The firm’s leverage-cash flow relationship

Catherine Shenoy, Paul D. Koch*

University of Kansas, School of Business, Lawrence KS 66045, USA

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Abstract

Two separate strands of the literature on capital structure under asymmetric information consider the relationship between a firm’s financial leverage and cash flow. Signalling theory suggests a positive relationship, while pecking order behavior implies a negative relationship. These contrasting theoretical implications appear contradictory. However, both are supported in different bodies of empirical literature. Leverage-changing event studies tend to support a positive relationship while cross-sectional studies typically reveal a negative relationship. This paper proposes that the appropriate pecking order relationship is contemporaneous – between current leverage and current cash flow, while the relevant signalling relationship is intertemporal-between current leverage and future cash flow. A dynamic simultaneous equations model is built which allows the firm’s leverage, cash flow, and risk to interact jointly in the same period, as well as across time. Empirical results reveal that, in the same time period, leverage and cash flow tend to be negatively related, while across time leverage is positively related to future cash flow. Thus the apparent contradictions in the theoretical and empirical literature may be reconciled by considering both the contemporaneous and dynamic aspects of the firm’s leverage/cash flow relationship.

JEL classification: G23; G35

Keywords: Capital structure policy; Dividend policy; Signalling theory; Agency theory; Free cash flow hypothesis

* Corresponding author. E-mail: pkoch@pobox.cc.ukans.edu or cshenoy@stat1.cc.ukans.edu. Fax: (913) 864-5328

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1. Introduction

Signalling theory and pecking order behavior suggest contradictory relationships between a firm's financial leverage and its cash flow. Signalling theory implies a positive relationship, in which firms with higher cash flow signal their performance with higher leverage. In contrast, pecking order behavior suggests a negative relationship, in which firms with higher internally generated cash flow require less debt. Both pecking order behavior and signalling theory have broad support in different bodies of empirical literature. Leverage-changing event studies focus on market expectations of future cash flow and generally support the signalling view, while cross-sectional leverage studies focus on the contemporaneous relationship and generally support the pecking order view.¹

The comparative statics of signalling models suggest that higher leverage is associated with higher cash flow in the same time period (Ross, 1977, Harris and Raviv, 1991). However, virtually all cross-sectional empirical studies of the leverage-cash flow relationship find a negative contemporaneous association. We propose that the positive relationship implied by signalling theory should be intertemporal in nature, rather than contemporaneous. According to signalling theory, managers possess asymmetric information regarding the firm's investment prospects. Managers then convey to the market their expectations of future performance through their financing decisions. While financing decisions are immediately reflected in the level of financial leverage, the investment payoffs from these decisions are in the future. Therefore, the relevant signalling relationship is between current leverage and future cash flow.

Pecking order financing, on the other hand, focuses on the contemporaneous relationship between cash flow and leverage. In a pecking order, a firm with productive investment opportunities in any given period will rely first on available cash flow to meet these financing needs. When cash flow is depleted, the firm will then issue debt, and as a last resort the firm will issue equity. This scenario implies that debt is a residual of cash flow in any given time period. Thus, pecking order behavior implies that cash flow and debt should be negatively related and simultaneously determined.

The existing empirical literature on the firm's leverage-cash flow relationship emphasizes either the contemporaneous relationship or the dynamic relationship inherent in market expectations – not both. Event studies which support the signalling hypothesis focus on market expectations of future cash flow, while cross-sectional studies reveal the contemporaneous relationship. We suggest that a dynamic model is necessary to capture the intertemporal signalling relationship from leverage to future cash flow. On the other hand, the joint determination of

¹ See Masulis (1988) for a summary of leverage-changing event studies. See Harris and Raviv (1991) for a comparison of the theoretical predictions and empirical results from cross-sectional studies.
cash flow and leverage implied by pecking order behavior requires that we focus on the contemporaneous relationship.

This paper attempts to reconcile these two strands of literature and address this apparent conflict, by considering both the contemporaneous and the dynamic interaction between a firm's capital structure and its cash flow. Since a firm's risk may also interact with its leverage and cash flow, we specify a dynamic simultaneous equations model in which a firm's leverage, cash flow, and risk may interact jointly in the same period, as well as across time. This model incorporates both the contemporaneous and intertemporal relationships between leverage and cash flow, and thus enables the data to reveal the full cycle of interaction between these variables. We apply this model to analyze six different samples of pooled time series and cross-sectional data, for firms in six different industries.

Several features of this analysis represent novel means for testing signalling theory and pecking order behavior. First, no previous work attempts to link these two separate strands of theoretical and empirical literature, and reconcile the contrasting implications. Second, previous tests of the signalling hypothesis consider only major leverage-changing events, focusing on the associated stock price response and the implied change in expected cash flow. In contrast, our pooled time series/cross-sectional approach takes into account all variation in leverage over time, and across firms. This approach reveals the nature and extent of the leverage/cash flow relationship under all circumstances, not just during major changes in firm policy. Third, few previous studies explicitly examine the contemporaneous pecking order relationship, although the results of many cross-sectional leverage studies are consistent with a pecking order explanation. This study extends previous cross-sectional investigations by, not only recognizing the cross-sectional association between leverage and cash flow, but also incorporating the potential simultaneity that is implied by pecking order behavior. This specification allows us to examine how leverage jointly determines, and is determined by, cash flow. Finally, other factors are also important in determining a firm's capital structure and cash flow, and at the same time are consistent with the implications of either pecking order behavior or signalling theory. With this in mind, we also incorporate exogenous influences such as tax considerations and asset composition into the simultaneous equations model.

Results reveal a negative contemporaneous interaction between the firm's leverage and cash flow, along with a positive relationship from leverage to future cash flow. These results provide support for both pecking order behavior and signalling theory in the context of a single model, and therefore help to reconcile the apparent contradictions in the existing theoretical and empirical literature.

The paper is organized as follows. Section 2 discusses the implications of signalling theory and pecking order behavior. Section 3 specifies our structural

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model. Section 4 discusses the data and methodology. Section 5 reports the results, and the final section summarizes and concludes.

2. Signalling theory and pecking order behavior

2.1. Capital structure signalling theory

In his early work on this issue, Ross (1977) examines managers' use of leverage as a signal to the market regarding a firm's quality, where quality is defined as the level of cash flow. Ross proposes that the relative amounts of debt and equity employed by a firm provide information to outside investors about the quality of a firm. He suggests that a manager of a high quality firm will issue more debt and have a higher level of financial leverage. The comparative statics of this scenario suggest that higher leverage should be associated with higher cash flow in the same period (Ross, 1977, Harris and Raviv, 1991).

We note that signalling theory further suggests that higher leverage should also be associated with higher future cash flow. From the shareholder's point of view, it is difficult to evaluate the current investment decisions of managers. Only later can investors observe the eventual outcome of current investment decisions, in future cash flow. On the other hand, financing decisions are immediately observable. Investors can therefore scrutinize the current level of leverage and infer managerial expectations of future cash flow resulting from the firm's current investment opportunities.

This argument suggests that the relevant signalling relationship is intertemporal in nature — between current financial leverage and future cash flow. Since Ross' (1977) paper appeared, other theoretical asymmetric information models have also been proposed to examine how financial leverage serves as a signal of future cash flow. The models of Blazenko (1987), Poitevin (1989), and Ravid and Sarig (1991) all predict that higher leverage should be associated with higher future cash flow.

Empirical research on this issue primarily consists of event studies that examine how major changes in leverage affect a firm's market value. This work generally supports the signalling hypothesis that higher leverage is associated with higher expected future cash flow. Studies of 'pure leverage changes' consistently find a positive announcement effect for leverage increases and a negative reaction to leverage decreases. However, not all studies of other leverage-changing events consistently support the signalling hypothesis.  

