenous variables. The process is modeled with the following set of equations:

Leverage: $$MVL_{it} = \nu(B)MVL_{it} + \beta(B)CF_{it} + A(B)\sigma_{it} + \gamma_{1i}TAX_{it} + \gamma_{2i}TGAST_{it} + \gamma_{3i}UNIQ_{it} + \gamma_{4i}SIZE_{it} + \lambda D + u_{1it} \quad (11)$$

Cash Flow: $$CF_{it} = \eta(B)MVL_{it} + \phi(B)CF_{it} + C(B)\sigma_{it} + \lambda D + u_{2it} \quad (12)$$

Risk: $$\sigma_{it} = \alpha(B)MVL_{it} + \pi(B)CF_{it} + D(B)\sigma_{it} + \gamma_{5i}TGAST_{it} + \gamma_{6i}SIZE_{it} + \lambda D + u_{3it}, \text{ where} \quad (13)$$

$\nu(B)$, $\phi(B)$, and $E(B)$ are polynomial lag operators for lags t to t-8, but the coefficient for lag t is constrained to zero. The other lag operators, $\beta(B)$, $C(B)$, $\eta(B)$, $D(B)$, $\alpha(B)$, and $\pi(B)$, are for lags t to t-4. In the first stage of 3SLS estimation, an instrumental variable for MVL, CF, and σ is obtained by estimating the reduced form coefficients. The reduced form coefficients are then used to find $\widehat{MVL}$, $\widehat{CF}$, and $\hat{\sigma}$. These estimates are used as the instrumental variables in the second stage, since they are highly correlated with MVL, CF, and σ; but by construction they are uncorrelated with u_1, u_2, and u_3. In the third stage, seemingly unrelated regression is used to estimate the model with the instrumental variables, $\widehat{MVL}$, $\widehat{CF}$, and $\hat{\sigma}$.

Model Diagnostics

Three-stage least squares estimation of the simultaneous equation model is appealing because of its potential to generalize interactions across firms and across time.

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[1]Two-stage least squares was also used. The results were robust with respect to the estimation method.

However, this modeling requires some strict assumptions about the parameters and about the residuals across time and across firms. We assume that the parameters are homogeneous across time and firms, if they are not homogeneous then the parameter estimates we obtain may be biased and inconsistent (see Hsiao (1986)). Not only must the parameters be homogeneous, but the residuals must also have constant variance across firms in the same time period and not be serially correlated. Further, the covariance of the residuals across firms in the same time period must be zero.

Several measures were used to ensure that these conditions are met. An indicator variable for each firm is included so that the assumption of a constant intercept across firms can be relaxed. A time trend and quarterly indicator variables are included in order to reduce heterogeneity due to time and seasonality. A size variable is included in the leverage equation and in the risk equation, and some variables are scaled, to achieve homoskedasticity. Cash flow from operations is scaled by total assets; other variables, such as leverage, are specified on a percentage basis.

To gauge the success of these measures, two types of specification tests are performed: a test for homogeneous slopes across firms within the system and autocorrelation and heteroskedasticity tests of the residuals. The specification tests for homogeneous slopes are F-tests that compared the pooled model to firm models. For the residuals, the Ljung-Box χ^2 statistic is computed for each firm and used to test for autocorrelation, and the Goldfedt-Quandt statistic using the mean squared error for each firm is used to test for heteroskedasticity.

The hypothesis that the regression slope coefficients are identical across firms can be formulated as a set of linear restrictions:

$$H_{13}: \ \mathbf{B}_1 = \mathbf{B}_2 = \ldots = \mathbf{B}_{Nj},$$

where $\mathbf{B}_i$, $i = 1, \ldots, N_j$ represents the coefficient matrix for firm i, with N_j firms in industry j.

The denominator for this F-test is the unrestricted residual sum of squares for the system of three equations, denoted S_1 with $N_jT(K+1)$ degrees of freedom. N_j is the number of firms in industry j, T is 36, the number of quarters, and K+1 is the number of parameters estimated in each system (See Hsiao (1982)). To find the denominator, each system of equations was estimated for each firm. S_1 is the sum of the system MSE for each firm. The numerator is the difference between the residual sum of squares of the pooled model (pooled by time and firm within each industry) and S_1, divided by the difference between the restricted and unrestricted model's degrees of freedom.

Table 6 reports the calculation of this F statistic for each industry. The null hypothesis of homogeneous slopes across firms cannot be rejected for any industry; therefore, pooling across firms within industries is not rejected by these data.

Table 6. F-test for Homogeneous Slopes

	IND=20	IND=27	IND=29	IND=33	IND=36	IND=52
(S1)Sum of firm's SSE=	1043	859	790	891	1448	1518
(S3)System SSE=	3354	3141	2022	3018	3524	5256
N_j=	25	22	19	22	36	36
S3-S1=	2311	2282	1232	2127	2077	3739
DF(S1)=	225	198	171	198	324	324
DF(S3)=	2553	2238	1923	2238	3708	3781
(DF(S3)-DF(S1))=	2328	2040	1752	2040	3384	3457
Numerator=	0.99	1.12	0.70	1.04	0.61	1.08
Denominator=	4.64	4.34	4.62	4.50	4.47	4.68
F*=	0.21	0.26	0.15	0.23	0.14	0.23

F-Critical Value (.95,inf,inf)=1.00

To test autocorrelation in the residuals the system of equations is estimated for each firm. The residuals from each equation should have mean zero and not be serially correlated; that is, they should be white noise. The Ljung-Box test is performed (see Appendix G). In each industry for each equation, one or two of the firms' model residual tests rejected the null hypothesis of white noise at the five percent level.

Overall for the cash flow residual six of 161 firms had residuals that are not white noise; or approximately four percent of the residuals were not white noise. Results are similar for the leverage residual also. Since this is less than would be expected at the 5 percent level of significance if all firm's residuals were truly white noise, this indicates that the residuals are not generally autocorrelated.

Finally the residuals are examined for heteroskedasticity using the Goldfeldt-Quandt method. The system of equations is estimated for each firm, and the smallest and the largest mean squared errors of the firm models from each industry are tested for equality. Under the hypothesis of equal variances, the ratio of any two firms' model's mean squared errors should have an F distribution with the appropriate degrees of freedom.[1] The null hypothesis of homoskedastic residuals is not rejected for four of the six industries. For two industries, retail sales (52) and food products (20), the hypothesis is rejected. Appendix F reports the mean squared error for each firm.

To provide an indication of whether this problem seriously compromised the results for these two industries, the system of equations was re-estimated with only those firms that do not have significantly different MSE's. The next largest MSE from industry 20 was not significantly different from the smallest MSE, and the next smallest MSE in industry 52 was not significantly different from the largest MSE. The system of equations was then re-estimated deleting that one firm from each industry with the largest and smallest respective MSE. The magnitude of the coefficients did change, but the sign and significance did not. Heteroskedasticity apparently does not qualitatively affect the results.

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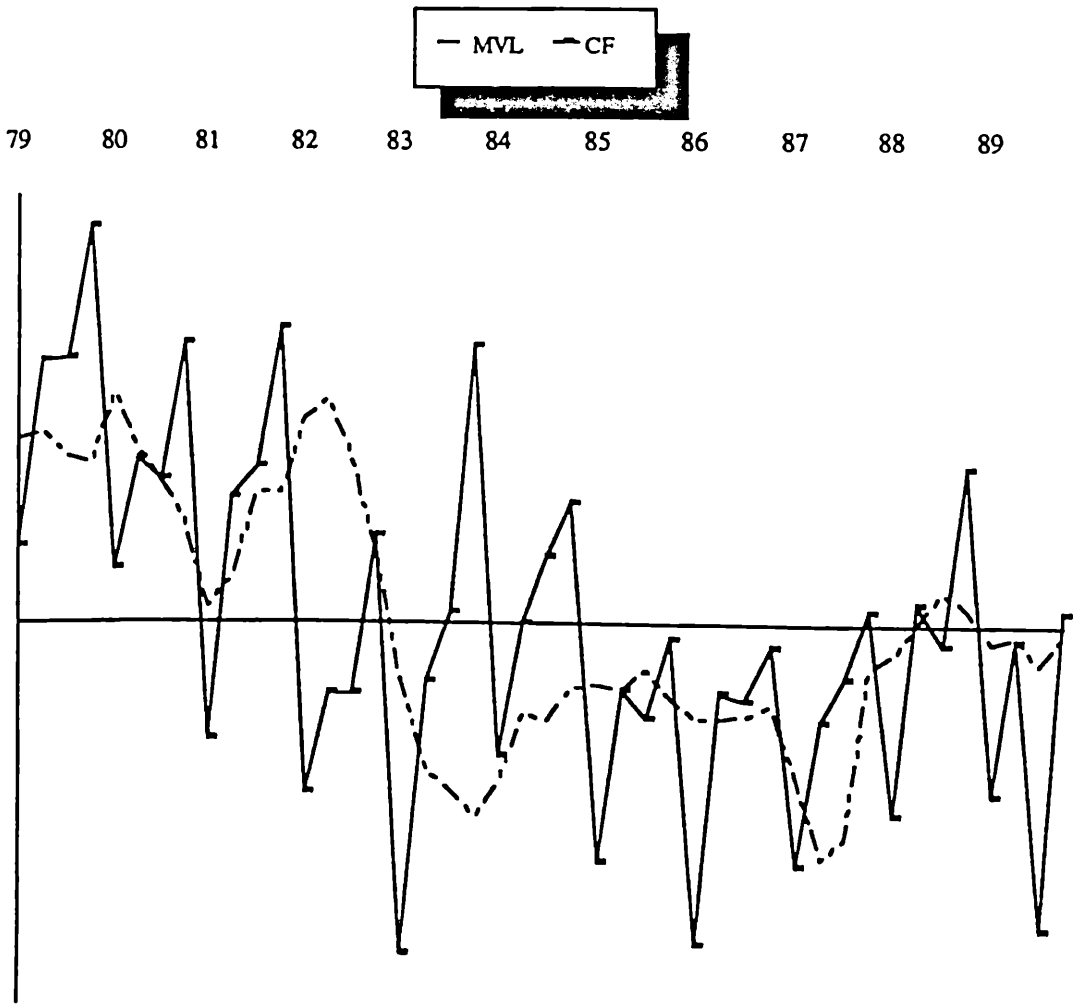
[1]Most firms had either 41 or 42 degrees of freedom depending upon the UNIQ variable. A large percentage of firms had no reported R&D expense, therefore, UNIQ was zero.

6.3. Leverage and Cash Flow

The general relationship between cash flow (CF) and leverage (MVL) for all firms over the sample period is shown in Figure 1. In general high values of cash flow seem to be associated with low values of leverage in the same period, and they are usually moving in the opposite direction. When leverage is increasing cash flow is decreasing, and vice versa. However, across a one year interval, we then see that low levels of leverage in year t are associated with low cash flows in year t+1— a direct relationship.

Figure 1: Average MVL and CF over the Sample Period (1979-1989)



There are two other important aspects of Figure 1. First, cash flow has a definite yearly seasonal pattern, therefore, the quarterly dummy variables should be an important control factor in the cash flow equation. The other aspect to note is that leverage is generally decreasing over the sample period. This is not surprising given the extraordinarily high interest rates in the early part of the sample period followed by lower interest rates in 1984-1985. However, since leverage has been generally increasing over the twentieth century, some of these results may be sample or time specific.

With the Granger tests in the previous section, the incremental predictive information of leverage is tested. Here, we include contemporaneous values of the variables as well as all predetermined variables in a structural model. Thus, it is the incremental explanatory power of the lagged endogenous variables that is tested. F-tests are used to test the following null hypotheses:

Cash flow does not lead leverage: H_4: $b_{t-1} = b_{t-2} = b_{t-3} = b_{t-4} = 0$, and

Signalling (leverage does not lead cash flow): H_5: $n_{t-1} = n_{t-2} = n_{t-3} = n_{t-4} = 0$.

The first two columns of Table 7 show the results of these F-tests. They show the significance of the lagged values and do not include the effect of contemporaneous value. Therefore, these results are comparable to the Granger F-tests in Table 4. Here the signalling hypothesis is supported in four of the six industries, and is close to significance in industry 27. The signalling hypothesis is supported more often in the context of this structural model than is the case in the Granger-causality model.

The last four columns of Table 7 show the significance of the indicator variables. The quarterly indicator variables for both cash flow and leverage are not significant except in two industries, electrical equipment (36) and retail (52). Firm specific effects are much more important. For the leverage equation, all of the firm F-

tests are significant. This indicates a strong firm-specific effect for leverage. Most of the F-tests for the firm indicator variables in the cash flow equation are significant or near-significance.

