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The Effect of Leverage on Microstructure Variables

by

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Abstract

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We study the impact of complete leverage on the microstructure characteristics of securities (i.e. the cost of trading and its components, inventory cost and adverse selection cost). We find that complete leverage increases the level of trade informativeness (a measure of adverse selection cost) and therefore the degree of information asymmetry. This result holds even when the effects of other variables such as size, insider concentration, institutional holdings and the number of noninsiders are taken into account. Additional evidence is obtained by examining both financial and operating leverages separately. We find that inventory costs are higher for firms with high leverage, although the link is not statistically significant. This result persists when we consider additional factors. We obtain a stronger relation when we substitute both financial and operating leverages for complete leverage. Using cumulative abnormal returns to measure overall trading cost, we find a strong link between leverage and this

cost. A larger degree of complete leverage increases trading cost. Both degrees of financial and operating leverage, used jointly or independently, also raise the cost of trading. These results do not vary with the addition of other factors. When the effect of factors such as size, insider concentration, institutional holdings and the number of noninsiders is removed from our leverage measures, we still find an overall positive link between the residual leverages and microstructure characteristics (i.e. total risk, variance of pricing error, trade informativeness). Therefore, variables traditionally associated with microstructure do not fully reflect the effect of leverage.

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Chapter I - Introduction

One factor that is usually identified as a determinant of a security's liquidity is the degree of information asymmetry between the firm's insiders and outsiders (which dealers and market makers are assumed to be part of). Copeland and Galai (1983) and Glosten and Milgrom (1985), among others, examine the effect of asymmetric information on trading costs. To include adverse selection cost, a typical assumption of these models is that the market maker is at an informational disadvantage vis a vis some of the other traders he/she is facing. Others, such as Stoll (1978), and Ho and Stoll (1981), have proposed inventory arguments to explain liquidity. These papers consider order costs as a fixed component of the spread (which is a measure of liquidity cost).

A large proportion of the empirical literature on this topic predates most of the theoretical papers. Articles by Tinic and West (1972), Benston and Hagerman (1974), and Hamilton (1978) seek to explain the dollar bid/ask spread in terms of stock statistics (e.g. trading volume, price level, volatility, etc ...) and microstructure (e.g. proportion of volume traded outside the NYSE, number of competing dealers, etc ...). More recent research is focused on using similar stock and microstructure characteristics to explain the different components of trading costs (e.g. Glosten and Harris (1988) and Laux (1993)). Another direction has been the analysis of the impact of specific events on liquidity. For example, Cakici, Shastri and Tandon (1996) study the microstructure consequences of mergers and acquisitions announcements. Noronha, Sarin and Saudagaran (1996) investigate the effect of listing NYSE/AMEX stocks on the London or Tokyo stock exchanges. Others, such as Lee, Mucklow and Ready (1993) and Kim (1994) focus on earnings announcements. Events such as market switching and stock splits have also attracted attention (e.g. Maloney & Mulherin (1992)).

An important issue that has yet to be explored is the link between liquidity and firm characteristics. Of special interest are the firm-specific variables that management controls. Indeed, value maximization may result from liquidity enhancement. Also, investors may be interested in detecting additional factors that help predict liquidity and therefore prices. A recent attempt is by Sarin, Shastri and Shastri (1996), who analyze the impact that ownership structure may have on trading liquidity.

Our contribution to this area is focused on the microstructure consequences of leverage (the combined effect of operating and financial leverage). Since it affects stock volatility, we examine and find that leverage may explain some attribute of liquidity. One such attribute is market quality, as measured by the variance of pricing errors caused by non-informational factors such as inventory and order costs. Another microstructure characteristic is the degree of informational asymmetry (and therefore its cost on trading), expressed as a proportion of the variance of efficient price changes explained by trade innovations. A gauge of liquidity we examine is the cumulative daily abnormal returns (see Amihud and Mendelson (1986) and Reinganum (1990)).

This research is organized as follows. We survey the related literature in Chapter II. In the first part of the chapter, we focus on trading costs and liquidity. In the second part, we examine the literature on leverage. In Chapter III, we develop the testable hypotheses. The empirical specifications are presented in Chapter IV. The specifications for our market-quality measure are based on Hasbrouck (1993). Similarly, the specifications for our information-asymmetry measure are based on Hasbrouck (1991). We present the data and the empirical results in Chapter V. Chapter VI concludes this research.

Chapter II - Literature Review and Background

Section 2. 1): Trading Costs and Liquidity

Stoll (1978) presents a formal model for the inventory cost of holding stocks. As a dealer is supplying immediacy, he maintains his level of utility by being compensated for deviating from his initial portfolio. Stoll shows that the holding cost of inventory depends on: (a) dealer characteristics such as relative risk aversion and wealth ; (b) the size of stock transaction; and (c) stock characteristics such as return variance and covariance between the stock and the initial position in the trading account. Amihud and Mendelson (1980) show that even if a market maker maximizes expected profit while facing a stochastic arrival of orders, he still has a preferred inventory position. Following a transaction, the market maker quotes a price that brings him back to the optimal position. Ho and Stoll (1981) investigate the intertemporal aspects of the problem. The dealer, facing the uncertainties of order arrivals, stock return and portfolio return, searches a utility-maximizing pricing strategy through dynamic programming. Their conclusions are similar to Stoll (1978): the bid/ask spread depends on the dealer's risk aversion and wealth, transaction size and stock-return variance.

The existence of information asymmetry is generally justified by the assumed presence of both informed traders and liquidity traders. Glosten and Milgrom (1985) note that if all traders (including the specialist) are risk neutral, and even if the market maker's expected profit is zero, asymmetry of information still yields a positive bid/ask spread. This is because ask prices impound information that a (possibly informed) sell order implies, and similarly, bid prices reflect information signaled by a buy order. The spread increases as the insiders' information becomes more accurate, as the proportion of insiders increases, and as the elasticity of uninformed demand / supply goes up. Copeland and Galai (1983) provide a different perspective by showing that a positive bid-ask spread arises naturally when a risk-neutral market-maker maximizes the difference between expected revenues received from liquidity-motivated traders and expected losses to informationmotivated traders. Modeling bid and ask quotes as a free strangle position (the call option's exercise price is the ask price, the put option's strike price is the bid price) offered to informed traders, they conclude that the bid-ask spread is a positive function of the price level and return variance, and a negative function of market activity, depth, continuity and degree of competition.

Furthermore, Kyle (1985) shows that, if liquidity is measured by depth (i.e. the order size that moves price by one dollar), a greater amount of private information will push it down, whereas more noise trading will help it. Using a more elaborate model, Easley and O'Hara (1987) draw additional conclusions. First, they point out that the probability of informed trading depends both on the fraction of insider trades and the probability of an information event. Second, market makers may be able to separate noise traders from information traders if the latter can trade in large quantities or if an informed trade is unlikely. In this case, information asymmetry will not affect trading liquidity for small (uninformed) transactions. When market makers cannot separate noise traders from information traders (i.e. there is a pooling equilibrium), they will widen the spread for securities that have a greater probability of an information event. They will also widen the spread for securities that have a larger fraction of informed trades following an information event and for securities that have a greater variance of value. Market makers will narrow the spread for securities that have greater market depth.

Most of the empirical literature focuses on the bid/ask spread as a measure of liquidity. For example, Glosten and Harris (1988) decompose the spread into an adverse-selection component and a transitory component by estimating a price-change model using maximum-likelihood estimation techniques. They find that the transitory spread, presumed to measure inventory and other non-informational costs, is positively related to the security's total risk and transaction frequency. They also find that the adverse-selection component varies positively (though not significantly) with insider concentration and negatively with the number of noninsider shareholders.

Laux (1993) tests different microstructure theories analyzing the effect of tradesize characteristics on the (proportional) bid-ask spread. He documents the following hypotheses:

(a) If inventory costs dominate, the average proportional spread increases with the mean trade size; it also increases with trade-size variation (as predicted by the "preferredinventory position" theory of Amihud and Mendelson (1980);

(b) If (constant) order costs dominate, the proportional spread decreases with the average trade size;

(c) If asymmetric-information costs dominate, the proportional spread and the coefficient of variation for trade sizes are negatively associated (since large trades will distinguish informed traders in a separating equilibrium).

Using daily quotes and trading data on NASDAQ stocks for October and November 1984, he finds that inventory costs dominate both order-processing costs and adverse-selection costs. For stocks with a low price, small capitalization or low volume, order-processing costs are greater than inventory costs. The opposite is true for high-price, large-capitalization, high-volume stocks. Also, inventory effects are more important than asymmetric-information costs when price or capitalization is lower.

However, Grossman and Miller (1988) note that the spread is an imperfect measure of liquidity, since it measures the cost of supplying immediacy only in the unlikely case where the market maker executes both sides of the trade simultaneously and with a single customer. Roll (1984) provides a solution in the form of an implicit spread computed as two times the square root of minus the covariance between successive price changes ($2\sqrt{-cov(\Delta p_t, \Delta p_{t+1})}$). Lee, Mucklow and Ready (1993) observe that depth (i.e. quoted quantities the market maker is willing to buy/sell) is another dimension of liquidity. A decrease in liquidity may be fully expressed by a widening of the spread and a decrease in depth. After all, the NYSE specialist is evaluated partly on the basis of his average spreads and depths. He may therefore be averse to quoting extremes in either dimension and is likely to use both spreads and depths in managing liquidity risk.

Hasbrouck (1991) considers both price mid quotes and trade sizes in a vector autoregressive (VAR) model. He uses the model to compute the contribution of trades to the variance of efficient prices. The larger this contribution, the more informative trades are, and, therefore, greater the degree of information asymmetry for the security. Empirically, he concludes that a higher market capitalization is correlated with lower trade informativeness (i.e. lower adverse-selection cost). In a later study, Hasbrouck (1993) uses a VAR model involving transaction prices and trade sizes to compute the variance of pricing error (measured as the difference between the transaction price and the efficient price). The greater this variance, the larger the non-information related transaction costs (i.e. inventory and order costs).

Using similar measures of liquidity, Cakici, Shastri and Tandon (1996) find some patterns in the case of mergers and acquisitions announcements. For example, information asymmetry seems to increase in the pre-announcement period for both bidder and target firms. The pattern reverses itself in the post-announcement period. As for market quality (measured by pricing error variance), it seems to deteriorate for target firms in the pre-announcement period. Sarin, Shastri and Shastri (1996) look at the effect of ownership structure. They find that market quality is improved by both insider trading and larger institutional holdings. Noronha, Sarin and Saudagaran (1996) examine the change in liquidity for NYSE/AMEX stocks that are subsequently listed on the London Stock Exchange (a sample of 68 firms) and on the Tokyo Stock Exchange (a sample of 58 firms) between 1983 and 1989. They conclude that there is no change in both spread and depth caused by the additional listing when changes in price, volume and variance are taken into account. However, they detect an increase in the level of information asymmetry (measured by trade informativeness and by the weight placed by the market maker on public information), an increase in the number of transactions and also an increase in the average transaction size.

Liquidity may change also around earnings announcements. Krinsky and Lee (1996) investigate the behavior of the spread and its components in such cases. They use the Stoll (1989) method to break the bid/ask spread down into three parts: adverse selection cost, inventory cost and order processing cost. Analyzing the 1989-1990 period, they conclude that: (a) there is no significant change in the spread two days before and during the announcement; (b) the adverse-selection cost increases before and during the announcement; the increase is larger for the event period; (c) the inventory holding cost rises before the announcement and falls during the event; and (d) the order-processing cost declines during both predisclosure and event periods. Brooks (1996) focuses on the change in information asymmetry at earnings and dividend announcements. He estimates the informativeness of trades, a measure of the degree of information asymmetry, for 90 firms during 1988 using the methodology of Hasbrouck (1991). He finds a significant reduction in the level of information asymmetry on the day of earnings announcements. The change is more pronounced for small firms. However, the reduction for small firms occurs only on (a) the day following the announcement of a dividend increase, and (b) the day prior to the announcement that dividend will either decrease or remain at its previous level.

Another issue related to liquidity measurement is whether illiquidity is compensated in the form of higher returns. Using relative spreads as exogenous variables, Amihud and Mendelson (1986) show that in equilibrium (where gross returns are minimized), investors with longer expected holding periods will outbid short-term investors for assets with larger spreads. As a result, even though spread and returns are positively associated to compensate traders for their costs, the association is concave since longer holding periods imply smaller compensation for a given increase in the spread. Examining the relationship between NYSE stock returns, beta and relative spread over the period 1961-1980, they find that both beta and the spread increase with returns. They also conclude that the return-spread relation is concave for their stock sample.

In a later study, Amihud and Mendelson (1989) confirm the above results even when they add residual risk and firm size to the set of return explanatory variables. Brennan and Subrahmanyam (1996) also find a positive association between return and illiquidity after adjusting for the Fama and French risk factors.[1] They decompose trading cost into its fixed and variable components, using the methodologies of Glosten and Harris (1988), Hasbrouck (1991) and Foster and Viswanathan (1993). They compute returns from 19841991 monthly data and estimate cost components from 1984-1988 intraday data. They use generalized least-square regressions to demonstrate a positive effect of both the variable and fixed costs of illiquidity, and a

[1] See Fama and French (1993).

negative effect of the inverse of price level (1/P) on excess return. In addition, they show that there is no (monthly) seasonality in the above effects.

Based on the relationship between returns and illiquidity, Reinganum (1990) uses monthly-return differentials to measure the difference in liquidity provided by the NYSE and the NASDAQ system. Using data spanning the 1973-1988 period, he concludes that NASDAQ seems to provide better liquidity (and therefore smaller returns) to small stocks than the NYSE does, even when controlling for factors such as risk, price level and price reversals (in the form of lagged returns). In analyzing market microstructure during earnings announcement, Kim (1994) measures liquidity as the (risk-adjusted) excess return caused by net buy pressure (in terms of frequency or number of shares) as the effect of unexpected earnings is removed.[2] Using daily data on 106 firms covering the 1983-1988 period, he hypothesizes and finds that, during earnings announcements, liquidity is positively associated both to the quality of earnings information (as indicated by forecast errors) and liquidity trading (measured by

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[2] The more sensitive the stock price is to an order imbalance, the lower the stock's liquidity. Kim uses the difference between the quantity of buy orders and the quantity of sell orders (expressed as a percentage of the annual order flow) as a measure of order imbalance.

volume), and is negatively related to the quality of private information (proxied by the number of financial analysts).

In this research, we analyze the link between trading costs and leverage by examining the effect of return volatility on inventory cost (see Stoll (1978) and Ho and Stoll (1981)) and adverse-selection cost (see Kyle (1985) and Easley and O'Hara (1987)). We use the measures of inventory costs and adverse-selection costs as developed by Hasbrouck (1991, 1993). Similar to Amihud and Mendelson (1986) and Reinganum (1990), we use cumulative abnormal returns as a measure of trading costs.

Section 2.2): Complete, Financial and Operating Leverage

Complete leverage, the combined effect of financial and operating leverages on equity risk, has long been calculated as their algebraic product.[3] Huffman (1983) argues that this calculation is

[3] The degree of operating leverage is defined as the percentage change in earnings before interest and taxes per one percent change in revenues. Similarly, the degree of financial leverage is defined as the percentage change in net income per one percent change in earnings before interest and taxes revenues. Complete leverage is the percentage in net income per one percent change in revenues. See Li and Henderson (1991).

incorrect since there is an interaction between the firm's debt decision and its capacity decision (i.e. its level of fixed cost). In a one-period model, she assumes that the firm maximizes the value of equity by making a capacity decision (x) at the beginning of the period (t=0) and a production decision at the end of the period (at t= 1 when demand is realized). She shows that, even though the optimal level of operating leverage x* increases the degree of complete leverage for low levels of debt, it actually decreases leverage when the debt level is high. She also shows that debt increases the degree of complete leverage. Li and Henderson (1991) test Huffman's theory empirically. Using data covering the 1969-1986 period, they confirm that complete leverage is a better predictor of stock risk (both total and systematic) than the combination of operating and financial leverages.

Petersen (1994) focuses on the determinants of a firm's pension choice (which is a part of operating leverage decisions). Since operating leverage raises cash flow variability, he predicts that firms which value stability will choose defined contribution plans over defined benefit plans, since defined contribution pensions generally allow the firms more payment flexibility.[4] Drawing on 1983-1986 pension plan data

[4] A defined benefit plan requires the firm to make annual contributions that must fall within the maximum and minimum limits established by law. A defined contribution

from the I.R.S., he finds that firms choose defined contributions when they have more cash flow variability, greater probability of low cash level and more intangible assets (measured by market-to-book value of equity). These firms value financial stability because it lowers the expected value of tax payments (e.g. in Smith and Stulz (1985)) and both the probability and cost of financial distress.

Blazenko (1996) examines the effect of operating leverage on the distribution of equity returns. Modeling sales both at firm and economy levels as a bivariate OrsteinOlenbeck process, he shows that operating leverage increases both the (conditional and unconditional) expected value and variance of equity return.[5] In turn, a joint increase in conditional mean and variance leads to increased (positive) skewness. As for financial leverage, Martikainen (1997) studies its impact on earnings response coefficients (ERCs).[6] Since accounting losses tend to bias ERC estimates downward, she hypothesizes that the dampening effect will be more pronounced for: (a) firms which have high growth opportunities because a change in (positive) earnings has a larger

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plan may allow the firm to match its pension contribution to its available cash flow (for example, in a profit-sharing plan, a firm may omit any contribution if profits are low).

[5] In his model, firms are assumed to be all-equity financed to abstract from the effect of financial leverage.

