

# Information, Trading, and Product Market Interactions: Cross-Sectional Implications of Informed Trading

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## ABSTRACT

I present a simple model of informed trading in which asset values are derived from imperfectly competitive product markets and private information events occur at individual firms. The model predicts that informed traders may have incentives to make information-based trades in the stocks of competitors, especially when events occur at firms with large market shares. In the context of 759 earnings announcements, I use intraday transactions data to test the hypothesis that net order flow and returns in the stocks of nonannouncing competitors have information content for announcing firms.

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How does an informed trader's propensity to trade on inside information in a given company's stock vary with industry and firm characteristics? Using a simple model of informed trading in which asset values are derived from imperfectly competitive product markets and private information events occur at individual firms, I examine the question of where informed traders choose to transact.<sup>1</sup> This paper adds to existing research by explicitly linking informed trading in stock markets to the structure of competition in product markets. It also provides new evidence on the process of information diffusion across stocks as we vary the location at which private information is observed. Given privately observed information at a particular location, informed traders may choose to trade in the stocks of related firms (in the same industry, for example). This paper examines both cross-stock trading incentives and cross-sectional differences in where (in which firms' stocks) informed trading is likely to occur.

I present a very simple model of informed trading in the context of both *firm-specific* and *industry-wide* information events. I assume that asset values are derived from a Cournot duopoly with asymmetric constant marginal costs. Small, wealth-constrained informed traders decide whether to trade on privately observed information regarding a given firm's future production costs in that firm's stock or the stock of a competitor. Given this setup, I solve for the conditions under which competitor trading occurs.<sup>2</sup> The model provides structure to the intuition of how information impacts more than one firm in an industry. We often start with returns as the basic element of financial models. What distinguishes the approach in this paper and in the literature on financial and product market interactions in general (e.g., Brander and Lewis (1986), Maksimovic and Titman (1991), Chevalier and Scharfstein (1996), Allen and Phillips (2000), Hou and Robinson (2006)) is that it takes one step back and explicitly accounts for the characteristics of firms and industries that generate returns. I begin with economic fundamentals in order to provide economic intuition as to what generates differences in stocks' sensitivities to common information and how these sensitivities interact with insiders' trading

strategies.

Beyond the implication that some insiders may choose to trade in the stocks of competing-firms, there are three additional cross-sectional predictions. First, the amount of information-based trading in a company's stock is likely to be decreasing in a firm's market share. In the Cournot example used in this paper, large market shares stem from competitive advantage. Stocks of firms with large market shares are less attractive locations for information-based trades because these firms are strong (that is, low-cost and more competitive). In contrast, small firms' stock prices exhibit higher sensitivity to shocks as a result of product market weakness, which creates opportunities for informed traders to extract higher excess returns from trades. In addition to competitor trading incentives, the well-known product market structure provides a link between firm size (within industries) and volatility that has not been emphasized. Second, as would be expected, the type of private information ("competitive" versus "industry-wide") is important. Competitor trading incentives are much larger when the information pertains to an industry-wide shock since these shocks have first-order effects on the profitability of all firms. Finally, as is common in the microstructure literature, liquidity matters: Informed traders are more likely to trade in liquid stocks because of their ability to "hide" their trades in these stocks.

A natural way to test these conjectures is to identify those traders who are informed and collect data on their trading portfolios. However, because such data are unavailable, I take an alternative approach. Using aggregate transaction data for a sample of 759 quarterly earnings announcements (times in which information asymmetry is likely to be high) in 128 industries, I estimate cross-stock price impacts of net order flow to infer the information content of trades and information transmission across stocks. The intuition is that if market makers learn from the trading process, they will update prices based on information from order flow and returns in all relevant securities. I examine information transmission across stocks. Consider an announcing-firm, A, and a competing-firm,

B. If it is optimal for informed traders to trade in the stock of B, then order flow in B should have information content for A, even when the information event is known to have occurred at A (and not at B). The main empirical findings support the hypothesis that nonannouncing competing-firms' stocks are locations for information-based trades. I find that order flows and returns in the stocks of nonannouncing competitors have information content for announcing-firm returns, even after controlling for lagged own-firm returns and both contemporaneous and lagged own-firm order flow. In addition, analysis of cross-sectional variation in cross-stock price impact of trades and returns provides some evidence that the information content varies systematically with the variables identified in the main model.

The transactions of informed traders are of interest because a central implication of asymmetric information models in the market microstructure literature is that these trades convey price-relevant information to markets (e.g., Kyle (1985), Glosten and Milgrom (1985)). Order flow (net buyer-initiated volume) is particularly useful in this paper since the price impact of trades reflects aggregation of traders' information. This is distinct from price changes due to public information, which can occur without trading (see, for example, Evans and Lyons (2002b)). Most empirical studies of price discovery in stock markets focus on the extent to which trading leads to price revisions in the context of individual securities (e.g., Hasbrouck (1991), Madhavan, Richardson, and Roomans (1997), and Dufour and Engle (2000) for stocks) or of multiple securities that represent different claims on the same underlying asset (e.g., Biais and Hillion (1994), Easley, O'Hara, and Srinivas (1998), Chan, Chung, and Fong (2002), Chakravarty, Gulen, and Mayhew (2004), and Cao, Chen, and Griffin (2005) for options and underlying stocks, and Harris (1989) and Chan (1992) for futures and stocks). Only in recent years has empirical focus turned to price discovery in multiple stock settings (e.g., Chordia, Roll, and Subrahmanyam (2000), Hasbrouck and Seppi (2001), and Harford and Kaul (2005)). These papers document common components of order flows and liquidity across stocks.<sup>3, 4</sup> The current paper

complements this work by shedding further light on where (within industries) we should expect price discovery to occur.

This study also contributes to the literature on insider trading and regulation. Registered insiders face regulatory constraints in own-firm trades that they do not face when they trade in the stocks of their competitors. Further, they are likely to be informed in settings in which information events occur at individual firms, making incentives for competitor trading particularly strong. Most empirical studies of trading by officers and directors of U.S. firms investigate abnormal returns to own-firm trades (e.g., Jaffe (1974), Finnerty (1976), Seyhun (1986, 1998), Lakonishok and Lee (2001), Jeng, Metrick, and Zeckhauser (2003)). Understanding variation in informed traders' incentives should help distinguish insiders who are likely to make information-based trades in own-firm stock from those who are more likely to trade for nonspeculative reasons. While this paper is not the first to link informed trading to product markets, the questions that have been addressed to date relate to how one firm can distort profits from entry by trading in the securities of other firms whose values are dependent on its actions (see, for example, Hansen and Lott (1995), Fishman and Hagerty (1992)) or the impact of own-firm trading by an insider who also chooses output levels (Jain and Mirman (2000)). The current paper focuses on informed trading in competitive stock markets with multiple securities and is the first to empirically examine the potential role of product market competition in cross-stock price discovery.

The remainder of this paper is organized as follows. In Section I, I present a very simple model of informed trading in the context of both firm-specific and industry-wide information events, and I map the implications of the model to the empirical tests. Section II contains the results of the empirical analysis of cross-stock net order flow and returns relationships during both "normal" and earnings announcement periods. Section III concludes.

## I. Hypothesis Development

The following provides a simple framework formalizing the hypotheses and main intuition. Firms compete in a Cournot product market and private information is revealed to insiders at a given firm. "Insiders" is a very broad that applies to all traders who are informed when an information event occurs, including corporate insiders and employees, as well as analysts following the firm who have access to information before it is released to the market.<sup>5</sup> What is important is the location (i.e., firm) at which the information is observed. Insiders trade either in the stock of the firm at which the event occurred or in a competitor's stock. The main results are that competitor trading incentives exist and that these incentives vary systematically with both a firm's (within-industry) market share and the type of information event ("firm-specific" or "industry-wide"). As will be clear in the discussion below, "firm-specific" information carries that name only because it relates to firm-specific costs. The information itself is relevant to the values of all firms due to the oligopolistic market structure.

### *A. Model*

I modify the sequential trade model in Easley, O'Hara, and Srinivas (1998) to consider informed trading in stocks that derive their values from a single, imperfectly competitive industry. Uncertainty stems from firms' random production costs, which can take two possible values,  $c_i - \Delta c$  or  $c_i + \Delta c$ . With probability  $\theta$ , an information event will occur at Firm  $i$ , in which true costs are privately revealed to Firm  $i$ 's insiders. Two assets ("Firms") trade in an equity market prior to competition in the product market. Ownership of a given firm represents rights to all cashflows from the asset's production of the good.<sup>6</sup>

### *Timing*

The exact timing is as follows. In period 0, nature decides whether an information event will occur. If an information event occurs, a perfect signal regarding Firm 1's future costs is revealed

to Firm 1's insiders (i.e., let  $i = 1$ ). With probability  $\delta$  the signal will reveal a low state (high future costs) for Firm 1; with probability  $(1 - \delta)$  the signal will reveal a high state. In period 1, trading occurs in the stock market. In period 2, a public signal regarding  $c_1$  is revealed to all market participants. This ensures efficient production decisions. Because the informed traders are assumed to behave competitively, as long as period 1 contains sufficiently many rounds of trading, revelation of costs will actually occur before period 2. Beginning in period 3, the product market meets and all profits are realized and returned to shareholders. Figure 1 provides a timeline.

[FIGURE 1 ABOUT HERE]

#### *Market Participants*

There are four types of equity market participants: Firm 1's insiders (those with access to Firm 1's private information); Firm 1's uninformed liquidity traders; Firm 2's uninformed liquidity traders; and a market maker.<sup>7</sup>

Insiders are risk neutral and competitive. Although it may be the case that the number of registered insiders at an individual firm is small, the potential group of indirect insiders (e.g., other employees, temporary insiders, analysts, and family members) and the possibility of unintentional leakage makes the number of potentially informed individuals large. This increases the likelihood that informed traders will behave competitively. Insiders are wealth-constrained investors who seek to maximize return on their \$1 investment. This return maximization assumption reflects borrowing restrictions present in real markets. If an information event occurs at Firm 1, Firm 1's insiders are always informed. Uninformed traders trade for exogenous liquidity reasons and are equally likely to buy or sell. The fractions of each type of trader in the market are as follows:

$\mu$  are informed if there is an information event regarding Firm 1's costs.

$(1 - \mu)$  are uninformed liquidity traders. Of these,  $f$  sell Stock 1,  $f$  buy Stock 1,  $g$  sell Stock 2, and  $g$  buy Stock 2, where  $2f + 2g = 1$ .

All traders arrive and submit orders sequentially to a competitive market maker. Following each trade, the market maker revises his quotes using Bayes' rule. "Own-firm trades" are defined as trades in the stock of Firm 1 by Firm 1's insiders (Firm 1 is the information source). "Competitor trades" are trades in the stock of Firm 2 by Firm 1's insiders. Figure 2 depicts the probabilistic structure.

[FIGURE 2 ABOUT HERE]

### *Trading Strategies*

The imperfectly competitive product market setup means that a change in Firm 1's costs changes equilibrium profitability and produces potential insider trading profits at both firms. I assume that traders cannot execute trades in both securities simultaneously; therefore, insiders face a trading location decision: trade in their own-firm's stock or that of a competitor. When Firm 1's insiders observe a signal, there are four possible equilibria: (1) all insiders trade in own-firm stock; (2) all insiders trade in the stock of the competing-firm; (3) insiders mix between Stocks 1 and 2; and (4) insiders refrain from trading. In the case of a low signal, the fraction of insiders trading in Stock 1 is  $\alpha_L \in [0,1]$ , and  $(1 - \alpha_L)$  trade in Stock 2. Equilibrium requires that market makers set bid and ask prices that result in zero expected profits given optimal behavior of informed traders.

### *B. The Product Market*

Consider a standard Cournot duopoly with a single homogenous good and asymmetric constant marginal costs. Starting from this well-known structure allows us to formulate the intuition behind the hypothesized link between insiders' trading strategies and both firm and industry characteristics within the context of a well-understood market.<sup>8</sup> What has not been emphasized previously is the

link between product market weakness (which produces a small market share and firm size) and the implicit leverage of firms. This stems *directly* from competitive disadvantage and creates insider trading incentives.

Given costs  $C_i(q_i) = c_i q_i$  and a linear inverse demand function  $p(Q) = a - bQ$ , firms simultaneously choose quantities  $q_i$ , where  $Q = \sum q_i$ . Equilibrium profits from production are returned to shareholders as dividends. The well-known first-order conditions for a Cournot-Nash Equilibrium give quantities and profits:

$$q_i^* = \frac{a - c_i - bq_j^*}{2b}; \quad \pi_i^* = \left[ \frac{a + \sum_{k=1}^2 c_k}{3} - c_i \right]^2 \frac{1}{b}. \quad (1)$$

It is clear from (1) that a high cost firm will produce a low quantity (i.e., high  $c_i$  firms are small due to competitive disadvantage) and realize a low profit.