Table 7. F-tests for MVL and CF Lag Coefficients and Indicator Variables for Simultaneous Equations

(P-values in parentheses)

Three-stage Least Squares Estimation with Firm and Quarter Dummy Variables and Time Trend

Industry	CF→MVL[1] H_0 $\beta(B)=0$	Signalling[1] H_0 $\eta(B)=0$	Leverage[2] Equation $q_1=q_2=q_3=0$	Cash Flow[2] Equation $q_1=q_2=q_3=0$	Leverage Equation $\lambda_1-\lambda_i=0$	Cash Flow Equation $\lambda_1-\lambda_i=0$
20[a]	3.29 (0.01)	3.46 (0.01)	0.72 (0.54)	0.37 (0.78)	2.17 (0.00)	1.30 (0.14)
27[b]	2.12 (0.08)	1.24 (0.29)	1.65 (0.18)	0.80 (0.49)	3.31 (0.00)	1.75 (0.02)
29[c]	1.75 (0.14)	0.73 (0.57)	0.71 (0.55)	0.27 (0.85)	2.23 (0.00)	1.41 (0.12)
33[d]	0.90 (0.47)	3.78 (0.00)	1.05 (0.37)	1.48 (0.22)	1.71 (0.02)	0.97 (0.49)
36[e]	1.41 (0.34)	3.85 (0.00)	2.79 (0.04)	3.11 (0.03)	4.68 (0.00)	2.50 (0.00)
52[f]	2.46 (0.04)	3.47 (0.01)	2.01 (0.11)	4.50 (0.00)	1.50 (0.03)	1.72 (0.01)

[a]degrees of freedom for denominator of the F-tests–2553; numerator for $\lambda_1-\lambda_i$–24 [b]2238;21 [c]1923;18 [d]2238;21 [e]3708;35 [f]3781;36. [1]df for numerator, 4. [2] df for numerator, 3.

In order to differentiate between the model's support for signalling models versus the pecking order hypothesis, the timing and the signs of the coefficients are important. The hypotheses as previously stated are:

Signalling Model: H_{10}: some $n_{t-n} \leq 0$, for n = 1, ... , 4.

Pecking Order: H_{11}: some $n_t < 0$ or some $b_{t-n} \leq 0$, for n = 0, ... , 4.

This is not a completely satisfactory way of stating the null hypotheses, since these hypotheses are not mutually exclusive. However, the signs and significance across industries suggest a consistent pattern of behavior regarding these hypotheses

Table 8. Leverage and Cash Flow Coefficients from 3SLS Estimation

Equation	Variable	Industry 20	27	29	33	36	52
Leverage	CF_t	-0.71**	-0.86**	-0.51	-0.55	0.93	-0.73**
CF→MVL	CF_{t-1}	-0.03	0.04	0.18	-0.45	-0.36	-0.17**
	CF_{t-2}	0.19**	-0.05	0.31**	0.37*	-0.15	0.02
	CF_{t-3}	-0.07	-0.05	0.14	-0.03	0.00	-0.13*
	CF_{t-4}	0.23	0.66**	-0.16	0.09	-0.21*	0.34*
Cash Flow	MVL_t	-0.18**	-0.08**	0.01	-0.24**	-0.10**	-0.27**
(Signalling)	MVL_{t-1}	0.14**	0.07**	0.01	0.20**	0.08**	0.24**
	MVL_{t-2}	-0.03*	0.01	-0.01	-0.00	0.01	0.01
	MVL_{t-3}	-0.03	-0.02	0.02	-0.03**	-0.01	-0.01
	MVL_{t-4}	0.02	0.01	0.02	0.03**	0.02*	0.00

*significant at the 10% level **significant at the 5%

Equation	Variable	Significant Negative Coefficients	Significant Positive Coefficients
Leverage	CF_t	50%	0%
CF→MVL	CF_{t-1}	17%	0%
	CF_{t-2}	0%	50%
	CF_{t-3}	17%	0%
	CF_{t-4}	33%	33%
Cash Flow	MVL_t	83%	0%
(Signalling)	MVL_{t-1}	0%	83%
	MVL_{t-2}	17%	0%
	MVL_{t-3}	17%	0%
	MVL_{t-4}	0%	33%

Table 8 shows that the pecking order hypothesis is generally supported at lag zero; that is, the contemporaneous relationship between cash flow and leverage is generally negative. The signalling hypothesis is supported for longer lag lengths, especially lag one and lag four.[1] These results support the notion that signalling is appropriately

[1]When the quarterly indicator variables are not included, lag 4 was significant and positive 83% of the time, and there were few significant positive coefficients for lag 1.

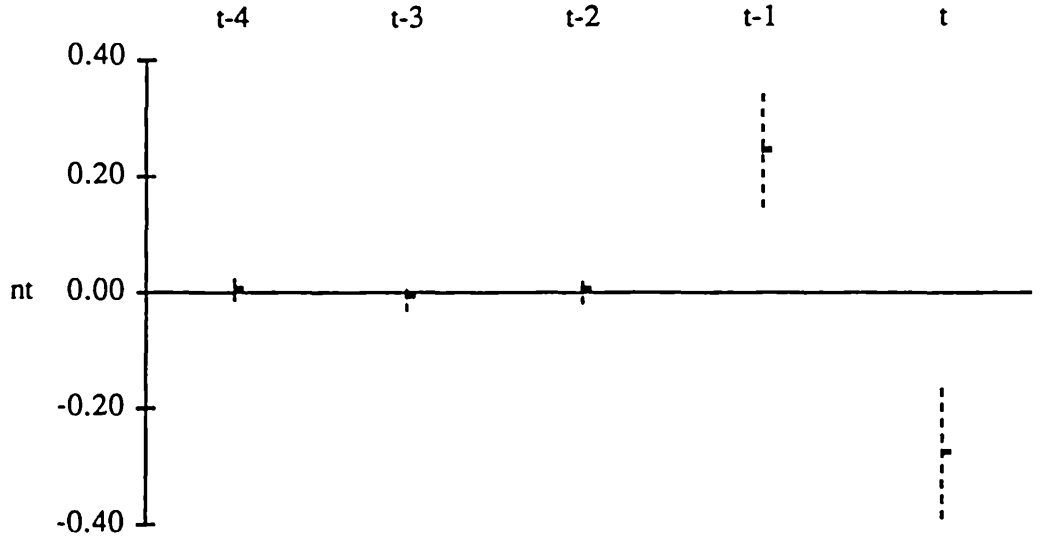
considered across time, and that pecking order is a better description of the cross-sectional or contemporaneous relationship between leverage and cash flow.

The addition of contemporaneous values of cash flow in the leverage equation and leverage in the cash flow equation is very important. Compare the significant lags from Table 5 and Table 8. In Table 8 the most significant lags in magnitude and number are found in the contemporaneous values and at the first lag. When the contemporaneous value is omitted, as in Table 5, lag 1 becomes much more important. The signs were more generally negative in Table 5. Here many more significant positive signs are found for lagged coefficients. In particular, for the signalling coefficients of $\eta(B)$, there are more positive coefficients. Contemporaneous leverage is negatively related to cash flow, but lagged values of leverage are generally positively related to cash flow.

In order to illustrate the pattern of coefficients over time, figures 2 and 3 show the coefficients b_t and n_t of the retail industry (52). The industry is representative of the other industries. The coefficients are indicated by a horizontal mark and surrounded by a 90% confidence interval represented by the dashed lines surrounding the coefficient.

Figure 2 shows the leverage coefficients from the cash flow equation. At time t, a change in leverage would produce an opposite change in cash flow. Leverage also also leads cash flow, since the coefficient at time t-1 is significant. A change in cash flow at t-1 produces a change in the same direction in leverage at time t. Longer lag coefficients in this industry are insignificant, but for two other industries there are also positive lags at t-4.

Figure 2. Leverage Coefficients from Cash Flow Equation (Industry 52)



If one considers that the signal concerns future cash flows, then the lag coefficients from the cash flow equation support Ross's signalling hypothesis that there should be a positive association between quality and leverage. The positive coefficients at time t-1 and t-4 indicate that high (low) values of leverage in time t-1 and in time t-4 are associated with high (low) cash flows in time t. This general relationship holds for all industries except oil and gas (29).

Consider Figure 3 which illustrates the effect of current and lagged values of cash flow on current leverage. The contemporaneous relationship, time t, is negative, at some later point the lagged values become positive, in this case at lag t-4. Holding everything else constant, a change in cash flow is associated with a contemporaneous change in leverage in the opposite direction. This evidence supports the pecking order hypothesis at time t. This suggests that pecking order behavior describes a cross-sectional relationship where high (low) values of leverage are associated with low (high) cash flows in the same time period.For longer lags the relationship is positive.

Figure 3. Cash Flow Coefficients from Leverage Equation (Industry 52)

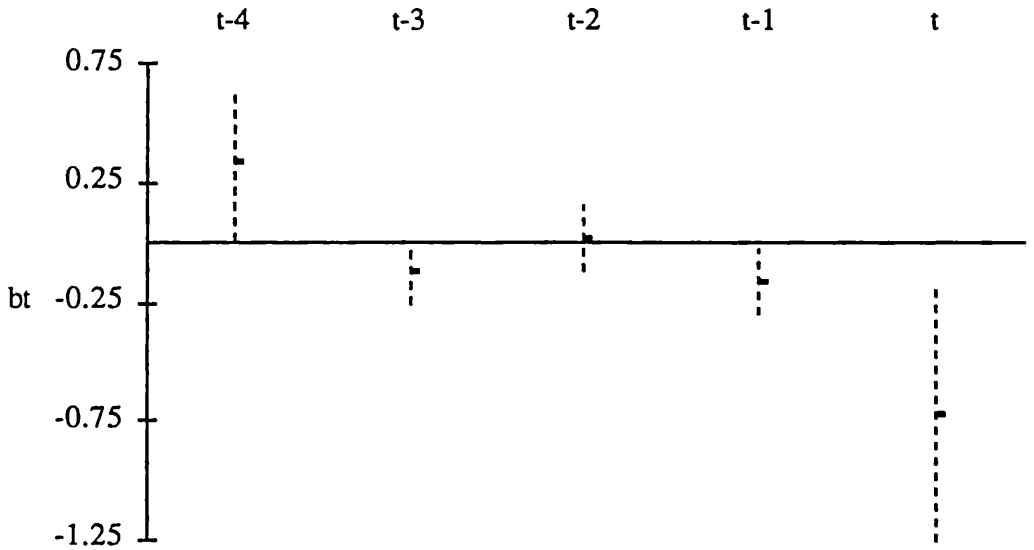


Table 9 provides information for each industry about the relationship between the equations in the model and the overall goodness of fit. There is high cross-model correlation indicating that there is some advantage in using three stage least squares over two-stage least squares.

Table 9. System r^2 and Cross-Model Correlation for 3SLS Estimation

Industry	System r^2	$\rho(u_{MVL},u_{CF})$	$\rho(u_{CF},u_{\beta})$	$\rho(u_{MVL},u_{\beta})$
20	0.93	0.58	-0.12	-0.01
27	0.91	0.32	0.51	0.62
29	0.87	-0.07	0.40	0.12
33	0.90	0.58	-0.27	-0.57
36	0.86	-0.16	0.17	-0.05
52	0.89	0.62	-0.05	-0.03

OLS versus 3SLS Estimation

The comparison of the Granger causality and simultaneous equation results indicate the importance of modelling simultaneity. Table 10 shows the coefficients from OLS

estimation and 3SLS estimation for the leverage equation (equation 11). The lag coefficients for cash flow and beta are reported in Appendix H.

The magnitude of the coefficients is different in many of the equations, especially for the contemporaneous coefficient of cash flow. Unfortunately it is not possible to use a t-test to determine if the coefficient estimates are significantly different from each other because the variance of the estimators is not the same. OLS seems to have generally higher levels of significance, and in some cases the signs are different. It is more often the case for the risk (beta) coefficients than for cash flow that the signs and significance of the coefficients change. But it is the the difference in the magnitudes of the contemporaneous coefficients that indicates why it is important to control for simultaneity.

The estimates of the coefficients are also different for TAX, TGAST, and UNIQ. Again the magnitude and signs of the coefficients differ with the two estimation methods. It is interesting to note that for TAX the 3SLS coefficients are always smaller, and many times they are negative. The 3SLS coefficients for TGAST are always larger. This may provide some indication of the direction of the OLS bias: upward for the depreciation tax shield variable, and downward for the proportion of tangible assets.