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3 See Copeland and Lee (1991), Cornett and Travlos (1989), Dann et al. (1989), and Israel et al. (1989). Masulis (1988) provides a survey. Out of 20 leverage-increasing event studies in this survey, 13 display significantly positive excess returns, while the rest display excess returns that are not significantly different from zero. Leverage-decreasing event studies offer similar results.
2.2. Pecking order behavior

During any given period, managers must resolve the problem of how to finance investment opportunities. One line of capital structure research observes that firms generally follow a pecking order to meet their financing needs: managers rely first on internally generated funds; next they issue debt; and as a last resort they issue equity. Myers and Majluf (1984) use the idea of information asymmetry to provide a theoretical explanation for this behavior. A higher quality firm will generate more internal cash flow, and should therefore require a lower level of external financing during any given time period. Holding dividends and investment constant, pecking order behavior implies that debt is a residual of cash flow in any time period. Pecking order behavior therefore implies that cash flow and leverage should be negatively related and simultaneously determined.

A large body of empirical work scrutinizes the cross-sectional relationship between a firm's leverage and accounting measures of firm quality, such as profitability or earnings. This work generally finds a negative contemporaneous association, consistent with pecking order behavior. Baskin (1989) and Vogt (1992) also find support for the pecking order hypothesis using a time series methodology. Baskin finds a negative association between earnings and leverage in the same time period, as well as a negative lagged relationship across time. His contemporaneous results are consistent with pecking order behavior. On the other hand, a negative dynamic relationship is not consistent with signalling theory. Jensen et al. (1992) develop a simultaneous equations model for the firm's debt, dividends, and capital structure. They find a negative cross-sectional relationship between cash flow and leverage. They also find support for a pecking order relationship in their dividend equation.

3. A dynamic structural model

3.1. Reconciling the implications of signalling theory and pecking order behavior

We suggest that the relevant signalling relationship is intertemporal in nature. Signalling theory implies that leverage should be positively associated with expected future cash flow. To the extent that expectations are eventually realized, leverage should also be positively associated with actual future cash flow. On the other hand, we note that pecking order behavior focuses on the contemporaneous relationship between cash flow and leverage. Pecking order behavior implies that debt is a residual of cash flow in any period; thus cash flow and debt should be negatively related and simultaneously determined.

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In a framework which considers both simultaneous and lagged interaction between leverage and cash flow, the implications of pecking order behavior and signalling theory are no longer inconsistent. During any given period, managers may tend to follow a pecking order in determining their financing needs. At the same time, managers may periodically adjust a firm's leverage which provides a signal of expectations of future performance. This combined behavior should result in a capital structure which tends to display a negative association with cash flow in the same period, along with a positive relationship with future cash flow.

3.2. A dynamic simultaneous equations model

We specify a model that describes this structural relationship between a firm's cash flow and leverage. To develop this specification, note that cash flow and leverage both influence, and are influenced by, a third factor, firm risk. As leverage increases, firm risk also increases. At the same time, cash flows with higher expected values may be more risky. Consequently, any model of cash flow and leverage behavior must also account for simultaneous changes in firm risk.

The interrelationships among a firm's cash flow, financial leverage, and risk may be both simultaneous and lagged. These three firm characteristics are modeled as jointly determined endogenous variables, as follows:

\[
\begin{align*}
CF_{it} &= \sum_{n=0}^{M_1} \alpha_{1n} CF_{it-n} + \sum_{n=0}^{M_2} \alpha_{2n} L_{it-n} + \sum_{n=0}^{M_2} \alpha_{3n} \sigma_{it-n} + \varepsilon_{1it} \\
L_{it} &= \sum_{n=0}^{M_2} \delta_{1n} CF_{it-n} + \sum_{n=1}^{M_4} \delta_{2n} L_{it-n} + \sum_{n=0}^{M_2} \delta_{3n} \sigma_{it-n} + \varepsilon_{2it} \\
\sigma_{it} &= \sum_{n=0}^{M_2} \gamma_{1n} CF_{it-n} + \sum_{n=0}^{M_2} \gamma_{2n} L_{it-n} + \sum_{n=1}^{M_3} \gamma_{3n} \sigma_{it-n} + \varepsilon_{3it},
\end{align*}
\]

where \( CF_{it} \) represents cash flow, \( L_{it} \) represents leverage, and \( \sigma_{it} \) represents risk, for firm \( i \) in period \( t \). Each error term, \( \varepsilon_{rit} \), is assumed to be distributed \( N(0,\sigma_r) \), for \( r = 1, 2, 3 \). Furthermore, these error terms are assumed to be not autocorrelated, but may be contemporaneously correlated across equations. \(^5\)

\(^5\) The assumption of no autocorrelation in the error terms is critical to the validity of the subsequent tests on the coefficients in this model, and is therefore tested formally in the analysis. These results (available upon request) uniformly indicate that the model's residuals are not autocorrelated for all firms in the analysis, lending credence to the structural interpretation of the model's coefficient estimates.
Note that the summation on the right-hand-side lagged endogenous variable in each equation is indexed from 1 to \( M_1 \), while the other summations in each equation run from 0 to \( M_2 \). The two terms at lag zero in each equation represent the right-hand-side endogenous variables that influence the left-hand-side variable in the same period, and that are in turn simultaneously determined in the other equations. The lagged terms in each equation represent the distributed lags of predetermined variables that reveal the dynamic influences across time.

Together, the contemporaneous and lagged influences represented by the coefficients, \( \alpha_{20} \) and \( \delta_{10} \), reflect the dynamic interaction between leverage and cashflow that is the primary focus of this paper. The pecking order relationship is embodied in the contemporaneous coefficients between cash flow and leverage (\( \alpha_{20} \) and \( \delta_{10} \)). The null hypothesis of no contemporaneous pecking order relationship between leverage and cash flow is therefore specified as follows:

\[ H_1: \alpha_{20} = 0 \text{ and } \delta_{10} = 0. \]

Significant negative contemporaneous coefficients would be consistent with pecking order behavior, while significant positive coefficients would be consistent with the signalling theory implications proposed by Ross (1977) and Harris and Raviv (1991).

Next, we propose that the signalling relationship appears in the distributed lag coefficients, \( \alpha_{2n} \), \( n = 1, ..., M_2 \), in the first equation. This proposition leads to the second null hypothesis of no lagged signalling relationship from leverage to future cash flow:

\[ H_2: \alpha_{21} = \alpha_{22} = ... = \alpha_{2M_2} = 0. \]

If one or more of these \( \alpha_{2n} \) coefficients are significantly positive, \( H_2 \) should be rejected in favor of the alternative hypothesis that higher leverage is systematically followed by higher cash flow.

### 3.3. Exogenous influences

The firm characteristics embodied in \( CF_{it}, L_{it} \), and \( \sigma_{it} \) are also influenced by other theoretical considerations that are omitted in Eqs. (1) to (3). First, the description of pecking order behavior is based upon holding investment and dividends constant. We therefore include measures of the firm’s investment (INV) and dividends (DIV) explicitly in all three equations. In addition, the three endogenous variables also depend upon other firm characteristics, which are discussed below for each equation in turn.

In the cash flow Eq. (1), we include investments and dividend since they directly affect the level of cash flow. We also include a GNP deflator since cash flow may vary over time due to cyclical macroeconomic conditions. Next we include intangible assets to reflect asset uniqueness. One common measure for the
unique intangible characteristics of a firm's asset base is R&D expenditures scaled by total assets. This variable (UNIQ) is also included in (1). The cash flow equation therefore incorporates four exogenous variables: INV, DIV, GNP, and UNIQ.

Four other exogenous variables are included in the leverage Eq. (2). The level of leverage may be influenced by: (i) non-debt tax shields, (ii) the type of assets held by the firm, and (iii) firm size.

Tax theories suggest that firms with larger non-debt tax shields may employ less debt, because the tax advantage of debt is offset by a larger amount of depreciation or other non-debt shield. We therefore include a depreciation tax shield variable (TAX), measured as the firm's depreciation divided by total assets.