Consider changes in profitability with respect to changes in a given firm's costs, that is,

Own profitability:

$$\frac{\partial \pi_i^*}{\partial c_i} = \frac{-4}{3b} \left[ \frac{a + \sum_{k=1}^2 c_k}{3} - c_i \right] \quad (2)$$

Competitor profitability:

$$\frac{\partial \pi_i^*}{\partial c_j} = \frac{2}{3b} \left[ \frac{a + \sum_{k=1}^2 c_k}{3} - c_i \right]. \quad (3)$$

Clearly, an increase in the competitive costs of Firm  $i$  decreases the value of that firm and increases the value of the competitor.

Before turning to the stock market, in which the possibility of trading by insiders will affect prices, it is useful to consider cross-sectional differences in return volatility (sensitivity of profits to the information). The percent changes in profitability with respect to a  $\Delta c$  increase in Firm 1's cost

are

$$\text{Firm 1: } \frac{\frac{\partial \pi_1^*}{\partial c_1} \Delta c}{\pi_1^*} = \frac{-4\Delta c}{[a + c_2 - 2c_1]} \quad \text{and} \quad \text{Firm 2: } \frac{\frac{\partial \pi_2^*}{\partial c_1} \Delta c}{\pi_2^*} = \frac{2\Delta c}{[a + c_1 - 2c_2]}. \quad (4)$$

Because earnings streams in high cost (small) firms are more volatile, insiders are more likely to choose to trade in the stocks of small competitors. If Firm 2's costs are sufficiently high (i.e.,  $5c_2 - 4c_1 > a$ ) then Firm 2's profitability will be more sensitive to Firm 1's firm-specific costs than Firm 1's profitability.

### *C. The Stock Market*

Firm 1's insiders observe changes in future costs. In order to establish a product market link, denote the value of Firm  $i$  given changes in costs for Firm 1 as

$$V_i^\Psi \approx \pi_i^* + \frac{\partial \pi_i^*}{\partial c_1} \Delta c_1, \quad (5)$$

where the signal  $\Psi \in \{H, L\}$  denotes state of the world (high or low) at Firm 1.

The objective is to characterize the conditions under which insiders choose to trade in competitors' stocks. Consider the equilibrium strategy of an insider making the first trade of the day.  $E[V_{it}/\Psi]$  is the expected value of Stock  $i$  given observed (perfect) signal  $\Psi$ ,  $b_{it}$  is the market maker's bid for Stock  $i$  at time  $t$ ,  $a_{it}$  is the ask for Stock  $i$  at time  $t$ . The trading rule is then: Sell if  $E[V_i/\Psi] < b_{1t}$ ; Buy if  $E[V_i/\Psi] > a_{2t}$ ; No trade in Stock  $i$  otherwise. Based on the optimal strategy for a given stock, insiders compare returns across stocks and choose their optimal trading location. This decision suggests where we might expect price discovery to occur.

#### *C.1. Market Maker's Opening Quotes*

To illustrate the impact of private information with respect to product market parameters on

equilibrium spreads, consider the market maker's opening quotes and the equilibrium strategy of an insider making the first trade of the day. Let Firm 1's insiders receive a low signal (high own-firm costs). The unconditional expected value of Stock  $i$  at time  $t$  is

$$V_{it}^* = E[V_{it}] = \delta_t V_i^L + (1 - \delta_t) V_i^H. \quad (6)$$

Given a trade in either Stock 1 or Stock 2, the market maker updates his belief regarding  $\delta_t$  using Bayes' rule and, by equation (6), revises his belief regarding the expected values of both stocks. For example, the bid for Stock 1 at time  $t$  is  $b_{1t} = E[V_{1t} / \text{Sell Stock 1}]$ . Since my focus is on the first trade of the day, I drop the  $t$  subscript here forward.

The bid and ask prices for Stock 1 are given by

$$b_1 = V_1^* - \frac{(1 - \delta)[V_1^H - V_1^L]\theta\delta\mu\alpha_L}{f(1 - \mu\theta) + \theta\delta\mu\alpha_L}; \quad a_1 = V_1^* + \frac{(1 - \delta)[V_1^H - V_1^L]\theta\delta\mu\alpha_H}{f(1 - \mu\theta) + \theta(1 - \delta)\mu\alpha_H}. \quad (7)$$

Similarly, the bid and ask prices for Stock 2 are given by

$$b_2 = V_2^* - \frac{(1 - \delta)[V_2^L - V_2^H]\theta\delta\mu(1 - \alpha_H)}{g(1 - \mu\theta) + \theta(1 - \delta)\mu(1 - \alpha_H)}; \quad a_2 = V_2^* + \frac{(1 - \delta)[V_2^L - V_2^H]\theta\delta\mu(1 - \alpha_L)}{g(1 - \mu\theta) + \theta\delta\mu(1 - \alpha_L)}. \quad (8)$$

Clearly, the deviation of bid and ask prices from the expected values of each asset is increasing in the fraction of insiders who choose to trade in that security. In this example, if none of Firm 1's insiders trade in Stock 2 (i.e.,  $\alpha_L = \alpha_H = 1$ ), then  $a_2 = b_2 = V_2^*$  and there would be no spread in the competitor's stock.

When Firm 1's insiders observe a low signal, they trade in Stock 2 if

$$\frac{V_2^L - a_2}{a_2} > \frac{b_1 - V_1^L}{b_1}. \quad (9)$$

The remainder of the analysis considers the case of a low signal, so the subscript on  $\alpha_L$  is dropped.

To provide intuition, I solve for the conditions under which insiders choose a pure strategy in competitor trades (that is, the conditions such that  $\alpha = 0$ ).

### *C.2. Pure Strategy in Competitor Trades*

LEMMA 1: *After observing a low signal regarding firm-specific costs, a sufficient condition for Firm 1's insiders to trade in Stock 2 is*

$$\frac{(V_2^L - V_2^*)g(1 - \theta\mu)}{V_2^*g(1 - \theta\mu) + \theta\delta\mu V_2^L} > \frac{V_1^* - V_1^L}{V_1^*}. \quad (10)$$

The argument is as follows. Let  $\alpha = 0$ . If, given that all insiders trade in Stock 2, returns from trade in that stock are greater than own-firm returns, then it must be the case that  $\alpha = 0$ . From equation (7), when  $\alpha = 0$  there is no informed trading in Stock 1 and  $b_1 = V_1^*$ . Returns from the sale of Stock 1 are then

$$\frac{b_1 - V_1^L}{b_1} = \frac{V_1^* - V_1^L}{V_1^*}. \quad (11)$$

If the insider buys Stock 2, returns are

$$\frac{V_2^L - a_2}{a_2} = \frac{(V_2^L - V_2^*)g(1 - \theta\mu)}{V_2^*g(1 - \theta\mu) + \theta\delta\mu V_2^L}. \quad (12)$$

■

From (10), it is clear that increasing liquidity traders in Firm 2 (increasing  $g$ ) increases the propensity of Firm 1's insiders to trade in that stock. A lower prior on the low signal ( $\delta$ ) also increases returns to trading in Stock 2.

Importantly, in this setup,  $V$  has a structure (product market profitability). We can use this fact to gain additional insight into the links between product market characteristics and trading

location.

LEMMA 2: *The range of microstructure parameters  $(\delta, \theta, \mu, f, g)$  for which there is a pure strategy in competitor trades is increasing in own-firm market share and decreasing in the market share of the competing-firm.*

Lemma 2 formalizes the intuition that because small firms within industries tend to be weak (e.g., they are new and vulnerable to shocks or they have some other competitive disadvantage), the sensitivity of their values to information is high. This makes their stocks attractive venues for information-based trading. To see why, return to the product market, where the traded assets derive their values. Recall from equation (5) that  $V_i^\Psi \approx \pi_i^* + \frac{\partial \pi_i}{\partial c_k} \Delta c_k$ . Firm  $i$ 's market share is

$$s_i^* = \frac{q_i^*}{\sum_{k=1}^2 q_k^*} = \frac{a + c_j - 2c_i}{2a - c_1 - c_2}. \quad (13)$$

equations (1), (2), and (3) give equilibrium profit and changes in profitability with respect to changes in costs. Substituting these and (13) into inequality (10), and letting  $\delta = 1/2$  (for simplification), we obtain:

$$s_1 g(1 - \theta\mu) - 2s_2 \left[ g(1 - \theta\mu) + \frac{\theta\mu}{2} \right] > \frac{2\Delta c \theta \mu}{2a - c_1 - c_2}. \quad (14)$$

Holding industry constant, the left-hand side of inequality (14) is strictly increasing in Firm 1's market share and strictly decreasing in Firm 2's market share. Thus, within an industry, small stocks are more susceptible to informed competitor trades. This within-industry market share result also has between-industry implications: All else equal, the range of parameters over which there will be a pure strategy in competitor trading is increasing in industry concentration (see the Appendix for

details).

#### *D. Industry-wide News*

Section C.2 focuses on firm-specific (competitive) costs  $c_i$ . However, in most industries, stock returns are characterized by positive comovement, which suggests that uncertainty is related to industry-wide variables. It is straightforward to modify the model to examine the case in which private information pertains to industry-wide costs and insiders instead observe a change in the cost  $c_I$ , which is common to both firms. The cost for Firm  $i$  in industry  $I$  is given by  $C_i(q_i) = (c_i + c_I)q_i$ . The percent change in profitability of Firm  $i$  with respect to a  $\Delta c_I$  increase in industry-wide costs is then

$$\frac{\Delta\pi_i}{\pi_i^*} = \frac{-2\Delta c_I}{a + c_j - 2c_i - c_I}. \quad (15)$$

From (15), it follows that whenever  $c_j > c_i$ , we have

$$\frac{|\Delta\pi_j|}{\pi_j^*} > \frac{|\Delta\pi_i|}{\pi_i^*}. \quad (16)$$

There are several differences between the industry-wide and competitive cost cases (inequalities (15) and (4), respectively). The most important is that the sensitivity of profitability to industry-wide costs is larger for the weakest (highest idiosyncratic cost) firms. Inequality (16) says that, all else constant, insiders in large firms would always want to trade on information regarding industry-wide shocks in the stocks of smaller, more volatile competitors. This is not always true with competitive information and provides a link between size and volatility that stems directly from the Cournot setup. The intuition is analogous to models of informed trading in options (e.g., Easley, O'Hara, and Srinivas (1998)) in that leverage stemming from the product market makes weak competitors' stocks attractive.<sup>9</sup> This link between size and informed trading is also consistent with the findings in

Fishe and Robe (2004), who report that stockbrokers who obtained advance copies of *Business Week* tended to choose smaller firms for their pre-announcement trades. Also note that from inequality (15), the sensitivity of profitability of the firm at which the information event occurs is  $\frac{1}{2}$  of that in the idiosyncratic cost case, further increasing competitor trading incentives. Another difference is that returns are positively correlated when information pertains to industry-wide costs. Therefore, the top two branches in Figure 2 would be the choice between selling Firm 1 and selling Firm 2.

In the industry-wide case, the conditions for a pure strategy in competitor trades (analogous to inequality (14)) becomes:

$$s_1g(1 - \theta\mu) - s_2[g(1 - \theta\mu) + \frac{\theta\mu}{2}] > \frac{-\theta\mu\Delta c_I}{2a - c_1 - c_2 - 2c_I}. \quad (17)$$

What distinguishes the industry-wide cost case is that the conditions in inequality (17) are much less restrictive on the range of microstructure parameters over which insiders will choose to engage in competitor trading (i.e., inequality (14)). As in the competitive information case, the range over which there exists a pure strategy in competitor trades is strictly increasing in the market share of Firm 1 and decreasing in the market share of Firm 2.