Table 10. Comparison of OLS and 3SLS Coefficients in the Leverage Equation

(Standard Error in parentheses)

Industry	CF_t OLS	CF_t 3SLS	βeta_t OLS	βeta_t 3SLS	TAX OLS	TAX 3SLS	Tgast OLS	Tgast 3SLS	UNIQ OLS	UNIQ 3SLS
20	-0.48	-0.71	0.01	0.42	0.61	-0.64	0.01	0.02	0.27	0.33
	(0.09)	(0.27)	(0.01)	(0.05)	(0.35)	(0.41)	(0.03)	(0.02)	(1.00)	(0.84)
27	-0.29	-0.86	0.01	-0.12	0.70	0.49	-0.09	0.02	15.48	0.33
	(0.10)	(0.27)	(0.01)	(0.07)	(0.31)	(0.39)	(0.03)	(0.02)	(2.38)	(0.84)
29	-0.45	-0.51	0.01	0.06	0.64	0.64	-0.06	-0.06	1.76	3.96
	(0.13)	(1.02)	(0.02)	(0.06)	(0.34)	(0.34)	(0.03)	(0.04)	(2.66)	(3.53)
33	-0.45	-0.55	0.01	0.08	0.15	-2.80	-0.01	0.11	-0.26	-2.66
	(0.13)	(0.78)	(0.02)	(0.05)	(0.81)	(1.24)	(0.04)	(0.05)	(2.46)	(2.56)
36	-0.19	0.93	0.01	0.03	-0.14	-0.62	0.06	0.07	0.11	0.21
	(0.07)	(0.63)	(0.01)	(0.04)	(0.23)	(0.50)	(0.02)	(0.03)	(0.19)	(0.26)
52	-0.50	-0.73	0.01	0.03	0.47	-0.77	-0.03	-0.01	n/a	n/a
	(0.09)	(0.26)	(0.01)	(0.04)	(0.43)	(0.41)	(0.03)	(0.02)		

[n/a] Industry 52 has no research and development expense.

6.4. Risk, Cash Flow, and Leverage Relationship

This section shows the effect of risk on the dynamic cash flow/leverage relationship. If risk changes simultaneously with leverage or cash flow, then the results from cross-sectional leverage studies and leverage-changing event studies may be misspecified. There may also be a lagged relationship among the three variables, but there is little empirical evidence and no theoretical predictions about these relationships. The results show that risk, as measured by beta, does not generally lead cash flow or leverage, but that lagged values of cash flow and leverage do lead beta. There is also a contemporaneous relationship among the three variables, but the direction of the relationship depends upon the industry.

The risk /leverage and risk/cash flow linkages are tested with the following F-tests:

$$\text{Leverage/risk:} \quad H_6: a_{t-1} = a_{t-2} = a_{t-3} = a_{t-4} = 0, \text{ and}$$

$$H_7: \alpha_{t-1} = \alpha_{t-2} = \alpha_{t-3} = \alpha_{t-4} = 0.$$

$$\text{Cash flow/risk:} \quad H_8: c_{t-1} = c_{t-2} = c_{t-3} = c_{t-4} = 0, \text{ and}$$

$$H_9: p_{t-1} = p_{t-2} = p_{t-3} = p_{t-4} = 0.$$

H_6 and H_8 test the joint significance of the lagged risk coefficients from the leverage and cash flow equations respectively. H_7 and H_9 are tests of the leverage and cash flow lag coefficients in the risk equation.

The results of the F-tests of these hypotheses are reported in Table 11. Beta is used to measure risk. As might be expected, risk does not lead cash flow or leverage. In three industries (20, 27, and 33) leverage leads risk, and in two industries (27 and 36) cash flow leads risk. Lagged values of cash flow or leverage are determinants current risk, but lagged values of risk do not provide much information about cash flow or leverage.

In all industries the firm indicator variables are significant, but the quarterly indicator variables are not. These results indicate that risk is firm specific, but there does not seem to be a seasonal pattern to beta.

Table 11. F-tests for Risk Lag Coefficients and for Coefficients and Indicator Variables in the Risk Equation

(P-values in parentheses)

Three-stage Least Squares Estimation with Firm and Quarter Indicator Variables and Time Trend

Industry	Leverage Equation $\beta \rightarrow MVL^1$ H_6: A(B) = 0	Cash Flow Equation $\beta \rightarrow CF^1$ H_8:C(B) = 0	Risk Equation $MVL \rightarrow \beta^1$ H_7: $\alpha(B)=0$	Risk Equation $CF \rightarrow \beta^1$ H_9: $\pi(B)= 0$	Risk Equation $\lambda_1-\lambda_i = 0$	Risk Equation[2] $q_1=q_2=q_3=0$
20[a]	1.87 (0.11)	0.49 (0.74)	2.04 (0.09)	0.23 (0.92)	1.45 (0.07)	0.60 (0.62)
27[b]	1.06 (0.37)	3.33 (0.01)	3.38 (0.01)	7.13 (0.00)	3.27 (0.00)	0.54 (0.66)
29[c]	0.94 (0.44)	1.18 (0.32)	1.03 (0.38)	1.63 (0.16)	2.65 (0.00)	0.68 (0.56)
33[d]	0.43 (0.79)	0.57 (0.68)	4.27 (0.00)	0.94 (0.44)	1.79 (0.01)	1.64 (0.18)
36[e]	1.82 (0.12)	1.74 (0.14)	0.47 (0.76)	2.70 (0.03)	3.28 (0.00)	0.48 (0.70)
52[f]	2.25 (0.06)	1.01 (0.40)	1.20 (0.31)	0.75 (0.56)	2.21 (0.00)	0.25 (0.86)

[a]degrees of freedom for denominator of the F-tests–2553; numerator for $\lambda_1-\lambda_i$–24 [b]2238;21 [c]1923;18 [d]2238;21 [e]3708;35 [f]3781;36. [1]df for numerator, 4. [2]df for numerator, 3.

Table 12 shows the coefficients pertaining to risk from the 3SLS estimation. In the third panel, the MVL coefficients in the risk equation are usually negative, but the contemporaneous coefficient is significant in only one industry (petroleum refining). Further, the contemporaneous coefficient for industry 33 (primary metals) is large, significant, and positive. A direct relationship between leverage and risk might be expected where higher levels of risk would be associated with higher levels of leverage, and vice versa. The evidence here to support that notion is weak. However, using the standard deviation of daily returns for each quarter (σ) as a measure of risk, the

contemporaneous coefficient for MVL from the risk equation is positive and significant for five out of six industries (see Appendix D).

The lag coefficients are not consistently positive or negative, so it is not possible to draw too many conclusions from the signs of the lagged leverage coefficients.

The cash flow coefficients in the risk equation have a more consistent pattern. All of the significant lagged coefficients are positive. A higher cash flow in the past is associated with a higher risk in the future (and vice versa). The contemporaneous coefficient is large in magnitude for all industries, but significantly negative only for industry 36 (electrical equipment) and industry 27 (printing and publishing). For industry 29 (petroleum refining) the coefficient is significant and positive.

Table 12. Coefficients for Lagged Risk and Coefficients of Lagged Cash Flow and Leverage from Risk Equation

		Industry					
Equation	Variable	20	27	29	33	36	52
Leverage	β_t	0.07	-0.08	0.07	0.10	0.02	0.03
$\beta \rightarrow$MVL	β_{t-1}	-0.03	0.07	-0.07	-0.09	-0.03	-0.00*
	β_{t-2}	-0.04*	0.00	0.01	-0.00	0.01	-0.05**
	β_{t-3}	0.01	-0.00	-0.01	0.00	0.01	0.02
	β_{t-4}	0.00	-0.02	0.00	0.01	0.01	0.00
Cash Flow	β_t	0.01	-0.05**	-0.02	-0.03*	-0.01	-0.01
$\beta \rightarrow$CF	β_{t-1}	-0.02	0.04**	0.02	-0.02	0.02	0.01
	β_{t-2}	0.01	-0.00	0.01	0.00	-0.01**	-0.01
	β_{t-3}	-0.01	0.01	-0.01	0.01	0.01**	0.00
	β_{t-4}	0.00	-0.01**	0.00	0.00**	-0.00	0.00
Risk	MVL_t	-0.11	-1.53**	-0.69	2.55**	-0.27	-0.28
MVL$\rightarrow\beta$	MVL_{t-1}	-0.17	1.29**	0.40	-2.25**	0.13	0.29
	MVL_{t-2}	0.24	-0.24	0.11	-0.23*	0.11	-0.17*
	MVL_{t-3}	0.12	0.38*	-0.07	0.60**	-0.21	-0.08
	MVL_{t-4}	-0.32**	-0.23	0.08	-0.16	0.13	0.08
Risk	CF_t	0.25	-3.00**	4.35**	1.74	-2.27**	0.74
CF$\rightarrow\beta$	CF_{t-1}	0.04	0.27	1.83**	1.81*	0.96*	0.14
	CF_{t-2}	-0.06	-0.27	-0.01	-0.42	0.78*	0.24
	CF_{t-3}	0.19	-0.10	0.04	-0.27	0.12	0.22
	CF_{t-4}	0.21	2.27**	0.81*	-0.22	0.40	-0.33

*significant at the 10% level **significant at the 5% level

While it may not be possible to draw too many general conclusions about the direction of the risk/cash flow or risk/leverage relationship, it is possible to say that the direction and importance of the relationship is industry-specific.

The results are also affected by the risk measure that is used. The results when the standard deviation of daily returns is used as the risk measure are reported in Appendix D. There the coefficients for the contemporaneous values of leverage in the risk equation are all positive, and all the significant lagged values of leverage, except one, are negative. Contemporaneously for the standard deviation of daily returns higher risk and higher leverage are associated. Intertemporally, previously high values of leverage imply lower risk, and vice versa. The contemporaneous cash flow coefficients are all positive. This indicates that if an appropriate measure of risk is the standard deviation of daily returns, then the higher return indicated by higher cash flows is consistent with mean/variance efficiency.

Some of the difference in results may be explained by the timing in how the variables are defined. Beta is a two year moving average, so that some of the lag values will be contemporaneous with the period over which beta is defined. On the other hand the standard daily return, σ, is entirely measured within that same quarter. From a timing perspective σ may be a better indicator of the dynamic relationship, while beta may be a superior indicator of the riskiness of a firm's cash flows..

6.5. Other Determinants of Leverage

There are many other things that may have an effect on a firm's leverage. In this section the exogenous variables that are included in the leverage equation are examined, and these results are compared to previous studies. Harris and Raviv (1991) summarize the results of nine other leverage studies. In most cases the signs of the

coefficients varied across the studies. Only the effect of fixed assets on leverage seem to be consistently positive.

The coefficients of the exogenous variables, TAX, TGAST, and UNIQ, depend upon the industry. The size and trend variables are more consistent. Table 13 shows the coefficients of the exogenous variables with t-statistics in parentheses.

Table 13. Control Variable Coefficients from Leverage Equation

(t-statistics in parentheses)

Industry	TAX	TGAST	UNIQ	SIZE	TREND
20	-0.643	0.022	0.331	0.060	-0.002
	(-1.561)	(1.036)	(0.392)	(5.945)	(-5.399)
27	0.485	-0.098	11.880	0.055	-0.001
	(1.234)	(-3.043)	(3.971)	(8.866)	(-4.935)
29	0.642	-0.064	-3.957	0.053	-0.001
	(1.889)	(-1.640)	(-1.122)	(3.721)	(-2.540)
33	-2.802	0.107	-2.665	0.003	-0.001
	(-2.261)	(1.950)	(-1.038)	(0.245)	(-1.863)
36	-0.621	0.074	0.206	0.066	-0.001
	(-1.239)	(2.620)	(0.788)	(9.685)	(-4.435)
52	-0.769	-0.012	n/a	0.017	-0.000
	(-1.862)	(-0.541)		(3.092)	(-0.446)

n/a Industry 52 has no research and development expense.

The tax variable (TAX) is a measure of a firm's depreciation tax shield. Tax theories suggest that firms with more depreciation need not issue as much debt because the tax advantage of debt may be offset by a large amount of depreciation. The hypothesized relationship between non-debt tax shields and leverage is negative. Previous results are mixed. Harris and Raviv (1991) report that two studies have found significant positive coefficients, and two other studies have found a negative and an insignificant coefficient.

The results found here depend upon the industry. The non-debt tax shield coefficient is sometimes significant, but the sign is mixed and depends upon the industry. For the primary metals industry (33) and the electrical equipment industry (36), the coefficient is negative. This suggests that tax laws and the type of depreciable

assets may vary by industry so that it is impossible to infer a universal depreciation tax shield effect.

The proportion of tangible assets (TGAST) should be positively related to leverage when agency costs of equity are high. Here again there is a positive coefficient as predicted for two industries, but overall the results are mixed.

More unique assets (UNIQ), which result from increased research and development, may also lead to higher agency costs of debt, therefore, according to this theory, there should be a negative relationship between the level of leverage and the uniqueness of a firm's assets. Here uniqueness is measured by the amount of research and development expense. Previous studies have usually found a negative relationship, but here there is no relationship between this variable and leverage. In the one industry (printing and publishing) that there is a significant coefficient, it is large and positive.