The type of assets held by a firm may also influence a firm's leverage by affecting the degree of information asymmetry. Myers and Majluf (1984) argue that leverage increases with the extent of information asymmetry because information asymmetry affects the relative costs of equity and debt capital. Firms with more unique assets, or higher levels of intangible assets, may have relatively higher costs of equity because of information asymmetry. On the other hand, a survey by Pinegar and Wilbricht (1989) indicates that asset composition may result in firms following a financing hierarchy for reasons that have little to do with information asymmetry. For example, firms with a higher proportion of tangible assets presumably have more collateralizable assets, and thus may have lower costs of debt. In this case a higher debt-to-equity ratio would be associated with a higher proportion of tangible assets and fewer unique assets. We employ two variables in Eq. (2) to account for the influence of asset composition on the firm's capital structure: the ratio of net property, plant, and equipment to total assets (TGAST) measures the proportion of tangible assets; and research and development expense divided by total assets (UNIQ) measures the uniqueness of a firm's assets.

We also include a firm size variable (SIZE) in the leverage equation since larger firms may have a greater debt capacity. The leverage Eq. (2), therefore includes six exogenous variables: INV, DIV, TAX, TGAST, UNIQ, and SIZE.

In the last Eq. (3), we include four additional exogenous variables. Firm risk may be influenced by the type of assets and firm size, as well as uncertainty about general market conditions. Firms with more unique assets may have a relatively higher level of risk. Thus, TGAST and UNIQ also appear in the risk equation. Firm SIZE is also included in the risk equation, because small firms may command an additional risk premium. Finally, changing uncertainty about conditions in the market as a whole may also account for changes in firm risk over time. To control for this market uncertainty, we include a variable which represents volatility in the market during each quarter (MVOL). The risk Eq. (3), therefore includes six exogenous variables: INV, DIV, TGAST, UNIQ, SIZE, and MVOL.

Finally, all three equations also include firm dummy variables, quarterly dummies, and a linear trend. These variables allow the model to isolate the
relevant structural interrelationships among cash flow, leverage, and risk, after accounting for firm-specific behavior, seasonality, and trend.

4. Sample selection, data, and methodology

4.1. Sample selection

The primary sample period covers eleven years from the first quarter of 1979 through the last quarter of 1989. There are sixteen industries which have at least 19 firms with a full 44 quarters of time series data from Compustat and CRSP on all endogenous and exogenous variables. For the primary analysis we select three manufacturing industries and three non-manufacturing industries at random from the sixteen. This sample selection procedure provides a sample of 162 firms which represents 5,832 observations in our analysis.

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Table 1
Industries used in the analysis

<table>
<thead>
<tr>
<th>Industry SIC Code</th>
<th>Industry Classification</th>
<th>Firms with 44 quarters of data</th>
<th>Total observations</th>
<th>Cash Flow (CF)</th>
<th>Leverage (L)</th>
<th>Risk (σ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Food Products</td>
<td>25</td>
<td>1,100</td>
<td>0.039</td>
<td>0.236</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.024)</td>
<td>(0.190)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>27</td>
<td>Printing and Publishing</td>
<td>22</td>
<td>968</td>
<td>0.052</td>
<td>0.133</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.040)</td>
<td>(0.156)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>29</td>
<td>Petroleum Refining</td>
<td>19</td>
<td>836</td>
<td>0.042</td>
<td>0.320</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.021)</td>
<td>(0.150)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>33</td>
<td>Primary Metal Industries</td>
<td>22</td>
<td>968</td>
<td>0.028</td>
<td>0.357</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.024)</td>
<td>(0.221)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>36</td>
<td>Electrical Equipment</td>
<td>36</td>
<td>1,584</td>
<td>0.038</td>
<td>0.128</td>
<td>0.023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.025)</td>
<td>(0.125)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>52</td>
<td>Retail Sales</td>
<td>38</td>
<td>1,672</td>
<td>0.041</td>
<td>0.245</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.029)</td>
<td>(0.187)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>All Firms</td>
<td></td>
<td>162</td>
<td>7,128</td>
<td>0.040</td>
<td>0.226</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.028)</td>
<td>(0.191)</td>
<td>(0.010)</td>
</tr>
</tbody>
</table>

* This table reports the sample size and the average values for leverage, cash flow and risk for each industry. The standard deviations are in parentheses.
Because most items of quarterly data are voluntarily provided and unaudited, the number of firms available for analysis is not large. No industry has more than 50 firms with data for the full 44 quarters. Balance sheet data and income statement details are not required reporting. Many firms provide sufficient data for our analysis for several years, but some important items may be missing several years. There are relatively few firms that consistently provide sufficient quarterly data over the full eleven-year primary sample period. Because the type of firm that chooses to consistently provide more quarterly data may be different from an average firm, these results may be sample specific.

To provide a robustness check on these results we select a second sample of firms from six additional industries for 36 quarters from 1984 to 1992. Of these, five are manufacturing or processing industries. To foreshadow the results we perform this analysis only on Eqs. (1) and (2) of our model, since we find Eq. (3) does not provide additional information about pecking order behavior and signalling. For this secondary sample we obtain 212 firms which represent 5,936 observations for analysis. 7

4.2. Data

The six industries selected for the primary investigation are defined by two-digit SIC codes, with the exception of retail sales which includes SIC 5200 through 5900. Table 1 summarizes the sample characteristics of the endogenous variables for the six industries included in this study. Three industries are manufacturing, and three non-manufacturing. According to Harris and Raviv’s (1991) review, three of these industries (SIC 20, 27, and 36) are ranked as low leverage, while the other three (SIC 29, 33, and 52) are ranked in the medium to high leverage range. These rankings are consistent with the mean values of leverage displayed in Table 1.

Another possible way to perform our analysis is to employ annual data rather than quarterly data. However, there are two rationale for preferring quarterly data. First quarterly data increase the number of time series degrees of freedom for each sample firm, for a given sample period, and enhance the ability of our methodology to reveal the dynamic relationships of interest. Annual Compustat data provides a maximum of twenty years. With a three year lag, we would have a maximum of 17 observations per firm. Second, higher frequency quarterly data may be more capable of distinguishing between a potential contemporaneous pecking order relationship and a lagged signalling relationship, if these relationships occur within a one-year time frame. For example, if a firm behaves in a manner consistent with pecking order behavior within a quarter, while signalling across quarters, then higher frequency quarterly data could better distinguish between the contemporaneous pecking order behavior and the lagged signalling behavior. Annual data, on the other hand, could not distinguish between possible contemporaneous and lagged relationships that might occur within a time interval shorter than one year. Our results in Table 3 indicate support for divergent contemporaneous and lagged relationships during a one-year time frame. On the other hand, extensions of our analysis using longer lag lengths of eight quarters indicate substantive lagged responses beyond one year.
Table 2
Variable definitions and descriptive statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF</td>
<td>operating cash flow</td>
<td>0.040</td>
<td>0.028</td>
<td>0.039</td>
<td>-0.225</td>
<td>0.314</td>
</tr>
<tr>
<td>L</td>
<td>(long-term debt + equity) / total assets</td>
<td>0.226</td>
<td>0.191</td>
<td>0.180</td>
<td>0.000</td>
<td>0.931</td>
</tr>
<tr>
<td>σ - Risk</td>
<td></td>
<td>0.021</td>
<td>0.010</td>
<td>0.019</td>
<td>0.003</td>
<td>0.176</td>
</tr>
<tr>
<td>DIV</td>
<td>dividends per share</td>
<td>0.229</td>
<td>0.747</td>
<td>0.160</td>
<td>0.000</td>
<td>40.000</td>
</tr>
<tr>
<td>GNP</td>
<td>gross national product</td>
<td>3,770</td>
<td>844</td>
<td>3,781</td>
<td>2,420</td>
<td>5,289</td>
</tr>
<tr>
<td>UNIQ</td>
<td>(research and development expense) / total assets</td>
<td>0.011</td>
<td>0.023</td>
<td>0.00</td>
<td>0.00</td>
<td>0.14</td>
</tr>
<tr>
<td>TAX</td>
<td>depreciation / total assets</td>
<td>0.009</td>
<td>0.007</td>
<td>0.009</td>
<td>0.000</td>
<td>0.119</td>
</tr>
<tr>
<td>TGAST</td>
<td>(net tangible assets) / total assets</td>
<td>0.383</td>
<td>0.162</td>
<td>0.373</td>
<td>0.021</td>
<td>0.861</td>
</tr>
<tr>
<td>SIZE</td>
<td>ln(total assets)</td>
<td>6.271</td>
<td>1.887</td>
<td>6.175</td>
<td>1.677</td>
<td>11.762</td>
</tr>
<tr>
<td>MVOL</td>
<td>σ(market return)</td>
<td>0.009</td>
<td>0.004</td>
<td>0.008</td>
<td>0.005</td>
<td>0.033</td>
</tr>
</tbody>
</table>