#### *E. Asymmetric Impact of Insider Trading Regulation*

While this paper applies to settings in which insider trading is unregulated, the presence of regulation makes the analysis potentially more relevant. Let  $p$  represent the expected fraction of own-firm trading profits that an insider keeps. If there are no regulations, then  $p = 1$ . Under current laws,  $p$  can be negative (insiders must disgorge profits, and they also face civil penalties of up to three times profit or avoided loss under 15 U.S.C. 78 u-1). For negative  $p$ , it is clear that, whenever possible,

insiders will want to trade in competing-firms' stocks. Consider the more realistic case in which monitoring is imperfect and  $p \in (0, 1)$ . In this context, equation (14) becomes

$$s_1 g(1 - \theta\mu) - 2ps_2 \left[ g(1 - \theta\mu) + \frac{\theta\mu}{2} \right] > \frac{2p\Delta c\theta\mu}{2a - c_1 - c_2}. \quad (18)$$

Clearly, regulation shifts information risk to the stocks of competitors, especially when competitors are weak (small). This asymmetry may be important to policy makers. In particular, traditional insiders face constraints in trading the securities of their own firms that they do not face when they choose to trade in the stocks of their competitors (Section 16 of the Securities and Exchange Act of 1934 requires own-firm trade reporting and prohibits both own-firm short sales and short-swing profit taking). Establishing a breach of a fiduciary duty to the source of privately observed information has been the basis for courts to determine whether illegal insider trading has occurred (see, for example, Bainbridge (2000)). While breach of fiduciary duty to the firm (and its shareholders) is clear in the case of own-firm trading on the basis of material private information, it is less clear in the case of competitor trading. Legal scholars hold that, under current laws, competitor trading may be legal in many circumstances.<sup>10</sup>

In addition to government regulation, firm-level policies can restrict competitor trading. In light of the incentives highlighted in this paper, one might expect firms to self-regulate if they expected such incentives to harm shareholders. To explore whether in practice employment contracts restrict executives and employees from trading the stocks of competitors, I review the current code of conduct policies in 60 firms: all of the Dow 30 stocks and 30 stocks randomly selected from the Nasdaq 100.<sup>11</sup> Most firms are silent on the issue of competitor trading.<sup>12, 13</sup> Importantly, where these policies do exist, they work against finding cross-stock price impact in empirical analysis. It also may not be reasonable to expect strict adherence and enforcement. For example, Bettis, Coles, and Lemmon (2000) report some evidence (albeit reduced) of own-firm insider trading during corporate blackout

periods.

*F. Implications and Motivation for Empirical Analysis*

The two primary implications of the analysis above are: (1) competitor trading incentives may exist and (2) incentives are likely to vary systematically with firm and industry characteristics as well as type of information ("competitive" versus "industry-wide"). While it is clear that competitor trading incentives can exist when firms operate in the same industry, what distinguishes the model is that the imperfectly competitive industry structure provides both a mechanism through which linkages exist and predictions as to when competitor trading incentives are likely to be strongest. To test these, one would ideally identify all of the informed traders at a given firm and analyze their entire trading portfolios. Given that such data are unavailable, I infer information content based on the estimated price impact of cross-stock net order flow and returns to test for consistency with the competitor trading hypothesis. Informed trades are not directly identified; however, the price impact reveals the market maker's *expectation* that trades contain value-relevant information.

Four possible equilibria are discussed in the previous section: Pure strategy in own-firm trades; pure strategy in competitor trades; mixed strategy in which insiders trade in both own and competitor stocks with positive probabilities; no trade. A goal of the empirical analysis is to identify which of these equilibria is most consistent with actual trading and returns relationships. In the earnings announcement setting, an empirical finding that suggests an informational role for trading and returns of the announcing-firm and no such role for those of a competitor implies a pure strategy equilibrium in own-firm (in this case, the announcing-firm) trades. The reverse finding would imply a pure strategy equilibrium in competitor trades. Evidence of informative order flow and returns in both announcers and competitors would be consistent with a mixed-strategy equilibrium. Finally, no information in

announcing and competing firms' order flows and returns would imply no informed trading. These relationships are summarized in Table I.

[TABLE I ABOUT HERE]

## II. Earnings Announcements, Cross-Stock Net Order Flow, and Returns Relationships

The model in Section I suggests that grouping stocks based on industry and then estimating cross-stock price impacts of order flow and returns (especially in event settings) might improve our understanding of cross-stock price discovery. In the empirical analysis, I infer information content from cross-stock price impacts, measured over "normal" trading periods as well as the days preceding and following 759 earnings events. These windows allow me to vary the information environment in order to examine whether there are changes in the structure of information diffusion when we vary the location at which private information is observed. A finding that the information content of trading in competitors' stocks decreases near earnings announcements would be inconsistent with competitor trading.

Earnings release periods provide a useful basis for testing since information asymmetry during these periods is likely to be high (in the notation of Section I,  $\theta$  close to one) and it is possible to identify the location at which the event occurred. The assumption that these announcements allow informed traders to value future cashflows is in line with evidence (e.g, Christophe, Ferri, and Angel (2004)) of informed trading in announcing-firms during the days prior to earnings announcements. Further, because many firms engage in self-regulation and restrict own-firm trades by insiders prior to earnings announcements (see Bettis, Coles, and Lemmon (2000)), competitor trading might be most evident during these pre-announcement "blackout" periods. In addition, Demarzo, Fishman, and Hagerty (1998) show that the optimal insider trading regulation involves allowing small information-motivated trades and imposing penalties for large trades. This is important since it suggests that

some insider trading will be allowed and that trading data should reflect at least some informationally motivated trades.

The main empirical model is in the spirit of Chan, Chung, and Fong (2002) and Easley, O’Hara, and Srinivas (1998). Both studies investigate the price discovery process across options and underlying stocks, where the main regression equation of interest is one in which the dependent variable is the five-minute change in the stock price.

### *A. Data and Sample Selection*

#### *Industry and Event Selection*

The initial sample consists of all common stocks that appear on both *CRSP* and *COMPUSTAT* at any time during the period 1993 to 2002. A valid announcement is an earnings announcement by a NYSE/AMEX firm that occurs within 90 days of quarter-end and that does not occur within two trading days of an earnings announcement by another firm in the industry. Industries are defined as all firms with the same primary *COMPUSTAT* four-digit SIC code.<sup>14</sup> Consistent with the information transfer literature (e.g., Freeman and Tse (1992)), I require announcers and competitors to have December fiscal year-ends in order to synchronize quarters. I also require that each industry have at least eight quarters with valid announcements over the 1993 to 2002 period. Earnings announcement dates are obtained from *COMPUSTAT*.<sup>15</sup> While earnings release dates for all competitors (including those listed on NASDAQ) are used to identify valid announcements, only NYSE and AMEX stocks’ net order flows and returns are analyzed in order to avoid confounding findings related to different trading mechanisms.

Intraday transactions data are from the *Trades and Quotes (TAQ)* database. Consistent with prior studies (e.g., Easley, O’Hara, and Srinivas (1998); Chan, Chung, and Fong (2002)), I impose an active trade filter of 50 trades per day in order to attenuate problems associated with nonsynchronous trading. From the group of active competitors for a given announcement, one competing-firm is

randomly selected for analysis.<sup>16</sup> All announcements in which there is at least one active announcing and one active competing firm are included in the final sample of 128 industries (four-digit SIC codes) and 759 valid earnings announcements.

### *Sample Description and Summary Statistics*

The sample consists of 398 unique firms, occupying 128 different industries. The firms are large, with average market capitalization in *CRSP* NYSE/AMEX/Nasdaq Decile 9. This is due to the selection criteria, in particular, the active trade filter (which eliminates the smallest firms), but should not cause important selection bias since it is within-industry variation is important to the analysis, not size. Forty-five percent of competing-firms have market shares less than the announcing-firm. Table II provides a summary of price reactions and trading volumes over the five-day event window (days  $-2$  to  $+2$ ). Abnormal event-period price reactions are defined as the absolute value of the sum of abnormal returns over the event window dates  $-2$  to  $+2$ . The mean (median) abnormal price changes during the event window are 6.5% (4.4%) for announcing-firms and 4.9% (3.4%) for competitors. Pre-event price changes are estimated over days  $-2$  and  $-1$  and exhibit similar variation. The mean (median) abnormal price changes are 3.2% (1.9%) for announcing-firms and 2.7% (1.9%) for competitors. The magnitudes of these price changes suggest that earnings announcements contain information, and the information begins to be incorporated into prices prior to the actual announcement date. Consistent with the main model, announcement-period price changes are larger for the 343 announcements in which competitors have smaller market shares than the announcer (5.9% versus 4.5%).

[TABLE II ABOUT HERE]

To provide a description of event-period trading volume, I define abnormal trading as volume relative to average daily trading volume over the calendar year ending 30 days prior to each announcement. From Table II, volumes in both announcers and competitors appear to increase during earnings

announcement periods. That these volumes accompany price changes motivates a closer examination of the information content of trading volumes.

The average dollar volumes in Table II suggest that, on average, competitors' stocks are more liquid than those of announcing-firms. Inequality (14) implies that information-based trading is more likely to occur in the stocks of weak competitors; it also suggests that, all else equal, informed traders prefer to trade in liquid stocks. Therefore, an analysis of cross-sectional variation in the price impact of trading and returns in competing-firms needs to control for differences in liquidity.

The data in Table II also indicate that firm values are sensitive to common information, with the average historical return and volume correlations among announcers and competitors of approximately 0.32 for returns and 0.19 for trading volume.<sup>17</sup> The empirical intraindustry information transfer literature (e.g., Foster (1981) and Freeman and Tse (1992) for earnings announcements, Hertzels (1991) for repurchases, Lang and Stulz (1992) for bankruptcies, Laux, Starks and Yoon (1998) for dividends, Bittlingmayer and Hazlett (2000) for litigation) documents that information releases affect the values of both announcers and competitors. This literature does not consider trading activity in nonannouncing competitors in the periods surrounding announcements. The analysis in this section documents these relationships.

The next step involves closer (intraday) examination of order flows and returns. The primary goal is to characterize cross-stock information transmission during both "normal" and announcement periods. The main tests are based on cross-stock net order flow and returns relationships during a benchmark period as well as during pre-, post-, and earnings announcement days. Benchmark observations are measured over ten trading days (the five days ending two weeks prior to the announcement and five days beginning two weeks following the announcement), since information asymmetry related to announcers' earnings should be lower at these times.<sup>18</sup>

I divide each trading day into 78 successive five-minute intervals from 9:30 a.m. until 4:00 p.m.

ET. Stock return in interval  $t$  is defined as the log ratio of quote midpoints at the end of intervals  $t$  and  $t-1$ . Returns are based on quote midpoints in order to reduce the effects of bid-ask bounce.<sup>19</sup> I assume that quotes are set symmetrically about the expected value and that they reflect all public information.

Following Chan, Chung, and Fong (2002), I calculate net stock trading volume (buyer-initiated volume minus seller-initiated volume) using the Lee and Ready (1991) trade classification algorithm. As in Chan, Chung, and Fong (2002) and Easley, O'Hara, and Srinivas (1998), all return and net trade volume variables are standardized using the mean and standard deviation of the series for each individual stock over each trading day. Standardization allows for pooling across firms in order to increase the power of the empirical tests.

### *B. Empirical Model*

To shed light on the informational role of cross-stock net order flow and returns, I take the basic econometric approach adapted from Hasbrouck (1991) for the case of multiple securities in Chan, Chung, and Fong (2002). The interactions between returns and order flow are modeled as a vector autoregressive (VAR) system. The main focus is on the null that net order flows in competitors' stocks have no information content for announcing-firms' returns (after controlling for announcing-firms' net order flows and lagged returns).<sup>20</sup>

I estimate the following system:

$$R_t = \alpha + \sum_{i=0}^k \beta_i V_{t-i} + \sum_{i=1}^k \gamma_i R_{t-i} + \sum_{i=0}^k \sum_{w=1}^W \beta_i^w V_{t-i} D^w + \sum_{i=1}^k \sum_{w=1}^W \gamma_i^w R_{t-i} D^w + \epsilon_t \quad (19)$$

$$V_t = \kappa + \sum_{i=1}^k \delta_i V_{t-i} + \sum_{i=1}^k \theta_i R_{t-i} + \sum_{i=0}^k \sum_{w=1}^W \delta_i^w V_{t-i} D^w + \sum_{i=1}^k \sum_{w=1}^W \theta_i^w R_{t-i} D^w + v_t, \quad (20)$$

where  $R_t$  is the  $(2 \times 1)$  return vector  $[R_t^a R_t^c]'$  where superscripts  $a$  and  $c$  denote announcers and com-

petitors, respectively, and  $V_t$  is the  $(2 \times 1)$  signed net order flow vector  $[V_t^a V_t^c]'$ .  $R_t$  is the standardized return over the five-minute return interval  $t$  and  $V_t$  is the standardized net order flow (buyer-initiated volume minus seller-initiated volume).<sup>21</sup> The coefficient matrices  $(2 \times 2)$  are:  $\beta_i$ ,  $\gamma_i$ ,  $\delta_i$ , and  $\theta_i$ . Superscript  $W$  indicates pre-event, event, and post-event windows (days  $-2$  to  $-1$ , day  $0$ , and days  $+1$  to  $+2$ , respectively). The dummy  $D^w$  is equal to one if the day is in the event window, zero otherwise. Intercepts ( $\alpha$  and  $\kappa$ ) and disturbance terms ( $\epsilon_t$  and  $v_t$ ) are  $2 \times 1$  vectors. Because net order flow and return series are standardized, errors are assumed to be homoskedastic.