Perhaps the most robust results come from the SIZE variable. It has been suggested that larger firms have a greater debt capacity than smaller firms. These results support this idea. Size is significantly related to the level of leverage, and larger firms tend to have more leverage.

Only one previous study (Marsh (1982)) has found that size is positively related to leverage. In most other studies the size variable has been insignificant. Size may be significant here because of scale differences across industries. Other studies include a size and an industry variable, but if the industries are combined, then the size effect may be within the industry. If so, the industry indicator variable, and other variables that have communalities across industries, may proxy for the size effect.

Trend and Seasonality

The trend variable for leverage is reported in Table 12. The coefficient is somewhat surprising since Masulis (1988) has reported that leverage has increased over

time. But the sample period covers the high interest rates of the early 1980's, so on average leverage decreased. For this period (1979–1989), leverage has decreased slightly, though significantly. From 1979 through 1983 leverage generally decreased. From 1983 until 1987 leverage was fairly constant, and seemed to be rising again in 1989. Figure 1 (page 49), a graph of the average leverage over the sample period, shows this decrease.

Average cash flow to total assets over the sample period is also shown in Figure 1. For most of the industries, the trend variable in the cash flow equation is not significant. For the two industries where it is significant, primary metals industry (33) and electrical equipment industry (36), it is also slightly negative over the sample period.

Quarterly indicator variables are included in each equation to help control for any seasonal variations. From Figure 1, it seems that cash flow may have some significant seasonal effects. The hypothesis that the coefficients of the quarterly indicator variables in the cash flow equation is zero is rejected for two industries, electrical equipment industry (36) and retail (52). For the leverage equation, the quarterly indicator variables are significantly different from zero only for industry 36. For the risk equation, the quarterly indicator variables are never significantly different from zero.

6.6. Changes in Cash Flow, Leverage, and Risk

Event studies consider changes in leverage instead of the level of leverage. In this section the effect of lagged changes in the variables is related to the current level. For example, the change in leverage in a previous period may have a significant effect on the level current cash flow; or the change in cash flow may have a significant effect on the level current leverage.

The change in the variables is the difference in the variable, x, from period t to period t-1; that is $\Delta x_t = x_t - x_{t-1}$. x_t can be MVL_t, CF_t, or β_t depending upon the equation.[1] The leverage equation, comparable to equation (11), that is estimated is:

$$\text{Leverage:} \quad MVL_{it} = \nu(B)MVL_{it} + \beta(B)\Delta CF_{it} + A(B)\Delta\beta_{it} + \gamma_{1i}TAX_{it} + \gamma_{2i}TGAST_{it} + \gamma_{3i}UNIQ_{it} + \gamma_{4i}SIZE_{it} + \lambda D + u_{1it} \quad (14)$$

The comparable equations for cash flow and risk are:

$$\text{Cash Flow:} \quad CF_{it} = \eta(B)\Delta MVL_{it} + \phi(B)CF_{it} + C(B)\Delta\beta_{it} + \lambda D + u_{2it} \quad (15)$$

$$\text{Risk:} \quad \beta_{it} = \alpha(B)\Delta MVL_{it} + \pi(B)\Delta CF_{it} + D(B)\sigma_{it} + \gamma_{2i}TGAST_{it} + \gamma_{4i}SIZE_{it} + \lambda D + u_{3it}. \quad (16)$$

The F-tests of $\beta(B) = 0$ and $\eta(B) = 0$ are shown in Table 14. These results can be compared to those in Table 7. The previous level of leverage (the signalling hypothesis) influences current cash flow in half of the industries. Changes in leverage are not as informative as the level of leverage, although the results change for only one industry (52–retail sales). In retail sales the previous level of leverage is more informative than previous changes in leverage. Changes in previous values of cash flow are always significant explanatory variables.

[1]The model was also estimated using percent change and first differences as both the lagged dependant and independent variables. There were no significant coefficients for any variables when percent change was used. The results using the first differences for the dependent variable were qualitatively similar to the results reported.

Table 14. F-tests for ΔMVL and ΔCF Lag Coefficients from Simultaneous Equations

(P-values in parentheses)

Three-stage Least Squares Estimation with Firm and Quarter Indicator Variables and Time Trend

Industry	ΔCF→MVL[1] H_0: β(B)=0	Signalling[1] ΔMVL→CF H_0: η(B)=0
20[a]	18.13 (0.00)	2.94 (0.02)
27[b]	5.30 (0.01)	1.21 (0.31)
29[c]	6.11 (0.00)	0.40 (0.81)
33[d]	7.43 (0.00)	5.70 (0.00)
36[e]	3.20 (0.01)	3.45 (0.01)
52[f]	17.77 (0.00)	0.71 (0.58)

[a]degrees of freedom for denominator of the F-tests–2556; [b]2238 [c]1923 [d]2238 [e]3708 [f]3778. [1]df for numerator, 4.

The coefficient from the leverage and cash flow equations for lagged values of cash flow and leverage are reported in Table 15. Ross's signalling hypothesis suggests that an increase in leverage is associated with a higher quality firm. Here the coefficients that show the effect of a change in leverage on operating cash flow are all negative; an increase in a previous period in leverage is associated with a decrease in the current level of cash flow, or vice versa.

In Ross's model debt is changed in order to finance an investment. Suppose that debt remains constant. Then, if leverage changes, it is due to a change in the value of equity. If the results are interpreted in this way, an increase in the lagged market value of equity is associated with an increase in current cash flow. It may be that changes in equity market value are much greater than most changes in debt. If so, these results show that the market generally anticipates higher levels of operating cash flow.

Table 15. ΔCF and ΔMVL Coefficients from 3SLS Estimation

Equation	Variable	Industry 20	27	29	33	36	52
Leverage	ΔCF_t	-0.81**	-0.44**	-0.69**	-0.97**	-0.30**	-0.74**
ΔCF→MVL	ΔCF_{t-1}	-0.79**	-0.43**	-0.68**	-0.88**	-0.06	-0.78**
	ΔCF_{t-2}	-0.53**	-0.40**	-0.28**	-0.26	0.06	-0.61**
	ΔCF_{t-3}	-0.53**	-0.41**	-0.06	-0.31*	0.10	-0.58**
	ΔCF_{t-4}	-0.05	-0.04	-0.10	0.33*	0.21**	-0.06
Cash Flow	ΔMVL_t	-0.11**	-0.06**	-0.06**	-0.04**	-0.06**	-0.08**
ΔMVL→CF	ΔMVL_{t-1}	-0.03**	-0.02	-0.01	-0.02**	-0.01	-0.01
(Signalling)	ΔMVL_{t-2}	0.01	0.01	0.01	-0.02**	-0.02*	-0.00
	ΔMVL_{t-3}	-0.01	-0.02	-0.01	-0.02**	-0.02**	0.01
	ΔMVL_{t-4}	-0.02*	0.00	-0.00	-0.00	-0.03**	0.01

**significant at the 5% level *significant at the 10% level

6.7. Other Measures of Quality

Operating cash flow is one measure of a firm's quality. It measures the quality of a firm's previous operating decisions. When a firm contains both debt and equity it is not clear that cash flow from operations is the only measure of a firm's quality. A firm may also be judged by the many other decisions it must make, such as its financing, tax, and dividend decisions. The combination, interaction, and the cumulative effect of these decisions are also important. Other variables may capture some of this effect. In this section other measures of quality are used to determine the robustness of the previous results and to link this study to other studies which have used other measures of quality.

Four other quality variables are used. They are return on assets (ROA), earnings per share (EPS), and two definitions of free cash flow (FCF). Free cash flow is defined as earnings before extraordinary items plus non-cash expenses less dividends. One free cash flow variable is scaled by total assets, and one is on a per share basis. Earnings per share uses income before extraordinary items and is adjusted

for stock splits and dividends. For EPS and FCF per share, SIZE is included as a control variable in the quality equation.

Table 16 reports the results of the following signalling F-test:

$$\text{Signalling:} \quad H_5: n_{t-1} = n_{t-2} = n_{t-3} = n_{t-4} = 0.$$

X is the quality variable which can be FCF, ROA, EPS, or CF.

Table 16. Test of Signalling for Different Quality Variables: MVL→X F-statistics

(p-value in parentheses)

Industry	FCF/Total Assets	ROA	EPS	Free Cash Flow per Share	Operating Cash Flow/Total Assets
20	2.78 (0.03)	1.13 (0.34)	1.15 (0.33)	2.17 (0.07)	3.46 (0.01)
27	9.15 (0.00)	0.61 (0.65)	3.37 (0.01)	7.86 (0.00)	1.24 (0.29)
29	1.81 (0.12)	2.55 (0.04)	5.06 (0.00)	3.83 (0.00)	0.73 (0.57)
33	0.79 (0.53)	1.17 (0.32)	4.52 (0.00)	3.79 (0.00)	3.78 (0.00)
36	1.08 (0.36)	1.47 (0.21)	2.34 (0.05)	1.12 (0.34)	3.85 (0.00)
52	1.38 (0.24)	0.26 (0.90)	2.23 (0.06)	3.29 (0.01)	3.47 (0.01)

For comparison, the results for CF that are previously reported in Table 7 are shown in the last column. Leverage provides little information about ROA. Leverage provides information about free cash flow scaled by total assets for only two industries (20 and 27). Previous values of leverage provide the most information about EPS and FCF per share. However, the information may not be similar. For three industries the CF and FCF per share results agree, and for three industries the CF and EPS results disagree. There are only two industries (33 and 52) where the hypothesis is rejected for EPS, CF, and FCF per share. There are no industries where the hypothesis is rejected for all of the quality variables.

Table 17. Leverage Coefficients from Quality Equation for Different Definitions of Quality

		Quality Variables					
Industry	Coefficient	EPS	t-statistic	FCF/share	t-statistic	Cash Flow	t-statistic
20	MVL_t	-0.71	-0.14	15.96	2.41	-0.18	-3.54
	MVL_{t-1}	-0.86	-0.20	-15.41	-2.63	0.14	2.95
	MVL_{t-2}	1.40	1.87	0.65	0.73	-0.03	1.86
	MVL_{t-3}	-0.20	-0.27	0.86	0.86	-0.03	-1.55
	MVL_{t-4}	-0.93	-0.68	0.61	0.85	0.02	1.38
27	MVL_t	3.12	2.15	-2.35	-0.39	-0.08	-2.30
	MVL_{t-1}	-3.64	-3.31	6.57	1.64	0.07	2.11
	MVL_{t-2}	1.01	1.53	-1.40	-0.66	0.01	0.28
	MVL_{t-3}	-0.49	-0.59	-9.08	-3.34	-0.02	-0.70
	MVL_{t-4}	0.96	1.43	9.07	4.29	0.01	0.32
29	MVL_t	-15.63	-2.12	-13.47	-1.25	0.01	0.09
	MVL_{t-1}	12.37	1.88	10.01	1.04	0.01	-0.18
	MVL_{t-2}	5.16	3.55	6.01	3.41	-0.01	1.04
	MVL_{t-3}	-4.43	-3.01	-4.84	-2.70	0.02	-1.18
	MVL_{t-4}	-1.05	-0.84	-0.50	-0.31	0.02	1.18
33	MVL_t	-34.97	-2.49	-25.76	-1.97	-0.24	-4.08
	MVL_{t-1}	33.00	2.77	25.47	2.15	0.20	3.76
	MVL_{t-2}	-1.61	-0.55	-2.44	-1.03	0.00	0.37
	MVL_{t-3}	-11.22	-3.99	-7.62	-2.62	-0.03	-2.07
	MVL_{t-4}	7.60	2.99	5.11	2.65	0.03	2.86
36	MVL_t	-2.66	-1.85	-6.34	-2.35	-0.10	-2.63
	MVL_{t-1}	2.01	1.77	4.95	2.22	0.08	2.40
	MVL_{t-2}	-0.08	-0.30	0.13	0.33	0.01	-0.73
	MVL_{t-3}	-0.71	-2.66	-0.81	-1.97	-0.01	-0.43
	MVL_{t-4}	0.43	2.24	0.50	1.65	0.02	1.68
52	MVL_t	-11.62	-3.56	-19.18	-2.60	-0.27	-4.20
	MVL_{t-1}	9.62	3.42	18.32	2.90	0.24	4.20
	MVL_{t-2}	-0.05	-0.11	-0.50	-0.45	0.01	0.40
	MVL_{t-3}	-0.82	-1.70	-0.98	-0.82	-0.01	-0.65
	MVL_{t-4}	1.24	3.00	0.87	0.10	0.00	0.43

The leverage coefficients from the quality equation are reported for EPS, FCF per share and CF in Table 17. The cash flow column repeats the results from Table 8 for comparison. Generally the contemporaneous lag is negative with few exceptions, and the first lag is usually positive. This is similar to the cash flow results. However, the direction of lags 2, 3, and 4 for EPS and FCF per share is more variable.