The sample size for these summary statistics is 7,128 for 162 firms with 44 quarters of data across six industries (1979–1989).

Table 2 summarizes the variable definitions and presents descriptive statistics for each variable over the entire sample. The sample includes 162 firms with 44 quarters of data. The model’s endogenous variables are defined as follows. Cash flow from operations (CF) is measured as earnings before interest, taxes, and depreciation, scaled by total assets. Leverage (L) is defined as book value of long term debt divided by the sum of book value of long term debt plus market value of equity. Firm risk (σ) is measured by the standard deviation of daily returns.

Four other measures of cash flow or earnings have also been investigated to determine the robustness of our results and to link this study to previous work that uses other measures. These four measures 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. We have included free cash flow scaled by total assets and free cash flow per share. Earnings per share includes income before extraordinary items and is adjusted for stock splits and dividends. The results are generally robust, and they are presented in Shenoy (1991).

The market value of equity is measured as the stock price times shares outstanding at the end of each quarter. If cash flow unexpectedly increases, then market value may increase while debt remains the same. In this case leverage would also decrease, but not because of pecking order behavior. To determine whether this scenario characterizes the behavior of our data, we have also measured leverage using book value in the denominator. The results are robust and available upon request.
stock returns during the quarter. CF and L are calculated from Compustat, while \( \sigma \) is computed from CRSP.

The exogenous variables are defined as follows. Investment (INV) is the net change in gross property, plant and equipment, scaled by total assets. Dividends (DIV) are quarterly dividends per share. GNP is obtained from Citibase, and all other exogenous variables are computed from the quarterly Compustat tapes. Asset uniqueness (UNIQ) is measured by the firm's R&D expenditure divided by total assets. The non-debt tax shield (TAX) is defined as depreciation scaled by total assets. The collateral value of a firm's tangible assets is measured as the ratio of net property, plant, and equipment to total assets (TGAST). Following Titman and Wessels (1988), we take the natural logarithm of total assets as a measure of firm SIZE. Finally, the market risk (MVOL) variable is computed as the standard deviation of daily returns on the CRSP value-weighted market index during each quarter.

We perform the analysis on Eqs. (1) to (3) by industry, because previous work has shown that capital structure tends to be similar for firms within industries, but different across industries (Bowen et al., 1982, Bradley et al., 1984, Smith, 1989). John and Ronen (1989) also argue that a signalling equilibrium depends upon the type of technological environment or investment opportunities facing firms. Controlling for the investment opportunity set facing a firm is not a problem if a single firm's current performance is compared to its own past. However, measurement across firms complicates matters. Grouping firms by industry helps to remedy this problem. Pooling by industry implicitly assumes that firms in the same industry face the same investment opportunity set. We estimate the model for six different samples of pooled time series and cross-sectional data, on firms within the six different industries.

4.3. Methodology

The structural model is Eqs. (1), (2), and (3) is estimated using three stage least squares (3SLS). This estimation technique provides two potential advantages over ordinary least squares (OLS) applied to each equation of the system. First, because

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10 We have re-estimated the model using quarterly beta as an alternative measure of firm risk. Results are robust and available in Shenoy (1991).

11 Investment tax credits are typically reported by firms for only one quarter in each year. Because of the limitations of these quarterly data, investment tax credits are not included in the tax shield variable. Likewise, intangible assets other than R&D, such as advertising and goodwill, are also recorded only annually, and are omitted from UNIQ.

12 The logarithmic transformation serves to compress the magnitude of the size variable of the largest firms, with the goal of reducing possible heteroskedasticity and skewness resulting from such outliers. This transformation also conforms with previous work (Titman and Wessels, 1988). We have also re-estimated the model using the level of total assets, with robust results (available upon request).
the contemporaneous values of the two right-hand-side endogenous variables in each equation are simultaneously determined with the left-hand-side variable in that equation, OLS estimation leads to biased and inconsistent estimates. An instrumental variables estimator such as 3SLS is a consistent estimator for simultaneously determined variables. Second, estimation of a single equation at a time ignores potential correlation across error terms in different equations. 3SLS incorporates such information and therefore offers a gain in efficiency in estimating the model’s parameters.

Before the model can be estimated, a finite lag length parameterization must first be selected. In each equation we incorporate $M_l = 8$ quarterly lags on the dependent variable, and $M_e = 4$ quarterly lags on the other lagged endogenous variables. Geweke (1982) argues that including more lags ($M_l$) on the dependent variable helps to insure that the error term in each equation is not autocorrelated, while including fewer lags ($M_e$) on the right-hand-side endogenous variables retains greater power in the hypothesis tests.

5. Empirical results

5.1. Pecking order behavior and the signalling hypothesis

The relationship between leverage and cash flow is the focus of this paper. The effect of pecking order behavior is observed in the contemporaneous relationship. In both the cash flow and leverage equations, pecking order behavior implies that the contemporaneous coefficients for these two variables ($\alpha_{20}$ and $\delta_{10}$) should be negative. On the other hand, the effect of signalling should be observed in the lagged leverage coefficients from the cash flow equation ($\alpha_{2n}$, $n > 0$). Significantly positive lagged coefficients would suggest that leverage provides information about subsequent cash flow, consistent with the signalling hypothesis.

Table 3 presents six sets of structural coefficient estimates representing these contemporaneous and lagged relationships between cash flow and leverage, for each of the six industries. First, consider the contemporaneous coefficients between cash flow and leverage in Panel A of Table 3. The contemporaneous

---

13 Although this methodology relaxes some of the assumptions about simultaneity that are implicit in OLS estimation, this methodology still imposes some assumptions about the covariance structure of the residuals. For example, we assume that $E(e_{it}e_{jr}) = \sigma$, for $i = j$ and for $r = Eqs. 1, 2, or 3$. This assumes homoskedasticity for each equation’s error variance across firms and time, within an industry. It would be desirable to allow the variance to change across firms, if not also across time. The next assumption, that $E(e_{it}e_{jr}) = 0$ for $i \neq j$, presumes that there is no error covariance across firms within an equation in the same period. An error components model would relax these two assumptions. Unfortunately, estimating an error components model is not computationally feasible for this problem (Judge et al., 1988).
coefficient for the cash flow equation (α_{20}) is significantly negative in five of the six industries. The contemporaneous coefficient in the leverage equation (β_{10}) is significantly negative in three of the six industries. These results display a generally significant negative simultaneous relationship between cash flow and leverage, consistent with pecking order behavior.