Equations (19) and (20) are similar to the standard VAR except that contemporaneous net order flows appear on the right-hand side in the returns equations; whereas, only lagged explanatory variables appear in the net order flow equations. As in Hasbrouck (1991), this is based on the assumption that net order flow can contemporaneously cause quote revisions, while contemporaneous quote revisions cannot cause net order flow. Event window interactions are included to allow cross-stock order flow and returns relationships to vary when the information event is known to have occurred (i.e., near earnings announcements). If most price discovery takes place within own-firm stock, cross-stock coefficients during the event window (e.g.,  $\beta_i^c + \beta_i^w D^w$  and  $\gamma_i^c + \gamma_i^w D^w$  in the announcing-firm return equation) will be zero. Both pre- and post- event periods are of interest since information asymmetry (and subsequent price discovery) can exist following public announcements (see, for example, Kim and Verrecchia (1997)). Consistent with this intuition, in the context of foreign exchange, Evans and Lyons (2002b) find greater price impact of trades when public information is flowing rapidly. I explore these interactions in greater depth in the cross-sectional tests (in Section II.E).

### *C. Main Hypotheses*

The two primary predictions from Section I are that competitor trading incentives (1) exist and (2) will vary systematically with firm and industry characteristics. Estimation of equations (19) and (20) allows for an examination of the first implication. The announcing-firm returns equation,  $R_t^a$

(equation (19)), is the primary focus of the analysis.

### C.1. *Announcing-firm Returns*

The model in Section I suggests that if information is revealed in the stocks of nonannouncing competitors, then  $\beta_i^c$ , the coefficients on the nonannouncing competitors' net order flow, will be significantly different from zero. Because announcing-firm market makers may not directly observe cross-stock net order flow, they might infer net order flow from observed competitor returns. In that case,  $\gamma_i^c$ , the coefficients on the nonannouncing competitors' returns, would be significantly different from zero. I interpret empirical findings of an informational role for either competitor order flow or competitor returns as evidence consistent with an informational role for trading in competitors' stocks. Equation (19) is estimated to test the following hypotheses:

$H0_1$ : *In the announcing-firm returns equation ( $R_t^a$ ), competing-firm net order flow has no information content. That is,  $\beta_i^c = 0$ ,  $i=0, \dots, k$ .*

$H0_2$ : *In the announcing-firm returns equation ( $R_t^a$ ), competing-firm returns have no information content. That is,  $\gamma_i^c = 0$ ,  $i=1, \dots, k$ .*

The empirical specification allows for variation in cross-stock information flow across event windows. If all learning takes place within own-firm stock at the time of the announcement, then the sum of the estimated coefficients on competitor order flow and returns for the event windows will be zero. More formally, from equations (19) and (20),

$$H0_{1w}: \beta_i^c + \beta_i^w D^w = 0 \text{ and } H0_{2w}: \gamma_i^c + \gamma_i^w D^w = 0.$$

Recall from equation (19) that subscripts  $i$  on coefficients  $\beta$  and  $\gamma$  represent lagged five-minute intervals. Because markets are not frictionless, past signed order flows of nonannouncing competitors may also have information content.

There is no ex ante hypothesis regarding the nature of the information contained in the announcements. However, the positive historical return correlation between announcing-firms in the sample (mean of 0.32) suggests that industry-wide information content tends to dominate competitive information ( $\gamma_i^c, \beta_i^c > 0$ ).

### C.2. Competing-Firm Returns

If price discovery takes place across stocks rather than within the context of individual stocks, the null hypotheses are identical to the announcing-firm tests:

H0<sub>3</sub>: *In the competing-firm returns equation ( $R_t^c$ ), announcing-firm net order flow has no information content. That is,  $\beta_i^a = 0, i=0, \dots, k$ .*

H0<sub>4</sub>: *In the competing-firm returns equation ( $R_t^c$ ), announcing-firm returns have no information content. That is,  $\gamma_i^a = 0, i=1, \dots, k$ .*

For event windows, we have:  $H0_{1w}: \beta_i^a + \beta_i^{aw} D^w = 0$  and  $H0_{2w}: \gamma_i^a + \gamma_i^{aw} D^w = 0$ .

### C.3. Cross-sectional Considerations

In Section II.E, I explicitly investigate the predictions above by allowing coefficients of the main model to vary with relative market shares, industry concentration, and return correlations, as well as both liquidity and leverage controls.

### C.4. Who Trades? An Interpretation of Cross-stock Information Content

Before presenting the empirical results, I address an important issue regarding the types of traders whose trades might generate cross-stock information linkages. The main model in Section I describes insiders as those who privately observe an information event when it occurs at a particular firm

(traditional insiders, employees, analysts following a firm, etc.). Traders either directly observe the information event or they are uninformed. In reality, it may be that some traders gain informational advantages by observing trades by informed agents, with their subsequent trades generating cross-stock linkages. While these "sophisticated traders" have an informational advantage, they are initially uninformed. Unfortunately, it is difficult to determine whether informative trades are being made by insiders, as defined in Section I, or by sophisticated traders. However, what matters in this analysis is the location in which these traders choose to transact, not how a particular trader becomes informed. If sophisticated traders choose to make cross-stock trades given their superior information, they would facilitate information transmission in ways that are consistent with the main model.

Importantly, if sophisticated traders learn from the trades of traditional insiders, the insiders and sophisticated traders will differ only in the extent to which their trades in a particular firm are subject to regulatory scrutiny. Asymmetric regulation (e.g., Section 16 constraints on own-firm trades) implies that whenever it is optimal for a traditional insider to trade in the stock of the announcing-firm, it must also be optimal for a sophisticated trader to do so. The reverse does not necessarily hold. One can then interpret an empirical finding that information flows from the stock of a competing-firm to an announcing-firm as evidence of competitor trading by either (i) insiders, as described in Section I, or (ii) both insiders and sophisticated traders.

#### *D. Competitor Trading Incentives? Results of the Cross-Stock Spillover Analysis*

The results of estimation of equations (19) and (20) are presented in Tables IIIa and IIIb. The discussion below focuses on benchmark results and pre- and post-event-period interactions. Event-day results are not emphasized due to variation in the timing of the announcements (i.e., some announcements occur between 9:30 a.m. and 4:00 p.m., in which case event day 0 contains both pre- and post-announcement trades).

### D.1. *Announcing-Firm Returns Equation*

The estimated coefficients on competing-firm order flow and returns in the announcing-firm equation ( $R_t^a$ , equation (19)) are of greatest interest. Consistent with the maintained hypothesis, the results in Table IIIa provide evidence that trading and returns in competing-firms' stocks have explanatory power for the stocks of announcing-firms, *even after controlling for contemporaneous and lagged announcing-firm order flow and lagged announcing-firm returns*. This is important since it is often assumed that price discovery takes place within a single security rather than through interaction across related markets.<sup>22</sup> Further, the coefficients on the event-period interactions show that cross-stock learning continues even during periods in which it is known that an information event has occurred at the announcing-firm. In fact, the insignificant estimates of event-window interaction terms indicate that cross-stock learning remains largely unchanged in the aggregate sample. Another important observation from the tables is that the magnitudes of the estimated coefficients decline with lag length, suggesting a rapid incorporation of information into prices.

[TABLE IIIa ABOUT HERE]

Note that the model is estimated using six lags; however, only three are reported in the tables (for brevity). Six lags are chosen based on examination of autocorrelations and cross-autocorrelations and for consistency with prior studies. {I also estimate the model over longer intervals (up to 10 lags). The conclusions are unchanged. One potential concern is the possibility that any observed price impacts are reversed over longer lags, leading the truncation at six lags to produce spurious results. The observed declining magnitudes of the estimated coefficients in the table, at least in part, address this concern.

### D.2. *Competitor Returns Equation*

The results from the competitor returns equation are presented in Table IIIb and are qualitatively similar to the results in the announcing-firm equation. Order flow equations (20) are estimated but not reported (for brevity) since returns equations are the central focus.

[TABLE IIIb ABOUT HERE]

### *D.3. Joint Tests, Direction of Information Flow, and Benchmark Comparison*

In addition to the individual cross-stock coefficients, their joint significance is of interest. Table IV presents the sums of the estimated coefficients on competing-firm returns and net order flow from the announcing-firm returns equation (19). The table also presents sums of the coefficients on announcing-firm returns and order flow from the competing-firm returns equations. I test the joint null hypothesis that the sums of the cross-stock coefficient estimates are not statistically different from zero. To provide further insight into the direction of information transmission, I also test the cross-equation restriction that the cross-stock price impacts of order flow and returns are the same for announcers and competitors: (1)  $\sum_{i=0}^6 \beta_i^c - \sum_{i=0}^6 \beta_i^a = 0$  and (2)  $\sum_{i=0}^6 \gamma_i^c - \sum_{i=0}^6 \gamma_i^a = 0$ . If the difference in the magnitudes of these estimated coefficients is significantly different from zero, then the evidence is consistent with the flow of information from the stocks of one group of firms to those of another.

[TABLE IV ABOUT HERE]

Consistent with competitor trading, Table IV indicates that information flows via both returns and order flows in competitors' stocks even when an information event is known to have occurred at a particular firm. Event-window interactions indicate that announcing-firm order flow does have a larger cross-stock price impact during the pre-event period, but (importantly) there is no corresponding decrease in the cross-stock price impact of competitor order flow. During this pre-event period the

cross-stock price impact of announcing-firm returns decreases and order flow increases, suggesting that market makers expect more information from trades prior to the announcement. Competitor order flow and returns remain informative for announcing-firm stock returns.

The results in Table IV indicate that competitor order flow actually becomes more informative during the post-event period. This could be a result of information from trading in the sense of superior processing of information contained in the announcement (e.g., in Kim and Verrecchia (1997)) as opposed to traditional “informed/insider trading” on nonpublic information.

Table IV presents pooled results for all events and announcer-competitor pairs. I also divide the sample in half according to the relative market shares of the announcer and competitor. These results are in Table V. Panel A shows results of estimating the structure of information transmission when competitors are relatively small and Panel B shows results for relatively large competitors. It is evident that the structure of price discovery changes during the event period and relative size plays an important role. In the benchmark period, information tends to flow via returns from relatively large firms to relatively small ones, whereas information from order flow is transmitted in both directions regardless of relative size. The returns findings are consistent with the findings in Hou (2003), who reports that returns on large firms lead returns on small firms within the same industry. During the pre-event period, there appears to be greater information transmission via order flow and less transmission via returns between announcers and smaller competitors. This is consistent with market makers expecting to learn more from order flow during periods in which information asymmetry is high. While the sign of the estimated coefficient on the pre-event window interaction with small-competitor order flow is positive, as predicted (i.e., there is informed trading in the stocks of smaller competitors), it is not significant at conventional levels. For larger competitors, there are no significant changes during the pre-event period; however, during the post-event period, there is actually an increase in the informativeness of competitor order flow. This is somewhat surprising, but may be related to the

liquidity of the stocks of larger competitors. The cross-sectional analysis in the next section controls for liquidity.

[TABLE V ABOUT HERE]

To summarize, the main conclusion from the announcing-firm returns equation is that competing-firm order flow and returns convey information for announcing-firm returns, even after controlling for contemporaneous and lagged own-firm net order flow and lagged own-firm returns. This cross-stock information transmission is evident even during periods in which an information event is known to have occurred at the announcing-firm.<sup>23</sup>

#### *E. Cross-Sectional Relationships*

The results in the previous section are important since they are consistent with the competitor trading incentives described in Section I. However, beyond an informational role for trading in competitors' stocks, the model presented in Section I also suggests that competitor trading will vary with firm market shares and the type of information expected to be contained in the announcement ("competitive" versus "industry-wide"). For a deeper analysis of the process by which information is incorporated into the prices of related securities, I reestimate the announcing-firm returns equation ( $R_t^a$ ), allowing the estimated coefficients on competitor order flow and returns to vary with relative market shares, industry concentration, and return correlations (measured ex ante). I also control for differences in liquidity and leverage.