Overall, considering both Tables 16 and 17, the results for industries 33, 36, and 52 are similar no matter what the definition of quality. For the other three industries, the results are not consistent for different definitions of quality. It is difficult to see what factors these industries have in common that would explain this discrepancy.

7. Limitations and Extensions

7.1. Limitations

Limitations Imposed by Quarterly Data

Quarterly data is voluntarily provided by those firms that choose to do so. It is unaudited. Some firms have provided quarterly statements for several years and then stop for several years. There are few firms that have consistently provided quarterly data from 1979 until the present, the sample period. Because the type of firm that chooses to consistently make quarterly statements available may be different than an average firm, these results may be sample specific. Firms that choose to voluntarily provide this type information may be higher quality firms. Therefore, selection bias may be a problem in this study.

Even if there is selection bias, this study still provides useful information about the signalling hypothesis. The results may not hold for an average firm, but if leverage is predictor of quality for a high quality firm, then a semi-pooling signalling equilibrium may exist, but not necessarily a fully revealing equilibrium.

Limitations Imposed by Methodology

Although this methodology relaxes some of the strong assumptions required by ordinary least square regression about simultaneity, this methodology requires some strong assumptions about the covariance structure of the residuals. Three stage least squares regression assumes that the covariance for each equation, r, is $E(\varepsilon_{rit}\varepsilon_{rjt})= \sigma_r^2$

for i=j, and if i≠j, then $E(\varepsilon_{rit}\varepsilon_{rjt})= 0$. These are two strong statements. The first, $E(\varepsilon_{rit}\varepsilon_{rjt}) = \sigma_r^2$ for i=j, is the assumption of homoskedasticity across firms and time within an industry. It would be preferable to assume, at a minimum, that the variance changes across firms, if not across time. The next statement, that $E(\varepsilon_{rit}\varepsilon_{rjt})= 0$, for i≠j, assumes that there is no covariance across firms within an equation or time period. If these assumptions are not true, the 3SLS estimators are still unbiased, but they are no longer efficient. Then the F-statistics and t-statistics may not be valid.

An error components model computes estimates that relax these two assumptions. Unfortunately, there is no statistical program available for an error components model. The algorithm for calculating an error component estimator is not very difficult; however, it does require a very large amount of computer memory.[1] Using the best statistical programs available and the limited computer memory available, it is not practical to compute error components estimators.

It is possible to compute the model for each individual firm within an industry. However, the presentation of the results presents a problem. It is not easy to draw conclusions from 161 different sets of regression coefficients.

Other Limitations

The interpretation of the results could be compromised if several firms within an industry issued a significant amount of equity over the period of this study. Pecking order behavior does not necessarily imply a monotonic relationship between quality and cash flow. The relationship is generally negative, but as a last resort, a very low

[1]The memory requirement is at least NT × NT × 8. The maximum memory size at the University of Kansas is 8 megabytes. For an industry with 25 firms at least $(36 \times 25)^2 \times 8 = 6.5$ megabytes of memory is required to store one adjustment matrix. That does not leave enough room for computations. For industry 52 at least 14 megabytes is required.

quality firm would issue equity. At that point a decrease in leverage would be associated with low cash flows.

If the argument is correct, that these firms are of higher than average quality, then this is not a problem because they would not be issuing a significant amount of equity. However, the type of financial offerings by each firm can be verified on the Security and Exchange Commission's (SEC) computer tape of Registered Offerings of Securities (ROS).

The interpretation of the results in this study also suffer from another limitation. There may be other dynamic explanations for a firm's capital structure, such as Fischer, Heinkel, and Zechner's (1989) transactions cost explanation. Nor have the dynamic effects of taxes and agency costs been considered. Still these results are consistent with the only available dynamic explanation of capital structure, the signalling theory.

7.2. Extensions

A great deal of theoretical work has been generated on the information problem and how it relates to a firm's financing decisions. However, empiricists have not yet tackled tests of some key points. John and Ronen (1989) provide a general framework that links information timing, the type of agent, the type of information structure, and the quality of the firm with the financing decision. However, empirically the idea of firm quality is still fuzzy. Where is the continuum of high and low quality firms, and on what basis is that continuum drawn? How is information revealed to outside and insiders and when do different agents receive information?

A related question is why industries are different? The asset structure of different industries should be different. SIC codes change frequently and may not be a good indicator of the underlying technology.

The study can also be extended to show how the market price relates relates leverage, risk, and cash flow. The market price should move with leverage, not cash flow, if leverage is functioning as an unbiased signal of cash flow.

Another extension is to explain why there are different results for different quality variables, and to determine what the market reacts to. Traditionally the focus has been on earnings per share, but the other variables may convey a different type of information. Nor have the risk results have not been adequately explained. It is not clear which factors are driving these results. Is it technological firm-specific factors, or it it some time-dependent economic factor. Finally, all of these extensions and this dissertation could be improved by using covariance estimators.

8. Conclusion

This thesis provides a description of the dynamic relationship among leverage, cash flow, and risk. I show that by considering both the intertemporal and the simultaneous aspects of this relationship, that an apparent conflict between signalling theory and pecking order behavior can be explained. Event study results and cross-sectional leverage results that appear to be contradictory can also be reconciled by considering the dynamic relationship. I show that event studies provide information about the relationship between leverage changes and expectations of future cash flow, while cross-sectional studies provide information about the contemporaneous relationship.

The first set of tests in this dissertation show that leverage fulfills a necessary condition for signalling; that is, a signal must provide information about the future quality of a firm. Another way of saying this is that a signal must improve forecasts of firm quality where firm quality is defined as cash flow from operations. Using a Granger-causality test, I show that leverage does function as a signal of future cash flow.

However, the forecasting model isolates only part of the process that determines leverage and cash flow. A more general dynamic simultaneous equation model provides even broader support for the signalling hypothesis. A structural model shows that contemporaneous cash flow and leverage are negatively related, but the lagged relationship is more often positive. These results support the idea that pecking order behavior is a description of the contemporaneous relationship between cash flow and leverage, while signalling information concerns future cash flows, not contemporaneous ones.

This thesis also provides an improvement over previous cross-sectional leverage studies because leverage, cash flow, and risk are simultaneously determined. Since leverage is simultaneously determined with cash flow and risk, previous cross-sectional leverage studies may be biased and inconsistent.

Finally this dissertation provides some insight into previous leverage studies. Harris and Raviv (1991) summarize the determinants of leverage from previous studies. Many of the results are conflicting. As they point out the comparisons suffer because the studies use different measures of firm characteristics, different samples, different methodologies, and different leverage measure. In this thesis the results depend upon the industry. So despite using the same measures of firm characteristics, the same sample, the same leverage measures, and the same methodology, the results from different industries are not consistent for all variables. This result supports John and Ronen's (1989) premise that the information structure and capital structure of a firm is a result of the underlying technology that the firm employs which should be industry specific.

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Appendix A: Firm Granger-Causality Autocorrelation Diagnostics

Granger Causality Tests for Firms within Primary Metals Industry (3300) using Lags 4 and 8

$$MVL_{it} = a_{it-1}MVL_{it-1} + \ldots + a_{it-8}MVL_{it-8} + b_{it}CF_{it} + \ldots + b_{it-4}CF_{it-4} + \varepsilon_{1ti}$$

$$CF_{it} = c_{it-1}CF_{it-1} + \ldots + c_{it-8}CF_{it-8} + d_{it}MVL_{it} + \ldots + d_{it-4}MVL_{it-4} + \varepsilon_{2ti}$$

(1) Company Number	(2) Cross-Model Correlation	(3) r^2	(4) CF→MVL P values for $F_{b1=\ldots=b4=0}$	(5) Signalling P values for $F_{d1=\ldots=d4=0}$	(6) ε_{2ti} Autocorrelation χ^2 Prob. value
013716	0.28	0.94	0.56	0.24	0.499
022249	-0.24	0.87	0.22	0.13	0.495
023127	-0.25	0.67	0.30	0.04**	0.289
042083	0.08	0.79	0.50	0.65	0.989
042170	-0.11	0.73	0.25	0.01**	0.172
043413	-0.39	0.79	0.45	0.04**	0.955
087509	-0.09	0.85	0.28	0.03**	0.928
117421	-0.09	0.71	0.31	0.16	0.801
144285	-0.15	0.86	0.32	0.42	0.396
217687	-0.29	0.73	0.40	0.19	0.967
370073	-0.22	0.67	0.08*	0.02**	0.378
410306	-0.16	0.68	0.03**	0.15	0.765
493422	-0.09	0.82	0.12	0.15	0.478
502210	-0.31	0.84	0.98	0.25	0.978
549866	-0.18	0.82	0.01**	0.05*	0.083*
577913	-0.06	0.78	0.08*	0.35	0.921
637742	-0.18	0.86	0.12	0.84	0.765
670346	-0.36	0.66	0.58	0.56	0.813
707271	-0.01	0.91	0.47	0.69	0.997
717265	-0.32	0.87	0.01**	0.91	0.944
743396	-0.03	0.94	0.22	0.09*	0.471
747620	0.12	0.79	0.35	0.01**	0.650
761763	-0.02	0.81	0.50	0.45	0.945
963150	-0.02	0.90	0.14	0.01**	0.009**
Proportion of significant tests			5/22	9/22	2/22

* Significant at the 10% level

**Significant at the 5% level

$$CF_{it} = \frac{CFFO_{it}}{Sales_{it}}$$

$$MVL_{it} = \frac{\text{Long-term Debt}_{it}}{\text{Total Liabilities}_{it} + \text{Market Value of Equity}_{it}}$$

Appendix B: Descriptive Statistics For Each Industry

Food and Kindred Products (2000)

Variable	Symbol	Mean	Std. Dev.	Median	Minimum	Maximum
$\frac{\text{cash flow}}{\text{total assets}}$	CF	0.039	0.024	0.038	-0.070	0.154
$\frac{\text{LT Debt}}{\text{Mkt Value}}$	MVL	0.236	0.190	0.187	0	0.794
$\frac{\text{LT Debt}}{\text{Book Value}}$	BVL	0.189	0.128	0.166	0	0.727
ln(total assets)	SIZE	6.301	1.717	6.248	3.149	9.624
$\frac{\text{Net PPE}}{\text{total assets}}$	TGAST	0.378	0.139	0.383	0.068	0.710
$\frac{\text{Depreciation}}{\text{total assets}}$	TAX	0.005	0.006	0.004	0	0.036
$\frac{\text{R\&D Exp}}{\text{total assets}}$	UNIQ	0.0001	0.001	0.000	0	0.023
σ(daily return)	σ	0.019	0.009	0.017	0.004	0.065
Weekly β	β	0.774	0.370	0.775	-0.843	2.017
Daily β	β	0.698	0.488	0.667	-1.306	2.668

Printing and Publishing (2700)

Variable	Symbol	Mean	Std. Dev.	Median	Minimum	Maximum
$\frac{\text{cash flow}}{\text{total assets}}$	CF	0.052	0.040	0.053	-0.101	0.314
$\frac{\text{LT Debt}}{\text{Mkt Value}}$	MVL	0.133	0.156	0.084	0	0.847
$\frac{\text{LT Debt}}{\text{Book Value}}$	BVL	0.134	0.130	0.104	0	1.274
ln(total assets)	SIZE	5.747	1.395	5.732	1.677	8.281
$\frac{\text{Net PPE}}{\text{total assets}}$	TGAST	0.318	0.127	0.337	0.065	0.664
$\frac{\text{Depreciation}}{\text{total assets}}$	TAX	0.009	0.008	0.010	0	0.065
$\frac{\text{R\&D Exp}}{\text{total assets}}$	UNIQ	0.0000	0.001	0.000	0	0.020
σ(daily return)	σ	0.020	0.013	0.017	0.006	0.176
Weekly β	β	0.935	0.380	0.890	-0.062	2.400
Daily β	β	0.689	0.547	0.645	-1.859	3.104

Petroleum Refining (2900)

Variable	Symbol	Mean	Std. Dev.	Median	Minimum	Maximum
$\frac{\text{cash flow}}{\text{total assets}}$	CF	0.042	0.021	0.041	-0.073	0.129
$\frac{\text{LT Debt}}{\text{Mkt Value}}$	MVL	0.320	0.150	0.300	0.002	0.806
$\frac{\text{LT Debt}}{\text{Book Value}}$	BVL	0.214	0.101	0.201	0.001	0.547
ln(total assets)	SIZE	8.251	1.758	8.319	4.273	10.723
$\frac{\text{Net PPE}}{\text{total assets}}$	TGAST	0.585	0.123	0.611	0.220	0.801
$\frac{\text{Depreciation}}{\text{total assets}}$	TAX	0.017	0.007	0.016	0	0.119
$\frac{\text{R\&D Exp}}{\text{total assets}}$	UNIQ	0.0001	0.0007	0.000	0	0.012
σ(daily return)	σ	0.021	0.009	0.019	0.003	0.066
Weekly β	β	1.011	0.409	1.000	-0.059	2.086
Daily β	β	1.005	0.584	1.011	-1.081	3.510