Next consider the coefficients on lagged leverage in the cash flow equation (α_{21} - α_{24}) in Panel B of Table 3. This lagged relationship shows how leverage is related to future cash flow for the firms in each industry, and represents our investigation of the signalling hypothesis. There are four lagged coefficients estimated for each industry's sample, and 24 lagged coefficients altogether. If there were no true lagged relationships, we would still expect two or three of these 24 coefficients to be statistically significant by chance, at the 0.10 level. In Table 3 we observe ten significant positive coefficients — many more than expected by chance. Furthermore, these ten significant coefficients are evenly distributed across all six industries. This result lends support to the signalling hypothesis, suggesting that increases in leverage are consistently followed by increases in cash flow.

While ten of these twenty-four lagged coefficients in Panel B of Table 3 are significantly positive, we note that only one or two lagged coefficients are significant for each industry. With this in mind, we investigate the strength of the overall lagged relationship from leverage to future cash flow for each industry. The last row of Table 3 presents the F-test of the overall significance of this lagged relationship, for each industry's sample. Each F statistic examines the joint hypothesis that all four lagged coefficients (α_{21} - α_{24}) are equal to zero, for each industry. Results reveal that leverage demonstrates a significant lagged relationship with future cash flow in four industries at the 0.01 level, and a fifth at the 0.05 level. This result underscores the support for the signalling hypothesis discussed above.

Taken together, the results in Table 3 are dramatic, pointing to a negative simultaneous relationship between cash flow and leverage, which is consistent with pecking order behavior, and a positive relationship from leverage to future cash flow, which is consistent with signalling theory. Therefore, when we incorporate both the contemporaneous and lagged relationships in a system of dynamic

---

14 We pursue this issue further by re-estimating the model with M_1 = 12 quarterly lags on the left-hand-side variable in each equation, and M_2 = 8 lags on all other right-hand-side endogenous variables. In the expanded model's cash flow equation, there are now 8 lagged leverage coefficients (α_{2n}; n = 1, ..., 8) for all six industries, and 48 such lagged coefficients altogether. Results reveal that 17 of these 48 lagged coefficients are significantly positive at the 0.10 level. Furthermore, 8 of these 17 significant coefficients are beyond a lag of four quarters. Finally, the joint F-tests of these overall lagged relationships indicate significant lagged relationships in four of the six industries. These results offer more evidence supporting a lagged relationship from leverage to future cash flow, which is consistent with signalling theory.
Table 3
Contemporaneous and lagged cash flow and leverage coefficients

The structural model:

\[
\begin{align*}
\text{CF}_t &= \sum_{n=1}^{4} \alpha_{1n} \text{CF}_{t-n} + \sum_{n=0}^{4} \alpha_{2n} \text{L}_{t-n} + \sum_{n=0}^{4} \alpha_{3n} \sigma_{t-n} + \lambda_1 \beta + \epsilon_{1t} \\
\text{L}_t &= \sum_{n=0}^{4} \delta_{1n} \text{CF}_{t-n} + \sum_{n=0}^{4} \delta_{2n} \text{L}_{t-n} + \sum_{n=0}^{4} \delta_{3n} \sigma_{t-n} + \lambda_2 \beta + \epsilon_{2t} \\
\sigma_t &= \sum_{n=0}^{4} \gamma_{1n} \text{CF}_{t-n} + \sum_{n=0}^{4} \gamma_{2n} \text{L}_{t-n} + \sum_{n=0}^{4} \gamma_{3n} \sigma_{t-n} + \lambda_3 \beta + \epsilon_{3t}
\end{align*}
\]

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficient</th>
<th>Coefficient of</th>
<th>SIC code and Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>20(FOOD)</td>
</tr>
<tr>
<td>Panel A: Contemporaneous cash flow and leverage coefficients</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash Flow</td>
<td>(\alpha_{30} )</td>
<td>(L_1)</td>
<td>-0.18 **</td>
</tr>
<tr>
<td>Leverage</td>
<td>(\delta_{10} )</td>
<td>(\text{CF}_t)</td>
<td>-0.46 *</td>
</tr>
<tr>
<td>Panel B: Lagged leverage coefficients</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash Flow</td>
<td>(\alpha_{21} )</td>
<td>(L_{t-1})</td>
<td>0.14 **</td>
</tr>
<tr>
<td></td>
<td>(\alpha_{22} )</td>
<td>(L_{t-2})</td>
<td>0.04 *</td>
</tr>
<tr>
<td></td>
<td>(\alpha_{23} )</td>
<td>(L_{t-3})</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(\alpha_{24} )</td>
<td>(L_{t-4})</td>
<td>0.01</td>
</tr>
<tr>
<td>(F_{a_{21} - a_{24}} )</td>
<td>3.65 **</td>
<td>3.90 **</td>
<td>1.11</td>
</tr>
<tr>
<td>(P-value)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.35)</td>
</tr>
</tbody>
</table>

\(\alpha_i \) and \(x_i \) represent the vectors of exogenous variables and coefficients in equation \(r\). For each equation these include firm and quarterly dummy variables and a time trend. In addition, the cash flows equation includes GNP, INV, DIV, and UNIQ; the leverage equation includes INV, DIV, TGAST, SIZE, TAX, and UNIQ; and the risk equation includes INV, DIV, TGAST, UNIQ, SIZE, and MVOL.

\(c\) The standard errors are in parentheses.

\(d\) The degrees of freedom for the numerator of each F-test is 4. The degrees of freedom for the denominator of the F-test for each industry is: 2550 for SIC 20, 2235 for SIC 27, 1920 for SIC 29, 2235 for SIC 33, 3600 for SIC 36, and 3778 for SIC 52.

* Indicates significance at the 10% level.

** Indicates significance at the 1% level.
simultaneous equations, the results help to reconcile the divergent implications implied by pecking order behavior and signalling theory in the theoretical and empirical literature.  

5.2. Other influences on cash flow

Table 4 presents the coefficient estimates for the cash flow Eq. (1). First, investment (INV) displays a significant positive association with cash flow in four industries, suggesting that firms with higher cash flow tend to engage in more investment. Second, dividends (DIV) reveal a significant positive relationship with cash flow in three industries. Third, the influence of R&D expenditures (UNIQ) is weak and mixed across industries. Fourth, as expected, general macroeconomic conditions (GNP) demonstrate a significant positive impact on the firm's cash flow performance in three industries. Fifth, firm risk (S) reveals a significant positive contemporaneous relationship with cash flow in just one industry, along with significant lagged impacts on cash flow in two other industries. Finally, as discussed above in Table 3, leverage reveals a significant negative contemporaneous (pecking order) relationship, along with a significant positive lagged (signalling) relationship, for five of the six industries.

It is noteworthy that leverage is the firm characteristic which demonstrates the strongest and most robust relationship with cash flow across these six industries. Only the oil industry fails to display this contemporaneous pecking order relationship combined with a lagged signalling relationship.

5.3. Other influences on leverage

Table 5 presents the coefficient estimates for the leverage Eq. (2). First, INV displays a consistently positive association with leverage, suggesting that firms

---

15 We have conducted this analysis using the first differences of leverage and cash flow in Eqs. (1) to (3), rather than the levels. The two major results are as follows. First, the contemporaneous coefficients ($\alpha_{20}$ and $\delta_{10}$) are robust with respect to this change in specification, as eight of the twelve possible contemporaneous coefficients across all six industries are significantly negative. Second, 15 of the 24 lagged leverage coefficients in the cash flow equation ($\alpha_{21} - \alpha_{24}$) are significant, although 14 of these 15 are negative rather than positive.