The model is specified as follows:

$$\begin{aligned}
 R_t^a = & \delta X + \sum_{i=0}^6 \beta_{ix}^c V_{t-i}^c X + \sum_{i=0}^6 \sum_{w=1}^3 \beta_{ixw}^{cw} V_{t-i}^c X D^w + \sum_{i=1}^6 \gamma_{ix}^c R_{t-i}^c X + \sum_{i=1}^6 \sum_{w=1}^3 \gamma_i^{cw} R_{t-i}^c D^w + \\
 & \sum_{i=0}^6 \beta_i^a V_{t-i}^a + \sum_{i=0}^6 \sum_{w=1}^3 \beta_i^{aw} V_{t-i}^a D^w + \sum_{i=1}^6 \gamma_i^a R_{t-i}^a + \sum_{i=1}^6 \sum_{w=1}^3 \gamma_i^{aw} R_{t-i}^a D^w + \epsilon_t.
 \end{aligned} \tag{21}$$

The specification in (21) is the same as equation (19), except that a vector  $X$  of cross-sectional variables and the associated coefficients have been added. The components of  $X$  are: 1, relative market share, industry concentration, return correlation, relative liquidity, and relative debt; that is,

1. *RHSARE* is relative market share, defined as the (log) ratio of year  $t-1$  share of sales in the industry to competitor share.
2. *HHI* is industry concentration, defined as the sum of squared market shares in industry  $i$  during year  $t-1$ .
3. *RETC* is the stock return correlation of the announcers and competitors, calculated with daily data for the year ending 30 days prior to the earnings announcement.
4. *RLIQ* is relative liquidity, defined as the (log) ratio of daily turnover in the competitor stock to that in the announcer stock during the year ending 30 days prior to the announcement.
5. *RDEBT* is relative debt, defined as the (log) ratio of announcing-firm leverage to the leverage of the competing-firm. Leverage ratios are defined as total debt divided by book value of equity in year  $t-1$ .

Based on the hypothesis that relatively weak firms are attractive venues for information-based trades, I expect that relative market share will increase the information content of competing-firm net order flow and returns. I also expect higher cross-stock information content when the returns of announcers and competitors tend to be highly correlated. Here, historical return correlation is a proxy for the relative amounts of industry-wide versus competitive information. I also include industry concentration (*HHI*) since I expect cross-stock information content from competitors in more concentrated industries. I control for liquidity and leverage with the *RLIQ* and *RDEBT* interactions. Informed traders may prefer to trade in more liquid stocks, implying less competitor stock information

content when announcing-firm stock is relatively liquid; on the other hand, equilibrium price impacts of trade in illiquid stocks will be greater if it is possible that information-based trades will occur in those stocks. Ex ante, this suggests that it is important to control for liquidity. Which of these effects dominates is an empirical question. The model presented in Section I assumes all-equity firms. Because capital structure impacts stock price volatility, I include a relative leverage variable to control for differences in volatility associated with leverage.

Table VI presents the results. The standard errors on estimated coefficients are noisier due to the number of parameters being estimated; however, the results indicate that cross-sectional characteristics are important. There are several important observations. First, the results from the pre-announcement period suggest that when the market share of the announcer is large relative to that of the competitor, competitor order flow becomes more informative. This is consistent with the cross-sectional predictions in Section I. Interestingly, the reverse holds for returns. That is, when announcers are relatively large, there is less cross-stock information flow in competitor returns. It may be that public information is quickly reflected in larger stocks' returns (consistent with the findings in the cross-stock return autocorrelation literature, for example, Lo and MacKinlay (1990), Badrinath, Kale, and Noe (1995), Sias and Starks (1997)), whereas information from trades can flow in the opposite direction.

Second, the expected type of information matters. During the benchmark period, the estimated coefficients on the historical return correlation interaction are positive and significant for both order flow and returns. In fact, this proxy for the relative amount of industry-wide versus competitive information is the most important determinant of cross-stock information transmission during "normal" periods. During the pre-event period, this sign actually switches and more competitive information matters. Thus, it might be the case that competitive information becomes relatively more important near earnings announcements.

Finally, the most significant cross-sectional differences are related to the changes of the pre-event period. During the post-event period, estimated coefficients on the cross-sectional interactions are insignificant, with the exception of market share. After the information is released to the public, there is less cross-stock information from the trades in relatively small competitors.

[TABLE VI ABOUT HERE]

### III. Conclusions

In this paper, I present a simple model of informed trading in which asset values are derived from imperfectly competitive product markets and information events occur at individual firms. Information-based trades can occur in the stocks of firms other than the firm at which an information event occurs. The primary cross-sectional implication is that when information events occur at dominant, large market-share firms, insiders are more likely to make information-based trades in the stocks of competitors. The intuition for this result is that firms with large market shares are less vulnerable to shocks, making them less attractive locations for information-based trades. A second prediction is that the informed trader's trading location decision also depends on the content of privately observed information ("competitive" versus "industry-wide").

The empirical investigation examines the hypothesis that informed trade may occur in stocks of competitors. In particular, for a sample of 759 earnings announcements, I use aggregate trade data to examine cross-stock net order flow and returns relationships. The most important finding is that even during announcement periods, trading and returns in competitors' stocks have information content beyond that contained in own-firm order flow and returns. This is consistent with competitor trading. While the strongest cross-sectional evidence is that information type ("competitive" versus "industry-wide") determines the informativeness of cross-stock trading and returns, there also is some evidence that relative market shares play a role in pre-announcement price discovery.

## Notes

<sup>1</sup>Throughout this paper, the terms "informed traders" and "insiders" refer to all traders who are informed when an information event occurs at a given firm. Broadly, this includes corporate insiders, employees, their tippees, and analysts following the firm who have access to information before it is released to the market.

<sup>2</sup>In practice, while little is known regarding the extent to which competitor trading occurs, there is anecdotal evidence. Consider a *Wall Street Journal* article pointing to an information leak regarding the development of a medical device by Boston Scientific. In the hours prior to the public announcement, trading in Boston Scientific was halted, but Johnson & Johnson shares declined 2.5% on high trading volume. In addition, "there was an even sharper drop in the same period of shares of SurModics Inc., a smaller company that supplies an important component of J&Js." *WSJ 9/18/2003 C3*.

<sup>3</sup>There is a small theoretical literature on informed trading in multiple stock settings, where securities have correlated fundamentals (e.g., Subrahmanyam (1991), Gorton and Pennacchi (1993), Caballe and Krishnan (1994), Bhattacharya, Reny, and Spiegel (1995)). This paper differs in focus from these in that I examine the role of product markets in generating the correlated fundamentals and implications of varying the location (firm) at which private information is observed.

<sup>4</sup>Program trading has become increasingly important, with average weekly volume as a percentage of NYSE volume up from 19% in 1999 to 57% in 2005 (source: NYSE.com). See Harris, Sofianos, and Shapiro (1994) for relationships between program trading and price movements.

<sup>5</sup>Following the adoption of Regulation Fair Disclosure in October 2000, analysts are less likely to have access to firms' material nonpublic information.

<sup>6</sup>Rights to future  $T$ -period cashflows might be a more realistic interpretation. Because the solution to the  $T$ -period game is the same as the one-shot solution, a single production period is assumed.

<sup>7</sup>This can be extended to include insiders at Firm 2. The resulting intuition regarding trading incentives is the same. I present the basic case for purposes of exposition.

<sup>8</sup>Examples can be found in, for example, Henderson and Quandt (1980).

<sup>9</sup>Back (1993) shows a distinct informational role for options in that they increase the types of signals the market receives.

<sup>10</sup>See, for example, Bainbridge (2000), Ayres and Bankman (2001), and Ayres and Choi (2002). Ayers and Bankman (2001) note that the default rule when firms are silent on the issue of competitor trading by employees is unclear. While not the focus of this study, competitor trading by firms is legal.

<sup>11</sup>Policies are as of May 2006 and are possibly tighter than restrictions during the 1993 to 2002 period (following Sarbanes Oxley in 2002).

<sup>12</sup>Trading on material information in the stocks of rivals is explicitly restricted in 12 out of 60 cases (six each of Dow and Nasdaq-100 firms). This is substantially fewer than the 18 cases in which customers, suppliers, and partners are explicitly mentioned. The codes of an additional 18 firms do not specifically mention competitors but might be interpreted to include rivals. Vague statements or silence on the issue might exist to provide firms with some discretion in blocking competitor trading. I would like to thank the referee for this point and for motivating this line of inquiry.

<sup>13</sup>In their conflict of interest statements, I find explicit mention of *ownership* in competitors in 35 out of 60 cases. Firms care about levels of holdings, but silence and broad language governing trading implies they care less about gains made from acquiring/disposing of competitors' stock. The allowed

ownership ranges are large (usually between 1% and 5% of the competitors' shares outstanding or 10% to 25% of wealth) and may not constrain employee trading gains. It is also significant that seven firms prohibit short positions in own-firm stock by employees. Gains from shorting competitors would be possible, as there are no examples of shorting restrictions in any other firm's securities.

<sup>14</sup>Financial institutions and conglomerates (SIC codes 6000-6299, 6600-6999, and 9997) are excluded.

<sup>15</sup>Where *COMPUSTAT* dates are unavailable, I/B/E/S dates are used. Announcement dates (and times) are confirmed via a *Factiva* newswire search. Announcements in which news dates and *COMPUSTAT* or I/B/E/S dates differ by more than one day are deleted. Otherwise, newswire dates are used. The author gratefully acknowledges Thompson Financial for providing the earnings announcement data as part of a broad academic program to encourage earning expectations research.

<sup>16</sup>The model in this paper includes only two alternatives for trading location. Most industries have several competitors and informed traders may choose to transact in several stocks (or in options). Analyzing only one competitor's stock would bias results against finding significant information content in nonannouncing firm order flow and returns.

<sup>17</sup>Correlations measure average comovement and potentially understate competitor trading opportunities since an informed trader would know the type of privately observed information and the correct cross-stock trading directions.

<sup>18</sup>If the bid and ask quotes are not updated simultaneously, the bid-ask bounce is not entirely eliminated and quote midpoints will exhibit a portion of the bounce. However, two points should be noted: (1) potential problems are reduced relative to transactions prices; and (2) this would primarily impact estimated autocorrelations in own-firm returns rather than cross-stock relationships.

<sup>19</sup>The pre-event benchmark is based on findings in Chae (2005), who reports abnormally low own-

firm turnover beginning on day -10 and continuing through day -3 relative to earnings news. The post-event benchmark assumes that announcement-related uncertainty is resolved within 10 days.

<sup>20</sup>While different in focus and method, the commonality in liquidity literature suggests the importance of order flow beyond own-firm stock. Using 15 broad industry classifications, Harford and Kaul (2005) find that both aggregate market index and industry order flows explain returns and that market index order flows are more important on average. Chordia, Roll, and Subrahmanyam (2000) report larger coefficients on industry variables than market variables for three to five measures of liquidity. Note that there are substantial differences between these studies and the empirical model in this paper. In Harford and Kaul (2005), the only explanatory variables are order flows (i.e., all lagged returns are excluded). In addition, industry and market index order flows are calculated by summing the number of trades across stocks. This measure is less relevant to the current paper since it underweights small firms' impact. Chordia, Roll, and Subrahmanyam (2000) measure variation in liquidity, not returns.

<sup>21</sup>The model is also estimated using net trades, rather than net volume. The R-squared for the returns regression using trades is substantially higher (0.17 versus 0.14), but the results are not qualitatively different. Net volume results are presented, following the literature.

<sup>22</sup>The importance of own-security order flow and lagged returns has been well-documented across a range of security markets (see, for example, Evans and Lyons (2002a) for foreign exchange markets).

<sup>23</sup>In unreported tests, I reestimate equations (19) and (20) for several subsamples: "high event-period price reaction" announcements; pre- and post- NYSE minimum tick reductions (eighths to sixteenths in 1997, and to one penny in 2001); and the 119 cases in which the announcements are the first quarterly announcements in the industry. While there is some variation in the magnitude of the coefficients across subsamples, the evidence of cross-stock learning is robust.

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## Appendix

This appendix provides additional discussion of the model presented in Section I.

### A.1 Mixed Strategies $\alpha \in (0, 1)$

The analysis and intuition for the mixed-strategy case is almost identical to the  $\alpha = 0$  case. Recall that if the conditions for a pure strategy in competitor trades do not hold, there are two possibilities: (1) pure strategy in own-firm trades; or (2) a mixed-strategy equilibrium. For the intuition behind a mixed-strategy equilibrium, consider a case in which the expected sensitivity of firm value to private information is equal across the two securities. If all of Firm 1's insiders choose to trade in own-firm stock, the market maker's quotes will take into account full informed participation in Stock 1 and Stock 2's quoted spreads will reflect no expected informed participation. This would give at least some of Firm 1's insiders the incentive to trade in Stock 2.