Primary Metal Industries (3300)

Variable	Symbol	Mean	Std. Dev.	Median	Minimum	Maximum
$\frac{\text{cash flow}}{\text{total assets}}$	CF	0.028	0.024	0.027	-0.066	0.116
$\frac{\text{LT Debt}}{\text{Mkt Value}}$	MVL	0.357	0.221	0.327	0	0.931
$\frac{\text{LT Debt}}{\text{Book Value}}$	BVL	0.209	0.116	0.206	0	0.741
ln(total assets)	SIZE	6.705	1.488	6.362	3.376	9.354
$\frac{\text{Net PPE}}{\text{total assets}}$	TGAST	0.465	0.138	0.462	0.098	0.752
$\frac{\text{Depreciation}}{\text{total assets}}$	TAX	0.009	0.006	0.009	0	0.065
$\frac{\text{R\&D Exp}}{\text{total assets}}$	UNIQ	0.0001	0.001	0.000	0	0.020
σ(daily return)	σ	0.024	0.010	0.021	0.008	0.083
Weekly β	β	1.121	0.428	1.148	-0.158	2.656
Daily β	β	0.894	0.582	0.845	-0.743	3.304

Electrical Equipment (3600)

Variable	Symbol	Mean	Std. Dev.	Median	Minimum	Maximum
$\frac{\text{cash flow}}{\text{total assets}}$	CF	0.038	0.025	0.038	-0.168	0.158
$\frac{\text{LT Debt}}{\text{Mkt Value}}$	MVL	0.128	0.125	0.089	0	0.744
$\frac{\text{LT Debt}}{\text{Book Value}}$	BVL	0.119	0.100	0.096	0	0.648
ln(total assets)	SIZE	5.424	1.913	5.083	1.761	11.762
$\frac{\text{Net PPE}}{\text{total assets}}$	TGAST	0.283	0.105	0.279	0.021	0.620
$\frac{\text{Depreciation}}{\text{total assets}}$	TAX	0.007	0.007	0.008	0	0.034
$\frac{\text{R\&D Exp}}{\text{total assets}}$	UNIQ	0.0008	0.005	0.000	0	0.102
σ(daily return)	σ	0.023	0.010	0.021	0.004	0.114
Weekly β	β	1.111	0.440	1.101	-0.285	2.656
Daily β	β	0.896	0.599	0.877	-1.348	3.212

Retail Sales (5200)

Variable	Symbol	Mean	Std. Dev.	Median	Minimum	Maximum
$\frac{\text{cash flow}}{\text{total assets}}$	CF	0.041	0.029	0.039	-0.225	0.186
$\frac{\text{LT Debt}}{\text{Mkt Value}}$	MVL	0.245	0.187	0.216	0	0.887
$\frac{\text{LT Debt}}{\text{Book Value}}$	BVL	0.198	0.133	0.204	0	1.152
ln(total assets)	SIZE	6.114	1.700	6.184	2.423	9.541
$\frac{\text{Net PPE}}{\text{total assets}}$	TGAST	0.370	0.155	0.355	0.031	0.861
$\frac{\text{Depreciation}}{\text{total assets}}$	TAX	0.009	0.006	0.009	0	0.042
$\frac{\text{R\&D Exp}}{\text{total assets}}$	UNIQ	0	0	0	0	0
σ(daily return)	σ	0.020	0.010	0.018	0.006	0.105
Weekly β	β	0.930	0.420	0.951	-0.368	2.292
Daily β	β	0.724	0.517	0.710	-0.805	2.984

Appendix C: Firms Used in the Analysis

Industry 20 (Food and Kindred Products)

1.	American Maize Prods Co.	027339
2.	Archer Daniels Midland Co.	039483
3.	Borden, Inc.	099599
4.	CPC International, Inc.	126149
5.	Cagle's, Inc.	127703
6.	Campbell Soup Co.	134429
7.	Chock Full O Nuts Corp.	170268
8.	Curtice-Burns Foods Inc.	231382
9.	Flowers Ind., Inc.	343496
10.	Glenmore Distilleries, Co.	378694
11.	Hershey Foods Corp.	427866
12.	Hormel, Geo. A. & Co.	440452
13.	Ionics Corp.	462218
14.	Kellogg Co.	487836
15.	Pepsico, Inc.	713448
16.	Quaker Oats Co.	747402
17.	Ralston Purina Co.	751277
18.	Sara Lee Corp.	803111
19.	Scope Industries	809163
20.	Seagram, Ltd.	811850
21.	Smucker, J. M. Co.	832696
22.	Stoneridge Resources, Inc.	861839
23.	Tootsie Roll Inds., Inc.	890516
24.	Universal Foods Corp.	913538
25.	Whitman Corp.	96647K

Industry 27 (Printing, Publishing, and Allied Products)

1.	American Business Products	024763
2.	Bowne & Co., Inc.	103043
3.	Donnelly, R. R. & Sons Co.	257867
4.	Dow Jones & Co. Inc.	260561
5.	Ennis Business Forms, Inc.	293389
6.	Gannett, Inc.	364760
7.	Harcourt, Brace, Jovanovich Inc.	411631
8.	Harland, John H. Co.	412693
9.	Houghton Mifflin Co.	441560
10.	Kleer Vu Industries, Inc.	498494
11.	Knight Ridder, Inc.	499040
12.	Lee Enterprises, Inc.	523768
13.	McGraw Hill, Inc.	580645
14.	Media Gen, Inc.	584404
15.	Meredith Corp.	589433
16.	Mickleberry Corp.	594780
17.	New York Times Co.	650111
18.	Playboy Enterprises, Inc.	728117

19.	Quebecor, Inc.	748193
20.	Times Mirror Co.	887360
21.	Wallace Computer Services, Inc.	932270
22.	Washington Post Co.	939640

Industry 29 (Petroleum Refining)

1.	Amerada Hess Corp.	023551
2.	American Petrofina, Inc.	028861
3.	Amoco Corp.	031905
4.	Ashland Oil, Inc.	044540
5.	Atlantic Richfield Co.	048825
6.	Chevron Corp.	166751
7.	Elcor Corp.	284443
8.	Holly Corp.	435758
9.	Kerr McGee Corp.	492386
10.	Mobil Corp.	607059
11.	Murphy Oil Corp.	626717
12.	Pennzoil Co.	709903
13.	Phillips Petroleum Co.	718507
14.	Quaker State Corp.	747410
15.	Sun Inc.	866762
16.	Tesoro Petroleum Corp.	881609
17.	Texaco, Inc.	881694
18.	Total Petroleum-North America, Ltd.	891508
19.	USX Corp.	902905

Industry 33 (Primary Metals Industry)

1.	Alcan Aluminum, Ltd.	013716
2.	Aluminum Corp of America	022249
3.	AMAX, Inc.	023127
4.	Asarco, Inc.	043413
5.	Bethlehem Steel Corp.	087509
6.	Brush Wellman, Inc.	117421
7.	Carpenter Technology Corp.	144285
8.	Copperweld Corp.	217687
9.	General Housewares Corp.	370073
10.	Handy & Harman	410306
11.	Keystone Cons Inds, Inc.	493422
12.	LTV Corp.	502210
13.	Lukens Inc.	549866
14.	Maxxam, Inc.	577913
15.	National Std. Co.	637742
16.	Nucor Corp	670346
17.	Penn Cent Corp.	707271
18.	Phelps Dodge Corp.	717265
19.	Proler International Corp.	743396
20.	Quanex Corp.	747620
21.	Reynolds Metals Co.	761763
22.	Wheeling Pittsburgh Steel Corp.	963150

Industry 36 (Electrical Equipment)

1.	American Precision Industries, Inc.	029069
2.	AMP Inc.	031897
3.	Applied Magnetics Corp.	038213
4.	Arrow Automotive Industries, Inc.	042727
5.	Augat, Inc.	051042
6.	Aydin Corp.	054681
7.	Baldor Electrical Co.	057741
8.	Cooper Industries, Inc.	216669
9.	Dynamics Corporation of America	268039
10.	Emerson Elec. Co.	291011
11.	Espey Manufacuring and Electronics Corp.	296650
12.	G T I Corp.	362360
13.	General Electric Corp.	369604
14.	Harris Corp.	413875
15.	Hubbell, Inc.	443510
16.	International Rectifier Corp.	460254
17.	Kollmorgen Corp.	500440
18.	Kuhlman Corp.	501206
19.	Matec Corp.	576667
20.	Motorola, Inc.	620076
21.	National Presto Industries, Inc.	637215
22.	National Service Industries, Inc.	637657
23.	Northern Telecom, Ltd.	665815
24.	Park Electrochemical Corp.	700416
25.	Rogers Corp.	775133
26.	Scientific Atlanta, Inc.	808655
27.	Semtech Corp.	806850
28.	Square D Co.	852206
29.	Standard Mtr Prods, Inc.	853666
30.	Technitrol, Inc.	878555
31.	Texas Instruments, Inc.	882508
32.	Thomas Industries, Inc.	884425
33.	Unitrode Corp.	913283
34.	Vishay Intertechnology, Inc.	928298
35.	Whirlpool Corp.	963320
36.	Zenith Electornics Corp.	989349

Industry 52 (Retail Sales)

1.	Albertson's	013104
2.	American Stores Co.	030096
3.	Ames Department Stores, Inc.	030789
4.	Carter, Hawley, Hale Stores, Inc.	146227
5.	Dayton Hudson Corp.	239753
6.	Dillard Department Stores, Inc.	254063
7.	Edison Brothers Stores, Inc.	280875
8.	Fays Drug, Inc.	313035
9.	Foodarama Supermarkets, Inc.	344820
10.	GRI, Corp.	362232
11.	GAP, Inc.	364760
12.	General Cinema Corp.	369352

13.	Genovese Drug Stores, Inc.	372442
14.	Giant Food, Inc.	374478
15.	Great Atlantic and Pacific Tea, Inc.	390064
16.	Greenman Brothers, Inc.	395370
17.	Hannaford Brothers Co.	410550
18.	House Fabrics, Inc.	441758
19.	Jamesway Corp.	470736
20.	K-Mart Corp.	482584
21.	Kroger Co.	501044
22.	May Department Stores Co.	577778
23.	McDonalds Corp.	580135
24.	Melville Corp.	585745
25.	Mercantile Stores, Inc.	587533
26.	Mott's, Ltd	620124
27.	J. C. Penney, Inc.	708160
28.	Petrie Stores Corp.	716434
29.	Ruddick Corp.	781258
30.	Sunshine Jr. Stores, Inc.	867830
31.	Tandy Brands, Inc.	875379
32.	Three D Department Stores, Inc.	885539
33.	United States Shoe Corp.	912605
34.	Walgreen Co.	931422
35.	Weis Markets, Inc.	948849
36.	Winn Dixie Stores, Inc.	974280

Industries not used in Analysis

Industry Number	Industry Name
1300	Oil and Gas Extraction
2600	Paper and Allied Products
2800	Chemicals & Allied Products
3400	Fabricated Metals
3500	Industrial Commercial Machinery, Computers
3700	Transportation Equipment
3800	Measuring, Photo. Goods,and Watches
5000	Wholesale Durable Goods
6300	Insurance Carriers and Agents
6700	Holding and Investment Companies

Appendix D: 3SLS Results using σ(Daily Returns) for Risk

	Leverage Equation		Cash Flow Equation		Risk Equation	
Industry	CF→MVL H_0 $\beta(B)=0$	σ→MVL Risk $A(B)=0$	Signalling H_0 $\eta(B)=0$	σ→CF Risk $C(B)=0$	MVL→σ Leverage $\alpha(B)=0$	CF→σ Cash Flow $\pi(B)=0$
20[a]	2.58	0.52	3.61	3.75	2.99	1.07
	(0.04)	(0.72)	(0.01)	(0.00)	(0.02)	(0.40)
27[b]	2.41	1.89	1.85	2.88	7.40	3.08
	(0.05)	(0.11)	(0.12)	(0.02)	(0.00)	(0.02)
29[c]	0.85	2.68	0.61	1.10	1.78	0.47
	(0.49)	(0.03)	(0.66)	(0.35)	(0.13)	(0.76)
33[d]	2.05	2.37	3.13	3.48	2.38	4.82
	(0.13)	(0.08)	(0.01)	(0.06)	(0.04)	(0.01)
36[e]	0.40	4.03	2.52	2.51	3.76	1.11
	(0.81)	(0.00)	(0.04)	(0.04)	(0.00)	(0.35)
52[f]	1.34	1.62	2.47	0.88	1.96	1.50
	(0.25)	(0.17)	(0.04)	(0.47)	(0.10)	(0.20)