[6] ERCs measure the unexpected equity return caused by unexpected earnings per dollar of share. They are computed by regressing returns against earnings changes per share.

impact on cash flow expectations and (b) firms which have low financial leverage (and therefore low systematic risk) because a change in expected cash flow will have a larger value (lower discount rate). Using annual data from the 1975-1990 period for a sample of NYSE firms, she concludes that growth opportunities (measured by market-to-book ratios) raise both ERCs (when earnings are positive) and (accounting) losses' dampening effect. However, the debt-to-equity ratio has the opposite impact.

One stylized fact about stock returns is their negative association with future volatility. Known as the leverage effect, this phenomenon is typically explained by the inverse relation between equity value and the debt-to-equity ratio: when the value of equity falls, debt-to-equity ratio rises, and equity volatility rises. Koutmos and Saidi (1995) examine whether the effect, documented for stock indices, also holds for individual stocks and whether the debt-to-equity ratio can explain its cross-sectional variations. They adopt the EGARCH specification to model the return process and use it with 1985-1988 data on the 30 firms that constitute the Dow Jones Industrial index. They detect an asymmetric impact of past return innovations on current volatility for all companies (negative innovations have larger impact than positive innovations). However, they do not find any statistically significant association between asymmetry and the debt-to-equity ratio.

In this research, we analyze the link between trading costs and leverage. We use the measures of operating, financial and complete leverage reported by Li and Henderson (1991).

Chapter III- Testable Hypotheses

Our objective is to investigate the impact of leverage on the microstructure characteristics of securities. Huffman (1983) shows that the combined effect of financial and operating leverages is better captured by the degree of complete leverage since there is an interaction between the firm's debt decision and its capacity decision (i.e. its level of fixed cost). Li and Henderson (1991) confirm that complete leverage is a better predictor of stock risk (both total and systematic) than the combination of operating and financial leverages.[7] As for microstructure characteristics, most studies have linked the level of total risk for a security to the cost of its trading. In particular, Stoll (1978) and Ho and Stoll (1981) establish that a greater variance of the security's return implies a higher inventory holding cost for the market maker. Hasbrouck (1993) proposes the variance of pricing error (measured as the difference between the transaction price and the efficient price) as a measure of inventory cost. Given these results, we formulate our first testable hypothesis:

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[7] Such combination is typically computed as the product of both degrees of financial and operating leverage.

Hypothesis 1: *Holding other factors constant, the variance of pricing error for a stock rises with the degree of complete leverage, since leverage increases the stock's level of risk and hence its inventory holding cost.*

Since both financial and operating leverages have separate effects on complete leverage (see Huffman (1983)) and hence on risk, our next hypothesis is:

Hypothesis 2: *Holding other factors constant, the variance of pricing error for a stock rises with both degrees of financial leverage and operating leverage, since both leverages increase the stock's level of risk and hence its inventory holding cost.*

The variance of return is a gauge for potential profit from superior information and therefore is positively associated with adverse-selection costs (see Kyle (1985) and Easley and O'Hara (1987)). Hasbrouck (1991) suggests that these costs be measured by the proportion of the efficient price contributed by trades (also known as trade informativeness). This leads to our third hypothesis:

Hypothesis 3: *Holding other factors constant, the informativeness of trades for a stock rises with its degree of complete leverage since leverage increases the stock's level of risk and hence its adverse-selection cost.*

Considering the distinct effects of financial and operating leverages on risk, we further hypothesize:

Hypothesis 4: *Holding other factors constant, the informativeness of trades for a stock*

rises with both degrees of financial leverage and operating leverage since both leverages increase the stock's level of risk and hence its adverse-selection cost.

The next two hypotheses are based on the use of cumulative excess returns as a measure of trading costs (see Amihud and Mendelson (1986) and Reinganum (1990)).

Hypothesis 5: *Holding other factors constant, the cumulative abnormal returns for a stock rise with its degree of complete leverage* *since leverage increases the stock's level of risk and hence its trading costs.*

Hypothesis 6: *Holding other factors constant, the cumulative abnormal returns for a stock rise with both degrees of financial leverage and operating leverage since both leverages increase the stock's level of risk and hence its trading costs.*

The other factors we take into consideration are market capitalization, insider concentration, institutional holdings and noninsider number (see, for example, Glosten and Harris (1988), Hasbrouck (1991) and Sarin,Shastri and Shastri (1996)). These regressions are outlined in Chapter V and various hypotheses tested using these additional variables.

Chapter IV- Empirical Specification

Section 4. 1): Variance of Pricing Error (VPE)

Hasbrouck (1993) decomposes the logarithm of transaction prices, p_t , as the sum of two components:

$$p_t = m_t + s_t \qquad \text{(eq. 4.1)}$$

where m_t is the efficient price which reflects all information, including private information inferred from the published terms of the transaction and s_t is the pricing error, measured as the difference between the (unobservable) informationally-efficient price and the transaction price. The pricing error reflects non-information-based microstructure characteristics such as inventory control, discreteness, etc ... As such, its variance, VPE, is a summary measure of market quality. The efficient price is assumed to follow a random walk:

$$m_t = m_{t-1} + w_t \qquad \text{(eq. 4.2)}$$

where w_t are uncorrelated increments with $E[w_t] = 0$, $E[w^2_t] = \sigma^2_w$, and $E[w_t, w_\tau] = 0$ for $t \neq \tau$.

From eq. 4.1 and eq. 4.2, the rate of return is:

$$r_t = p_t - p_{t-1} = w_t + s_t - s_{t-1} \qquad \text{(eq. 4.3)}$$

Following Hasbrouck (1991), trades and price changes can also be modeled in a vector autoregression (VAR):

$$r_t = a_1 r_{t-1} + a_2 r_{t-2} + \ldots + b_1 x_{t-1} + b_2 x_{t-2} + \ldots + v_{1t}$$

$$x_t = c_1 r_{t-1} + c_2 r_{t-2} + \ldots + d_1 x_{t-1} + d_2 x_{t-2} + \ldots + v_{2t} \qquad \text{(eq. 4.4)}$$

where

r_t is the trading price return (logarithm differentials) at time t, x_t is the signed trade size at time and t is the time index, incremented by 1 after a transaction.

The lagged dependencies in eq. 4.4 are used to capture the microstructure effects such as inventory control and price discreteness. Therefore, v_{2t} is the trade innovation at time t that contains both private and public information (the public information mentioned here does not refer to trade and price history but refers to public news) . In the same vein, v_{1t} is the price innovation at time t that contains both private and public information. The VAR in eq. 4.4 has a vector moving average (VMA) representation as follows:

$$r_t = e_1 v_{1,t} + e_2 v_{1,t-1} + \ldots + f_1 v_{2,t} + f_2 v_{2,t-1} + \ldots$$

$$x_t = g_1 v_{1,t} + g_2 v_{1,t-1} + \ldots + h_1 v_{2,t} + h_2 v_{2,t-1} + \ldots \quad \text{(eq. 4.5)}$$

Combining equations 4.3 and eq. 4.5, Hasbrouck (1993) demonstrates that the pricing error s_t, can be written as:

$$s_t = A_0 v_{1,t} + A_1 v_{1,t-1} + \ldots + B_0 v_{2,t} + B_1 v_{2,t-1} + \ldots \quad \text{(eq. 4.6)}$$

where

$$Aj = -\Sigma_{k=j+2,\infty} e_k \text{ and } Bj = -\Sigma_{k=j+2,\infty} f_k;$$

The variance of the pricing error s_t, VPE, is given by VPE = $\Sigma_{j=0,\infty}$ [Aj Bj].cov(v).[Aj Bj $]^T$ where v= (v_1, v_2).

Section 4.2): Measure of Trade Informativeness

Hasbrouck (1991) uses a similar model as above to measure trade informativeness. He formulates the following model:

$$q_t = m_t + s_t \quad \text{(eq. 4. 7)}$$

$$m_t = m_{t-1} + w_t \quad \text{(eq. 4.8)}$$

$$r_t = q_t - q_{t-1} = w_t + s_t - s_{t-1} \quad \text{(eq. 4.9)}$$

and

$$r_t = a_1 r_{t-1} + a_2 r_{t-2} + \ldots + b_0 x_t + b_1 x_{t-1} + \ldots + v_{1t}$$

$$x_t = c_1 r_{t-1} + c_2 r_{t-2} + \ldots + d_1 x_{t-1}$$

$$+ d_2 x_{t-2} + \ldots + v_{2t} \quad \text{(eq. 4.10)}$$

This model differs from the previous model in several ways. First, the price variable q_t denotes the logarithm of quote midpoints. Second, t indicates transactions and quote changes. Third, the return specification includes the contemporaneous trade, x_t. While a causal relationship is assumed to run from trade x, to the consequently updated quote q_t in eq. 4. 10, simultaneity is assumed between p_t and x_t in eq. 4.4. The lagged dependencies in eq. 4.10 are modeled to capture microstructure effects such as inventory control and price discreteness.

Similar to eq. 4.4, v_{2t} is the trade innovation at time t that contains both private and public information. However, unlike eq. 4.4, $v_{1,t}$, the price innovation at time t, contains public information only since the contemporaneous trade variable x_t is included as an explanatory variable.

If Φ_{t-1} is the public information set prior to trade x_t, the market's signal of private information is the trade innovation

$$x_t - E[x_t / \Phi_{t-1}]$$

The impact of this trade innovation on the efficient price is

$$E[w_t / x_t - E[x_t / \Phi_{t-1}]]$$

A summary measure of trade informativeness, denoted by TINFO, is defined as:

$$Var(E[w_t / x_t - E[x_t / \Phi_{t-1}]]) / Var(w_t) \qquad \text{(eq. 4.11)}$$

The VAR in eq. 4.10 follows a VMA representation as under:

$$r_t = v_{1,t} + e_2 v_{1,t-1} + \ldots + f_1 v_{2,t} + f_2 v_{2,t-1} + \ldots$$

$$x_t = g_1 v_{1,t} + g_2 v_{1,t-1} + \ldots + h_1 v_{2,t} + h_2 v_{2,t-1} + \ldots \qquad \text{(eq. 4.12)}$$

Using equations 4.9 and 4.12, Hasbrouck (1991) shows that trade informativeness TINFO, can be defined as the ratio $v_{w,x}/v_w$ in eq. 4.11, where:[8]

$$v_{w,x} = (\Sigma_{i=1,\infty} f_i).\text{var}(v_{2,t}).(\Sigma_{i=1,\infty} f_i)^T \qquad \text{(eq. 4.13)}$$

and

$$v_w = v_{w,x} + (1+\Sigma_{i=2,\infty} e_i)^2.\text{var}(v_{1,t}) \qquad \text{(eq. 4.14)}$$

Section 4.3): Cumulative Abnormal Returns (CARs)

We use the following market model:

[8] TINFO is the proportion of efficient price that trade innovations explain. Trade innovations are excess trade sizes unexplained by public information. Therefore, they carry the market's signal of private information. Their impact on price is TINFO, a measure of trade informativeness.

$$r_{i,t} = a_i + b_i \, r_{m,t} + e_{i,t} \qquad \text{(eq. 4.15)}$$

where $r_{i,t}$ is the rate of return from stock i on day t, $r_{m,t}$ is the rate of return from the market index on day t, $e_{i,t}$ is an error term and a_i and b_i are constants.

We estimate the coefficients a_i and b_i for each stock i using the market model regression for a given and cumulative estimation period. We then use the estimates to compute the daily abnormal returns, $e_{i,t}$, for the period.

Section 4.4): Measures of Complete, Financial and Operating Leverages

Following O'Brien and Vanderheiden (1987) and Li and Henderson (1991), the degree of complete leverage DOCL is computed as:

$$u_{xt} = DOCL.\, u_{st} + e_t \qquad \text{(eq. 4.16)}$$

where

u_{xt} = percentage deviation of net income (X) from its trend;

u_{st} = percentage deviation of sales (S) from its trend;

e_t = error term.

For each firm j, u_{xt} is obtained by regressing:

$$\ln X_{jt} = \ln X_{jo} + g_x.t + u_{xt} \qquad \text{(eq. 4.17)}$$

where

X_{jo} = X in period 0, the first in the sample;

X_{jt} = X in period t;

t = time index.

Similarly, u_{st} is obtained as:

$$\ln S_{jt} = \ln S_{jo} + g_s.t + u_{st} \qquad \text{(eq. 4.18)}$$

Similarly, the degree of financial leverage DFL, and the degree of operating leverage DOL, are computed using the same procedure as used to estimate DOCL above. In other words,

$$u_{xt} = DFL.\ u_{et} + e_t \qquad \text{(eq. 4.19)}$$

and

$$u_{et} = DOL.\ u_{st} + e_t \qquad \text{(eq. 4.20)}$$

where

u_{xt} = percentage deviation of net income (X) from its trend;

u_{et} = percentage deviation of earnings before interest and taxes (EBIT) from its trend;

u_{st} = percentage deviation of sales (S) from its trend;

e_t = error term.

The coefficients are estimated in a similar manner as equations 4.17 and 4.18 above.

Chapter V describes the data and presents the empirical results of the various hypotheses presented earlier.

Chapter V- Data and Empirical Results

Section 5. 1): Sample Description

We start with a random selection of 100 firms that are listed on the 1994 CRSP tapes and also have second-quarter trading data recorded on the NYSE's 1994 TAQ data tapes.[9] Our final analysis is for only 86 firms for which we have accounting data on the 1994 COMPUSTAT tapes. A list of the sample firms is presented in Appendix A.

Table 1 contains sample descriptive statistics. In addition to market capitalization, other variables of interest include insider concentration, institutional holdings, number of shareholders, and number of insiders. Capitalization data (for March 31) are taken from the 1994 CRSP tapes. Insider concentration data and insider count data are collected from the 1994 proxy statements available at the NYSE. Institutional holdings are obtained from Value Line, Moody's Handbook of Common Stocks, and Standard and Poors Security

[9] We randomly draw a firm from the 1994 CRSP roster and match it to the 1994 TAQ roster. The drawing process is identically repeated until we obtain a list of 100 different firms.

Owners Stock Guide. Shareholder numbers are obtained from Value Line and 10K reports.

Market capitalization varies from $3 million to $29 billion, with an average of $1.5 billion.[10] There is a large variation in insider concentration, ranging from 0% to 85%, with a mean concentration of 23%.[11] Institutional shareholders, typically, control 40% of a firm's equity in our sample. Here too, the range of values is wide, varying from 2.41 % to 85.16%.[12] The number of noninsiders, computed as the difference between the number of shareholders and the number of insiders, varies from 99 to 93,985 for an average of about 10,000.

Section 5.2): Estimation of Pricing Error Variance (VPE)

Our data source, the NYSE's TAQ database, contains quote data that include timestamped bid prices, ask prices, depths (on both sides), and quote origins (i.e. name of Stock Exchanges).[13] The database

[10] Market capitalization is the product of share price and shares outstanding on March 31, 1994.

[11] Insider concentration measures the proportion of shares owned by top management, 5% reporters and individuals (obviously) related to top management.

[12] Institutional holdings measure the proportion of shares owned by financial institutions.

contains transactions data, that is, time-stamped trade prices, trade sizes and exchanges. A third type of data included in TAQ is dividend amounts (cash and stock) and ex-dividend dates.

For each firm in our sample, we create a database which extracts the transactions and quote data described above, for the second quarter of 1994. We use the selection program, SELECT, which is provided with the TAQ database (each compact disk contains one month of data). The program requires the entry of request details such as data type (trade or quote) and date range. The outputs from the SELECT program are recorded in a file containing one month of trade data (SELECT.T) and another file containing one month of quote data (SELECT.Q) for each firm. SELECT.T includes trade attributes such as date, name of exchange, time, price, size and trade condition.[14] SELECT.Q includes quote attributes such as date, exchange, time, bid price, bid size, offer price, offer size and quote mode.[15] [16]

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[13] The TAQ database lists quotes for the NYSE, the Amex and the NASDAQ. Participants on the exchanges include the following regional exchanges: Boston, Cincinatti, Midwest, Pacific, Philadelphia, Instinet and CBOE.

[14] One example of a trade condition is whether the securities are paid and delivered on the same day the trade takes place (i.e. a cash sale) or on the next day.

[15] One example of a quote condition or mode is that the quote is the last from a participant for that security during the trading day.

[16] SELECT can access only one TAQ disk at a time and we extract three months worth of data for each firm. The SELECT program requires several runs for each firm and takes 45 to 60 minutes per run per firm.

Next, we compute each transaction return as the difference between the logarithms of successive prices and record the corresponding trade size (using the SELECT.T file). Similar to Hasbrouck (1993), we do not use overnight returns since the trade/return process is assumed to start anew each morning.[17] Hasbrouck (1991) notes that the NYSE reporting process delays most trades relative to quotes, leading to spurious reversals in the transactions record. As a result, the last quote recorded within 5 seconds or more prior to a transaction x_t is the prevailing quote q_{t-1}. Using both SELECT.T and SELECT.Q files, we classify transactions as buy orders (positive sign) if the transaction price is above the mid-quote price, and sell orders (negative sign) if the transaction price is below the mid-quote price; if the transaction price equals the mid-quote price, transaction size is set to zero.[18]

The VAR in eq. 4.4 is estimated with a time lag of 5. The trade variable x_t is the signed square root of trade size at time t.[19] We then

[17] At the start of each day, lagged values of trades and returns are set to zero.

[18] This classification scheme has been extensively used in the literature. See for example Lee and Ready (1991), Hasbrouck (1991), Hasbrouck (1993) and Noronha, Sarin and Saudagaran (1996).

[19] See for example Cakici, Shastri and Tandon (1994).

calculate the VMA in eq. 4.5 with a time lag of 10.[20] The coefficient estimates are used to compute the variance VPE as noted previously.