*After observing a low signal regarding firm-specific costs, Firm 1's insiders will trade in Firm 2's stock with positive probability if*

$$\frac{(V_2^H - V_2^L)}{V_2^*} > \frac{(V_1^H - V_1^L)f(1 - \theta\mu)}{V_1^*f(1 - \theta\mu) + \delta V_1^L\theta\mu}. \quad (\text{A1})$$

The argument is as follows: Let  $\alpha = 1$  (pure strategy in own-firm trades). If, given that all insiders trade in Stock 1, returns from trade in Stock 2 are greater than own-firm returns, then it must be that  $\alpha < 1$ . When  $\alpha = 1$ , returns to trade in Stock 1 (given a low signal) are

$$\frac{b_1 - V_1^L}{b_1} = \frac{(1 - \delta)(V_1^H - V_1^L)f(1 - \theta\mu)}{(\delta V_1^L + (1 - \delta)V_1^H)f(1 - \theta\mu) + \delta V_1^L\theta\mu} = \frac{(1 - \delta)(V_1^H - V_1^L)f(1 - \theta\mu)}{V_1^*f(1 - \theta\mu) + \delta V_1^L\theta\mu}, \quad (\text{A2})$$

and for Stock 2, returns are

$$\frac{V_2^L - a_2}{a_2} = \frac{(1 - \delta)(V_2^H - V_2^L)}{(\delta V_2^L + (1 - \delta)V_2^H)} = \frac{(1 - \delta)(V_2^H - V_2^L)}{V_2^*}. \quad (\text{A3})$$

■

Given that the conditions for a mixed strategy equilibrium are satisfied, the equilibrium  $\alpha^*$  for the first trade of the day is

$$\alpha^* = \frac{f(V_1^H - V_1^L)[(1 - \theta\mu)gV_2^* + \theta\delta\mu V_1^{L1}] - g(V_1^H - V_1^L)f(1 - \theta\mu)V_1^*}{\theta\delta\mu[g(V_2^H - V_2^L)V_1^L + f(V_1^H - V_1^L)V_2^L]}. \quad (\text{A4})$$

Substituting product market parameters into (A1) provides conditions for a mixed-strategy equilibrium that are analogous to inequality (14):

$$s_1[f(1 - \theta\mu) + \frac{\theta\mu_1}{2}] - 2s_2f(1 - \theta\mu) > \frac{2\Delta c\theta\mu}{2a - c_1 - c_2}. \quad (\text{A5})$$

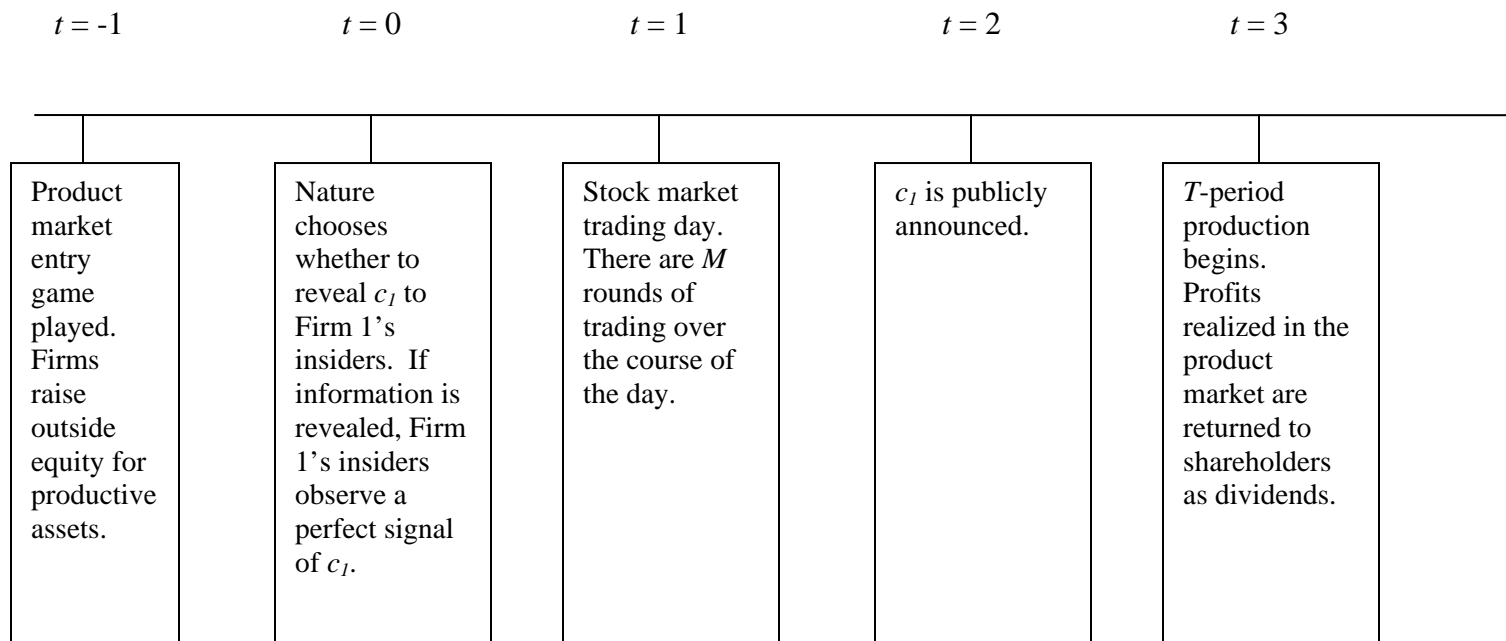
Informed competitor trading is more likely when own firms have large market shares. Conditions for a pure strategy in own-firm trades are analogous, but inequality (A5) is reversed.

## A.2 Industry HHI

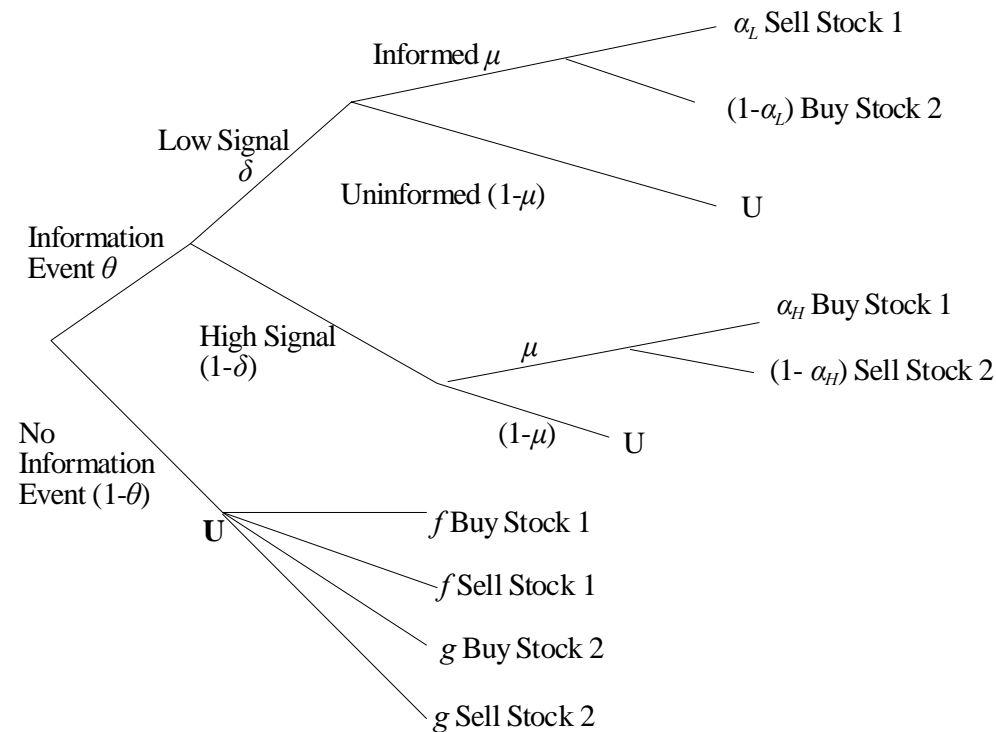
The within-industry market share result in inequality (14) also has between-industry implications. Consider two industries identical in all respects except the marginal cost of the lowest-cost firm, Firm L. Market share is decreasing in  $c$ , so the lowest-cost firm will have  $s_L^I > \frac{1}{2}$ . A standard measure of industry competitiveness is the Hirschman-Herfindahl Index (HHI), the sum of squared market shares. Higher HHI suggests a less competitive industry. In the Cournot example,

$$HHI = s_L^2 + (1 - s_L)^2 = F(s_L(c_L, c_H)). \quad (\text{A6})$$

This is strictly increasing in  $s_L$  for  $s_L > \frac{1}{2}$ . If  $c_L$  decreases, both HHI and competitor trading incentives increase. Between industries, *all else equal, the range of microstructure parameters for which there will be a pure strategy in competitor trades is increasing in industry concentration (HHI).*



**Figure 1. Timeline.** This figure shows the timeline of events. Firm 1's production cost is denoted  $c_I$ .



**Figure 2. Structure of stock trading: Firm-specific (competitive) information event.** This figure gives the structure of information revelation and stock market trading. With probability  $\theta$ , nature reveals a perfect signal of future own-firm costs to Firm 1's insiders. The signal reveals a low state with probability  $\delta$  and a high state with probability  $(1-\delta)$ . Fractions  $\mu$  and  $(1-\mu)$  traders are informed and uninformed, respectively. Of the  $(1-\mu)$  uninformed traders, fractions  $f$  buy/sell Stock 1 and  $g$  buy/sell Stock 2. Uninformed nodes U are equal and  $2f+2g = 1$ . Fractions  $\alpha_L$  and  $\alpha_H$  are the informed traders who choose to trade in Stock 1 after observing a low signal and high signal, respectively.

**Table I**  
**Empirical Implications**

This table presents the four possible equilibrium strategies for informed traders: pure strategy in own-firm trades; pure strategy in competitor trades; mixed strategy, in which informed traders trade in both own and competitor stocks with positive probabilities; no trade. "Yes" and "No" indicate whether returns and order flow of announcing and competing firms are predicted to have information content across stocks during periods in which information events occur at individual firms. Note that the main model suggests an informational role for order flow across own- and competing firms; however, because order flow may not be directly observable across stocks, returns may also have cross-stock information content.

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| <b>Cross-stock information content?</b> | <b>Own-Firm Order Flow</b> | <b>Competitors' Order Flow</b> |
|---|----------------------------|--------------------------------|
| <b>Type of Equilibrium</b>              |                            |                                |
| Pure Strategy in Announcer Stock        | Yes                        | No                             |
| Pure Strategy in Competitor Stock       | No                         | Yes                            |
| Mixed Strategy                          | Yes                        | Yes                            |
| No trade                                | No                         | No                             |

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**Table II****Summary of Trading Volume, Returns, and Firm Characteristics**

This table summarizes the sample of announcers and competing firms. There are 759 valid announcements in 128 industries (four-Digit SIC codes). For each valid announcement, I require at least one actively traded competitor on the NYSE or AMEX. Trading volume and price changes (returns) are based on *CRSP* data. Trade data are from *TAQ*. Event-period volumes, price changes, and trades are calculated over days -2 to +2 relative to the announcement day. "Pre-Event" volumes, trades, and price changes are calculated over days -2 and -1. Abnormal price changes are based on market models estimated over the benchmark 365 calendar days ending 30 days prior to the announcement. Trading volume and return correlations are calculated over the same period. Event-period abnormal trading volume is defined as  $[V_e/V_B]$ , where  $V_e$  is average daily event period volume and  $V_B$  is benchmark daily volume. Event-period abnormal trades are defined as  $[T_e/T_B]$ . Market shares and industry *HHI* (sum of squared market shares of all *COMPUSTAT* firms in the same four-digit SIC code as the announcing firm) are based on year  $t-1$  total sales.

|   | Announcing Firms |        |          | Competitors |        |          |
|---|------------------|--------|----------|-------------|--------|----------|
|   | Mean             | Median | Std. Dev | Mean        | Median | Std. Dev |
| <b>Volume and Returns</b>                 |                  |        |          |             |        |          |
| Avg. Daily Volume (\$000)                 | 27,593           | 9,700  | 51,229   | 32,889      | 12,738 | 62,282   |
| Avg. Daily Trades                         | 446              | 208    | 790      | 501         | 232    | 775      |
| Event Period Abnormal Price Change (%)    | 0.14%            | 0.14%  | 0.09     | 0.29%       | -0.06% | 0.06     |
| Event Per. Abnormal Price Change  (%)     | 6.46%            | 4.43%  | 0.07     | 4.86%       | 3.43%  | 0.05     |
| Pre-Event Abnormal Price Change (%)       | 0.26%            | -0.10% | 0.07     | 0.13%       | 0.07%  | 0.04     |
| Pre-Event Abnormal Price Change  (%)      | 3.16%            | 1.92%  | 0.06     | 2.70%       | 1.92%  | 0.00     |
| Event Period Abnormal Trades              | 1.37             | 1.19   | 0.94     | 1.14        | 1.02   | 0.58     |
| Pre-Event Abnormal Trades                 | 1.43             | 1.24   | 0.95     | 1.14        | 1.01   | 0.62     |
| Event Period Abnormal Volume              | 1.56             | 1.29   | 1.81     | 1.19        | 1.01   | 0.63     |
| Pre-Event Abnormal Volume                 | 1.24             | 0.98   | 2.31     | 1.19        | 0.96   | 0.85     |
| <b>Industry and Firm Characteristics</b>  |                  |        |          |             |        |          |
| Firm Market Share                         | 0.18             | 0.13   | 0.18     | 0.21        | 0.15   | 0.19     |
| Industry HHI                              | 0.2594           | 0.2190 | 0.1671   | 0.2594      | 0.2190 | 0.1672   |
| Trading Volume Correlation with Announcer | 1.000            | 1.000  | 0.000    | 0.186       | 0.177  | 0.155    |
| Return Correlation with Announcer         | 1.000            | 1.000  | 0.000    | 0.316       | 0.292  | 0.175    |
| Equity Market Capitalization (\$M)        | 6,427            | 2,090  | 10,701   | 9,010       | 3,111  | 23,948   |