[a]degrees of fredom for first six F-tests (4, 2553) and (24, 2553) for last 3. [b]df(4,2238); (21,2238). [c]df(4,1923); (18,1923). [d](4,2238); (21,2238), [e]df(4,3708); (35,3708). [f]df(4,3814); (36,3814)

Firm Dummy Variable Test

Risk=σ

Leverage $\lambda_1-\lambda_i=0$	Cash Flow $\lambda_1-\lambda_i=0$	Risk $\lambda_1-\lambda_i=0$
2.20	1.05	2.39
(0.00)	(0.39)	(0.00)
3.15	1.37	2.07
(0.00)	(0.12)	(0.00)
2.08	1.03	1.48
(0.00)	(0.42)	(0.09)
1.30	1.53	1.87
(0.06)	(0.04)	(0.01)
2.93	1.05	2.51
(0.00)	(0.39)	(0.00)
1.23	1.40	1.23
(0.17)	(0.06)	(0.17)

Coefficients from 3SLS Estimation

Risk=σ

Equation	Variable	Industry 20	27	29	33	36	52	% of Negative Significant Coefficients	% of Positive Significant Coefficients
Leverage	CF_t	-0.89**	-0.58**	-1.28	-1.45**	0.72	-0.47**	67%	0%
CF→MVL	CF_{t-1}	-0.01	0.08	0.09	0.17	-0.23	-0.14**	17%	0%
	CF_{t-2}	0.17**	0.01	0.09	0.54**	-0.15	0.06	0%	33%
	CF_{t-3}	-0.09	0.01	0.21	-0.03	0.01	0.00	0%	0%
	CF_{t-4}	0.43**	0.57**	-0.04	0.16	-0.12	0.23	0%	33%
Cash Flow	MVL_t	-0.12	-0.12**	-0.00	-0.21**	-0.10**	-0.22**	67%	0%
(Signalling)	MVL_{t-1}	0.12*	0.08**	-0.02	0.18**	0.09**	0.18**	0%	67%
	MVL_{t-2}	-0.03	0.02	0.02	-0.01	0.00	0.03**	0%	17%
	MVL_{t-3}	-0.03	-0.01	-0.02	-0.02*	-0.02	0.01	17%	0%
	MVL_{t-4}	0.06**	0.00	0.03*	0.03**	0.03**	0.00	0%	67%

System r^2 and Cross-Model Correlation for Three-Stage Least Squares Estimation

Risk Variable is Standard deviation of Daily Returns (σ)

Industry	System r^2	$\rho_{\varepsilon(MVL),\varepsilon(CF)}$	$\rho_{\varepsilon(CF),\varepsilon(\sigma)}$	$\rho_{\varepsilon(MVL),\varepsilon(\sigma)}$
20	0.88	0.13	-0.74	-0.20
27	0.92	0.33	-0.29	-0.78
29	0.74	0.08	0.48	0.44
33	0.87	0.59	-0.57	-0.70
36	0.82	-0.15	0.47	-0.39
52	0.86	0.47	-0.46	-0.02

Coefficients for Lagged Risk and Coefficients of Lagged Cash Flow and Leverage from Risk Equation

Risk defined as Standard Deviation of Daily Returns

		Industry					
Equation	Variable	20	27	29	33	36	52
Leverage risk→MVL	σ_t	0.12	2.11**	-4.33**	5.46**	2.99**	2.23
	σ_{t-1}	-0.13	-0.17	1.10**	-0.16**	-0.70**	-0.23
	σ_{t-2}	-0.05	-0.04	0.28	-0.12**	-0.50**	-0.42*
	σ_{t-3}	-0.29	-0.36	0.30	-0.03	-0.06	-0.23
	σ_{t-4}	0.18	-0.47**	-0.36	-0.27	0.17	0.34**
Cash Flow risk→CF	σ_t	4.12**	0.56**	-1.59**	1.43**	-1.90**	1.63**
	σ_{t-1}	-0.92**	-0.12	0.30*	-0.39**	0.32**	-0.33*
	σ_{t-2}	-0.65**	-0.12	0.10	-0.25**	0.24**	-0.10
	σ_{t-3}	0.20*	-0.13	0.16*	0.09	0.29**	-0.14**
	σ_{t-4}	-0.05	-0.24**	0.11	0.07	-0.01	0.07
Risk MVL→risk	MVL_t	0.14**	0.24**	-0.04	0.10**	0.09**	0.07*
	MVL_{t-1}	-0.12**	-0.17**	0.02	-0.09**	-0.08**	-0.06
	MVL_{t-2}	0.00	0.01	0.01	0.00	0.00	-0.01**
	MVL_{t-3}	0.01	-0.06**	0.00	0.01*	-0.01	0.00
	MVL_{t-4}	0.00	0.04**	0.01	-0.02**	0.01**	0.00
Risk CF→risk	CF_t	0.10**	0.16**	-0.20**	0.25**	-0.12**	0.09**
	CF_{t-1}	0.01	-0.24	0.05	-0.08*	0.04	0.00
	CF_{t-2}	-0.02	-0.01	-0.02	-0.06*	0.03**	-0.01
	CF_{t-3}	0.00	-0.01	0.02	-0.01	-0.01	-0.02**
	CF_{t-4}	-0.04*	-0.16**	0.02	-0.02	0.01	-0.04*

Percent of Significant Coefficients and Signs

risk=σ

Equation	Variable	Significant Negative Coefficients	Significant Positive Coefficients
Leverage risk→MVL	σ_t	17%	67%
	σ_{t-1}	50%	17%
	σ_{t-2}	67%	0%
	σ_{t-3}	17%	0%
	σ_{t-4}	17%	17%
Cash Flow risk→CF	σ_t	33%	17%
	σ_{t-1}	17%	33%
	σ_{t-2}	17%	17%
	σ_{t-3}	0%	17%
	σ_{t-4}	17%	0%
Risk MVL→risk	MVL_t	0%	83%
	MVL_{t-1}	67%	0%
	MVL_{t-2}	17%	0%
	MVL_{t-3}	17%	17%
	MVL_{t-4}	17%	17%
Risk CF→risk	CF_t	33%	67%
	CF_{t-1}	17%	0%
	CF_{t-2}	17%	17%
	CF_{t-3}	17%	0%
	CF_{t-4}	50%	0%

Appendix E: Results for Mean-Adjusted Variables

Coefficients from 3SLS Estimation(Mean-Adjusted)

Equation	Variable	Industry 20	27	29	33	36	52
Leverage	ιCF_t	-0.87**	-0.23	0.34	-2.46**	-0.53**	-0.97**
$\iota CF \rightarrow \iota MVL$	ιCF_{t-1}	-0.01	0.04	-0.48	0.67**	0.21	-0.17**
	ιCF_{t-2}	0.19**	0.01	0.25	0.33	0.12	-0.00
	ιCF_{t-3}	-0.08	-0.03	0.14	-0.02	-0.05	-0.14**
	ιCF_{t-4}	0.45**	0.22	-0.31	0.30	-0.03	0.50**
Cash Flow	ιMVL_t	-0.17**	-0.09**	0.02	-0.26**	-0.11**	-0.26**
(Signalling]	ιMVL_{t-1}	0.14**	0.08**	-0.02	0.21**	0.09**	0.23**
	ιMVL_{t-2}	0.03**	0.00	0.02	0.00	-0.01	0.01
	ιMVL_{t-3}	-0.03	-0.01	-0.02	-0.03**	-0.01	-0.01
	ιMVL_{t-4}	0.02	0.00	0.02	0.03**	0.02*	0.00

Equation	Variable	Significant Negative Coefficients	Significant Positive Coefficients
Leverage	ιCF_t	67%	0%
$\iota CF \rightarrow \iota MVL$	ιCF_{t-1}	17%	0%
	ιCF_{t-2}	0%	0%
	ιCF_{t-3}	17%	0%
	ιCF_{t-4}	0%	33%
Cash Flow	ιMVL_t	83%	0%
(Signalling]	ιMVL_{t-1}	0%	83%
	ιMVL_{t-2}	0%	17%
	ιMVL_{t-3}	17%	0%
	ιMVL_{t-4}	0%	33%

System r^2 and Cross-Model Correlation for Three-Stage Least Squares Estimation (Mean Adjusted)

Industry	System r^2	$\rho_{\varepsilon(\iota MVL),\varepsilon(\iota CF)}$	$\rho_{\varepsilon(\iota CF),\varepsilon(\iota \beta)}$	$\rho_{\varepsilon(\iota MVL),\varepsilon(\iota \beta)}$
20	0.78	0.48	-0.12	0.03
27	0.78	0.12	0.51	0.33
29	0.80	-0.22	0.39	0.06
33	0.82	-0.70	-0.27	-0.53
36	0.70	0.21	0.16	0.08
52	0.78	0.57	-0.09	-0.23

Coefficients for Lagged Risk and Coefficients of Lagged Cash Flow and Leverage from Risk Equations (Mean Adjusted)

Equation	Variable	Industry 20	27	29	33	36	52
Leverage	$\iota\beta_t$	0.06	-0.05	0.08	0.05	-0.01	0.07**
$\iota\beta \rightarrow \iota MVL$	$\iota\beta_{t-1}$	-0.03	0.03	-0.08	-0.05	0.01	-0.04
	$\iota\beta_{t-2}$	-0.04**	0.00	0.01	0.01	-0.01	-0.05**
	$\iota\beta_{t-3}$	0.01	-0.01	-0.01	0.01	0.02	0.02
	$\iota\beta_{t-4}$	0.00	-0.01	-0.00	0.00	0.00	0.00
Cash Flow	$\iota\beta_t$	0.02	-0.08**	-0.02	0.01	-0.01	0.00
$\iota\beta \rightarrow \iota CF$	$\iota\beta_{t-1}$	-0.02	0.07**	0.02	-0.01	0.01	0.00
	$\iota\beta_{t-2}$	-0.00	-0.00	0.01	0.00	-0.01**	-0.01**
	$\iota\beta_{t-3}$	-0.00	0.01	-0.01	0.01	0.01*	0.00
	$\iota\beta_{t-4}$	0.00	-0.01**	0.00	-0.01	-0.00	0.00
Risk	ιMVL_t	-0.18	-1.44**	-0.76	2.82**	-0.50	0.57
$\iota MVL \rightarrow \iota\beta$	ιMVL_{t-1}	-0.11	1.23**	0.45	-2.48**	0.32	-0.45
	ιMVL_{t-2}	0.25	-0.22	0.11	-0.23*	0.12	-0.19*
	ιMVL_{t-3}	0.11	0.32*	-0.07	0.64**	-0.22	0.00
	ιMVL_{t-4}	-0.32**	-0.20	0.07	-0.19	0.13	0.01
Risk	ιCF_t	0.17	-4.02**	-4.44**	2.30**	-2.44**	1.29*
$\iota CF \rightarrow \iota\beta$	ιCF_{t-1}	0.04	0.23	1.85**	1.73*	1.03**	0.27
	ιCF_{t-2}	-0.06	-0.39**	0.01	-0.51	0.82**	0.20
	ιCF_{t-3}	0.18	-0.18	0.04	-0.21	0.12	0.35**
	ιCF_{t-4}	0.25	3.08**	0.81	-0.26	0.41	-0.61

*significant at the 10% level **significant at the 5% level

Appendix F: Mean Squared Error-Firm 3SLS Estimation

Industry=20

Conum	MSE	Degrees of Freedom
027339	1.34	41
039483	1.03	41
099599	0.94	42
126149	0.99	41
127703	0.59	42
134429	1.04	42
170268	1.19	42
231382	0.92	42
343496	0.93	42
378694	0.88	43
427866	0.98	42
440452	0.98	41
462218	1.40	41
487836	1.00	41
713448	0.82	41
747402	1.02	41
751277	1.12	42
803111	0.82	42
809163	0.85	42
811850	0.90	42
832696	1.00	43
861839	1.06	42
890516	1.11	45
913538	1.07	41
96647K	0.99	41

Industry=27

Conum	MSE	Degrees of Freedom
024763	0.78	43
103043	0.87	42
257867	0.94	42
260561	0.91	42
293389	0.99	42
364730	1.16	42
411631	1.03	42
412693	0.90	42
441560	0.92	42
498494	0.69	41
499040	0.97	42
523768	0.91	42
580645	0.91	42
584404	1.00	42
589433	0.90	42
594780	0.96	42
650111	0.78	42
728117	0.93	42
748193	0.98	43
887360	0.97	42
932270	1.00	42
939640	0.98	42