We report descriptive statistics of our estimates for pricing error variance in the second row of Table 2. We find an average variance of 0.000186 or an average standard deviation of 0.0136, which is about 1.36% of the stock price.[21] The variances range from $6.4 * 10^{-8}$ (i.e. a standard deviation of about 0.02% of the price) to 0.009108 (i.e. a standard deviation of about 9.5% of the price). Our average standard deviation estimate of 1.36% lies between the values computed by Cakici, Shastri and Tandon (1994), who analyzing their merger and acquisition sample find a standard deviation of 4.95% (of the price) for the target firms and 1.2% for the bidder firms, and by Hasbrouck (1993) who estimates an average standard deviation of 0.33% of the price for his NYSE sample. Hasbrouck (1993) notes that, assuming the initiator of a trade always pays for transaction cost and the pricing errors are normally distributed, the absolute value of the pricing error, $|s_t|$, measures that cost and its expected value $E[| s_t |]$ equals approximately 80% of the standard deviation. If Hasbrouck's assumptions are correct, this implies an average

[20] Ibid.

[21] Technically, the reference price is the (unobservable) efficient price.

transaction cost of about 1% of the transaction value for our sample.[22]

Section 5.3): Estimation of Trade Informativeness (TINFO)

The data source and the estimation process are similar to those used to compute pricing error variances. Next, we discuss the differences between the estimation of trade informativeness and the pricing error variance.

For each firm in our sample, we calculate the return as the difference between the logarithms of successive quote midpoints and record the intervening transaction size (which is set to zero if there is none). The return is set to zero if no quote revision follows a trade within 5 seconds.[23] To alleviate the problem of reporting fragmentation (e.g. if there are three sellers and one buyer, three transactions will be recorded), transactions occurring within 5 seconds of each other without any intervening quote are aggregated.

[22] Since the average standard deviation is 1.36% (of the stock price) for our sample, 80% of that value (which equals 1.088%) is the average transaction cost.

[23] See Hasbrouck (1991).

Since trade reporting is slower than quotes, a quote posted within less than 5 seconds prior to a trade is considered an anomaly, and therefore is resequenced.

The VAR we estimate is eq. 4.10 and the subsequent VMA is eq. 4.11. The coefficient estimates are used to compute trade informativeness (TINFO), as noted in eqs. 4.13 and 4.14.

The descriptive statistics of our estimates for trade informativeness are reported in Table 2, second row. We find an average TINFO of .1139. This implies that, for our sample, 11.39% of the variance in the random-walk (efficient) component of the stock price is attributable to trades. Our estimates range from 0.03% to 98.17%. Cakici, Shastri and Tandon (1994) report similar averages for their merger and acquisition sample (12.55% for the targets and 14.15% for the bidders before the announcement), whereas Hasbrouck (1991) reports a higher average (34%) for his NYSE sample.

Section 5.4): Estimation of Cumulative Abnormal Returns (CARs)

The daily stock rates of return are extracted from the 1994 CRSP tapes. We estimate eq. 4.15 by using daily returns for the 250 trading days prior to April 1, 1994. We then compute and cumulate the daily abnormal returns from April 1 to May 31, 1994. Three stocks are excluded from our sample since they are missing more than 20 observations in the estimation period.

We report summary statistics on the estimates of cumulative abnormal returns (CARs) in the last row of Table 2. As expected, the excess returns are not significant. The average is -0.37% with a standard deviation of 2.34%. The maximum value is 8.55% while the minimum value is -5.82%.

Section 5.5): Estimation of Leverage

Earnings, net income and sales data for the 86 firms in our sample are taken from COMPUSTAT. The data covers 48 quarters, starting with the first quarter of 1982 and ending with the first quarter of 1994.[24]

Table 3 reports summary statistics of leverage estimates. On average, the degree of complete leverage amounts to 1.40, with a

[24] Missing earnings data lead to differences in the sizes of samples used to estimate the leverage measures in Table 2.

standard deviation of 3.42. Its value ranges from - 19.75 to +10. 16. This result suggests that an unexpected 1% increase in revenue tends to increase net income by approximately 1.40% for the firms in our sample.[25] Similarly, the degree of financial leverage averages 1.32, with a standard deviation of 0.88. The estimated value ranges from -0.40 to 4.60. Therefore, an unexpected 1% increase in earnings leads to an increase in net income by approximately 1.32% for the firms in our sample.[26] The degree of operating leverage averages 1.43. The standard deviation is 1.48 and the value ranges from -0.77 to 10.40. Therefore, an unexpected 1% increase in sales increases earnings by approximately 1.43% for the firms in our sample.

Section 5.6): Pricing-Error Variance and Leverage

Section 5.6.1 analyzes the impact of complete leverage on error variance, while Section 5.6.2 focuses on the relation between pricing-error variance and financial leverage. Section 5.6.3 focuses on operating leverage and error variance, while Section 5.6.4 focuses on

[25] The literature on the degree of complete leverage has focused on the variable's explanatory power and, therefore, does not provide values with which to compare our estimates.

[26] The literature on the degree of financial leverage has focused on the variable's explanatory power and, therefore, does not provide values with which to compare our estimates.

cross-sectional regressions with both financial and operating leverage as explanatory variables. Section 5.6.5 summarizes the findings of Section 5.6.

All functional forms are empirically determined. As a starting point, we use the forms suggested by two-variable data plots relating the dependent variable to each independent variable. Then we vary our functional specifications (e.g. the exponent values) to check which specification leads to a higher level of significance of the regression coefficients under study.

5.6.1): Pricing-Error Variance and Complete Leverage (DOCL)

We test the relationship between pricing-error variance (VPE) and the degree of complete leverage (DOCL). Results are presented in Table 4. We first estimate the following regression :[27]

[27] The logarithmic and power functions are used to account for nonlinearity. Alternative functional specifications (including exponential) and alternative exponent values yield lower statistical significance for leverage (results are available on request). See Levin (1987). Constants are added to both VPE and DOCL to avoid computer overflow when using the logarithmic function.

$$[\ln(VPE + 1)]^{-.385} = a + b\,[\ln(DOCL + 19.76)]^{.05} \qquad \text{(eq. 5.1)}$$

where VPE and DOCL are unitless. We find a positive, but not statistically significant, relationship between both these variables (i.e. b>O). This indicates a positive relationship between inventory costs and complete leverage.[28] See Table 4, regression 1 for results.

Market capitalization (CAP) has often been cited as an important variable in determining the microstructure characteristics of a security (e.g. Hasbrouck (1991)). We include it as an additional explanatory variable as follows:

$$[\ln(VPE + 1)]^{-.385} = a + b\,[\ln(DOCL + 19.76)]^{.05} + c\,CAP \qquad \text{(eq. 5.2)}$$

where CAP is measured in '000 dollars. The results of regression (5.2) are reported in column 3 of Table 4. The relationship between VPE and DOCL is still positive (b>O), but not statistically significant. However, VPE and firm capitalization CAP are negatively and are significantly related (c<O); i.e. stocks of larger firms seem to benefit from lower

[28] VPE is used as a proxy for dealer inventory costs. See Hasbrouck (1993).

dealer inventory costs. Hasbrouck (1993) finds a similar relation between market capitalization and pricing error variance.

When we include a variable for the interaction between leverage (DOCL) and capitalization (CAP), the regression equation estimated is:

$$[\ln(VPE + 1)]^{-.385} = a + b\,[\ln(DOCL + 19.76)]^{.05}$$
$$+ c\,CAP$$
$$+ d\,(CAP*[\ln(DOCL + 19.76)]^{.05}) \qquad \text{(eq. 5.3)}$$

None of the coefficients are statistically significant. See Table 4, regression 3 (column 4) for results.

Several studies have found that insider concentration (ICE), institutional holdings (IHLDG) and noninsider number (NNINS) also affect trading costs (e.g. Glosten and Harris (1988) and Sarin,Shastri and Shastri (1996)). As a result, we estimate the following regression:[29]

[29] Similar to eq. 5.1, the logarithmic, exponential and power functions are used to account for nonlinearities. Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables (results are available on request). See Levin (1987). Constants are added to both VPE and DOCL to avoid computer overflow when using the logarithmic function.

$$[\ln(VPE + 1)]^{.385} = a + b\,[\ln(DOCL + 19.76)]^{.05} + c\,CAP + d\,\exp(ICE) + e\,\exp(IHLDG) + f\,\exp(NNINS/10{,}000) \qquad \text{(eq. 5.4)}$$

where ICE, IHLDG are unitless and NNINS is in entities. Results are presented in Table 4, column 5. We find that institutional holdings are significantly negatively related to pricing-error variance (i.e., e<O), while other variables are statistically insignificant. Sarin, Shastri and Shastri (1996) find a similar relationship in their Value Line sample. Both insider concentration and the number of noninsiders do not significantly affect pricing error.

Finally, we also include interaction variables and estimate the following regression:

$$VPEP = a + b.DOCLP + c.CAP + d.ICEP + e.IHLDGP + f.NNINSP + g.DCAP + h.DICE + i.DIHLDG + j.DNNINS \qquad \text{(eq. 5.5)}$$

where VPEP is $[\ln(VPE + 1)]^{.385}$, DOCLP is $[\ln(DOCL + 19.76)]^{.05}$, ICEP is exp(ICE), IHLDGP is exp(IHLDG), NNINSP is exp(NNINS/10,000), DCAP is DOCLP*CAP, DICE is DOCLP*ICE, DIHLDG is DOCLP*IHLDG, DNNINS is DOCLP*NNINS. None of the coefficients are statistically significant. See Table 4, regression 5 for results.

5.6.2): Pricing-Error Variance and Financial Leverage (DFL)

Next, we replace complete leverage with financial leverage (DFL) and then with operating leverage (DOL). The results are presented in Tables 5, 6 and 7. We test the following regression:[30]

$$[\ln(VPE + 1)]^{.5} = a + b\,(DFL + 1.5)^{.001} \qquad \text{(eq. 5.6)}$$

[30] The logarithmic and power functions are used to account for nonlinearities. Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables (results are available on request). See Levin (1987). Constants are added to VPE and DFL to avoid computer overflow when using the logarithmic and power functions.

where DFL is unitless (see Table 5, regression 1 for results). The regression coefficient (b) is positive but is not statistically (i.e. b>O but insignificant).

When we include market capitalization in eq. 5.6, the regression equation is:

$$[\ln(VPE + 1)]^{.5} = a + b\,(DFL + 1.5)^{.001} + c\,CAP \qquad \text{(eq. 5.7)}$$

Higher degree of financial leverage still is associated with greater pricing variance (b>O), but not significantly. Capitalization also does not affect VPE (c<0 but insignificant). The results are reported in Table 5, column 3.

Adding a variable for the interaction between financial leverage and capitalization to eq. 5.7 yields similar results: none of the coefficients are statistically significant though the coefficient for financial leverage is still positive (b>O). The regression equation is:

$$VPEP = a + b.DFLP + c.CAP + d.FCAP \qquad \text{(eq. 5.8)}$$

where VPEP is $[\ln(VPE + 1)]^{.5}$, DFLP is $(DFL + 1.5)^{.001}$ and FCAP is DFLP*CAP. See Table 5, regression 3 for results.

However, when we include additional explanatory variables, the coefficient for financial leverage becomes statistically significant. See regression 5.9 below:

$$VPEP = a + b.DFLP + c.CAP + d.ICEP + e.IHLDGP + f.NNINSP \qquad \text{(eq. 5.9)}$$

where VPEP is $[\ln(VPE + 1)]^{.5}$, DFLP is $(DFL + 1.5)^{.001}$, ICEP is exp(ICE), IHLDGP is exp(IHLDG) and NNINSP is exp(NNINS/10,000). In addition to a positive and significant effect of financial leverage on pricing error ($b>O$), the results indicate a negative and significant effect of both insider concentration and institutional holdings (i.e. $d<O$ and $e<O$). The effect of institutional holdings on pricing-error variance reported here is similar to eq. 5.4. See Table 5, regression 4 (column 5).

5.6.3): Pricing-Error Variance and Operating Leverage (DOL)

Similar to the above, we first regress the following equation is:[31]

$$[\ln(VPE + 1)]^{.5} = a + b\,(DOL + 1.7)^2 \qquad \text{(eq. 5.10)}$$

where operating leverage, DOL, is unitless. The coefficient for operating leverage is negative but not statistically significant (i.e. $b<0$ and insignificant). See Table 6, regression 1 for results.

Adding market capitalization to eq. 5.10 yields:

$$[\ln(VPE + 1)]^{.5} = a + b\,(DOL + 1.7)^2 + c\,CAP \qquad \text{(eq. 5.11)}$$

Results of eq. 5.11 are presented in Table 6, regression 2. We find that the coefficient for operating leverage is again not significant. However,

[31] The logarithmic and power functions are used to account for nonlinearities. Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables (results are available on request). See Levin (1987). Constants are added to VPE and DOL to avoid computer overflow when using the logarithmic and power functions.

similar to eq. 5.2, the effect of market capitalization on pricing error is negative and significant.

When we include a variable for the interaction between operating leverage and market capitalization in eq. 5.11, none of the coefficients are significant. The regression equation is:

$$VPEP = a + b.DOLP + c.CAP + d.OCAP \qquad \text{(eq. 5.12)}$$

where VPEP is $[\ln(VPE + 1)]^{.5}$, DOLP is $(DOL + 1.7)^2$ and OCAP is DOLP*CAP. See Table 6, regression 3 for results.

Taking additional explanatory variables into account, we run the following regression:

$$VPEP = a + b.DOLP + c.CAP + d.ICEP + e.IHLDGP + f.NNINSP \qquad \text{(eq. 5.13)}$$

where VPEP is $[\ln(VPE + 1)]^{.5}$, DOLP is $(DOL + 1.7)^2$, ICEP is exp(ICE), IHLDGP is exp(IHLDG) and NNINSP is exp(NNINS/ 10,000). Similar to the results of eqs. 5.4 and 5.9, institutional holdings affect pricing-error variance negatively and significantly ($e<0$). Results for eq. 5.13 are presented in Table 6, regression 4.

5.6.4): Pricing-Error Variance, Financial and Operating Leverage: Cross-Sectional Regressions

We next include both DFL and DOL in the same regression:

$$[\ln(VPE + 1)]^{.5} = a + b\,(DFL + 1.5)^{.001} + c\,(DOL + 1.7)^{2} \qquad \text{(eq. 5.14)}$$

where both DFL and DOL are unitless (see Table 7, regression 1 for results). Although none of the regression coefficients are statistically significant, the coefficient for financial leverage is positive (i.e. $b>0$) while that of operating leverage is negative (i.e. $c<0$). In the next regression, we include market capitalization as follows:

$$[\ln(VPE + 1)]^{.5} = a + b\,(DFL + 1.5)^{.001} + c\,(DOL + 1.7)^{2} + d\,CAP \qquad \text{(eq. 5.15)}$$

Higher degree of financial leverage still is associated with greater pricing variance ($b>0$). As with the earlier analysis (see for example eq. 5.2), larger firms seem to benefit from smaller pricing errors, and the relation between VPE and CAP is statistically significant (d>O).

Adding insider concentration, institutional holdings and noninsider count, we estimate the following regression :

$$[\ln(VPE + 1)]^{.5} = a + b\,(DFL + 1.5)^{.001} + c\,(DOL + 1.7)^{2} + d\,CAP + e\,\exp(ICE) + f\,\exp(IHLDG) + g\,\exp(NNINS/10{,}000) \qquad \text{(eq. 5.16)}$$

Results are reported in Table 7, regression 3. We find a positive and significant association between financial leverage and pricing-error variance (b>O), and a negative and statistically significant relationship between the variance of pricing error and institutional holdings (f<O). We obtain the same results (i.e. b>O and f<O) when we include interaction variables in eq. 5.16, although the coefficients are not significant. The regression equation is:

$$VPEP = a + b.DFLP + c.DOLP + d.CAP$$
$$+ e.ICEP + f.IHLDGP + g.NNINSP$$
$$+ h.FCAP + i.FICE + j.FIHLDG$$
$$+ k.FNNINS + l.OCAP + m.OICE$$
$$+ n.OIHLDG + o.NNINS + p.FOL \quad \text{(eq. 5.17)}$$

where VPEP is $[\ln(VPE + 1)]^{.5}$, DFLP is $(DFL + 1.5)^{.001}$, DOLP is $(DOL + 1.7)^2$, ICEP is exp(ICE), IHLDGP is exp(IHLDG), NNINSP is exp(NNINS/10,000), FCAP is DFLP*CAP, FICE is DFLP*ICE, FIHLDG is DFLP*IHLDG, FNNINS is DFLP*NNINS, OCAP is DOLP*CAP, OICE is DOLP*ICE, OIHLDG is DOLP*IHLDG, ONNINS is DOLP*NNINS and FOL is DFLP*DOLP. While the coefficient for financial leverage is still positive, though statistically insignificant (b>O), the coefficient for market capitalization is negative and not statistically significant (d<O). See Table 7, regression 4 for results.

<u>5.6.4) Summary</u>

We find that the effect of complete leverage on pricing-error variance is positive but not statistically significant, even when additional factors are taken into account. The positive and statistically significant effect of financial leverage supports our hypothesis that leverage raises error variance (and hence the cost of liquidity). The effect of operating leverage is not statistically significant. Other significant results include the negative effects of both institutional holdings and insider concentration on pricing-error variance. These results imply that firms need to consider the risk impact of leverage (especially financial leverage) on the trading cost for their securities; leverage-induced volatility will tend to raise the cost of inventory for securities dealers.

