CHAPTER 29

CORRELATED ASSET TRADING AND DISCLOSURE OF PRIVATE INFORMATION

Ariadna Dumitrescu

ABSTRACT

This chapter studies the trading behavior of informed and uninformed traders in an environment with two correlated assets. In this setup, informed traders receive a signal about the liquidation value of an asset that also conveys information about the other asset. I extend Kyle's (1985) model to a multi-asset market and show that public disclosure of information about one asset affects the trading behavior and market performance both in the market of this asset and the market of the correlated asset.

INTRODUCTION

The information firms disclose about their own business can be valuable information about the performance of all the firms in the industry. Since the returns of the firms in the same industry are correlated, the disclosure of information about a specific firm can provide information about the others. Hence the disclosure of information reduces the asymmetry of information

not only in the market where this disclosure takes place, but also in the markets of correlated assets. Moreover, the existence of markets of correlated assets increases the value of acquiring information because insiders can use their informational advantage when trading different correlated assets.

In this chapter, I develop a strategic trading model where I consider the existence of two firms with correlated liquidation values and I study how the disclosure of information about the liquidation value of one of the firms affects the market liquidity of the shares of both firms. I analyze the optimal strategies of the managers of the two firms who have private information about the payoff of their firm and the pricing strategy of the market maker. I model the interactions between managers as insiders and market makers, as in Kyle (1985). Both the managers and the noise traders submit market orders and the market maker sets the price to clear the market. However the information structure in my model is different. One of the firms discloses information about the realization of the firm's payoff and this reduces the asymmetry of information between managers and noise traders. However, since the firms have correlated payoffs, the information disclosed about the liquidation value of one asset can be used also in the other market to reduce the asymmetry of information. Consequently, my model shows that the performance of a firm in the financial markets might be determined by the actions of other firms in the same industry.

The rest of this chapter is organized as follows: the second section of this chapter provides a review of literature while the third section presents the model. I establish the information structure and characterize the equilibrium: a unique equilibrium in which price functions and managers' demands are linear. This chapter's fourth section studies the impact of disclosure of information on market liquidity. Finally, the fifth section of this chapter summarizes the results.

Literature Review

This chapter brings together two lines of research: the literature about multi-asset security markets and the literature that studies the effect of information disclosure by firms. The literature concerned with multi-security markets starts with the work of Admati (1985) who extends Grossman and Stiglitz's (1980) analysis of endogenous information acquisition to multiple assets and shows how individuals face different risk-return tradeoffs when differential

information is not fully revealed in equilibrium. Thus in Admati (1985), since agents submit multi-asset demand schedules conditioning on the prices of all assets, it is therefore possible to have a price that decreases with the liquidation value of the asset. This is due to the fact that agents use various signals that are correlated, hence the direct effects can be dominated by the indirect effects.

Subrahmanyam (1991) considers a multi-asset model where strategic liquidity traders can choose the market in which they execute their trades. He shows that the adverse selection problem of liquidity traders is reduced if they trade in a security index basket as opposed to trading a single security. The outcome is a liquidity-based explanation of the large use of stock index futures. Similarly, Bhushan (1991) also considers a multi-asset setup to examine cross-sectional variation in trading costs and liquidity and shows that liquidity traders diversify their trading across assets. A similar setup, where assets are correlated is considered by Chan (1993). In his model, one of the market makers observes only the order flow of the asset for which he sets the price. He does not observe the order flows in other markets but deduces information about these order flows from the prices set by other market makers.

In the papers mentioned above, traders ignore the effect their trade has both on prices and other traders' strategies. To account for the impact of their trading, Caballé and Krishnan (1994) consider a setup with multiple traders and multiple correlated assets, but unlike Admati (1985), they allow for the strategic behavior of traders. They extend thus the model of Kyle (1985) to a multi-asset framework. The market makers in their model can glean information from the order flows of the other assets and use this information strategically when setting prices. They extrapolate the result of Kyle (1985) that more noise leads to more aggressive trading and show that portfolio diversification arises in their model due to the strategic behavior of the agents and not because of risk considerations.

Pasquariello and Vega (2009) extend Caballé and Krishnan (1994) by allowing for the release of news about fundamental values and they found also empirical evidence for cross-asset informational effects. In addition, Bernhardt and Taub (2008) develop a multi-asset model where underlying asset values are correlated and show that, if correlated, the profits of informed speculators are lower. They study how the information contained in the prices of assets is used by speculators and market makers to trade and

set up the prices of the assets. Their model extends the model of Admati (1985) along the lines of Kyle (1989) in the sense that traders behave strategically and choose their demand conditioning on prices too.

Other papers have extended the previous models to a dynamic setting with multiple risky assets. Thus, the model of Bernhardt and Taub (2008) is extended by Seiler and Taub (2008), who answer a similar question but in a dynamic setting. The dynamic modeling allows them to show how this cross-asset information evolves dynamically over time. Zhou (1998) also extends in a dynamic setting the model of Admati (1985) and studies portfolio choices in a multi-asset securities market with differential information. He shows that the information structure has a significant impact both on asset prices and portfolio choices.