**Table III(a)**

**Signed Order Flow and Returns of Announcing and Competing Firms**

This table presents regression results, where the dependent variable is the announcing-firm return over the five-minute interval  $t$ . Independent variables are lagged returns and both lagged and contemporaneous order flows in announcing and competing firms.  $R_t$  and  $RC_t$  denote announcer and competitor returns, respectively. They are defined as  $\log(P_t/P_{t-1})$ , where  $P_t$  is the quote midpoint at the end of five-minute interval  $t$ . Order flows are denoted  $V_t$  and  $VC_t$  and are defined as buyer- minus seller-initiated volume. All variables are standardized using mean and standard deviation of returns and order flows for each firm over each trading day. The full set of equations (estimated separately by OLS) are:

$$R_t, RC_t = \alpha + \sum_{i=1}^6 \beta_i R_{t-i} + \sum_{i=1; w=1}^{i=6; w=3} \beta_{i,w} R_{t-i} D^w + \sum_{i=1}^6 \beta_{6+i} RC_{t-i} + \sum_{i=1; w=1}^{i=6; w=3} \beta_{6+i,w} RC_{t-i} D^w + \sum_{i=0}^6 \gamma_i V_{t-i} + \sum_{i=0; w=1}^{i=6; w=3} \gamma_{i,w} V_{t-i} D^w + \sum_{i=0}^6 \gamma_{7+i} VC_{t-i} + \sum_{i=0; w=1}^{i=6; w=3} \gamma_{7+i,w} VC_{t-i} D^w + \varepsilon_t$$

$$V_t, VC_t = \kappa + \sum_{i=1}^6 \delta_i R_{t-i} + \sum_{i=1; w=1}^{i=6; w=3} \delta_{i,w} R_{t-i} D^w + \sum_{i=1}^6 \delta_{6+i} RC_{t-i} + \sum_{i=1; w=1}^{i=6; w=3} \delta_{6+i,w} RC_{t-i} D^w + \sum_{i=1}^6 \theta_i V_{t-i} + \sum_{i=1; w=1}^{i=6; w=3} \beta_{i,w} \theta_{t-i} D^w + \sum_{i=1}^6 \theta_{6+i} VC_{t-i} + \sum_{i=1; w=1}^{i=6; w=3} \theta_{6+i,w} VC_{t-i} D^w + v_t$$

$D^w$  is a dummy vector indicating the event window (pre-event, event day, and post-event). Benchmark periods are 10 trading days: five days ending two weeks prior to the announcement and five days beginning two weeks following the announcement. The pre-announcement period is from day -2 to -1 relative to the announcement and the post-announcement period is from day +1 to +2. \* denotes 10% significance level, \*\* denotes 5% significance level, and \*\*\* denotes 1% significance level. There are 772,418 observations. The model is estimated using six lags; however, only results from lags zero to three are included in the table (for brevity).

**Table IIIa - continued**

| <i>Dependent Variable=R<sub>t</sub>, Announcing firm</i> |                                   |         |                         |         |                       |         |                          |         |
|--|-----------------------------------|---------|-------------------------|---------|-----------------------|---------|--------------------------|---------|
| <i>Event Window Interactions</i>                         |                                   |         |                         |         |                       |         |                          |         |
| Explanatory Variables                                    | All Periods (Including Benchmark) |         | Pre-Announcement Period |         | Event Date            |         | Post-Announcement Period |         |
|  | Estimated Coefficient             | t-value | Estimated Coefficient   | t-value | Estimated Coefficient | t-value | Estimated Coefficient    | t-value |
| Intercept  | 0.001                             | 0.78    |                         |         |                       |         |                          |         |
| R <sub>t-1</sub>   | -0.052***                         | -37.43  | 0.021***                | 6.19    | 0.044***              | 8.89    | 0.019***                 | 5.64    |
| R <sub>t-2</sub>   | -0.028***                         | -20.08  | 0.008**                 | 2.52    | 0.024***              | 4.81    | 0.010***                 | 2.88    |
| R <sub>t-3</sub>   | -0.016***                         | -11.38  | 0.005                   | 1.55    | -0.002                | -0.34   | 0.009***                 | 2.65    |
| V <sub>t</sub>   | 0.342***                          | 288.29  | 0.010***                | 3.43    | -0.045***             | -11.47  | -0.011***                | -3.96   |
| V <sub>t-1</sub>   | 0.033***                          | 25.71   | -0.008***               | -2.61   | -0.011**              | -2.47   | -0.001                   | -0.25   |
| V <sub>t-2</sub>   | 0.003**                           | 2.40    | -0.003                  | -1.05   | -0.004                | -0.91   | -0.003                   | -1.04   |
| V <sub>t-3</sub>   | 0.000                             | -0.36   | 0.000                   | -0.15   | 0.002                 | 0.49    | -0.006*                  | -1.79   |
| RC <sub>t-1</sub>  | 0.021***                          | 15.49   | 0.000                   | -0.10   | -0.009*               | -1.95   | -0.003                   | -0.98   |
| RC <sub>t-2</sub>  | 0.013***                          | 9.77    | 0.000                   | -0.01   | -0.008*               | -1.68   | 0.000                    | -0.08   |
| RC <sub>t-3</sub>  | 0.007***                          | 5.29    | -0.001                  | -0.16   | 0.000                 | -0.02   | -0.002                   | -0.57   |
| VC <sub>t</sub>  | 0.026***                          | 22.04   | -0.003                  | -1.03   | -0.007*               | -1.75   | -0.003                   | -0.88   |
| VC <sub>t-1</sub>  | -0.004***                         | -2.85   | -0.001                  | -0.26   | 0.009***              | 2.09    | 0.005*                   | 1.71    |
| VC <sub>t-2</sub>  | -0.003**                          | -2.49   | 0.002                   | 0.48    | 0.004                 | 0.84    | 0.004                    | 1.32    |
| VC <sub>t-3</sub>  | 0.001                             | 0.69    | -0.002                  | -0.68   | 0.000                 | -0.08   | -0.001                   | -0.47   |
| Adjusted R <sup>2</sup>                                  | 0.1417                            |         |                         |         |                       |         |                          |         |

**Table III(b)**

**Signed Order Flow and Returns of Announcing and Competing Firms**

This table presents regression results, where the dependent variable is the competing-firm return over the five-minute interval  $t$ . Independent variables are lagged returns and both lagged and contemporaneous order flows in announcing and competing firms.  $R_t$  and  $RC_t$  denote announcer and competitor returns, respectively. They are defined as  $\log(P_t/P_{t-1})$ , where  $P_t$  is the quote midpoint at the end of five-minute interval  $t$ . Order flows are denoted  $V_t$  and  $VC_t$  and are defined as buyer- minus seller-initiated volume. All variables are standardized using mean and standard deviation of returns and order flows for each firm over each trading day. The full set of equations (estimated separately by OLS) are:

$$\begin{aligned}
 R_t, RC_t &= \alpha + \sum_{i=1}^6 \beta_i R_{t-i} + \sum_{i=1;w=1}^{i=6; w=3} \beta_{i,w} R_{t-i} D^w + \sum_{i=1}^6 \beta_{6+i} RC_{t-i} + \sum_{i=1;w=1}^{i=6; w=3} \beta_{6+i,w} RC_{t-i} D^w + \sum_{i=0}^6 \gamma_i V_{t-i} + \sum_{i=0;w=1}^{i=6; w=3} \gamma_{i,w} V_{t-i} D^w + \sum_{i=0}^6 \gamma_{7+i} VC_{t-i} \\
 &+ \sum_{i=0;w=1}^{i=6; w=3} \gamma_{7+i,w} VC_{t-i} D^w + \varepsilon_t \\
 V_t, VC_t &= \kappa + \sum_{i=1}^6 \delta_i R_{t-i} + \sum_{i=1;w=1}^{i=6; w=3} \delta_{i,w} R_{t-i} D^w + \sum_{i=1}^6 \delta_{6+i} RC_{t-i} + \sum_{i=1;w=1}^{i=6; w=3} \delta_{6+i,w} RC_{t-i} D^w + \sum_{i=1}^6 \theta_i V_{t-i} + \sum_{i=1;w=1}^{i=6; w=3} \beta_{i,w} \theta_{t-i} D^w + \sum_{i=1}^6 \theta_{6+i} VC_{t-i} \\
 &+ \sum_{i=1;w=1}^{i=6; w=3} \theta_{6+i,w} VC_{t-i} D^w + v_t.
 \end{aligned}$$

$D^w$  is a dummy vector indicating the event window (pre-event, event day, and post-event). Benchmark periods are 10 trading days: five days ending two weeks prior to the announcement and five days beginning two weeks following the announcement. The pre-announcement period is from day -2 to -1 relative to the announcement and the post-announcement period is from day +1 to +2. \* denotes 10% significance level, \*\* denotes 5% significance level, and \*\*\* denotes 1% significance level. There are 772,418 observations. The model is estimated using six lags; however, only results from lags zero to three are included in the table (for brevity).

**Table IIIb - continued**

| <i>Dependent Variable=RC<sub>t</sub>, Competing firm</i> |                                   |                 |                                  |            |                       |                 |                          |                 |
|--|-----------------------------------|-----------------|----------------------------------|------------|-----------------------|-----------------|--------------------------|-----------------|
| Explanatory Variables                                    | All Periods (Including Benchmark) |                 | <i>Event Window Interactions</i> |            |                       |                 | Post-Announcement Period |                 |
|  | Estimated Coefficient             | <i>t</i> -value | Pre-Announcement Period          | Event Date | Estimated Coefficient | <i>t</i> -value | Estimated Coefficient    | <i>t</i> -value |
| Intercept  | 0.001                             | 0.74            |                                  |            |                       |                 |                          |                 |
| RC <sub>t-1</sub>  | 0.024***                          | 17.51           | -0.008**                         | -2.26      | -0.002                | -0.40           | -0.005                   | -1.52           |
| RC <sub>t-2</sub>  | 0.012***                          | 8.79            | 0.002                            | 0.58       | -0.002                | -0.37           | 0.002                    | 0.68            |
| RC <sub>t-3</sub>  | 0.009***                          | 6.82            | -0.007**                         | -1.96      | -0.005                | -0.97           | 0.001                    | 0.23            |
| V <sub>t</sub>   | 0.024***                          | 19.84           | 0.001                            | 0.26       | -0.003                | -0.66           | -0.006*                  | -1.94           |
| V <sub>t-1</sub>   | -0.002                            | -1.54           | 0.002                            | 0.71       | 0.000                 | 0.08            | -0.001                   | -0.23           |
| V <sub>t-2</sub>   | -0.009**                          | -2.28           | 0.001                            | 0.40       | 0.002                 | 0.44            | -0.003                   | -0.91           |
| V <sub>t-3</sub>   | -0.001                            | -0.66           | -0.001                           | -0.31      | 0.003                 | 0.61            | 0.003                    | 0.92            |
| RC <sub>t-1</sub>  | -0.054***                         | -38.56          | 0.005                            | 1.43       | 0.015***              | 3.37            | 0.004                    | 1.30            |
| RC <sub>t-2</sub>  | -0.027***                         | -19.69          | -0.002                           | -0.52      | 0.006                 | 1.30            | 0.004                    | 1.24            |
| RC <sub>t-3</sub>  | -0.015***                         | -10.83          | -0.003                           | -0.87      | 0.002                 | 0.43            | -0.001                   | -0.36           |
| VC <sub>t</sub>  | 0.342***                          | 286.07          | -0.009***                        | -3.06      | -0.005                | -1.26           | -0.001                   | -0.18           |
| VC <sub>t-1</sub>  | 0.027***                          | 20.83           | 0.004                            | 1.41       | -0.005                | -1.16           | 0.002                    | 0.77            |
| VC <sub>t-2</sub>  | 0.004***                          | 3.06            | -0.002                           | -0.60      | -0.007                | -1.56           | -0.003                   | -1.04           |
| VC <sub>t-3</sub>  | -0.002                            | -1.34           | -0.002                           | -0.60      | -0.001                | -0.26           | 0.000                    | 0.10            |
| Adjusted R <sup>2</sup>                                  | 0.1410                            |                 |                                  |            |                       |                 |                          |                 |

**Table IV**  
**Joint Significance of Event Window-Varying Coefficients**

This table presents the sum of the estimated coefficients on cross-stock order flow and returns from the announcer and competitor returns equations.

$$R_t, RC_t = \alpha + \sum_{i=1}^6 \beta_i R_{t-i} + \sum_{i=1; w=1}^{i=6; w=3} \beta_{i,w} R_{t-i} D^w + \sum_{i=1}^6 \beta_{6+i} RC_{t-i} + \sum_{i=1; w=1}^{i=6; w=3} \beta_{6+i,w} RC_{t-i} D^w + \sum_{i=0}^6 \gamma_i V_{t-i} + \sum_{i=0; w=1}^{i=6; w=3} \gamma_{i,w} V_{t-i} D^w + \sum_{i=0}^6 \gamma_{7+i} VC_{t-i} + \sum_{i=0; w=1}^{i=6; w=3} \gamma_{7+i,w} VC_{t-i} D^w + \varepsilon_t.$$

The dependent variable is five-minute return. Independent variables are lagged returns and both lagged and contemporaneous order flows in announcing and competing firms.  $R_t$  and  $RC_t$  denote announcer and competitor returns, respectively. Announcer and competitor order flows are denoted  $V_t$  and  $VC_t$  and are defined as buyer- minus seller-initiated volume. All variables are standardized using mean and standard deviation of returns and order flows for each firm over each trading day.