Section 5.7): Trade Informativeness and Leverage

Section 5.7.1 focuses on the impact of complete leverage on trade informativeness. The next subsection analyzes the relation between trade informativeness and financial leverage. The following subsection (5.7.3) focuses on operating leverage and trade informativeness. Section 5.7.4 considers both financial and operating leverage as explanatory variables. The following subsection summarizes our findings.

All functional forms are empirically determined. As a starting point, we use the forms suggested by two-variable data plots relating the dependent variable to each of the independent variables. We vary our functional specification (e.g. the exponent values) to arrive at the highest level of statistical significance of the regression coefficients.

5.7.1): Trade Informativeness and Complete Leverage

We first test the statistical relationship between trade informativeness (TINFO) and the degree of complete leverage (DOCL). We first regress the following:[32]

$$\ln(\text{TINFO} + 1) = a + b \exp(\text{DOCL}+21) \qquad \text{(eq. 5.18)}$$

where, TINFO and DOCL are unitless. Results are reported in Table 8, regression 1. We find a positive and statistically significant relation between information asymmetry and degree of complete leverage (i.e.

[32] The logarithmic and exponential functions are used to account for nonlinearities. Alternative functional specifications yield lower statistical significance for the degree of complete leverage (results are available on request). See Levin (1987). Constants are added to TINFO and DOCL to avoid computer overflow (respectively, underflow) when using the logarithmic and exponential functions.

b>0). This is consistent with the concept of a link between adverse selection and total risk, as documented in the theoretical literature (e.g. Easley and O'Hara (1987)), where complete leverage is the proxy for total risk.

When market capitalization (CAP) is added as an explanatory variable, the above regression equation becomes:

$$\ln(TINFO + 1) = a + b \exp(DOCL+21) + c\,CAP \qquad \text{(eq. 5.19)}$$

where CAP is market capitalization in thousands of dollar. The results are presented in Table 8, regression 2. The positive and significant relationship between trade informativeness and complete leverage still holds (b>O). However, the association between information asymmetry and capitalization is negative but not significant (c<O). Hasbrouck (1991) reports a negative and statistically significant relation between information asymmetry and market capitalization in his NYSE sample.

When we add a variable for the interaction between complete leverage and market capitalization to eq. 5.19, the regression equation is:

$$\text{TINFOP} = a + b.\text{DOCLP} + c.\text{CAP} + d.\text{DCAP} \qquad \text{(eq. 5.20)}$$

where VPEP is $[\ln(\text{VPE} + \text{I})]^{.385}$, DOCLP is $[\ln(\text{DOCL} + 19.76)]^{.05}$ and DCAP is DOCLP*CAP. Similar to eq. 5.19, the coefficient for leverage is positive and significant ($b>O$) and the coefficient for capitalization is negative but not significant ($c<O$). The coefficient for the interaction variable is negative but not significant ($d<O$). See Table 8, regression 3 for results.

We next include insider concentration (ICE), institutional holdings (IFILDG) and noninsider count (NNINS) as additional explanatory variables in eq. 5.19:

$$\ln(\text{TINFO} + 1) = a + b \exp(\text{DOCL}+21) + c\ \text{CAP} + d \exp(\text{ICE}) + e \exp(\text{IHLDG}) + f \exp(\text{NNINS}/10{,}000) \qquad \text{(eq. 5.21)}$$

where ICE, IHLDG are unitless and NNINS is the number of noninsider units. The results are presented in Table 8, regression 4. We still find a positive and statistically significant association between trade informativeness and complete leverage (i.e. $b>O$). We also find a positive and significant link between insider concentration and trade informativeness (d>O). Using a different methodology, Glosten and Harris (1988) report a positive but statistically insignificant relationship between the adverse-selection component of the spread and insider concentration. Our results are similar to Glosten and Harris (1988) and suggest a link between the degree of information asymmetry and the level of insider concentration.

When we add interaction variables to eq. 5.21, the regression equation is:

$$\begin{aligned} TINFOP = {} & a + b.DOCLP + c.CAP \\ & + d.ICEP + e.IHLDGP + f.NNINSP \\ & + g.DCAP + h.DICE + i.DIHLDG \\ & + j.DNNINS \end{aligned} \qquad \text{(eq. 5.22)}$$

where, TINFOP is ln(TINFO + 1), DOCLP is exp(DOCL + 21), ICEP is exp(ICE), IHLDGP is exp(IHLDG), NNINSP is exp(NNINS/10,000), DCAP is DOCLP*CAP, DICE is DOCLP*ICE, DIHLDG is DOCLP*IHLDG and DNNINS is DOCLP*NNINS. Similar to above results, the coefficients for complete leverage and institutional holdings are positive and significant (b>O; e>0), while the interactive coefficient between complete leverage and institutional holdings is negative and significant (i<O). This suggests that institutional holdings tend to decrease trade informativeness for highly leveraged firms. See Table 8, regression 5 for results.

5.7.2): Trade Informativeness and Financial Leverage

We extend the above findings by substituting degree of financial leverage (DFL) and degree of operating leverage (DOL) for complete leverage. Results for financial leverage are reported in Table 9, while those for operating leverage are presented in Table 10. First, we regress the following:[33]

$$(\text{TINFO}+1)^{200} = a + b\exp(\text{DFL} + 1.5) \qquad \text{(eq. 5.23)}$$

[33] The power and exponential functions are used to account for nonlinearities. Alternative specifications of the regression equation (including the constant values used) yield lower statistical significance for the explanatory variables (results are available on request). See Levin (1987). Constants are added to TINFO and DFL to avoid computer underflow when using the logarithmic and exponential functions.

where DFL is unitless. The results are reported in Table 9, regression 1. There is a positive but insignificant relation between information asymmetry and financial leverage (i.e. b>O).

Adding market capitalization to eq. 5.23 yields:

$$(TINFO + 1)21 = a + b \exp(DFL + 1.5) + c\ CAP \qquad \text{(eq. 5.24)}$$

See Table 9, regression 2 for results. Although none of the coefficients is statistically significant, the coefficient for financial leverage is positive (b>O). This coefficient is however statistically significant when we take the interaction between financial leverage and capitalization into account. The regression is :

$$TINFOP = a + b.DFLP + c.CAP + d.FCAP \qquad \text{(eq. 5.25)}$$

where TINFOP is $(TINFO + 1)^{200}$, DFLP is exp(DFL + 1.5) and FCAP is DFL*CAP. Again, the main finding is that financial leverage affects trade informativeness positively and this is similar to earlier results for complete leverage (eqs. 5.18 through 5.22). See Table 9, regression 3 for details.

When other explanatory variables are taken into account, the regression equation is:

$$(\text{TINFO}+1)^{200} = a + b\exp(\text{DFL}+1.5)^2 + c\,\text{CAP} + d\exp(\text{ICE}) + e\exp(\text{IHILDG}) + f\exp(\text{NNINS}/10{,}000) \quad \text{(eq. 5.26)}$$

Similar to eq. 5.25, financial leverage increases trade informativeness ($b>0$). This relationship is statistically significant. The coefficient for institutional holdings is negative and significant ($e<0$). See Table 9, regression 4.

5.7.3): Trade Informativeness and Operating Leverage

We repeat the above analysis now for operating leverage. The first equation is:[34]

[34] The power and exponential functions are used to account for nonlinearities. Alternative specifications of the regression equation (including the constant values used) yield lower statistical significance for the explanatory variables (results are available on request). See Levin (1987). Constants are added to TINFO and DOL to avoid computer underflow when using the logarithmic and exponential functions.

$$(\text{TINFO}+1)^{200} = a + b \exp(\text{DOL} + 1.7) \qquad \text{(eq. 5.27)}$$

The coefficient for operating leverage is positive but not statistically significant (b>O). See Table 10, regression 1. Adding market capitalization to eq. 5.10 does not change this result. We regress:

$$(\text{TINFO}+1)^{200} = a + b \exp(\text{DOL} + 1.7) + c\,\text{CAP} \qquad \text{(eq. 5.28)}$$

Similar to eqs. 5.19 through 5.22, the coefficient for capitalization is negative but not statistically significant (c<O). The results are reported in Table 10.

When an interaction variable between operating leverage and trade informativeness is added to eq. 5.28, the coefficient for operating leverage is still positive and not significant (b>O). The regression equation is:

$$\text{TINFOP} = a + b.\text{DOLP} + c.\text{CAP} + d.\text{OCAP} \qquad \text{(eq. 5.29)}$$

where TINFOP is $(\text{TINFO} + 1)^{200}$, DOLP is exp(DOL + 4.2) and OCAP is DOL*CAP.

Incorporating additional explanatory variables, we regress:

$$(TINFO+1)^{200} = a + b\exp(DOL+1.7)^2 + c\,CAP + d\exp(ICE) + e\exp(IHLDG) + f\exp(NNINS/10{,}000) \qquad (eq.\ 5.30)$$

None of the coefficients is statistically significant but the coefficient for operating leverage remains positive (b>O). See Table 10, regression 4 for results.

5.7.4): Trade Informativeness, Financial and Operating Leverage

Next, we include financial and operating leverage together. We regress:[35]

[35] The power and exponential functions are used to account for nonlinearities. Alternative specifications of the regression equation (including the constant values used) yield lower statistical significance for the explanatory variables (results are available on request). See Levin (1987).

$$(TINFO+1)^{200} = a + b\exp(DFL + 1.5) + c\exp(DOL + 1.7) \quad \text{(eq. 5.31)}$$

Results are presented in Table 11. Although the coefficients are positive for both financial and operating leverages (b>O, c>O), they are not statistically significant (Table 11, regression 1).

Adding capitalization to the above regression equation yields:

$$(TINFO+1)^{200} = a + b\exp(DFL + 1.5) + c\exp(DOL + 1.7) + d\,CAP \quad \text{(eq. 5.32)}$$

Similar to previous results, we find a positive and but an insignificant relation between trade informativeness and degree of financial leverage (b>O), as well as between trade informativeness and degree of financial leverage (c>O). The coefficient for market capitalization is negative but not significant (Table 11, regression 2).

When we include additional variables such as insider concentration, institutional holdings and noninsiders, the next regression equation:

$$(TINFO+1)^{200} = a + b\,\exp(DFL+1.5)^2 + c\,\exp(DOL+1.7)^2 + d\,CAP + e\,\exp(ICE) + f\,\exp(IHLDG) + g\,\exp(NNINS/10{,}000) \quad \text{(eq. 5.33)}$$

The association between information asymmetry and financial leverage is positive and now statistically significant (b>O). We also find a negative and significant impact of institutional holdings on trade informativeness (f>O). Adding interaction variables to eq. 5.33, we regress:

$$TINFOP = a + b.DFLP + c.DOLP + d.CAP + e.ICEP + f.IHLDGP + g.NNINSP + h.FCAP + i.FICE + j.FIHLDG + k.FNNINS + l.OCAP + m.OICE + n.OIHLDG + o.NNINS + p.FOL \quad \text{(eq. 5.34)}$$

where TINFOP is $(TINFO + 1)^{200}$, DFLP is exp(DFL + 1.5), DOLP is exp(DOL + 4.2), ICEP is exp(ICE), IHLDGP is exp(IHLDG), NNINSP is exp(NNINS/10,000), FCAP is DFL*CAP, FICE is DFL*ICE, FIHLDG is DFL*IHLDG, FNNINS is DFL*NNINS, OCAP is

DOL*CAP, OICE is DOL*ICE, OIHLDG is DOL*IHLDG, ONNINS is DOL*NNINS and FOL is DFL*DOL. The coefficient for financial leverage is still positive and statistically significant (b>O). However, the coefficient for insider concentration is now negative and significant (e<O) and the coefficient for institutional holdings is now positive and significant (f>0). The significant interaction coefficients are financial leverage/insider holdings (j<0) and financial leverage/operating leverage (p>O). See Table 11, regression 4 for results.

5.7.5) Summary

The degree of complete leverage has a positive and statistically significant effect on trade informativeness, even when additional factors are taken into account. The positive and statistically significant relation between financial leverage and trade informativeness also supports the hypothesis that leverage increases adverse-selection costs. The relation between operating leverage and trade informativeness is positive but not statistically significant. Other effects on trade informativeness that are statistically significant include the negative impact of institutional holdings (especially for highly leveraged firms) and the positive impact of the financial/operating (leverage) interaction variable. These results suggest that leverage-induced volatility (especially from financial leverage) tends to raise adverse-selection costs for securities dealers. They confirm hypotheses 3 and 4, that complete leverage, and financial leverage raise the level of trade informativeness. Hence, firms need to take into account the effect of leverage on the (perception of) level of information asymmetry (which, in turn, raises the cost of trading).

Section 5.8): Cumulative Abnormal Returns (CARs) and Leverage

Subsections 1, 2 and 3 focus on the impact of complete leverage, financial leverage and operating leverage on cumulative abnormal returns. The next subsection incorporates both financial and operating leverage as explanatory variables while subsection 5 summarizes the findings on cumulative abnormal returns (CARs).

All functional forms are empirically determined. As a starting point, we use the forms suggested by two-variable data plots relating the dependent variable to each independent variable. Then we vary our functional specifications (e.g. the exponent values) to achieve the highest significance level of the regression coefficients.

5.8.1): Cumulative Abnormal Returns and Complete Leverage

We examine the relation between cumulative abnormal returns (CARs) and complete leverage (DOCL) in Table 12.

The first regression equation is:[36]

$$CAR = a + b.\exp(DOCL + 21) \qquad \text{(eq. 5.35)}$$

We find a positive and significant relation between cumulative abnormal returns and complete leverage (i.e. b>O; regression 1). This is consistent with our hypothesis that liquidity costs, compensated in the form of higher returns, rise with leverage since leverage increases risk.

Adding market capitalization (CAP) to eq. 5.35 yields a similar result. We regress:

$$CAR = a + b.DOCLP + c.CAP \qquad \text{(eq. 5.36)}$$

[36] The exponential function is used to account for nonlinearity. Alternative specifications of the regression equation (including the constant value used) yield lower statistical significance for the explanatory variable (results are available on request). See Levin (1987). A constant is added to DOCL to avoid computer underflow when using the exponential function.

where DOCLP is exp(DOCL + 21). The coefficient for complete leverage is positive and statistically significant (b>O). The coefficient for capitalization is not significant (Table 12, regression 2).

When the interaction between complete leverage and capitalization is taken into account, the regression equation becomes:

$$CAR = a + b.DOCLP + c.CAP + d.DCAP \quad \text{(eq. 5.37)}$$

where DOCLP is exp(DOCL + 21) and DCAP is DOCL*CAP. The coefficient for complete leverage is still positive and statistically significant (b>O), while the other coefficients are not significant (regression 3).

Next, we include insider concentration (ICE), institutional holdings (IHLDG) and noninsider count (NNINS) as additional regressors:

$$CAR = a + b.DOCLP + c.CAP + d.ICE + e.IHLDG + f.NNINS \quad \text{(eq. 5.38)}$$

where DOCLP is exp(DOCL + 21). Again, the coefficient for complete leverage is positive and significant (b>O), while the other coefficients are not significant (Table 12, regression 4).

When we add interaction variables to eq. 5.38, the coefficient for leverage is positive but no longer significant (Table 12, regression 5). The regression equation is:

$$CAR = a + b.DOCLP + c.CAP + d.ICE + e.IHLDG + f.NNINS + g.DCAP + h.DICE + i.DIHLDG + j.DNNINS \quad \text{(eq. 5.39)}$$

where DOCLP is exp(DOCL + 21), DCAP is DOCL*CAP, DICE is DOCL*ICE, DIHLDG is DOCL*IHLDG and DNNINS = DOCLP*NNINS/10,000. See regression 5, Table 12 for results.

5.8.2): Cumulative Abnormal Returns and Financial Leverage

We extend the above analysis by substituting degree of financial leverage (DFL) and degree of operating leverage (DOL) for complete leverage in Tables 13, 14 and 15. First, we regress the following:

$$CAR = a + b.DFL \qquad \text{(eq. 5.40)}$$

Consistent with the previous results for complete leverage, the coefficient for financial leverage is positive and statistically significant (i.e. b>O). See Table 13, regression 1. This result supports the hypothesis that firms with higher degree of financial leverage have higher trading costs because of their higher risk level and are compensated by higher excess returns. We find similar results when we add market capitalization to the regression equation:

$$CAR = a + b.DFL + c.CAP \qquad \text{(eq. 5.41)}$$

The coefficient for financial leverage is positive and significant (i.e. b>O), but the coefficient for capitalization is not significant (Table 13, regression 2).

When we add an interaction variable to eq. 5.41, the equation becomes:

$$CAR = a + b.DFL + c.CAP + d.FCAP \qquad \text{(eq. 5.42)}$$

where FCAP equals DFL*CAP. The coefficient for financial leverage is still positive and significant (i.e. b>O), while the other coefficients are not significant (Table 13, regression 3).

Incorporating additional factors such as insider concentration, institutional holdings and noninsider count, we regress:

$$CAR = a + b.DFL + c.CAP + d.ICE + e.IHLDG + ENNINS \qquad \text{(eq. 5.43)}$$

The coefficient for financial leverage is still positive and significant (i.e. b>O), while none of the other coefficients are significant (Table 13, regression 4).

5.8.3): Cumulative Abnormal Returns and Operating Leverage

We repeat the above analysis for operating leverage. First, we regress:[37]

$$CAR = a + b.DOLP \qquad \text{(eq. 5.44)}$$

where DOLP is $[\exp(DOL + 4.2)]^{10}$. The coefficient for operating leverage is positive and statistically significant (i.e. b>O). This is consistent with the previous results for complete and financial leverage. When we include market capitalization as an additional regressor, the equation is:

$$CAR = a + b.DOLP + c.CAP \qquad \text{(eq. 5.45)}$$

[37] The exponential function is used to account for nonlinearity. Alternative specifications of the regression equation (including the constant value used) yield lower statistical significance for the explanatory variable (results are available on request). See Levin (1987). A constant is added to DOL to avoid computer underflow when using the exponential function.

where DOLP is $[\exp(DOL + 4.2)]^{10}$. The coefficient for operating leverage is still positive and statistically significant (i.e. b>O) but the coefficient for capitalization is not (Table 14, regression 2).