Another group of models addressing a multi-asset setup are the studies concerned with contagion among financial markets—the propagation of a shock to an asset to other unrelated assets. Some of these papers have focused on contagion through correlated information or a correlated liquidity shock channel. The correlated liquidity shock channel assumes that when some market participants need to liquidate some of their assets, they choose to liquidate assets in a number of markets, effectively transmitting the shock. There are several other alternative explanations for contagion: wealth effects (Kyle and Xiong, 2001), portfolio rebalancing (Kodres and Pritsker, 2002), borrowing constraints (Yuan, 2005), and the heterogeneity of insiders' beliefs and strategic portfolio rebalancing (Pasquariello, 2007).

Finally, Pagano (1989), Chowdhry and Nanda (1991), Huddart, Hughes, and Brunnermeier (1999), and Baruch, Karolyi, and Lemmon (2007) examine the distribution of trades between different marketplaces. Pagano (1989) focuses on the role of traders' expectations of other traders' actions and show that both markets can survive only with a certain exchange design (equal transaction costs and equal numbers of traders in each market). Chowdhry and Nanda (1991) allow for both discretionary and nondiscretionary liquidity trading, and show that informed and uninformed trades concentrate in markets with more stringent disclosure policies. Similarly, Huddart, Hughes, and Brunnermeier (1999) show that insiders always choose to list their company on the stock exchange with the highest disclosure requirement in order to benefit from the presence of the discretionary liquidity traders. Baruch, Karolyi, and Lemmon (2007) develop a model to explain the differences in the foreign share of the trading volume of internationally cross-listed stocks and show that the trading volume of a cross-listed

stock is proportionally higher on the exchange in which asset returns are more correlated to the returns of other assets traded on that market.

On the other hand, this chapter is linked to the stream of literature about the disclosure of information by firms. The disclosure of private information transforms private information into public information and as a result, the asymmetry of information between market participants is reduced. Diamond (1985) develops a model in which he shows that the disclosure of information improves welfare because it eliminates the costs of information acquisition. Disclosure of information helps firms attract investors because it reduces the asymmetry of information and therefore reduces the cost of capital. Diamond and Verrecchia (1991) and Kim and Verrecchia (1994) show that voluntary disclosure reduces the asymmetry of information between uninformed and informed investors, and thus increases the liquidity of a firm's stock. Similarly, Botosan (1997) shows that there is a negative relationship between the voluntary level of disclosure and the cost of capital when there is a low analyst following.

Firms that want to disclose information face the problem that truthful credible disclosure is costly, so they have to take into account these costs when they take their disclosure decision. To exemplify this, Verrechia (1983) develops a model where the seller of an asset has to decide whether to reveal or conceal information about the asset. Revealing information is costly but concealing it can be perceived as a bad signal by investors who then bid low prices for the asset. Narayanan (2000) extends Verrechia's (1983) model by endogenizing the disclosure costs by allowing the seller of the asset to trade upon his private information. Also, Fishman and Hagerty (1989) show that firms have incentives to disclose a certain amount of information but they claim that mandatory disclosure is not socially optimal since the benefits outweigh the costs. Admati and Pfleiderer (1990) examine the sale of financial information and demonstrate that externalities between buyers affect the value of information and how broadly a given packet of information should be sold.

THE MODEL

I consider an economy with two firms in the same industry, so their liquidation values are correlated. Shares in the two firms are both traded on the financial market. We assume that the first firm has a project with liquidation value $\tilde{v}_1 = \tilde{v}$ that is normally distributed with mean $\bar{v}$ and variance V_v and the second firm has a project $\tilde{v}_2 = \tilde{v} + \tilde{e}$, where $\tilde{e}$ is normally distributed with

mean 0 and variance V_e. Consequently, the second firm's payoff is normally distributed with mean $\tilde{v}$ and variance $V_v + V_e$.

Both managers learn the realization of the payoff of their firms and make use of their private information by trading the shares of both firms in the two financial markets. I denote by M_i the manager of the firm i, $i = 1, 2$. The market participants in each of the two markets are, therefore, two informed traders—the two managers, some noise traders, and a market maker. I assume that noise traders' order in the market for the shares of firm j, ω_j is a random variable normally distributed with mean 0 and variance $V_{\omega j}$, with $j = 1, 2$. The market maker in the market for the shares of firm j observes the total order flow and sets a price p_j for the firm j's shares.