This alternative specification yields regression coefficients which may be interpreted as "second order derivatives." To get an intuitive feel for the interpretation of this alternative specification, consider the negative lagged coefficients ($\alpha_{21} - \alpha_{24}$). These negative coefficients suggest that a "deceleration" in the rate of change in leverage is associated with a subsequent "acceleration" in the rate of change in cash flow. Such a relationship could reflect one of two possible distinct situations: (1) leverage decreases could followed by increases in cash flow (such behavior would be inconsistent with signalling theory); or (2) leverage increases could be followed by increases in cash flow (consistent with signalling theory), but leverage could be increasing at a decreasing rate while cash flow is increasing at an increasing rate.
Table 4
Estimated coefficients from the cash flow equation

The cash flow equation:

\[ CF_t = \sum_{n=1}^{8} \alpha_{1n} CF_{t-n} + \sum_{n=0}^{4} \alpha_{2n} L_{t-n} + \sum_{n=0}^{4} \alpha_{3n} e_{t-n} + \lambda_1 INV + \lambda_2 DIV + \lambda_3 UNIQ + \lambda_4 GNP + e_{1t} \]

<table>
<thead>
<tr>
<th>Industry (SIC)</th>
<th>INV [\times 10,000]</th>
<th>DIV</th>
<th>UNIQ</th>
<th>GNP [\times 10,000]</th>
<th>(L_t)</th>
<th>F: Lagged Leverage ((\sigma_t))</th>
<th>F-test Lagged Risk (F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD</td>
<td>0.07 *</td>
<td>0.005</td>
<td>-0.36</td>
<td>0.13 *</td>
<td>-0.18 **</td>
<td>3.65 **</td>
<td>0.12</td>
</tr>
<tr>
<td>20</td>
<td>(0.04)</td>
<td>(0.006)</td>
<td>(0.38)</td>
<td>(0.07)</td>
<td>(0.05)</td>
<td>(0.01)</td>
<td>(0.15)</td>
</tr>
<tr>
<td>PRINT</td>
<td>0.01</td>
<td>0.002 **</td>
<td>3.05 *</td>
<td>-0.13</td>
<td>-0.16 **</td>
<td>3.97 **</td>
<td>0.02</td>
</tr>
<tr>
<td>27</td>
<td>(0.02)</td>
<td>(0.001)</td>
<td>(1.27)</td>
<td>(0.08)</td>
<td>(0.04)</td>
<td>(0.00)</td>
<td>(0.16)</td>
</tr>
<tr>
<td>OIL</td>
<td>-0.00</td>
<td>0.003 *</td>
<td>-1.98 *</td>
<td>0.02</td>
<td>0.02</td>
<td>1.11</td>
<td>-0.11</td>
</tr>
<tr>
<td>29</td>
<td>(0.00)</td>
<td>(0.002)</td>
<td>(0.78)</td>
<td>(0.10)</td>
<td>(0.05)</td>
<td>(0.35)</td>
<td>(0.17)</td>
</tr>
<tr>
<td>METAL</td>
<td>0.07 *</td>
<td>0.001</td>
<td>-0.75</td>
<td>0.39 **</td>
<td>-0.32 **</td>
<td>3.65 **</td>
<td>0.63 **</td>
</tr>
<tr>
<td>33</td>
<td>(0.03)</td>
<td>(0.002)</td>
<td>(0.80)</td>
<td>(0.13)</td>
<td>(0.09)</td>
<td>(0.00)</td>
<td>(0.22)</td>
</tr>
<tr>
<td>ELEC EQ</td>
<td>0.08 **</td>
<td>0.004</td>
<td>-0.07</td>
<td>0.18 **</td>
<td>-0.07 **</td>
<td>2.48 *</td>
<td>0.11</td>
</tr>
<tr>
<td>36</td>
<td>(0.02)</td>
<td>(0.004)</td>
<td>(0.07)</td>
<td>(0.07)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.11)</td>
</tr>
<tr>
<td>RETAIL</td>
<td>0.08 **</td>
<td>0.006 *</td>
<td>d</td>
<td>0.06</td>
<td>-0.32 **</td>
<td>3.45 **</td>
<td>0.07</td>
</tr>
<tr>
<td>52</td>
<td>(0.02)</td>
<td>(0.001)</td>
<td>(0.08)</td>
<td>(0.08)</td>
<td>(0.01)</td>
<td>(0.12)</td>
<td>(0.38)</td>
</tr>
</tbody>
</table>

Predicted + + ? + - +

Sign

\[ F \text{ Statistic for test: } \alpha_{31} = \alpha_{32} = \alpha_{33} = \alpha_{34} = 0. \]
\[ F \text{ Statistic for test: } \alpha_{21} = \alpha_{22} = \alpha_{23} = \alpha_{24} = 0. \]

No firms in Industry 52 reported research and development expense.

* Indicates significance at the 10% level.
** Indicates significance at the 1% level.

This table reports the coefficient estimates from the cash flow equation of the three-stage least squares regression. The standard errors of the estimates are in parentheses.

The cash flow equation also includes a trend and firm and quarterly dummy variables.

These coefficients and standard errors are multiplied by 10,000.

which increase investment also tend to increase leverage. Second, dividends (DIV) and leverage also tend to be positively associated. Beyond these two influences, the overall results for other exogenous variables tend to be industry-specific. However, some general conclusions can be summarized.

This equation incorporates the effect of depreciation tax shields on leverage with the variable, TAX. Firms with more depreciation allowances may not enjoy the full tax benefits from leverage, and may therefore tend to have lower leverage. Table 5 generally supports this negative relationship, as five of the six industries reveal a negative coefficient on TAX, with three coefficients significantly less than zero. These results are stronger than previous work on this issue, which generally indicates mixed results (Harris and Raviv, 1991).

The two variables, TGAST and UNIQ, are included in the model to measure different aspects of information asymmetry. Table 5 reveals that the influence of
Table 5
Estimated coefficients from the leverage equation 1

The leverage equation:

\[ L_t = \sum_{n=0}^{4} \delta_{1n} CF_{t-n} + \sum_{n=1}^{4} \delta_{2n} L_{t-n} + \sum_{n=0}^{4} \delta_{3n} \sigma_{t-n} + \lambda_1 INV + \lambda_2 DIV + \lambda_3 TAX + \lambda_4 TGAST + \lambda_5 UNIQ + \lambda_6 SIZE + \varepsilon_{2t} \]