Industry=29

Conum	MSE	Degrees of Freedom
023551	1.33	42
028861	1.09	41
031905	0.98	41
044540	1.01	41
048825	0.85	41
166751	0.82	41
284443	0.97	42
435758	0.91	42
492386	1.18	41
607059	1.39	41
626717	0.77	42
709903	0.83	42
718507	0.82	41
747410	0.93	42
866762	1.02	42
881609	1.04	42
881694	1.08	41
891508	1.09	42
902905	1.03	41

Industry=33

Conum	MSE	Degrees of Freedom
013716	0.96	41
022249	0.99	41
023127	0.96	42
043413	1.08	41
087509	1.17	41
117421	0.93	41
144285	1.07	41
217687	0.92	42
370073	0.85	42
410306	1.04	42
493422	1.02	42
502210	1.02	41
549866	0.92	42
577913	0.80	42
637742	0.85	43
670346	0.92	42
707271	1.04	41
717265	1.09	41
743396	1.03	42
747620	0.93	42
761763	0.92	41
963150	0.93	42

Industry=36

Conum	MSE	Degrees of Freedom
029069	0.90	4
031897	0.99	41
038213	0.83	41
042727	1.07	43
051042	1.02	41
054681	0.86	41
057741	0.99	41
216669	0.84	41
268039	0.96	41
291011	1.00	41
296650	0.95	41
362360	1.14	42
369604	1.32	41
413875	1.07	41
443510	0.95	42
460254	1.15	41
500440	0.89	41
501206	0.97	41
576667	1.01	41
620076	0.99	41
637215	0.88	42
637657	1.22	42
665815	0.97	41
700416	0.86	42
775133	0.86	41
808655	1.01	41
816850	0.93	41
852206	1.03	41
853666	0.90	42
878555	0.98	42
882508	0.90	41
884425	0.92	41
913283	0.87	41
928298	0.94	41
963320	0.96	41
989349	0.95	41

Industry=52

Conum	MSE	Degrees of Freedom
013104	0.86	42
030096	0.91	42
030789	1.01	42
146227	1.10	42
239753	1.02	42
254063	0.94	42
280875	1.04	42
313035	0.90	42
344820	0.97	42
362232	1.19	42
364760	0.85	42
369352	0.90	42
372442	0.79	42
374478	0.91	42
390064	0.85	42
395370	1.11	42
410550	1.28	42
441758	0.94	42
470736	1.87	42
482584	1.07	42
501044	0.95	42
577778	0.93	43
580135	1.08	42
585745	0.94	42
587533	1.02	42
620124	0.70	42
708160	0.97	42
713278	1.02	42
716434	1.09	42
781258	1.20	43
867830	1.08	42
875379	0.84	42
885539	0.85	9
912605	0.93	42
931142	0.86	42
931422	0.97	42
974280	0.97	42

Appendix G: Residual Autocorrelation Check

Industry=20

Conum	Cash Flow u_i P-value	Leverage (MVL) u_i P-value
027339	0.40	0.22
039483	0.60	0.38
099599	0.23	0.83
126149	0.59	0.39
127703	0.28	0.20
134429	0.74	0.85
170268	0.72	0.68
231382	0.28	0.79
343496	0.17	0.87
378694	0.25	0.76
427866	0.37	0.24
440452	0.52	0.24
462218	0.48	0.27
487836	0.15	0.85
713448	0.62	0.35
747402	0.34	0.05
751277	0.76	0.78
803111	0.10	0.46
809163	0.41	0.03
811850	0.65	0.77
832696	0.32	0.13
861839	0.74	0.22
890516	0.49	0.00
913538	0.88	0.52
96647K	0.54	0.65

Industry=27

Conum	Cash Flow u_i P-value	Leverage(MVL) u_i P-value
024763	0.49	0.33
103043	0.13	0.14
257867	0.63	0.20
260561	0.91	0.58
293389	0.13	0.15
364730	0.37	0.65
411631	0.52	0.27
412693	0.79	0.21
441560	0.74	0.80
498494	0.90	0.65
499040	0.59	0.27
523768	0.68	0.51
580645	0.75	0.68
584404	0.21	0.53
589433	0.63	0.25
594780	0.95	0.92
650111	0.32	0.26
728117	0.20	0.88
748193	0.71	0.91
887360	0.90	0.73
932270	0.89	0.09
939640	0.20	0.75

Industry=29

Conum	Cash Flow u_i P-value	Leverage(MVL) u_i P-value
023551	0.37	0.63
028861	0.41	0.75
031905	0.00	0.07
044540	0.97	0.27
048825	0.77	0.54
166751	0.31	0.00
284443	0.29	0.22
435758	0.60	0.60
492386	0.02	0.67
607059	0.40	0.15
626717	0.84	0.13
709903	0.70	0.32
718507	0.57	0.47
747410	0.74	0.25
866762	0.24	0.13
881609	0.85	0.52
881694	0.29	0.34
891508	0.75	0.52
902905	0.02	0.52

Industry=33

Conum	Cash Flow u_i P-value	Leverage(MVL) u_i P-value
013716	0.11	0.79
022249	0.53	0.17
023127	0.28	0.22
043413	0.30	0.42
087509	0.35	0.71
117421	0.55	0.63
144285	0.33	0.03
217687	0.19	0.38
370073	0.06	0.09
410306	0.57	0.23
493422	0.15	0.23
502210	0.22	0.14
549866	0.48	0.48
577913	0.79	0.54
637742	0.37	0.15
670346	0.49	0.60
707271	0.19	0.16
717265	0.32	0.90
743396	0.46	0.18
747620	0.41	0.53
761763	0.70	0.46
963150	0.90	0.53

Industry=36

Conum	Cash Flow u_i P-value	Leverage(MVL) u_i P-value
029069	0.21	0.39
031897	0.69	0.71
038213	0.33	0.60
042727	0.31	0.48
051042	0.22	0.44
054681	0.88	0.36
057741	0.59	0.25
216669	0.46	0.11
268039	0.86	0.55
291011	0.33	0.53
296650	0.81	0.77
362360	0.85	0.74
369604	0.13	0.45
413875	0.84	0.98
443510	0.90	0.24
460254	0.63	0.24
500440	0.64	0.71
501206	0.15	0.79
576667	0.77	0.50
620076	0.86	0.46
637215	0.97	0.77
637657	0.03	0.67
665815	0.77	0.60
700416	0.26	0.26
775133	0.01	0.19
808655	0.61	0.06
816850	0.72	0.59
852206	0.49	0.52
853666	0.32	0.30
878555	0.50	0.26
882508	0.79	0.67
884425	0.19	0.53
913283	0.27	0.28
928298	0.20	0.44
963320	0.63	0.72
989349	0.29	0.00

Industry=52

Conum	MSE	Degrees of Freedom
013104	0.86	42
030096	0.91	42
030789	1.01	42
146227	1.10	42
239753	1.02	42
254063	0.94	42
280875	1.04	42
313035	0.90	42
344820	0.97	42
362232	1.19	42
364760	0.85	42
369352	0.90	42
372442	0.79	42
374478	0.91	42
390064	0.85	42
395370	1.11	42
410550	1.28	42
441758	0.94	42
470736	1.87	42
482584	1.07	42
501044	0.95	42
577778	0.93	43
580135	1.08	42
585745	0.94	42
587533	1.02	42
620124	0.70	42
708160	0.97	42
713278	1.02	42
716434	1.09	42
781258	1.20	43
867830	1.08	42
875379	0.84	42
885539	0.85	9
912605	0.93	42
931142	0.86	42
931422	0.97	42
974280	0.97	42

Appendix H: Comparison of OLS and 3SLS Coefficients for the Leverage Equation

(Standard Error in parentheses)

Industry	CF OLS	CF 3SLS	CF_{t-1} OLS	CF_{t-1} 3SLS	CF_{t-2} OLS	CF_{t-2} 3SLS	CF_{t-3} OLS	CF_{t-3} 3SLS	CF_{t-4} OLS	CF_{t-4} 3SLS
20	-0.48	-0.71	-0.08	-0.03	0.18	0.19	-0.06	-0.07	0.23	0.23
	(0.09)	(0.27)	(0.08)	(0.09)	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.45)
27	-0.29	-0.86	0.00	0.04	0.01	-0.05	-0.03	-0.05	0.23	0.66
	(0.10)	(0.27)	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)	(0.06)	(0.09)	(0.20)
29	-0.45	-0.51	-0.18	-0.18	0.29	0.31	0.13	0.14	-0.17	-0.16
	(0.13)	(1.02)	(0.14)	(0.41)	(0.15)	(0.15)	(0.15)	(0.15)	(0.14)	(0.24)
33	-0.45	-0.55	-0.18	-0.45	0.29	0.37	0.13	-0.03	-0.17	0.09
	(0.13)	(0.78)	(0.14)	(0.50)	(0.15)	(0.22)	(0.15)	(0.22)	(0.14)	(0.21)
36	-0.19	0.93	0.07	-0.36	0.05	0.15	-0.04	-0.00	-0.07	-0.21
	(0.07)	(0.63)	(0.08)	(0.25)	(0.08)	(0.14)	(0.07)	(0.08)	(0.07)	(0.11)
52	-0.50	-0.73	-0.20	-0.17	0.03	0.02	-0.13	-0.13	0.18	0.34
	(0.09)	(0.26)	(0.06)	(0.07)	(0.06)	(0.07)	(0.06)	(0.07)	(0.09)	(0.20)
	βeta OLS	βeta 3SLS	β_{t-1} OLS	β_{t-1} 3SLS	β_{t-2} OLS	β_{t-2} 3SLS	β_{t-3} OLS	β_{t-3} 3SLS	β_{t-4} OLS	β_{t-4} 3SLS
20	0.01	0.42	0.03	-0.02	-0.04	-0.04	0.01	0.01	-0.00	0.00
	(0.01)	(0.05)	(0.01)	(0.05)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)
27	0.01	-0.12	-0.02	0.11	-0.01	-0.00	-0.01	-0.00	-0.01	-0.03
	(0.01)	(0.07)	(0.01)	(0.07)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
29	0.01	0.06	-0.02	-0.07	-0.02	0.01	-0.01	-0.01	-0.01	0.00
	(0.02)	(0.06)	(0.01)	(0.06)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
33	0.01	0.08	-0.00	-0.07	-0.00	-0.00	0.01	0.01	-0.00	0.01
	(0.02)	(0.05)	(0.02)	(0.05)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
36	0.01	0.03	-0.01	-0.04	-0.00	0.01	0.01	0.00	0.01	0.01
	(0.01)	(0.04)	(0.12)	(0.05)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
52	0.01	0.03	0.02	-0.00	-0.05	-0.05	0.01	0.02	0.00	0.00
	(0.01)	(0.04)	(0.01)	(0.04)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)
	TAX OLS	TAX 3SLS	Tgast OLS	Tgast 3SLS	UNIQ OLS	UNIQ 3SLS	SIZE OLS	SIZE 3SLS	Trend OLS	Trend 3SLS
20	0.61	-0.64	0.01	0.02	0.27	0.33	0.07	0.06	-0.00	-0.00
	(0.35)	(0.41)	(0.03)	(0.02)	(1.00)	(0.84)	(0.01)	(0.01)	(0.00)	(0.00)
27	0.70	0.49	-0.09	0.02	15.48	0.33	0.06	0.06	-0.00	-0.00
	(0.31)	(0.39)	(0.03)	(0.02)	(2.38)	(0.84)	(0.01)	(0.01)	(0.00)	(0.00)
29	0.64	0.64	-0.06	-0.06	1.76	3.96	0.05	0.05	-0.00	-0.00
	(0.34)	(0.34)	(0.03)	(0.04)	(2.66)	(3.53)	(0.01)	(0.01)	(0.00)	(0.00)
33	0.15	-2.80	-0.01	0.11	-0.26	-2.66	0.03	0.00	-0.00	-0.00
	(0.81)	(1.24)	(0.04)	(0.05)	(2.46)	(2.56)	(0.01)	(0.01)	(0.00)	(0.00)
36	-0.14	-0.62	0.06	0.07	0.11	0.21	0.06	0.07	-0.00	-0.00
	(0.23)	(0.50)	(0.02)	(0.03)	(0.19)	(0.26)	(0.01)	(0.01)	(0.00)	(0.00)
52	0.47	-0.77	-0.03	-0.01	n/a	n/a	0.02	0.02	-0.00	-0.00
	(0.43)	(0.41)	(0.03)	(0.02)			(0.01)	(0.01)	(0.00)	(0.00)

n/a Industry 52 has no research and development expense.