Including an interaction variable to eq. 5.45 yields:

$$CAR = a + b.DOLP + c.CAP + d.OCAP \qquad \text{(eq. 5.46)}$$

where DOLP is $[\exp(DOL + 4.2)]^{10}$ and OCAP = DOL*CAP. Again, the degree of operating leverage affects excess returns positively (i.e. b>O), but none of the other coefficients are statistically significant (Table 14, regression 3).

When we include additional factors such as insider concentration, institutional holdings and noninsider count, the regression equation becomes:

$$CAR = a + b.DOLP + c.CAP$$
$$+ d.ICE + e.IHLDG + f.NNINS \qquad \text{(eq. 5.47)}$$

where DOLP is $[\exp(DOL + 4.2)]^{10}$. The coefficient for operating leverage remains positive and statistically significant (i.e. b>O), while none of the other coefficients are significant (Table 14, regression 4).

5.8.4): Cumulative Abnormal Returns, Financial and Operating Leverage

Next, we include both degrees of financial and operating leverage as explanatory variables in the same regression. We regress:[38]

$$CAR = a + b.DFL + c.DOLP \qquad \text{(eq. 5.48)}$$

where DOLP is $[\exp(DOL + 4.2)]^{10}$. The coefficient for financial leverage is positive and statistically significant, while the coefficient for operating leverage is positive but not statistically significant (b>0; c>0 but not significant). See Table 15, regression 1 for results.

Adding market capitalization to the above equation yields:

$$CAR = a + b.DFL + c.DOLP + d.CAP \qquad \text{(eq. 5.49)}$$

[38] The exponential function is used to account for nonlinearity. Alternative specifications of the regression equation (including the constant value used) yield lower statistical significance for the explanatory variables (results are available on request). See Levin (1987). A constant is added to DOL to avoid computer underflow when using the exponential function.

where DOLP is $[\exp(DOL + 4.2)]^{10}$. Again, the coefficient for financial leverage is positive and statistically significant (b>O), but operating leverage and market capitalization are not (Table 15, regression 2).

Incorporating additional factors such as insider concentration, institutional holdings and noninsider count, the regression equation is:

$$CAR = a + b.DFL + c.DOLP + d.CAP + e.ICE + f.IHLDG + g.NNINS \qquad \text{(eq. 5.50)}$$

where DOLP is $[\exp(DOL + 4.2)]^{10}$. The coefficients for both financial and operating leverage are positive and statistically significant (i.e. b>0; c>O), but other variables do not have any statistical significance (Table 15, regression 3). This supports the hypothesis that leverage has an effect on trading costs and abnormal returns. We obtain similar results when we include several interaction variables in eq. 5.50. The regression equation is:

$$CAR = a + b.DFL + c.DOLP + d.CAP + e.ICE + f.IHLDG + g.NNINS + h.FCAP + i.FICE + j.FIHLDG + k.FNNINS + l.OCAP$$

$$+ m.OICE + n.OIHLDG$$

$$+o.NNINS + p.FOL \qquad \text{(eq. 5.51)}$$

where DOLP is $[\exp(DOL + 4.2)]^{10}$, FCAP is DFL*CAP/10,000, FICE is DFL*ICE, FIHLDG is DFL*IHLDG, FNNINS is DFL*NNINS/10,000, OCAP is DOL*CAP/10,000, OICE is DOL*ICE, OIHLDG is DOL*IHLDG, ONNINS is DOL*NNINS/10,000 and FOL is DFL*DOL. We find that both degrees of leverage affect excess returns positively and significantly (i.e. $b>0$; $c>0$). Other statistically significant factors include the interaction variable between operating leverage and institutional holdings ($n>0$) and the interaction between operating leverage and noninsider count ($o<0$). These additional results suggest that larger institutional holdings tend to increase trading costs for the securities of firms with high operating leverage, but an increase in the number of noninsiders tends to have a negative effect on trading costs for high leverage firms (Table 15, regression 4).

5.8.5): Summary

All three measures of leverage, complete, financial and operating, are positively and significantly related to cumulative abnormal returns, which are a proxy measure of trading costs. These results suggest that leverage, whether financial or operating, tends to raise the overall cost of trading securities because of its effect on total risk. Thus, firms need to take into account these costs when making value-maximizing decisions that involve leverage.

Section 5.9): Correlation between Explanatory Variables

In this section, we examine whether traditional explanatory variables such as market capitalization and insider concentration empirically capture the effect of various measures of leverage on the microstructure characteristics of securities.

We compute the correlation between leverage (complete, operating and financial) and explanatory variables such as capitalization, insider concentration, institutional holdings and noninsider count. The results are reported in Table 16. We find that all three measures of leverage are positively related to each other. Firms with large market capitalization tend to have large degrees of financial leverage, with a statistically significant 21.87% rank correlation level. Other related (and statistically significant) results are:

a) Large firms tend to have their stocks held by financial institutions, not by insiders, and they tend to have more noninsider stockholders than smaller firms;

b) Higher insider concentration is associated with lower institutional holdings and fewer noninsider stockholders;

c) Stocks held by financial institutions attract more noninsiders.

Since leverage affects volatility, and volatility affects the microstructure characteristics of securities (see Stoll (1978) and Copeland and Galai (1983)), we further examine whether volatility and the explanatory variables are related. The Pearson correlation coefficients are reported in Table 17.[39] We find that annual standard deviation is positively correlated to complete leverage (with a coefficient of 26.49%) as well as operating leverage (with a coefficient of 54.91 %). The correlation between standard deviation and insider concentration is also positive but not statistically significant. Institutional holdings are negatively related to standard deviation with a coefficient of -29.07%. Both market capitalization and noninsider count

[39] The variables, standard deviation (STDV), complete leverage (DOCL), financial leverage (DFL) and operating leverage (DOL) are unitless. To account for nonlinearities, we use the exponential, logarithmic and power functions. To avoid overflow/underflow problems, we add constants to the functional arguments. The variables are transformed as: $\exp[(STDV + 1)^{40}]$, $\ln[DOCL + 21]$, $\exp[(DFL + 1.5)^2]$, $\exp[(DOL + 4.2)^2]$. Alternative specifications yield smaller correlation coefficients.

have negative but statistically insignificant correlations to standard deviation.

Since the traditional explanatory variables may already capture the impact of leverage on the microstructure of securities, we analyze how that impact changes as the leverage effect captured by those variables is removed. To measure this, we first compute the regression residuals when leverage is regressed against market capitalization, insider concentration, institutional holdings and noninsider count. We then calculate the correlation coefficients between those residuals and the microstructure variables we analyze here: standard deviation, pricing error variance and trade informativeness. The results are reported in Table 18.

The second cell of the second column presents the correlation coefficient between the residual complete leverage (RCL1) and standard deviation (STDV). To get this result, we compute the residual from the following regression:[40]

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[40] This equation is consistent with the relation between STDV and DOCL shown in Table 17.

$$\ln(DOCL + 21) = a + b\ CAP + c\ \exp(ICE) + d\ \exp(IHLDG) + e\ \exp(NNINS\ /10{,}000) + RCL1 \qquad \text{(eq. 5.52)}$$

where the variables have been defined earlier in eqs. 5.1 through 5.4 and RCL1 is the residual term. The correlation coefficient, computed between RCL1 and $\exp((STDV+1)^{40})$, is statistically insignificant at 14.16% (see Table 18).

The correlation between residual complete leverage RCL2 and variance of error VPE is not statistically significant. RCL2 is computed from:[41]

$$[\ln(DOCL + 19.76)]^{.05} = a + b\ CAP + c\ \exp(ICE) + d\ \exp(IHLDG) + e\ \exp(NNINS/10{,}000) + RCL2 \qquad \text{(eq. 5.53)}$$

The correlation coefficient between RCL2 and $[\ln(VPE + 1\ )]^{.385}$ is 4% but statistically insignificant.

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[41] This equation is consistent with eq. 5.4, which links VPE to DOCL.

However, there is a positive and significant relationship between residual complete leverage RCL3 and trade informativeness TINFO. The correlation coefficient is 28.19% between RCL3 and ln(TINFO+ 1). The residual RCL3 is estimated from the following equation:[42]

$$\begin{aligned} \exp(\text{DOCL}+21) = {} & a + b.\text{CAP} + c.\exp(\text{ICE}) \\ & + d.\exp(\text{IHLDG}) \\ & + e.\exp(\text{NNINS}/10{,}000) \\ & + \text{RCL3} \qquad \text{(eq. 5.54)} \end{aligned}$$

Next, we run tests similar to the ones described above to detect any effect of residual financial (RFL) and operating leverages (ROL). We find that residual financial leverage is positively associated with total risk (STDV) and pricing error variance (VPE).

To compute the correlation between residual financial leverage (RFL1) and STDV, we first estimate RFL1 from:[43]

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[42] This regression equation is consistent with eq. 5.21, which links TINFO to DOCL. The functional specification for DOCL is different from eq. 5.35.

[43] This equation is consistent with the relation between STDV and DFL shown in Table 17.

$$\exp(DFL + 1.5)^2 = a + b \exp(DOL + 4.2)^2 + c\ CAP + d \exp(ICE) + e \exp(IHLDG) + f \exp(NNINS/10{,}000) + RFL1 \qquad \text{(eq. 5.55)}$$

where DFL and DOL are unitless variables, defined earlier. The correlation coefficient, computed between RFL1 and $\exp((STDV+1)^{40})$, is statistically insignificant and measures 15.67%. The correlation coefficient, computed between RFL2 and $[\ln(VPE+1)]^{.5}$, is 36.22% and statistically significant. We compute RFL2 from the equation:[44]

$$(DFL + 1.5)^{.001} = a + b\,(DOL + 1.7)^2 + c\ CAP + d \exp(ICE) + e \exp(IHLDG) + f \exp(NNINS/10{,}000) + RFL2 \qquad \text{(eq. 5.56)}$$

Finally, the correlation between residual financial leverage RFL3 and trade informativeness TINFO is not statistically significant. We compute RFL3 from the regression equation:[45]

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[44] This specification is consistent with eq. 5.7, which links VPE to DFL.

[45] This specification is consistent with eq. 5.23, which links TINFO to DFL.

$$\exp(DFL+1.5) = a + b\exp(DOL+1.7) + c\,CAP + d\exp(ICE) + e\exp(IHLDG) + f\exp(NNINS/10{,}000) + RFL3 \qquad \text{(eq. 5.57)}$$

To estimate the relationship between residual operating leverage ROL1 and total risk STDV, we run the following regression:[46]

$$\exp(DOL + 4.2)^2 = a + b\exp(DFL + 1.5)^2 + c\,CAP + d\exp(ICE) + e\exp(IHLDG) + f\exp(NNINS/10{,}000) + ROL1 \qquad \text{(eq. 5.58)}$$

The correlation coefficient, computed between ROL1 and $\exp((STDV+1)^{40})$, is 30.70% and statistically significant.

The correlation between ROL2 and $[\ln(VPE+1)]^{.5}$ is statistically insignificant at -6.6%. ROL2 is computed from:[47]

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[46] This equation is consistent with the relation between STDV and DOL shown in Table 17.

[47] This specification is consistent with eq. 5.10, which links VPE to DOL.

$$(DOL + 1.7)^2 = a + b\,(DFL + 1.5)^{.001} + c\,CAP + d\,\exp(ICE) + e\,\exp(IHLDG) + f\,\exp(NNINS/10{,}000) + ROL2 \qquad \text{(eq. 5.59)}$$

The estimation of the correlation between residual operating leverage and trade informativeness is based on the following ROL3 computation:[48]

$$\exp(DOL+1.7) = a + b\,\exp(DFL+1.5) + c\,CAP + d\,\exp(ICE) + e\,\exp(IHLDG) + f\,\exp(NNINS/10{,}000) + ROL3 \qquad \text{(eq. 5.60)}$$

The correlation coefficient, computed between ROL3 and TINFO, is also statistically insignificant and a low value of -3.40%.

[48] This specification is consistent with eq. 5.23, which links TINFO to DOL.

Chapter VI- Conclusion

In this study, we analyze the impact of (complete, financial and operating) leverage on the microstructure characteristics of securities. We find that complete leverage increases the level of trade informativeness. This holds even when the effects of other variables such as size, insider concentration, institutional holdings, the number of noninsiders and interaction variables are taken into account. The effect of complete leverage on cumulative abnormal returns is also positive and statistically significant. The addition of other explanatory variables does not change the results. The relation between complete leverage and pricing-error variance is also positive but is not statistically significant. Adding size, insider concentration, institutional holdings, the number of noninsiders and interaction variables does not have any significant effect.

We next analyze the impact of financial leverage on the microstructure characteristics of securities. We find a positive and statistically significant effect of financial leverage on cumulative abnormal returns. When we add variables such as size, insider concentration, institutional holdings and the number of noninsiders as explanatory variables, the relation between financial leverage and abnormal returns remains positive and statistically significant. The degree of financial leverage also increases pricing-error variance when the effect of variables such as size, insider concentration, institutional holdings and the number of noninsiders are taken into account. The relation between trade informativeness and financial leverage is also positive and statistically significant even when the effects of variables such as size, insider concentration, institutional holdings and the number of noninsiders are taken into account.

Finally, we find that a greater degree of operating leverage raises the level of cumulative abnormal returns even when additional explanatory variables such as size, insider concentration, institutional holdings and the number of noninsiders are taken into account. The result still holds when financial leverage and interaction variables are included as explanatory variables. However, the effect of operating leverage is statistically insignificant on both trade informativeness and pricing-error variance. Taking into account additional explanatory variables does not lead to any significant changes in our results.

Since trade informativeness is a measure of adverse-selection cost, pricing-error variance is a measure of inventory cost and the level of abnormal returns is a measure of overall liquidity cost, the above results imply a relation between leverage choice and securities trading costs. First, overall liquidity cost (as measured by abnormal returns) increases with financial leverage, operating leverage and also their combined effect. Second, adverse-selection (as measured by trade informativeness) increases with financial leverage. Also, operating leverage raises adverse-selection cost when the degree of financial leverage is high (i.e. combined effect). Third, inventory cost increases with financial leverage. Therefore, in addition to its traditional role in corporate finance, effect of leverage on trading costs should be a factor in shaping corporate policy.

A potential direction for future research is to analyze whether firm attributes affect the link between leverage and microstructure characteristics of securities established in this research. If there is a relation between attributes and the leverage-microstructure link then the pricing of leverage-induced volatility (in terms of trading costs) is not uniform. For example, assuming that they minimize trading costs, firms may choose a high level of complete leverage if their trading cost per leverage unit is low. Similary, firms with low leverage level may have a high trading cost per leverage unit.

The previous example can be extended to both financial and operating leverages. Firms may choose a high degree of financial leverage if the level of their trading cost does not vary with this choice.

And firms with low operating leverage may have a high trading cost per (operating) leverage unit.

Table 1

Sample Characteristics (1994). **Market Capitalization** is computed as of 03/31/94 from CRSP tapes. **Insider Concentration** is obtained from 1994 proxies. **Institutional Holdings** are reported in Value Line, Moody's Handbook of Common Stocks, and Standard and Poors Security Owners Stock Guide. The **Number of Noninsiders** is measured as the difference between the total number of shareholders reported in Value Line (or 10K reports) and the number of insiders in the 1994 proxies.

	Market capitalization ($000)	Insider concentration (%)	Institutional holdings (%)	Noninsider count
Mean	1,579,942	20.17	39.72	10,184.28
Standard deviation	4,060,405	22.77	23.16	16,318.22
Maximum value	29,201,648	85	85.16	93,985
Minimum value	3,073.5	0	2.41	99
Number of observations	85	84	84	78

Table 2

Sample Statistics of microstructure-variable estimates. **Variance of Pricing Error** (VPE) and **Trade Informativeness** (TINFO) are estimated for the second quarter of 1994. **Cumulative Abnormal Returns** (CARs) are estimated for the 61-day period starting April 1, 1994.

	Mean	Standard deviation	Maximum value	Minimum value	Number of observa-tions
Variance of pricing error VPE[a]	0.000186	0.001074	0.009108	$6.46 * 10^{-8}$	86
Trade informative - ness TINFO[b]	0.1139	0.1503	0.9817	0.0003	86
Cumulative abnormal returns CARs[c][d]	-0.00365	0.02340	0.08555	-0.0582	83

(a) Following Hasbrouck (1993), we regress:

$$r_t = a_1 r_{t-1} + \dots + a_5 r_{t-5} + b_1 x_{t-1} + \dots + b_5 x_{t-5} + v_{1t}$$
$$x_t = a_c r_{t-1} + \dots + c_5 r_{t-5} + d_1 x_{t-1} + \dots + d_5 x_{t-5} + v_{2t}$$

where

t = transaction index;

r_t = trading price return (logarithm differentials) at time t. Overnight returns are not used;

x_t = signed square root of trade size at time t. The sign is positive if the transaction price is above the mid-quote price, and negative if the transaction price is below the mid-quote price; if the transaction price equals the mid-quote price, transaction size is set to zero. The last quote recorded within 5 seconds or more prior to a transaction is the prevailing quote.