"All periods" are all observations from both the benchmark and event periods. The benchmark period is defined as the five trading days ending two weeks prior to the announcement and five trading days beginning two weeks following the announcement. The pre-event period is from day -2 to -1 relative to the announcement date, the event day is day 0, and the post-event period is from day +1 to +2. "To Announcer from Competitor" indicates information flow from order flow/returns in the competing firm to the announcer (coefficients on competing firm order flow/returns in the announcing firm returns equations). "From Announcer to Competitor" indicates information flow from order flow/returns in the announcing firm to the competitor. Superscript *a* corresponds to a rejection of the null hypothesis at the 1% significance level, *b* at the 5% significance level, and *c* at the 10% significance level.

|                              | All Periods        | Pre-Event Interaction | Event Day Interaction | Post-Event Interaction |
|------------------------------|--------------------|-----------------------|-----------------------|------------------------|
| <i>Returns</i>               |                    |                       |                       |                        |
| To Announcer From Competitor | 0.056 <sup>a</sup> | -0.001                | -0.028 <sup>b</sup>   | -0.011                 |
| From Announcer To Competitor | 0.061 <sup>a</sup> | -0.020 <sup>b</sup>   | -0.006                | -0.003                 |
| Difference                   | -0.005             | 0.019                 | -0.022                | -0.008                 |
| <i>Order Flow</i>            |                    |                       |                       |                        |
| To Announcer From Competitor | 0.020 <sup>a</sup> | 0.001                 | 0.011                 | 0.016 <sup>b</sup>     |
| From Announcer To Competitor | 0.016 <sup>a</sup> | 0.014 <sup>c</sup>    | 0.007                 | -0.005                 |
| Difference                   | 0.004              | -0.012                | 0.003                 | 0.021 <sup>a</sup>     |

**Table V**

**Joint Significance of Event Window-Varying Coefficients (by Relative Size)**

This table presents the sum of the estimated coefficients on cross-stock order flow and returns from the announcer and competitor returns equations:

$$R_t, RC_t = \alpha + \sum_{i=1}^6 \beta_i R_{t-i} + \sum_{i=1, w=1}^{i=6, w=3} \beta_{i,w} R_{t-i} D^w + \sum_{i=1}^6 \beta_{6+i} RC_{t-i} + \sum_{i=1, w=1}^{i=6, w=3} \beta_{6+i,w} RC_{t-i} D^w + \sum_{i=0}^6 \gamma_i V_{t-i} + \sum_{i=0, w=1}^{i=6, w=3} \gamma_{i,w} V_{t-i} D^w + \sum_{i=0}^6 \gamma_{7+i} VC_{t-i} + \sum_{i=0, w=1}^{i=6, w=3} \gamma_{7+i,w} VC_{t-i} D^w + \varepsilon_t$$

The dependent variable is five-minute return.  $R_t$  and  $RC_t$  denote announcer and competitor returns, respectively. Announcer and competitor order flows are denoted  $V_t$  and  $VC_t$  and are defined as buyer- minus seller-initiated volume. All variables are standardized using mean and standard deviation for each firm over each trading day.

"Small (Large) Competitors" are those firms with market shares that are smaller (larger) than announcing firms.  $D$  is a vector of dummy variables indicating pre-event, event, and post-event windows ( $w = 1, 2,$  and  $3$  respectively). For announcing-firm returns, the null hypotheses are  $\sum_i \beta_{6+i} = 0$  and  $\sum_i \gamma_{7+i} = 0$ . Similarly, for competing-firm returns, the null hypotheses are  $\sum_i \beta_i = 0$  and  $\sum_i \gamma_i = 0$ . "All periods" are all observations from both the benchmark and event periods. The benchmark period is defined as the five trading days ending two weeks prior to the announcement and five trading days beginning two weeks following the announcement. Pre-event days are days -2 to -1 relative to the announcement date, event day is day 0, and post-event days are days +1 and +2. "To Announcer from Competitor" indicates information flow from order flow/returns in the competing firm to the announcer (coefficients on competing-firm order flow/returns in the announcing-firm returns equations). "From Announcer to Competitor" indicates information flow from order flow/returns in the announcing firm to the competitor. Superscript  $a$  corresponds to a rejection of the null hypothesis at the 1% significance level,  $b$  at the 5% significance level, and  $c$  at the 10% significance level.

Table V - *continued*

|                                   | All Periods         | Pre-Event Interaction | Event Day Interaction | Post-Event Interaction |
|-----------------------------------|---------------------|-----------------------|-----------------------|------------------------|
| <b>Panel A: Small Competitors</b> |                     |                       |                       |                        |
| <i>Returns</i>                    |                     |                       |                       |                        |
| To Announcer From Competitor      | 0.038 <sup>a</sup>  | -0.023 <sup>c</sup>   | -0.002                | -0.010                 |
| From Announcer To Competitor      | 0.079 <sup>a</sup>  | -0.037 <sup>a</sup>   | 0.002                 | 0.001                  |
| Difference                        | -0.041 <sup>a</sup> | 0.014                 | -0.004                | -0.011                 |
| <i>Order Flow</i>                 |                     |                       |                       |                        |
| To Announcer From Competitor      | 0.017 <sup>a</sup>  | 0.016                 | -0.008                | 0.003                  |
| From Announcer To Competitor      | 0.009 <sup>c</sup>  | 0.024 <sup>c</sup>    | 0.007                 | 0.001                  |
| Difference                        | 0.008               | -0.008                | -0.014                | 0.003                  |
| <b>Panel B: Large Competitors</b> |                     |                       |                       |                        |
| <i>Returns</i>                    |                     |                       |                       |                        |
| To Announcer From Competitor      | 0.072 <sup>a</sup>  | 0.017                 | -0.050 <sup>a</sup>   | -0.012                 |
| From Announcer To Competitor      | 0.046 <sup>a</sup>  | -0.006                | -0.012                | -0.006                 |
| Difference                        | 0.026 <sup>a</sup>  | 0.023                 | -0.038                | -0.006                 |
| <i>Order Flow</i>                 |                     |                       |                       |                        |
| To Announcer From Competitor      | 0.022 <sup>a</sup>  | -0.011                | 0.026 <sup>c</sup>    | 0.026 <sup>b</sup>     |
| From Announcer To Competitor      | 0.021 <sup>a</sup>  | 0.006                 | 0.007                 | -0.010                 |
| Difference                        | 0.001               | -0.017                | 0.019                 | 0.036 <sup>b</sup>     |

**Table VI**

**Information Content of Competitor Order Flow and Returns: Cross-Sectional Analysis**

This table presents the sum of the estimated coefficients on competitor order flow and returns from the announcer returns equation, with interaction variables:

$$R_t = \delta X + \sum_{i=1}^6 \beta_i R_{t-i} + \sum_{i=1; w=1}^{i=6; w=3} \beta_{i,w} R_{t-i} D^w + \sum_{i=1}^6 \beta_{6+i,X} RC_{t-i} X + \sum_{i=1; w=1}^{i=6; w=3} \beta_{6+i,w,X} RC_{t-i} X D^w + \sum_{i=0}^6 \gamma_i V_{t-i} + \sum_{i=0; w=1}^{i=6; w=3} \gamma_{i,w} V_{t-i} D^w + \sum_{i=0}^6 \gamma_{7+i,X} VC_{t-i} X + \sum_{i=0; w=1}^{i=6; w=3} \gamma_{7+i,w,X} VC_{t-i} X D^w + \varepsilon_t$$

$R_t$  and  $RC_t$  denote announcer and competitor returns, respectively (based on five-minute quote midpoints). Order flows are denoted  $V_t$  and  $VC_t$  and are defined as buyer- minus seller-initiated volume.  $D$  is a vector of dummy variables indicating pre-event period, event and post-event windows ( $w = 1, 2$  and  $3$  respectively). Pre-event days are days  $-2$  to  $-1$  relative to the announcement date, event day is day  $0$ , and post-event days are days  $+1$  and  $+2$ .

Relative market share ( $RSHARE$ ) is defined as the ratio of year  $t-1$  announcing firm shares of sales in the industry to competitor share. Relative liquidity ( $RLIQ$ ) is ratio of announcer to competitor turnover. Return correlation ( $RETC$ ) is the daily stock return correlation of the announcing and competing firms.  $HHI$  is the sum of squared market shares based on year  $t-1$  sales. Turnover and return correlations are measured using daily data during the year ending thirty days prior to the announcement. Relative leverage is the (log) ratio of competitor leverage to announcer leverage. Leverage ratios are defined as total debt/(debt plus market value of equity in year  $t-1$ ). All ratios are calculated as  $\ln(\text{ratio}+1)$ . There are 772,418 valid observations.

Superscript \*\*\*corresponds to a rejection of the null hypothesis at the 1% significance level, \*\* at the 5% significance level, and \* at the 10% significance level.

Table VI - continued

|   | Event Window Interactions               |           |           |            |
|---|---|-----------|-----------|------------|
|   | All Periods<br>(including<br>Benchmark) | Pre-Event | Event Day | Post-Event |
| <b>Returns</b>  |   |           |           |            |
| $\sum\beta_{i,d}$   | 0.068                                   | -0.182    | 0.033     | -0.090     |
| <i>Interactions (Variable*<math>\sum\beta_{i,d}</math>):</i>  |   |           |           |            |
| Relative Market Share ( <i>RSHARE</i> )                       | -0.011                                  | -0.083*   | 0.058     | -0.029     |
| Industry HHI ( <i>HHI</i> )                                   | 0.013                                   | -0.059    | 0.020     | -0.020     |
| Relative Liquidity ( <i>RLIQ</i> )                            | -0.016                                  | -0.015    | 0.019     | -0.031     |
| Relative Debt ( <i>RDEBT</i> )                                | -0.021                                  | -0.083    | 0.107     | -0.033     |
| Return Correlation ( <i>RETC</i> )                            | 0.133***                                | -0.007    | 0.031     | 0.019      |
| <b>Order Flow</b>   |   |           |           |            |
| $\sum\gamma_{i,d}$  | -0.013                                  | 0.150     | -0.018    | 0.091      |
| <i>Interactions (Variable*<math>\sum\gamma_{i,d}</math>):</i> |   |           |           |            |
| Relative Market Share ( <i>RSHARE</i> )                       | -0.001                                  | 0.022**   | -0.017    | -0.019*    |
| Industry HHI ( <i>HHI</i> )                                   | 0.003                                   | -0.023    | 0.005     | -0.008     |
| Relative Liquidity ( <i>RLIQ</i> )                            | -0.013                                  | 0.055**   | 0.024     | 0.004      |
| Relative Debt ( <i>RDEBT</i> )                                | -0.016                                  | 0.030     | -0.045    | -0.004     |
| Return Correlation ( <i>RETC</i> )                            | 0.064***                                | -0.116**  | -0.004    | -0.002     |
| <i>Adjusted R<sup>2</sup></i>                                 | 0.142                                   |           |           |            |