<table>
<thead>
<tr>
<th>Industry (SIC)</th>
<th>INV (^a)</th>
<th>DIV</th>
<th>TAX</th>
<th>TGAST</th>
<th>UNIQ</th>
<th>SIZE</th>
<th>CF</th>
<th>F: Lagged CF (^b)</th>
<th>RISK ((\alpha))</th>
<th>F: Lagged Risk (^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD</td>
<td>0.26 *</td>
<td>0.022</td>
<td>-0.75 *</td>
<td>0.02</td>
<td>-0.21 **</td>
<td>0.06 **</td>
<td>-0.46 *</td>
<td>2.75 *</td>
<td>0.53</td>
<td>0.45</td>
</tr>
<tr>
<td>20</td>
<td>(0.11)</td>
<td>(0.016)</td>
<td>(0.42)</td>
<td>(0.02)</td>
<td>(1.01)</td>
<td>(0.01)</td>
<td>(0.27)</td>
<td>(0.02)</td>
<td>(0.39)</td>
<td>(0.77)</td>
</tr>
<tr>
<td>PRINT</td>
<td>1.89 **</td>
<td>0.013 **</td>
<td>-0.35</td>
<td>-0.04</td>
<td>9.38 **</td>
<td>0.04 **</td>
<td>-0.71 **</td>
<td>3.73 **</td>
<td>0.94 **</td>
<td>3.08 **</td>
</tr>
<tr>
<td>27</td>
<td>(0.42)</td>
<td>(0.001)</td>
<td>(0.40)</td>
<td>(0.03)</td>
<td>(2.96)</td>
<td>(0.01)</td>
<td>(0.25)</td>
<td>(0.00)</td>
<td>(0.35)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>OIL</td>
<td>0.06 **</td>
<td>0.014 **</td>
<td>0.80</td>
<td>-0.07 *</td>
<td>-1.65</td>
<td>0.05 *</td>
<td>-0.17</td>
<td>1.53</td>
<td>1.41 **</td>
<td>0.75</td>
</tr>
<tr>
<td>29</td>
<td>(0.02)</td>
<td>(0.005)</td>
<td>(0.34)</td>
<td>(0.04)</td>
<td>(3.15)</td>
<td>(0.01)</td>
<td>(0.89)</td>
<td>(0.19)</td>
<td>(0.53)</td>
<td>(0.56)</td>
</tr>
<tr>
<td>METAL</td>
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<td>-3.67 **</td>
<td>0.11</td>
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<td>-0.00</td>
<td>0.16</td>
<td>1.44</td>
<td>1.41 *</td>
<td>2.11 *</td>
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<td>33</td>
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<td>(0.007)</td>
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<td>(0.04)</td>
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<td>(0.22)</td>
<td>(0.61)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>ELEC EQ</td>
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<td>0.016</td>
<td>-0.61</td>
<td>0.09 **</td>
<td>0.25</td>
<td>0.06 **</td>
<td>1.16 **</td>
<td>1.89</td>
<td>1.29 **</td>
<td>3.12 u * *</td>
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<tr>
<td>36</td>
<td>(0.06)</td>
<td>(0.012)</td>
<td>(0.40)</td>
<td>(0.03)</td>
<td>(0.31)</td>
<td>(0.01)</td>
<td>(0.48)</td>
<td>(0.11)</td>
<td>(0.27)</td>
<td>(0.01)</td>
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<tr>
<td>RETAIL</td>
<td>0.73 **</td>
<td>0.018 **</td>
<td>-1.01 **</td>
<td>-0.01</td>
<td>d</td>
<td>0.02 **</td>
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<td>2.08 *</td>
<td>0.23</td>
<td>0.39</td>
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<td>52</td>
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<td>(0.001)</td>
<td>(0.30)</td>
<td>(0.02)</td>
<td>(0.00)</td>
<td>(0.24)</td>
<td>(0.09)</td>
<td>(0.28)</td>
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<td>?</td>
<td>-</td>
<td>?</td>
<td>+</td>
<td>-</td>
<td>+</td>
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<td>(\dagger)</td>
<td>(\dagger)</td>
<td>(\dagger)</td>
<td>(\dagger)</td>
</tr>
</tbody>
</table>

1 This table reports the coefficient estimates from the leverage equation of the three-stage least squares regression. The standard errors of the estimates are in parentheses.

2 The equation also includes a trend and firm and quarterly dummy variables.

3 These coefficients and standard errors are multiplied by 10,000.

4 F Statistic for test: \(\delta_{11} = \delta_{12} = \delta_{13} = \delta_{14} = 0\).

5 F Statistic for test: \(\delta_{11} = \delta_{12} = \delta_{13} = \delta_{14} = 0\).

6 No firms in Industry 52 reported research and development expense.

* Indicates significance at the 10% level.

** Indicates significance at the 1% level.
these two variables is mixed across industries. These results are not generally consistent with the information asymmetry arguments put forth by Myers and Majluf (1984), as an explanation of pecking order behavior. Since our previous results in Table 3 are consistent with pecking order behavior, it may be that firms follow a pecking order for reasons other than information asymmetry (Pinegar and Wilbricht, 1989).

Many researchers hypothesize that larger firms have a greater debt capacity, and should therefore have a larger proportion of debt (Titman and Wessels, 1988). However, few empirical studies find evidence to support this hypothesis. In contrast, Table 5 indicates that SIZE has a significant positive association with leverage in five industries, supporting the debt capacity hypothesis.

The contemporaneous coefficient for risk ($\sigma$) is positive in all six industries, and is statistically significant in four industries. The coefficients on lagged risk reveal a jointly significant influence on subsequent leverage in three of the six industries. These results provide support for the notion that increased risk is associated with increased leverage.

Finally, the contemporaneous coefficients on cash flow are significantly negative in three industries. These results embody the pecking order relationship discussed above in Table 3. Furthermore, the coefficients on lagged cash flow also reveal a jointly significant influence on subsequent leverage in four industries.

5.4. The risk equation

Table 6 presents the coefficient estimates for the risk Eq. (3). Only one variable in the model demonstrates a powerful and robust influence on firm risk: underlying market volatility (MVOL). This variable reveals a significant positive coefficient which is near unity in all six industries. After accounting for the influence of underlying market volatility, however, the other endogenous and exogenous influences on firm risk are generally weak and industry-specific.

5.5. Additional analysis on an expanded sample of firms

In order to check for robustness we extend our analysis to an expanded sample of firms in six additional industries. As noted above, the relevant results regarding the leverage-cash flow relationship are robust when we omit the risk equation.

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16 In Harris and Raviv's (1991) summary of leverage studies, none of the five cross-sectional regression studies that include size as an independent variable find a significant association between size and leverage.

17 As mentioned above in the data discussion, we have also examined the empirical implications of omitting all interactions with risk from the model, by specifying an alternative two-equation system that describes only the interaction between the firm's leverage and cash flows. Results for the firm's leverage/cash flow relationship are robust and available upon request.
Table 6  
Estimated coefficients from the risk equation \(^{†}\)  
The risk equation:  
\[
\sigma_t = \sum_{n=0}^{4} \gamma_{1n} CF_{t-n} + \sum_{n=0}^{2} \gamma_{2n} L_{it-n} + \sum_{n=1}^{8} \gamma_{3n} CF_{t-n} + \lambda_1 INV + \lambda_2 DIV + \lambda_3 SIZE + \lambda_4 TGAST + \lambda_5 UNIQ + \lambda_6 MVOL + \varepsilon_{3it}
\]

<table>
<thead>
<tr>
<th>Industry (SIC)</th>
<th>INV (^{a})</th>
<th>DIV (^{a})</th>
<th>SIZE</th>
<th>TGAST</th>
<th>UNIQ</th>
<th>MVOL</th>
<th>L</th>
<th>F: Lagged Leverage (^{b})</th>
<th>CF</th>
<th>F: Lagged CF (^{c})</th>
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<tbody>
<tr>
<td>FOOD 20</td>
<td>-0.001</td>
<td>-0.009 **</td>
<td>-0.002</td>
<td>-0.001</td>
<td>0.13</td>
<td>0.82 **</td>
<td>-0.03</td>
<td>1.35</td>
<td>-0.05 *</td>
<td>1.24</td>
</tr>
<tr>
<td>PRINT 27</td>
<td>0.063</td>
<td>0.001 *</td>
<td>0.005</td>
<td>-0.022 *</td>
<td>6.67 **</td>
<td>1.02 **</td>
<td>-0.11 *</td>
<td>4.42 **</td>
<td>-0.04</td>
<td>0.83</td>
</tr>
<tr>
<td>OIL 29</td>
<td>0.000</td>
<td>-0.001</td>
<td>0.002</td>
<td>0.005</td>
<td>0.48</td>
<td>0.94 **</td>
<td>-0.01</td>
<td>2.09 *</td>
<td>0.00</td>
<td>0.26</td>
</tr>
<tr>
<td>METAL 33</td>
<td>0.0002</td>
<td>0.000</td>
<td>0.001</td>
<td>-0.001</td>
<td>-0.05</td>
<td>0.94 **</td>
<td>0.01</td>
<td>1.60</td>
<td>0.06</td>
<td>1.15</td>
</tr>
<tr>
<td>ELEC EQ 36</td>
<td>-0.012</td>
<td>-0.006 *</td>
<td>-0.007 *</td>
<td>-0.003</td>
<td>-0.01</td>
<td>0.91 **</td>
<td>0.07 **</td>
<td>3.01 *</td>
<td>-0.09 *</td>
<td>0.91</td>
</tr>
<tr>
<td>RETAIL 52</td>
<td>0.028</td>
<td>0.001 *</td>
<td>0.002 *</td>
<td>-0.006 *</td>
<td>d</td>
<td>1.00 **</td>
<td>-0.04 *</td>
<td>0.57</td>
<td>0.02</td>
<td>3.78 **</td>
</tr>
<tr>
<td>Predicted</td>
<td>?</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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</tr>
</tbody>
</table>

\(^{†}\) This table reports the coefficient estimates from the risk equation of the three-stage least squares regression. The standard errors of the estimates are in parentheses.