We regress:

$$r_t = e_1 v_{1,t} + \dots + e_{11} v_{1,t-10} + f_1 v_{2,t} + \dots + f_{11} v_{2,t-10}$$

The variance of pricing error VPE is given by VPE = $\Sigma_{j=0,9}$ [Aj Bj].cov(v).[Aj Bj $]^T$,

where v= (v_1, v_2), Aj = $\Sigma_{k=j+2,11}\, e_k$ and Bj = $-\Sigma_{k=j+2,11}\, f_k$.

(b) Following Hasbrouck (1991), we regress:

$$r_t = a_1 r_{t-1} + \ldots + a_5 r_{t-5} + b_0 x_t + \ldots + b_5 x_{t-5} + v_{1t}$$
$$x_t = c_1 r_{t-1} + \ldots + c_5 r_{t-5} + d_1 x_{t-1} + \ldots + d_5 x_{t-5} + v_{2t}$$

where

t = index incremented by 1 whenever a transaction or a quote change occurs. A quote change occuring within less than 5 seconds after or before a transaction is assigned the same index as the transaction. Transactions occuring within 5 seconds of each other without any intervening quote are aggregated;

r_t = quote-midpoint return (logarithm differentials) at time t. The return is set to zero if no quote revision follows a trade (i.e. if no quote change has the same index value as the trade). Overnight returns are not used;

x_t = signed square root of trade size at time t. The sign is positive if the transaction price is above the mid-quote price, and negative if the transaction price is below the mid-quote price; if the transaction price equals the mid-quote price, transaction size is set to zero. The trade size is set to zero if there is no intervening transaction while a quote change occurs. A quote recorded 5 seconds or more prior to a transaction is the prevailing quote.

We regress:

$$r_t = v_{1,t} + e_2 v_{1,t-1} + \ldots + e_{11} v_{1,t-10} + f_1 v_{2,t} + f_2 v_{2,t-1} + \ldots + f_{11} v_{2,t-10}$$

The informativeness of trades TINFO is given by TINFO = $v_{w,x}/v_w$
where $v_{w,x} = (\Sigma_{i=1,11} f_i).\text{var}(v_{2,t}).(\Sigma_{i=1,11} f_i)^T$ and $v_w = v_{w,x} + (1+\Sigma_{i=2,11} e_i)^2.\text{var}(v_{1,t})$.

(c) To estimate the cumulative abnormal returns, we use the following market model:

$$r_{i,t} = a_i + b_i r_{m,t} + e_{i,t}$$

where

$r_{i,t}$ = rate of return from stock i on day t;

$r_{m,t}$ = rate of return from the CRSP value-weighted index on day t;

$e_{i,t}$ = regression residual.

First, we estimate the coefficients a_i and b_i for each stock i by using daily returns for the 250 trading days prior to April 1, 1994. Then, we compute and cumulate the daily abnormal returns $e_{i,t}$, from April 1 to March 31, 1994. Any stock missing more than 20 returns in the estimation period or more than 30% of its returns in the whole sample period is excluded.

(d) Three stocks are excluded from our sample since they are missing more than 20 returns in the estimation period.

Table 3

Summary Statistics on **Leverage** estimates.

	Mean	Standard deviation	Maximum value	Minimum value	Number of observa-tions [c]
Degree of complete leverage [a]	1.40296	3.42319	10.16353	-19.75070	86
Degree of financial leverage [b]	1.31616	0.87756	4.60172	-0.40221	76
Degree of operating leverage [b]	1.42799	1.47598	10.39903	-0.77053	76

(a) Following O'Brien and Vanderheiden (1987) and Li and Henderson (1991), the degree of complete leverage DOCL is computed as:

$$u_{xt} = DOCL.\ u_{st} + e_t$$

where
u_{xt} = percentage deviation of net income (X) from its trend;
u_{st} = percentage deviation of sales (S) from its trend;
e_t = error term

For each firm j, u_{xt}, is obtained by regressing:

$$\ln X_{jt} = \ln X_{jo} + g_x.t + u_{xt}$$

where
X_{jo} = X in period 0, the first in the sample;
X_{jo} = X in period t;
t = time index.

Similarly, u_{st} is obtained as:

$$\ln S_{jt} = \ln S_{jo} + g_s.t + u_{st}$$

(b) The degree of financial leverage DFL and the degree of operating leverage DOL are computed by using the same DOCL procedure described above. For example,

$$u_{xt} = DFL.\ u_{et} + e_t$$

and

$$u_{et} = DOL.\ u_{st} + e_t$$

where
u_{xt} = percentage deviation of net income from its trend;
u_{et} = percentage deviation of earnings before interest and taxes from its trend;

u_{st} = percentage deviation of sales from its trend;
e_t = error term.

Table 4

Regression of pricing error variance (VPE) against complete leverage (DOCL), market capitalization (CAP), insider concentration (ICE), institutional holdings (IHLDG) and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)(a)(f)	(2)(b)(f)	(3)(c)(f)	(4)(d)(f)	(5)(e)(f)
Intercept	-4.8924 (4.9729)	-3.6496 (5.0207)	-4.0610 (5.6829)	-1.0604 (5.7574)	-1.241 (6.9287)
Degree of complete leverage	4.8748 (4.9458)	3.6393 (4.9928)	4.0485 (5.6513)	1.0771 (5.7254)	1.2350 (6.8888)
Capitalization		$-2.97*10^{-10}$ $(2*10^{-10})^{@}$	$1.45*10^{-7}$ $(9.2*10^{-7})$	$-2.54*10^{-10}$ $(3.9*10^{-10})$	$6.211*10^{-8}$ $(1.1*10^{-5})$
Leverage * Capitalization			-0.00145 (0.00915)		$-6.179*10^{-8}$ $(1.14*10^{-6})$
Insider concentration				$-4.278*10^{-4}$ $(9.6*10^{-40})$	$-5.33*10^{-40}$ $(109*10^{-41})$
Institutional holdings				-0.0081 (0.0031)@@	0.0175 (0.0287)
Noninsider number				$5*10^{-7}$ $(1.10*10^{-6})$	$5.8*10^{-7}$ $(1.35*10^{-6})$
Leverage * Concentration					$1.64*10^{-5}$ $(5.93*10^{-5})$
Leverage * Holdings					-0.0404 (0.0441)
Leverage * Noninsider count					$-8.09*10^{-4}$ (0.00115)
R^2	0.0131	0.0391	0.0394	0.1635	0.1811

@ significant at the 10% level in a one-tailed test;
@ @ significant at the 1% level in a two-tailed test;

(a) The model is:

VPEP = a + b.DOCLP where
$VPEP = [\ln(VPE + 1)]^{.385}$;
$DOCLP = [\ln(DOCL + 19.76)]^{.05}$;

(b) The model is:

VPEP = a + b.DOCLP + c.CAP where
$VPEP = [\ln(VPE + 1)]^{.385}$;
$DOCLP = [\ln(DOCL + 19.76)]^{.05}$;

(c) The model is:

VPEP = a + b.DOCLP + c.CAP + d.DCAP where

$VPEP = [\ln(VPE + 1)]^{.385}$;

$DOCLP = [\ln(DOCL + 19.76)]^{.05}$;

DCAP = DOCLP*CAP;

(d) The model is:

VPEP = a + b.DOCLP + c.CAP + d.ICEP + e.IHLDGP + f.NNINSP where

$VPEP = [\ln(VPE + 1)]^{.385}$;

$DOCLP = [\ln(DOCL + 19.76)]^{.05}$;

ICEP = exp(ICE);

IHLDGP = exp(IHLDG);

NNINSP = exp(NNINS/10,000);

(e) The model is:

VPEP = a + b.DOCLP + c.CAP + d.ICEP + e.IHLDGP + ENNINSP + g.DCAP + h.DICE + i.DIHLDG + j.DNNINS where

$VPEP = [\ln(VPE + 1)]^{.385}$;

$DOCLP = [\ln(DOCL + 19.76)]^{.05}$;

ICEP = exp(ICE);

IHLDGP = exp(IHLDG);

NNINSP = exp(NNINS/10,000);

DCAP = DOCLP*CAP;

DICE = DOCLP*ICE;

DIHLDG = DOCLP*IHLDG;

DNNINS = DOCLP*NNINS;

(f) Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables. Constants are added to both VPE and DOCL to avoid computer overflow when using the logarithmic function.

Table 5

Regression of pricing error variance (VPE) against financial leverage (DFL), market capitalization (CAP), insider concentration (ICE), institutional holdings (IHLDG) and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)[(a)(e)]	(2)[(b)(e)]	(3)[(c)(e)]	(4)[(d)(e)]
Intercept	-1.1772 (1.3923)	-1.18 (1.388)	-1.7829 (1.589)	-2.0465 (1.5261)@
Degree of financial leverage	1.1787 (1.3909)	1.1817 (1.3875)	1.7841 (1.588)	2.0510 (1.5246)@
Capitalization		$-9.7*10^{-11}$ ($8.5*10^{-11}$)	$2.47*10^{-7}$ ($3.1*10^{-7}$)	$-1.72*10^{-10}$ ($2*10^{-10}$)
Financial leverage * Capitalization			-0.0025 (0.0031)	
Insider concentration				$-5.36*10^{-37}$ ($3.9*10^{-17}$)@
Institutional holdings				-0.0022 (0.0013)@@
Noninsider number				$3.95*10^{-7}$ ($5.3*10^{-7}$)
R^2	0.0116	0.0326	0.0426	0.1471

@ significant at the 10% level in a one-tailed test;
@ @ significant at the 10% level in a two-tailed test;

(a) The model is:

VPEP = a + b.DFLP where
$VPEP = [\ln(VPE + 1)]^{.5}$;
$DFLP = (DFL + 1.5)^{.001}$;

(b) The model is:

VPEP = a + b.DFLP + c.CAP where
$VPEP = [\ln(VPE + 1)]^{.5}$;
$DFLP = (DFL + 1.5)^{.001}$;

(c) The model is:

VPEP = a + b.DFLP + c.CAP + d.FCAP where
$VPEP = [\ln(VPE + 1)]^{.5}$;
$DFLP = (DFL + 1.5)^{.001}$;
FCAP = DFLP*CAP;

(d) The model is:

VPEP = a + b.DFLP + c.CAP + d.ICEP + e.IHLDGP + f.NNINSP where

$VPEP = [\ln(VPE + 1)]^{.5}$;
$DFLP = (DFL + 1.5)^{.001}$;
ICEP exp(ICE);
IHLDGP = exp(IHLDG);
NNINSP = exp(NNINS/10,000);

(e) Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables. Constants are added to VPE and DFL to avoid computer underflow/overflow when using the logarithmic and power functions.

Table 6

Regression of pricing error variance (VPE) against operating leverage (DOL), market capitalization (CAP), insider concentration (ICE), institutional holdings (IHLDG) and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)[(a)(e)]	(2)[(b)(e)]	(3)[(c)(e)]	(4)[(d)(e)]
Intercept	0.00323 (0.0011)@@@	0.00362 (0.0012)@@@	0.0035 (0.0011)@@@	0.0072 (0.002)@@
Degree of operating leverage	$-1.91*10^{-5}$ $(3.56*10^{-5})$	$-2.62*10^{-5}$ $(3.59*10^{-5})$	$-2.02*10^{-5}$ $(3.73*10^{-5})$	
Capitalization		$-1.07*10^{-10}$ $(86*10^{-12})$@	$1.37*10^{-10}$ $(3.9*10^{-10})$	$-2.47*10^{-5}$ $(3.9*10^{-5})$
Operating leverage * Capitalization			$-1.13*10^{-7}$ $(1.8*10^{-7})$	$-1.15*10^{-7}$ $(2*10^{-10})$
Insider concentration				$-3.74*10^{-37}$ $(3.9*10^{-37})$
Institutional holdings				-0.0023 (0.001)@@
Noninsider number				$1.83*10^{-7}$ $(5.2*10^{-7})$
R^2	0.0047	0.0295	0.036	0.1237

@ significant at the 10% level in a one-tailed test;
@ @ significant at the 10% level in a two-tailed test;
@ @ @ significant at the 1% level in a two-tailed test;

(a) The model is:

VPEP = a + b.DOLP where
VPEP = $[\ln(VPE + 1)]^{.5}$;
DOLP = $(DOL + 1.7)^2$;

(b) The model is:

VPEP = a + b.DOLP + c.CAP where
VPEP = $[\ln(VPE + 1)]^{.5}$;
DOLP = $(DOL + 1.7)^2$;

(c) The model is:
VPEP = a + b.DFLP + c.CAP + d.OCAP where
VPEP = $[\ln(VPE + 1)]^{.5}$;
DOLP = $(DOL + 1.7)^2$;
OCAP = DOLP*CAP;

(d) The model is:

VPEP = a + b.DOLP + c.CAP + d.ICEP + e.IHLDGP + f.NNINSP where

$VPEP = [\ln(VPE + 1)]^{.5}$;

$DOLP = (DOL + 1.7)^2$;

ICEP = exp(ICE);

IHLDGP = exp(IHLDG);

NNINSP = exp(NNINS/10,000);

(e) Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables. Constants are added to VPE and DOL to avoid computer underflow/overflow when using the logarithmic and power functions.

Table 7

Regression of pricing error variance (VPE) against financial leverage (DFL), operating leverage (DOL), market capitalization (CAP), insider concentration (ICE), institutional holdings (IHLDG) and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)[a][e]	(2)[b][e]	(3)[c][e]	(4)[d][e]
Intercept	-1.5070 (1.4547)	-1.5990 (1.4483)	-2.4233 (1.5724)@@	-8.3089 (19.418)
Degree of financial leverage	1.5090 (1.4535)	1.6014 (1.4472)	2.4286 (1.5711)@@	8.3101 (19.411)
Degree of operating leverage	-0.00003 (0.00004)	-0.00004 (0.00004)	$-3.9*10^{-5}$ ($3.9*10^{-5}$)	$-6.63*10^{-5}$ ($1.84*10^{-4}$)
Capitalization		$-1.12*10^{-10}$ ($9*10^{-11}$)@@	$-1.91*10^{-10}$ ($2.0*10^{-10}$)	$-7.35*10^{-10}$ ($3.4*10^{-9}$)
Insider concentration			$-4.93*10^{-37}$ ($4.0*10^{-37}$)	$-5.45*10^{-37}$ ($5.5*10^{-37}$)
Institutional holdings			-0.0023 (0.001)@@@	-0.0018 (0.0089)
Noninsider number			$4.14*10^{-7}$ ($5.3*10^{-7}$)	$9.45*10^{-7}$ ($1.3*10^{-7}$)
DFLP*CAP				0.0678 (0.1063)
DFLP*ICE				-0.0613 (0.1016)
DFLP* IHLDG				-8.4487 (7.8273)
DFLP* NNINS				-5.6193 (24.028)
DOLP*CAP				$-1.37*10^{-7}$ ($1.04*10^{-4}$)
DOLP*ICE				$1.78*10^{-7}$ ($3.12*10^{-5}$)
DOLP* IHLDG				$2.19*10^{-3}$ ($4.36*10^{-3}$)
DOLP* NNINS				0.5877 (82.5905)
DFLP*DOLP				-0.2435 (5.4826)
R^2	0.0223	0.0492	0.1637	0.2327

@ @ significant at the 10% level in a one-tailed test;
@ @ @ significant at the 10% level in a two-tailed test;

(a) The model is:

VPEP = a + b.DFLP + c.DOLP where
$VPEP = [\ln(VPE + 1)]^{.5}$;
$DOLP = (DOL + 1.7)^2$;
$DFLP = (DFL + 1.5)^{.001}$;

(b) The model is:

VPEP = a + b.DFLP + c.DOLP + d.CAP where
$VPEP = [\ln(VPE + 1)]^{.5}$;
$DOLP = (DOL + 1.7)^2$;
$DFLP = (DFL + 1.5)^{.001}$;

(c) The model is:

VPEP = a + b.DFLP + c.DOLP + d.CAP + e.ICEP + f.IHLDGP + g.NNINSP
where
$VPEP = [\ln(VPE + 1)]^{.5}$;
$DOLP = (DOL + 1.7)^2$;
$DFLP = (DFL + 1.5)^{.001}$;
ICEP = exp(ICE);
IHLDGP = exp(IHLDG);
NNINSP = exp(NNINS/10,000);

(d) The model is:

VPEP = a + b.DFLP + c.DOLP + d.CAP + e.ICEP + f.IHLDGP + g.NNINSP + h.FCAP + i.FICE + j.FIHLDG + k.FNNINS + l.OCAP + m.OICE + n.OIHLDG + o.NNNS + p.FOL where

$VPEP = [\ln(VPE + 1)]^{.5}$;
$DOLP = (DOL + 1.7)^2$;
$DFLP = (DFL + 1.5)^{.001}$;
ICEP = exp(ICE);
IHLDGP = exp(IHLDG);
NNINSP = exp(NNINS/10,000);
FCAP = DFLP*CAP;
FICE = DFLP*ICE;
FIHLDG = DFLP*IHLDG;
FNNINS = DFLP*NNINS;
OCAP = DOLP*CAP;
OICE = DOLP*ICE;
OIHLDG = DOLP*IHLDG;
ONNINS = DOLP*NNINS;
FOL = DFLP*DOLP;

(e) Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables. Constants are added to VPE, DFL and DOL to avoid computer underflow/overflow when using the logarithmic and power functions.

Table 8

Regression of trade informativeness (TINFO) against complete leverage (DOCL), market capitalization (CAP), insider concentration (ICE), institutional holdings (IHLDG), and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)[a]	(2)[b]	(3)[c]	(4)[d]	(5)[e]
Intercept	0.0836 (0.0083)@@	0.0858 (0.009)@@	0.0885 (0.009)@@	0.1228 (0.0431)@@	-0.1066 0.1264
Degree of complete leverage	$3.45*10^{-14}$ ($1.3*10^{-14}$) @@	$3.43*10^{-14}$ ($1.3*10^{-14}$) @@	$4.44*10^{-14}$ ($1.4*10^{-14}$) @@	$3.35*10^{-14}$ ($1.3*10^{-14}$) @@	$3.68*10^{-14}$ ($1.5*10^{-14}$) @@
Capitalization		$-1.29*10^{-9}$ ($1.99*10^{-9}$)	$-6.75*10^{-9}$ ($2.0*10^{-11}$)	$-1.43*10^{-9}$ ($3.72*10^{-9}$)	$-1.3*10^{-9}$ ($2.0*10^{-8}$)
Complete leverage * Capitalization			$-1.56*10^{-14}$ ($9.1*10^{-15}$)		$6.89*10^{-4}$ ($9.98*10^{-4}$)
Insider concentration				$1.54*10^{-38}$ ($.93*10^{-38}$) @	$1.12*10^{-38}$ ($.99*10^{-38}$)
Institutional holdings				-0.0238 (0.0287)	0.2196 (0.1298)@
Noninsider number				$3.89*10^{-6}$ ($1.07*10^{-5}$)	$3.96*10^{-6}$ ($1.21*10^{-5}$)
Leverage * Concentration					$1.8*10^{-5}$ ($2.32*10^{-5}$)
Leverage * Holdings					-0.0162 (0.0087)@
Leverage * Noninsider count					-4.7161 (4.4849)
R^2	0.0834	0.0883	0.1221	0.1482	0.2277

@ significant at the 10% level in a two-tailed test;
@ @ significant at the 1% level in a two-tailed test;

(a) The model is:

TINFOP = a + b.DOCLP where
TINFOP = ln(TINFO+1);
DOCLP = exp(DOCL+21);

(b) The model is:

TINFOP = a + b.DOCLP + c.CAP where

TINFOP = ln(TINFO+1);
DOCLP = exp(DOCL+21);

(c) The model is:

TINFOP = a + b.DOCLP + c.CAP + d.DCAP where
TINFOP = ln(TINFO+1);
DOCLP = exp(DOCL+21);
DCAP = DOCLP*CAP;

(d) The model is:

TINFOP = a + b.DOCLP + c.CAP + d.ICEP + e.IHLDGP + f.NNINSP where
TINFOP = ln(TINFO+1);
DOCLP = exp(DOCL+21);
ICEP = exp(ICE);
IHLDGP = exp(IHLDG);
NNINSP = exp(NNINS/10,000);

(e) The model is:

TINFOP= a + b.DOCLP + c.CAP + d.ICEP + e.IHLDGP + f.NNINSP + g.DCAP + h.DICE + i.DIHLDG +j.DNNINS
where
TINFOP = ln(TINFO+1);
DOCLP = exp(DOCL+21);
ICEP = exp(ICE);
IHLDGP = exp(IHLDG);
NNINSP = exp(NNINS/10,000);
DCAP = DOCLP*CAP;
DICE = DOCLP*ICE;
DIHLDG = DOCLP*IHLDG;
DNNINS = DOCLP*NNINS;

(f) Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables. Constants are added to both TINFO and DOCL to avoid computer overflow/underflow when using the logarithmic and exponential functions.

Table 9

Regression of trade informativeness (TINFO) against financial leverage (DFL), market capitalization (CAP), insider concentration (ICE), institutional holdings (IHLDG), and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)[(a)(e)]	(2)[(b)(e)]	(3)[(c)(e)]	(4)[(d)(e)]
Intercept	$-1.36*10^{28}$ ($8.50*10^{28}$)	$-7.97*10^{27}$ ($8.67*10^{28}$)	$-5.79*10^{28}$ ($9.75*10^{28}$)	$3.49*10^{29}$ ($2.94*10^{29}$)
Degree of financial leverage	$3.24*10^{27}$ ($3.36*10^{27}$)	$3.49*10^{27}$ ($3.42*10^{27}$)	$6.76*10^{27}$ ($3.4*10^{27}$)@	$6.53*10^{27}$ ($3.4*10^{27}$)@
Capitalization		$-6.72*10^{21}$ ($1.29*10^{22}$)	$5.91*10^{21}$ ($1.71*10^{22}$)	$-8.74*10^{21}$ ($3.27*10^{22}$)
Financial leverage * Capitalization			$-8.81*10^{25}$ ($7.94*10^{25}$)	
Insider concentration				$-6.3*10^{-5}$ ($6.8*10^{-5}$)
Institutional holdings				$-2.67*10^{29}$ ($1.9*10^{29}$)@
Noninsider number				$2.66*10^{25}$ ($8.56*10^{25}$)
R^2	0.0141	0.0183	0.0371	0.0683

@ significant at the 10% level in a one-tailed test;

(a) The model is:

TINFOP = a + b.DFLP where
$TINFOP = (TINFO+1)^{200}$;
DFLP = exp(DFL+1.5);

(b) The model is:

TINFOP = a + b.DFLP + c.CAP where
$TINFOP = (TINFO+1)^{200}$;
DFLP = exp(DFL+1.5);

(c) The model is:

TINFOP = a + b.DFLP + c.CAP + d.FCAP where
$TINFOP = (TINFO+1)^{200}$;
DFLP = exp(DFL+1.5);
FCAP = DFL*CAP;

(d) The model is:

TINFOP = a + b.DFLP + c.CAP + d.ICEP + e.IHLDGP + f.NNINSP where

$TINFOP = (TINFO+1)^{200}$;
DFLP = exp(DFL+1.5);
ICEP = exp(ICE);
IHLDGP = exp(IHLDG);
NNINSP = exp(NNINS/10,000);

(e) Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables. Constants are added to TINFO and DFL to avoid computer underflow when using the power and exponential functions.

Table 10

Regression of trade informativeness (TINFO) against operating leverage (DOL), market capitalization (CAP), insider concentration (ICE), institutional holdings (IHLDG), and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)[a][e]	(2)[b][e]	(3)[c][e]	(4)[d][e]
Intercept	$2.27*10^{28}$ $(9.75*10^{28})$	$3.09*10^{28}$ $(9.75*10^{28})$	$3.58*10^{28}$ $(7.77*10^{28})$	$3.86*10^{29}$ $(3.02*10^{29})$
Degree of operating leverage	$8.80*10^{25}$ $(1.46*10^{26})$	$8.18*10^{25}$ $(1.49*10^{26})$	$1.07*10^{26}$ $(1.56*10^{26})$	$8.80*10^{25}$ $(1.66*10^{26})$
Capitalization		$-3.91*10^{21}$ $(1.29*10^{22})$	$6.47*10^{21}$ $(2.21*10^{22})$	$-8.47*10^{21}$ $(3.16*10^{22})$
Operating leverage * Capitalization			$-9.07*10^{24}$ $(1.56*10^{25})$	
Insider concentration				$-2.43*10^{-5}$ $(6.32*10^{-5})$
Institutional holdings				$-2.37*10^{29}$ $(2.00*10^{29})$
Noninsider number				$-1.86*10^{25}$ $(8.19*10^{25})$
R^2	0.0055	0.0069	0.0122	0.0354

(a) The model is:

TINFOP = a + b.DOLP where
TINFOP = $(TINFO+1)^{200}$;
DOLP = exp(DOL+ 4.2);

(b) The model is:

TINFOP = a + b.DOLP + c.CAP where
TINFOP = $(TINFO+1)^{200}$;
DOLP = exp(DOL+ 4.2);

(c) The model is:

TINFOP = a + b.DOLP + c.CAP + d.OCAP where
TINFOP = $(TINFO+1)^{200}$;
DOLP = exp(DOL+ 4.2);
OCAP = DOL*CAP;

(d) The model is:

TINFOP = a + b.DOLP + c.CAP + d.ICEP + e.IHLDGP + f.NNINSP where
TINFOP = $(TINFO+1)^{200}$;

DOLP = exp(DOL+ 4.2);
ICEP = exp(ICE);
IHLDGP = exp(IHLDG);
NNINSP = exp(NNINS/10,000);

(e) Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables. Constants are added to TINFO and DOL to avoid computer underflow when using the power and exponential functions.

Table 11

Regression of trade informativeness (TINFO) against financial leverage (DFL), operating leverage (DOL), market capitalization (CAP), insider concentration (ICE), institutional holdings (IHLDG), and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)(a)(e)	(2)(b)(e)	(3)(c)(e)	(4)(d)(e)
Intercept	$-3.12*10^{28}$ $(9.43 * 10^{28})$	$-2.34*10^{28}$ $(9.65* 10^{28})$	$3.32*10^{29}$ $(3.0* 10^{29})$	$-3.1*10^{30}$ $(1.0*10^{30})$@@@
Degree of financial leverage	$3.00*10^{27}$ $(3.43* 10^{27})$	$3.26*10^{27}$ $(3.49* 10^{27})$	$6.32*10^{27}$ $(45* 10^{26})$@	$2.34*10^{28}$ $(1.5* 10^{28})$@
Degree of operating leverage	$6.78*10^{25}$ $(1.49* 10^{26})$	$5.68*10^{25}$ $(1.52 * 10^{26})$	$5.23 *10^{25}$ $(1.7 * 10^{26})$	$-3.6*10^{26}$ $(3.01* 10^{26})$
Capitalization		$-5.93*10^{21}$ $(1.31* 10^{22})$	$-7.33*10^{21}$ $(3.3* 10^{22})$	$1.89*10^{23}$ $(3.17* 10^{23})$
Insider concentration			$6.41*10^{-5}$ $(6.88* 10^{-5})$	$-2.81*10^{-4}$ $(9* 10^{-5})$@@@
Institutional holdings			$-2.66*10^{29}$ $(1.9* 10^{29})$@	$2.31 *10^{3}$ $(9*10^{29})$@@@
Noninsider number			$2.41*10^{25}$ $(8.7* 10^{25})$	$-9.12*10^{24}$ $(8.67* 10^{25})$
DFL*CAP				$1.67* 10^{28}$ $(5.16* 10^{28})$
DFL*ICE				$2.32* 10^{28}$ $(4.27* 10^{28})$
DFL*IHLDG				$-1.46* 10^{30}$ $(4.2* 10^{29})$ @@@
DFL*NNINS				$-8.1* 10^{30}$ $(1.24* 10^{35})$
DOL*CAP				$-4.0* 10^{28}$ $(6.16* 10^{28})$
DOL*ICE				$-1.6* 10^{27}$ $(2.25* 10^{27})$
DOL*IHLDG				$-4.04* 10^{28}$ $(2.56* 10^{29})$
DOL*NNINS				$-2.70* 10^{34}$ $(7.03* 10^{34})$
DFL*DOL				$8.28* 10^{34}$ $(3.9* 10^{34})$@@
R^2	0.0173	0.0204	0.1635	0.1589

@ significant at the 15% level in a two-tailed test;
@@ significant at the 5% level in a two-tailed test;
@ @ @ significant at the 1% level in a two-tailed test;

(a) The model is:

TINFOP = a + b.DFLP + c.DOLP where
$TINFOP = (TINFO+1)^{200}$;
DFLP = exp(DFL+1.5);
DOLP = exp(DOL+4.2);

(b) The model is:

TINFOP = a + b.DFLP + c.DOLP + d.CAP where
$TINFOP = (TINFO+1)^{200}$;
DFLP = exp(DFL+1.5);
DOLP = exp(DOL+4.2);

(c) The model is:

TINFOP = a + b.DFLP + c.DOLP + d.CAP + e.ICEP + f.IHLDGP + g.NNINSP where
$TINFOP = (TINFO+1)^{200}$;
DFLP = exp(DFL+1.5);
DOLP = exp(DOL+4.2);
ICEP = exp(ICE);
IHLDGP = exp(IHLDG);
NNINSP = exp(NNINS/10,000);

(d) The model is:

TINFOP = a + b.DFLP + c.DOLP + d.CAP + e.ICEP + f.IHLDGP + g.NNINSP + h.FCAP + i.FICE + j.FIHLDG + k.FNNINS + l.OCAP + m.OICE + n.OIHLDG +o.NNINS + p.FOL

where

$TINFOP = (TINFO+1)^{200}$;
DFLP = exp(DFL+1.5);
DOLP = exp(DOL+4.2);
ICEP = exp(ICE);
IHLDGP = exp(IHLDG);
NNINSP = exp(NNINS/10,000);
FCAP = DFL*CAP;
FICE = DFL*ICE;
FIHLDG = DFL*IHLDG;
FNNINS = DFL*NNINS;
OCAP = DOL*CAP;
OICE = DOL*ICE;
OIHLDG = DOL*IHLDG;
ONNINS = DOL*NNINS;
FOL = DFL*DOL;

(e) Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables. Constants are added to TINFO, DFL and DOL to avoid computer underflow when using the power and exponential functions.

Table 12

Regression of cumulative abnormal returns (CARs) against complete leverage (DOCL), market capitalization (CAP), insider concentration (ICE), institutional holdings (IHLDG), and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)[a]	(2)[b]	(3)[c]	(4)[d]	(5)[e]
Intercept	$-4.38*10^{-3}$ ($2.54*10^{-3}$) @	$-5.02*10^{-3}$ ($2.75*10^{-3}$)	$-5.17*10^{-3}$ ($2.79*10^{-3}$)	$-7.49*10^{-3}$ ($8.77*10^{-3}$)	$-6.75*10^{-3}$ ($9.11*10^{-3}$)
Degree of complete leverage	$1.35*10^{-15}$ ($66*10^{-17}$) @@	$1.36*10^{-15}$ ($66*10^{-17}$) @@	$1.36*10^{-15}$ ($66*10^{-17}$) @@	$1.34*10^{-15}$ ($7.2*10^{-16}$) @	$8.84*10^{-16}$ ($6.6*10^{-16}$)
Capitalization		$3.91*10^{-10}$ ($6.2*10^{-10}$)	$4.33*10^{-10}$ ($6.3*10^{-10}$)	$-1.09*10^{-10}$ ($128*10^{-11}$)	$-2.02*10^{-10}$ ($133*10^{-11}$)
Complete leverage * Capitalization			$9.57*10^{-11}$ ($23*10^{-11}$)		$1.29*10^{-10}$ ($3.3*10^{-10}$)
Insider concentration				$8.83*10^{-6}$ ($1.59*10^{-4}$)	$-3.88*10^{-6}$ ($1.8*10^{-4}$)
Institutional holdings				$5.23*10^{-3}$ ($1.51*10^{-2}$)	$-1.34*10^{-3}$ ($1.87*10^{-2}$)
Noninsider number				$1.09*10^{-7}$ ($3.3*10^{-7}$)	$1.86*10^{-7}$ ($3.6*10^{-7}$)
Leverage * Concentration					$-3.34*10^{-6}$ ($4.51*10^{-5}$)
Leverage * Holdings					$2.83*10^{-3}$ ($5.07*10^{-3}$)
Leverage * Noninsider count					$-4.99*10^{-4}$ ($7.39*10^{-4}$)
R^2	0.0477	0.0524	0.0543	0.0055	0.0629

@ significant at the 10% level in a two-tailed test;
@@ significant at the 5% level in a two-tailed test;

(a) The model is:

CAR = a + b.DOCLP where
DOCLP = exp(DOCL+21);

(b) The model is:

CAR = a + b.DOCLP + c.CAP where
DOCLP = exp(DOCL+21);

(c) The model is:

CAR = a + b.DOCLP + c.CAP + d.DCAP where
DOCLP = exp(DOCL+21);
DCAP = DOCL*CAP;

(d) The model is:

CAR = a + b.DOCLP + c.CAP + d.ICE + e.IHLDG + f.NNINS where
DOCLP = exp(DOCL+21);

(e) The model is:

CAR = a + b.DOCLP + c.CAP + d.ICE + e.IHLDG + f.NNINS + g.DCAP +
h.DICE + i.DIHLDG + j.DNNINS

where

DOCLP = exp(DOCL+21);
DCAP = DOCL*CAP;
DICE = DOCL*ICE;
DIHLDG = DOCL*IHLDG;
DNNINS = DOCLP*NNINS/10,000;

(f) Alternative functional specifications yield lower statistical significance for the explanatory variables. A constant is added to DOCL to avoid computer underflow when using the exponential function.

Table 13

Regression of cumulative abnormal returns (CARs) against financial leverage (DFL), market capitalization (CAP), insider concentration (ICE), institutional holdings (IHLDG), and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)[a]	(2)[b]	(3)[c]	(4)[d]
Intercept	$-1.82*10^{-2}$ $(5*10^{-3})^{@@}$	$-1.95*10^{-2}$ $(5*10^{-3})^{@@}$	$-2.02*10^{-2}$ $(5*10^{-3})^{@@}$	$-1.94*10^{-2}$ $(9*10^{-3})^{@}$
Degree of financial leverage	$1.04*10^{-2}$ $(3*10^{-3})^{@@}$	$1.07*10^{-2}$ $(3*10^{-3})^{@@}$	$1.13*10^{-2}$ $(3*10^{-3})^{@@}$	$1.7*10^{-2}$ $(4*10^{-4})^{@}$
Capitalization		$5.46*10^{-10}$ $(6.1*10^{-10})$	$7.84*10^{-10}$ $(8.3*10^{-10})$	
Financial leverage * Capitalization			$-3.27*10^{-10}$ $(7.8*10^{-10})$	
Insider concentration				$-1.73*10^{-4}$ $(1.64*10^{-4})$
Institutional holdings				$-8.4*10^{-3}$ $(1.55*10^{-2})$
Noninsider number				$-2.84*10^{-7}$ $(3.2*10^{-7})$
R^2	0.1314	0.1413	0.1434	0.2499

@ significant at the 10% level in a two-tailed test;
@@ significant at the 1% level in a two-tailed test;

(a) The model is:

CAR = a + b.DFL;

(b) The model is:

CAR = a + b.DFL + c.CAP;

(c) The model is:

CAR= a + b.DFL + c.CAP + d.FCAP where
FCAP = DFL*CAP;

(d) The model is:

CAR = a + b.DFL + c.CAP + d.ICE + e.IHLDG + f.NNINS.