\(^{a}\) The equation also includes firm and quarterly dummy variables.

\(^{b}\) These coefficients and standard errors are multiplied by 10,000.

\(^{b}\) F Statistic for test: \(\gamma_{21} = \gamma_{22} = \gamma_{23} = \gamma_{24} = 0\).

\(^{c}\) F Statistic for test: \(\gamma_{11} = \gamma_{12} = \gamma_{13} = \gamma_{14} = 0\).

\(^{d}\) No firms in Industry 52 reported research and development expense.

* Indicates significance at the 10% level.

** Indicates significance at the 1% level.
Table 7
Contemporaneous and lagged cash flow and leverage coefficients
The structural model:

\[ CF_t = \sum_{n=1}^{8} \alpha_{1n} CF_{t-n} + \sum_{n=0}^{4} \alpha_{2n} L_{t-n} + \lambda_1 x_1 + \varepsilon_{1t} \]

\[ L_t = \sum_{n=0}^{8} \delta_{1n} CF_{t-n} + \sum_{n=1}^{8} \delta_{2n} L_{t-n} + \lambda_2 x_2 + \varepsilon_{2t} \]

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficient</th>
<th>Coefficient of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SIC code and Industry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26(PAPER)</td>
</tr>
<tr>
<td><strong>Panel A:</strong> Contemporaneous cash flow and leverage coefficients b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash Flow</td>
<td>( \alpha_{20} )</td>
<td>( L_1 )</td>
</tr>
<tr>
<td></td>
<td>( \alpha_{21} )</td>
<td>( L_{1-1} )</td>
</tr>
<tr>
<td>Leverage</td>
<td>( \delta_{10} )</td>
<td>( CF_1 )</td>
</tr>
<tr>
<td></td>
<td>( \delta_{20} )</td>
<td>( L_{1-0} )</td>
</tr>
<tr>
<td></td>
<td>( \alpha_{22} )</td>
<td>( L_{1-2} )</td>
</tr>
<tr>
<td></td>
<td>( \alpha_{23} )</td>
<td>( L_{1-3} )</td>
</tr>
<tr>
<td></td>
<td>( \alpha_{24} )</td>
<td>( L_{1-4} )</td>
</tr>
<tr>
<td></td>
<td>( \alpha_{25} )</td>
<td>( L_{1-5} )</td>
</tr>
</tbody>
</table>

\( \alpha, x, \) represents the vectors of exogenous variables and coefficients in equation \( r \). For each equation these include firm and quarterly dummy variables and a time trend. In addition, the cash flow equation includes INV, DIV, and UNIQ; the leverage equation includes INV, DIV, T Gast, SIZE, TAX, and UNIQ.

The standard errors are in parentheses.

The degrees of freedom for the numerator of each F-test is 4. The degrees of freedom for the denominator of the F-test for each industry is: 2550 for SIC 20.2235 for SIC 27.1920 for SIC 29.2235 for SIC 33.3600 for SIC 36, and 3778 for SIC 52.

Indicates significance at the 10% level.

Indicates significance at the 1% level.

\( \alpha_{20} \) represents the vectors of exogenous variables and coefficients in equation \( r \). For each equation these include firm and quarterly dummy variables and a time trend. In addition, the cash flow equation includes INV, DIV, and UNIQ; the leverage equation includes INV, DIV, T Gast, SIZE, TAX, and UNIQ.

The standard errors are in parentheses.

The degrees of freedom for the numerator of each F-test is 4. The degrees of freedom for the denominator of the F-test for each industry is: 2550 for SIC 20.2235 for SIC 27.1920 for SIC 29.2235 for SIC 33.3600 for SIC 36, and 3778 for SIC 52.

* Indicates significance at the 10% level.

** Indicates significance at the 1% level.
from the analysis. This expanded analysis is limited to the dynamic simultaneous equations model describing the interaction of the firm's cash flow and leverage, excluding firm risk. The sample selection criterion applied to this additional sample is analogous to that applied to the original sample, and leads to a total of 212 additional firms in six different industries investigated over 36 quarters from 1984 to 1992.

Results for this expanded sample are provided in Table 7, for comparison with the results in Table 3. Panel A of Table 7 presents the contemporaneous coefficients that represent the pecking order relationship in our model. Ten of the twelve contemporaneous coefficients in this Panel are negative, with six coefficients significantly negative. These significant negative contemporaneous coefficients are spread across all six industries in Table 7. These results reinforce the significant negative contemporaneous pecking order relationship found in Table 3 in the earlier analysis.

Panel B of Table 7 presents the lagged coefficients that represent the signalling relationship. Six of the twenty-four lagged coefficients presented in Panel B are significantly positive, while none are significantly negative. These significant positive coefficients are concentrated in three industries, while the other three new industries reveal no significant lagged relationships. For three of the six additional industries, therefore, these results reinforce the significant lagged signalling relationship supported in Table 3.

These results corroborate a significant negative contemporaneous pecking order relationship for all six new industries investigated, along with a significant positive lagged signalling relationship for three of the six additional industries. Thus, overall, this additional analysis provides evidence in support of a contemporaneous negative pecking order relationship along with a lagged positive signalling relationship between leverage and cash flow.

6. Summary and conclusions

Asymmetric information models provide insight into the relationship between a firm's financing choices and its cash flow. Pecking order behavior and signalling theory are two such models that have contrasting implications for the relationship between a firm's financial leverage and cash flow. Signalling theory implies a positive relationship, while pecking order behavior implies a negative relationship. Both models boast broad support in different bodies of the empirical literature. Leverage-changing event studies tend to support a positive relationship while cross-sectional studies typically reveal a negative relationship.

We propose that these contrasting implications in the theoretical and empirical literature can be reconciled by considering both the contemporaneous and dynamic interrelationships between leverage and cash flow. We suggest that pecking order behavior describes the simultaneous relationship between contemporaneous
movements in leverage and cash flow, while the signalling relationship character-
izes the dynamic interaction between current leverage and future cash flow. No
previous research explicitly addresses these contrasting implications of signalling
type and pecking order behavior, or attempts to reconcile the contradictory
behavior through modelling both the simultaneous and dynamic aspects of the
structural relationships involved.

This study attempts to fill this void in the literature and reconcile these two
competing schools of thought, by specifying a system of dynamic simultaneous
equations which incorporate both the contemporaneous and lagged interrelation-
ships among a firm's leverage, cash flow, and risk. This model enables the data to
distinguish between the interaction of leverage and cash flow in the same period
versus that displayed across time. We also control for changes in firm risk,
investments, dividends, and other exogenous variables in the model.

Results reveal a negative simultaneous relationship between cash flow and
leverage, consistent with pecking order behavior, along with a positive relationship
from current leverage to future cash flow, consistent with signalling theory. This
support for both pecking order behavior and signalling theory is quite robust
across the industries investigated, and thus offers a reconciliation of the contrast-
ing theoretical and empirical implications in the existing literature.

While the contemporaneous pecking order relationship and the dynamic sig-
nalling relationship are robust across industries, there is some variation across
industries in the extent of the pecking order and signalling relationships revealed.
This observation raises several issues. For example, to what extent do these
relationships vary across industries, and how could such variation be rigorously
measured? To what extent do these relationships vary across firms within an
industry? At the firm level, such differences might be due to agency theoretic or
organizational considerations. These issues remain the subject of future inquiry.

7. For further reading

Hill and Stone (1980).

Acknowledgements

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anonymous referee.

References

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