Table 14

Regression of cumulative abnormal returns (CARs) against operating leverage (DOL), market capitalization (CAP), insider concentration (ICE), institutional holdings JHLDG), and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)[a]	(2)[b]	(3)[c]	(4)[d]
Intercept	$-4.29*10^{-3}$ $(28*10^{-4})$@	$-5.0*10^{-3}$ $(30*10^{-4})$@	$-5.1*10^{-3}$ $(31*10^{-4})$@	$-9.24*10^{-3}$ $(9*10^{-3})$@
Degree of operating leverage	$1.34*10^{-39}$ $(8.8*10^{-40})$@	$1.37*10^{-39}$ $(8.8*10^{-40})$@	$1.37*10^{-39}$ $(8.8*10^{-40})$@	$1.48*10^{-39}$ $(93*10^{-41})$@
Capitalization		$4.01*10^{-10}$ $(6.4*10^{-10})$	$2.92*10^{-10}$ $(8.1*10^{-10})$	$-1.25*10^{-10}$ $(13*10^{-10})$
Operating leverage * Capitalization			$1.12*10^{-10}$ $(4.8*10^{-10})$	
Insider concentration				$-4.70*10^{-5}$ $(1.81*10^{-4})$
Institutional holdings				$1.46*10^{-2}$ $(1.65*10^{-2})$
Noninsider number				$3.80*10^{-8}$ $(3.6*10^{-7})$
R^2	0.0321	0.0374	0.0382	0.0571

@ significant at the 10% level in a one-tailed test;

(a) The model is:

CAR = a + b.DOLP where
DOLP = $[\exp(DOL+4.2)]^{10}$;

(b) The model is:

CAR = a + b.DOLP + c.CAP where
DOLP = $[\exp(DOL+4.2)]^{10}$;

(c) The model is:

CAR = a + b.DOLP + c.CAP + d.OCAP where
DOLP = $[\exp(DOL+4.2)]^{10}$;
OCAP = DOL*CAP;

(d) The model is:

CAR = a + b.DOLP + c.CAP + d.ICE + e.IHLDG + f.NNINS where
DOLP = $[\exp(DOL+4.2)]^{10}$;

(e) Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables. A constant is added to DOL to avoid computer underflow when using the exponential function.

Table 15

Regression of cumulative abnormal return (CAR) against financial leverage (DFL), operating leverage (DOL), market capitalization (CAP), insider concentration (ICE), institutional holdings (IHLDG), and number of noninsiders (NNINS). Standard errors are in parentheses.

	(1)[a][e]	(2)[b][e]	(3)[c][e]	(4)[d][e]
Intercept	$-1.84*10^{-2}$ ($5*10^{-3}$)@@@@	$-1.98*10^{-2}$ ($5*10^{-3}$)@@@@	$-1.96*10^{-2}$ ($9*10^{-3}$)@@@	$-3.5*10^{-2}$ ($1*10^{-2}$)@@@
Degree of financial leverage	$1.02*10^{-2}$ ($3*10^{-3}$)@@@@	$1.04*10^{-2}$ ($3*10^{-3}$)@@@@	$1.64*10^{-2}$ ($4*10^{-3}$)@@@@	$3.5*10^{-2}$ ($1*10^{-2}$)@@@
Degree of operating leverage	$1.16*10^{-39}$ ($83*10^{-41}$)@	$1.19*10^{-39}$ ($83*10^{-41}$)@	$1.11*10^{-39}$ ($83*10^{-41}$)@	$1.75*10^{-39}$ ($1*10^{-39}$)@@
Capitalization		$5.83*10^{-10}$ ($6.1*10^{-10}$)	$1.32*10^{-9}$ ($1.2*10^{-9}$)	$-3.37*10^{-10}$ ($29*10^{-10}$)
Insider concentration			$-1.85*10^{-4}$ ($1.63*10^{-4}$)	$3.67*10^{-5}$ ($3.8*10^{-4}$)
Institutional holdings			$-6.76*10^{-3}$ ($1.55*10^{-2}$)	$-1.03*10^{-2}$ ($3.22*10^{-2}$)
Noninsider number			$-2.6*10^{-7}$ ($3.2*10^{-7}$)	$-5.88*10^{-7}$ ($9.3*10^{-7}$)
DFL*CAP				$-1.99*10^{-4}$ ($2.49*10^{-4}$)
DFL*ICE				$-4.17*10^{-5}$ ($2.25*10^{-4}$)
DFL*IHLDG				$-2.23*10^{-2}$ ($2.22*10^{-2}$)
DFL*NNINS				$2.11*10^{-2}$ ($5.91*10^{-2}$)
DOL*CAP				$2.17*10^{-4}$ ($1.91*10^{-4}$)
DOL*ICE				$-1.38*10^{-4}$ ($1.36*10^{-4}$)
DOL*IHLDG				$2.37*10^{-2}$ ($1.49*10^{-2}$)@
DOL*NNINS				$-7.62*10^{-2}$ ($5.17*10^{-2}$)@
DFL*DOL				$-3.67*10^{-3}$ ($4.25*10^{-3}$)
R^2	0.155	0.1662	0.1966	0.1885

@ significant at the 10% level in a one-tailed test;
@@ significant at the 10% level in a two-tailed test;
@@@ significant at the 5% level in a two-tailed test;
@@@@ significant at the 1 % level in a two-tailed test;

(a) The model is:

$$CAR = a + b.DFL + c.DOLP \text{ where } DOLP = [\exp(DOL + 4.2)]^{10};$$

(b) The model is:

$$CAR = a + b.DFL + c.DOLP + d.CAP \text{ where } DOLP = [\exp(DOL + 4.2)]^{10};$$

(c) The model is:

$$CAR = a + b.DFL + c.DOLP + d.CAP + e.ICE + f.IHLDG + g.NNINS \text{ where } DOLP = [\exp(DOL + 4.2)]^{10};$$

(d) The model is:

$$CAR = a + b.DFL + c.DOLP + d.CAP + e.ICE + f.IHLDG + g.NNINS + h.FCAP + i.FICE + j.FIHLDG + k.FNNINS + LOCAP + m.OICE + n.OIHLDG + o.NNINS + p.FOL$$

where

$$DOLP = [\exp(DOL + 4.2)]^{10};$$
$$FCAP = DFL*CAP/ 10{,}000;$$
$$FICE = DFL*ICE;$$
$$FIHLDG = DFL*IHLDG;$$
$$FNNINS = DFL*NNINS/10{,}000;$$
$$OCAP = DOL*CAP/10{,}000;$$
$$OICE = DOL*ICE;$$
$$OIHLDG = DOL*IHLDG;$$
$$ONNINS = DOL*NNINS/10{,}000;$$
$$FOL = DFL*DOL;$$

(e) Alternative functional specifications and alternative exponent values yield lower statistical significance for the explanatory variables. A constant is added to DOL to avoid computer underflow when using the exponential function.

Table 16

Spearman rank correlation coefficients between explanatory variables. The significance probabilities are in parentheses.

	Degree of complete leverage	Degree of financial leverage	Degree of operating leverage	Market capitalization	Insider concentration	Institutional holdings	Number of noninsiders
Degree of complete leverage		0.4576 @@@@ (10^{-4})	0.5010 @@@@ (10^{-4})	0.0668 (0.554)	0.0027 (0.981)	-0.0201 (0.86)	-0.1135 (0.332)
Degree of financial leverage			0.2772 @@@@ (0.015)	0.2187 @@ (0.059)	0.0007 (0.995)	0.0882 (0.455)	-0.0836 (0.495)
Degree of operating leverage				0.1610 (0.168)	-0.0347 (0.77)	-0.0065 (0.957)	-0.0671 (0.58)
Market capitalization					-0.5808 @@@@ (10^{-4})	0.6635 @@@@ (10^{-4})	0.6133 @@@@ (10^{-4})
Insider concentration						-0.4347 @@@@ (10^{-4})	-0.6803 @@@@ (10^{-4})
Institutional holdings							0.3612 @@@@ (10^{-4})
Number of noninsiders							

@ significant at the 10% level in a one-tailed test;
@@ significant at the 10% level in a two-tailed test;
@@@ significant at the 5% level in a two-tailed test;
@@@@ significant at the 1% level in a two-tailed test;

Table 17

Pearson correlation coefficients between annual standard deviation and the microstructure explanatory variables. The significance probabilities are in parentheses.

	Degree of complete leverage [(b)(e)]	Degree of financial leverage [(c)(e)]	Degree of operating leverage [(d)(e)]	Market capitalization	Insider concentration	Institutional holdings	Number of noninsiders
Standard deviation	0.2649 @@ (0.022)	-0.0629 (0.608)	0.5491 @@@ (0.022)	-0.1164 (0.313)	0.1703 @ (0.144)	-0.2907 @@ (0.011)	-0.1501 (0.211)

@ significant at the 10% level in a one-tailed test;
@@ significant at the 5% level in a two-tailed test;
@@@ significant at the 1% level in a two-tailed test;

(a) The original value, STDV, has been transformed as $\exp[(STDV+1)^{40}]$ to maximize the correlation coefficient;

(b) The original value, DOCL, has been transformed as $\ln[DOCL+21]$ to maximize the correlation coefficient;

(c) The original value, DFL, has been transformed as $\exp[(DFL + 1.5)^2]$ to maximize the correlation coefficient;

(d) The original value, DOL, has been transformed as $\exp[(DOL + 1.7)^2]$ to maximize the correlation coefficient;

(e) To account for nonlinearities, we use the exponential, logarithmic and power functions. To avoid overflow/underflow problems, we add constants to the functional arguments. Alternative specifications yield smaller correlation coefficients.

Table 18

Correlation between residual leverage (i.e. leverage unexplained by market capitalization CAP, insider concentration ICE, institutional holdings IHLDG and number of noninsiders NNINS) and standard deviation STDV, variance of pricing error VPE, trade informativeness TINFO. The leverage measures are complete leverage (DOCL), financial leverage (DFL), and operating leverage (DOL).The significance probabilities are in parentheses. The reported correlation coefficient is either a Pearson or a Spearman coefficient, whichever has the highest value.

	Standard deviation STDV	Variance of pricing error VPE	Trade informativeness TINFO
Residual complete leverage RCL	0.1436 (a)(c) (0.2357)	0.04 (a)(d) (0.75)	0.2819@@(a)(e) (0.0157)
Residual financial leverage RFL	0.1567 (b)(f) (0.2445)	0.3622@(b)(g) (0.0643)	0.0942 (a)(h) (0.4741)
Residual operating leverage ROL	0.3070@@(a)(i) (0.0202)	-0.066 (a)(j) (0.63)	-0.0340(a)(k) (0.7962)

@ significant at the 10% level in a two-tailed test;
@@ significant at the 5% level in a two-tailed test;

(a) Pearson coefficient;

(b) Spearman coefficient;

(c) Residual complete leverage RCL is the residual of the following regression:

$$\ln(DOCL+21) = a + b.CAP + c.\exp(ICE) + d.\exp([HLDG) + e.\exp(NNINS/10{,}000) + RCL;$$

The correlation coefficient is computed between RCL and $\exp((STDV+1)^{40})$ where STDV is standard deviation;

(d) Residual complete leverage RCL is the residual of the following regression:

$$[\ln(DOCL + 19.76)]^{.05} = a + b.CAP + c.\exp(ICE) + d.\exp([HLDG) + e.\exp(NNINS/10{,}000) + RCL;$$

The correlation coefficient is computed between RCL and $[\ln(VPE+1)]^{.385}$ where VPE is variance of pricing error;

(e) Residual complete leverage RCL is the residual of the following regression:

$$\exp(DOCL+21) = a + b.CAP + c.\exp(ICE) + d.\exp(IHLDG) + e.\exp(NNINS/10{,}000) + RCL;$$

The correlation coefficient is computed for RCL and ln(TINFO+ 1) where TINFO is trade informativeness;

(f) Residual financial leverage RFL is the residual of the following regression:

$$\exp(DFL+1.5)^{.2} = a + b.\exp(DOL + 4.2)^{2} + c.CAP + d.\exp(ICE) + d.\exp(IHLDG) + e.\exp(NNINS/10{,}000) + RFL;$$

The correlation coefficient is computed for RFL and $\exp((STDV+1)^{40})$ where STDV is standard deviation;

(g) Residual financial leverage RFL is the residual of the following regression:

$$(DFL+1.5)^{.001} = a + b.(DOL + 1.7)^{2} + c.CAP + d.\exp(ICE) + d.\exp(IHLDG) + e.\exp(NNINS/10{,}000) + RFL;$$

The correlation coefficient is computed for RFL and $[\ln(VPE+1\ )]^{.5}$ where VPE is variance of pricing error;

(h) Residual financial leverage RFL is the residual of the following regression:

$$\exp(DFL+1.5) = a + b.\exp(DOL+4.2) + c.CAP + d.\exp(ICE) + e.\exp([HLDG) + f.\exp(NNINS/10{,}000) + RFL;$$

The correlation coefficient is computed for RFL and (TINFO+1) where TINFO is trade informativeness;

(i) Residual operating leverage ROL is the residual of the following regression:

$$\exp(DOL + 4.2)^{2} = a + b.\exp(DFL + 1.5)^{2} + c.CAP + d.\exp(ICE) + e.\exp(IHLDG) + f.\exp(NNINS/10{,}000) + ROL;$$

The correlation coefficient is computed for ROL and $\exp((STDV+ 1)^{40})$ where STDV is standard deviation;

(j) Residual operating leverage ROL is the residual of the following regression:

$$(DOL + 1.7)^{2} = a + b.(DFL + 1.5)^{.001} + c.CAP + d.\exp(ICE) + e.\exp(IHLDG) + f.\exp(NNINS/10{,}000) + ROL;$$

The correlation coefficient is computed for ROL and $[\ln(VPE+1)]^{.5}$ where VPE is variance of pricing error;

(k) Residual operating leverage ROL is the residual of the following regression:

$$\exp(DOL+4.2) = a + b.\exp(DFL+1.5) + c.CAP + d.\exp(ICE) + e.\exp(IHLDG) + f.\exp(NNINS/10{,}000) + ROL;$$

The correlation coefficient is computed for ROL and (TINFO+1) where TINFO is trade informativeness.

APPENDIX

Sample of 86 firms which are included in all of the following databases: CRSP, COMPUSTAT, TAQ.

ACKERLEY COMMUNICATIONS INC.
ADAMS RESOURCES & ENERGY
AIR WATER TECHNOLOGIES
ALAMCO INC.
ALLIANT TECHSYSTEMS INC.
AMERICAN LIST CORP.
AMERICAN OIL & GAS CORP.
AMP INC.
APACHE CORP.
ARK RESTAURANTS CORP.
ARTRA GROUP INC.
ARX INC.
BIC CORP.
BROOKLYN UNION GAS CORP.
CALMAT CORP.
CANADIAN MARCONI COMP.
CARPENTER TECHNOLOGY CORP.
CHAPARRAL STEEL COMP.
CLEAR CHANNEL COMMUNICATION INC.
COCA-COLA ENTERPRISES INC.
CONNECTICUT ENERGY CORP.
CONVEX COMPUTER CORP.
CROWN CORK SEAL COMP. INC.
CRYSTAL BRANDS INC.
CSS INDUSTRIES INC.
DELUXE CORP.
DIANA CORP.
DIEBOLD INC.
DONNELLY CORP.
DRIVER-HARRIS COMP.
FARAH INC.
GANNETT INC.
GRUBB ELLIS COMP.
HALLIBURTON CORP.
HALSEY DRUG INC.
HANDY & HARMAN

HEXCEL CORP.
HOUGHTON MIFFLIN COMP.
IBP INC.
IGI INC.
INSTEEL INDUSTRIES INC.
INTERNATIONAL RECOVERY CORP.
JAN BELL MARKETING INC.
K-V PHARMACEUTICAL COMP.
LAURENTIAN CAPITAL CORP.
LOCTITE
LORICORP.
MATTEL INC.
MEDICORE INC.
MHI GROUP INC.
MOLECULAR BIOSYSTEMS IND.
MOORE MEDICAL CORP.
NATIONAL FUEL GAS CORP.
NEVADA POWER COMP.
NORTHROP CORP.
NUCOR CORP.
PEPSICO INDUSTRY
PFIZER
PHILADELPHIA SUBURBAN CORP.
PLY GEM INDUSTRY COMP.
RAYTHEON CORP.
SAFETY KLEEN CORP.
SALOMON INC.
SIFCO INDUSTRIES INC.
SOUTHWEST AIRLINES CORP.
STANDARD MOTOR PRODUCTS INC.
STONE WEBSTER INC.
THE BOMBAY COMPANY INC.
THE NEW HILLHAVEN CORP.
TIFFANY
TIMBERLAND COMP.
TOLL BROTHERS INC.
TOROTEL INC.
UNC INC.
UNIFIRST CORP.
UNION PACIFIC CORP.
UNITED GUARDIAN INC.
UNITRODE CORP.

UNO RESTAURANT CORP.
VINTAGE PETROLEUM INC.
WILSHIRE OIL COMPANY
WINDMERE CORP.
WOLF HOWARD INC.
WOLVERINE WORLD WIDE
ZEMEX CORP.
ZERO CORP.

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