The sequence of events is as follows:

1. The firms' payoffs $\tilde{v}_1$ and $\tilde{v}_2$ are realized and observed privately by the manager of each firm, respectively.
2. Firm 1 discloses information about asset 1, $\tilde{s} = \tilde{v}_1 + \tilde{\varepsilon}$, where ε, is a random variable normally distributed with mean 0 and variance V_ε.
3. The manager M_i, $i = 1, 2$, submits an order x_i^j for shares in the firm j, $j = 1, 2$ to a market maker who is in charge of setting the price in the stock market.
4. The market maker in the market for asset j observes the total order flow $u_j = x_1^j + x_2^j + \omega_j$ consisting of the managers' orders x_1^j and x_2^j and the order made by noise traders ω_j but cannot observe x_1^j, x_2^j or ω_j individually. Upon observing the total order flow, the market maker sets a price p_j for the firm j's shares and trading takes place.

The pricing rules for the market maker and the trading strategies for informed traders are such that each trader takes the trading strategies of all the other traders and the pricing rules of the market makers as given. Each informed trader maximizes his expected profit from trading conditional on his information and each market maker earns zero expected profits. Thus, the demand of the manager M_i for asset j is as follows:

$$x_i^j = \arg\max_{x_i^j} E\left((v_j - p_j)\, x_i^j \mid v_i, s\right), \; i, \; j = 1, 2.$$

We assume that in each financial market there is a market maker who sets the price such that to satisfy the semi-strong efficiency condition $p_j = E(v_j \mid u_j) = \mu_j + \lambda_j u_j, \quad j = 1, 2.$

The Equilibrium

In the following proposition, I describe the equations that characterize the symmetric Bayesian-Nash equilibrium. This equilibrium has linear trading and pricing rules and is shown to be unique among all linear, symmetric Bayesian-Nash equilibria. As in most Kyle-type models, linearities are not imposed beforehand in the agent's strategy sets: as long as informed traders use linear trading strategies, the pricing rule will be linear and vice versa.

Proposition 1: *There is a unique linear equilibrium in the market of asset 1, where the demands of the managers and the equilibrium price are*

- $x_1^1(v_1, s) = \frac{1}{3\lambda_1 U}\left(\frac{3}{2}(U - V_v V_\varepsilon)(v_1 - \bar{v}) - 2V_v V_e(S - \bar{v})\right)$
- $x_2^1(v_2, s) = \frac{V_v}{3\lambda_1 U}\left(3V_\varepsilon(v_2 - \bar{v}) + 4V_e(s - \bar{v})\right)$
- $p_1(u_1) = \bar{v} + \lambda_1 u_1$
- $\lambda_1 = \frac{1}{3U}\sqrt{\frac{V_v}{V_{\omega_1}}(U(2U + V_e V_\varepsilon) - 6V_v V_e V_\varepsilon^2)}$

There is a unique linear equilibrium in the market of asset 2 where the demands of the managers and the equilibrium price are

- $x_1^2(v_1, s) = \frac{1}{3\lambda_2 U}\left(3\left(V_v V_\varepsilon + V_v V_e + V_\varepsilon V_e\right)\left(v_1 - \bar{v}\right) + V_v V_e\left(s - \bar{v}\right)\right)$
- $x_2^2(v_2, s) = \frac{1}{3\lambda_2 U}\left(3\left(V_v V_\varepsilon + 2V_v V_e + 2V_\varepsilon V_e\right)\left(v_2 - \bar{v}\right) - 2V_v V_e\left(s - \bar{v}\right)\right)$
- $p_2(u_2) = \bar{v} + \lambda_2 u_2$
- $\lambda_2 = \frac{1}{3U}\sqrt{\frac{K}{V_{\omega_2}}}$, where

$K = 72V_v V_e^3 V_\varepsilon + 48V_v^3 V_\varepsilon + 36V_v^2 V_v^3 + 32V_v^3 V_e^2 + 18V_v^3 V_\varepsilon^2 + 36V_v^3 V_\varepsilon^2 + 81V_v V_e^2 V_\varepsilon^2 + 63V_v^2 V_e V_\varepsilon^2 + 113V_v^2 V_e^2 V_\varepsilon$, *and* $U = 3V_v V_\varepsilon + 4V_v V_e + 4V_\varepsilon V_e$.

Notice that manager M_i trades twice as aggressively on the information revealed by the public signal s in the market for shares in his own firm than in the market where shares in the other firm are traded. Moreover, in the market for asset j the demand of manager M_i decreases with the signal about the liquidation value of firm s, when $i = j$ while the demand for the shares of the other firm increases with the signal, when $i \neq j$. When some information is disclosed, the manager weighs his private signal against the public signal when he trades in his own market. However, when manager M_i trades in the market of the shares in the other firm j he uses the signal about the liquidation value of asset 1 as a signal about the liquidation value of asset j, thereby weighs the signal positively.

DISCLOSURE OF INFORMATION AND MARKET LIQUIDITY

I study next the effects of releasing information about the payoff of one asset on the market performance of both assets. I limit my study of market performance only in terms of market liquidity since it is recognized as the most important characteristic of financial markets. To measure market liquidity I use market depth as defined by Kyle (1985): the volume needed to move the price by one unit.

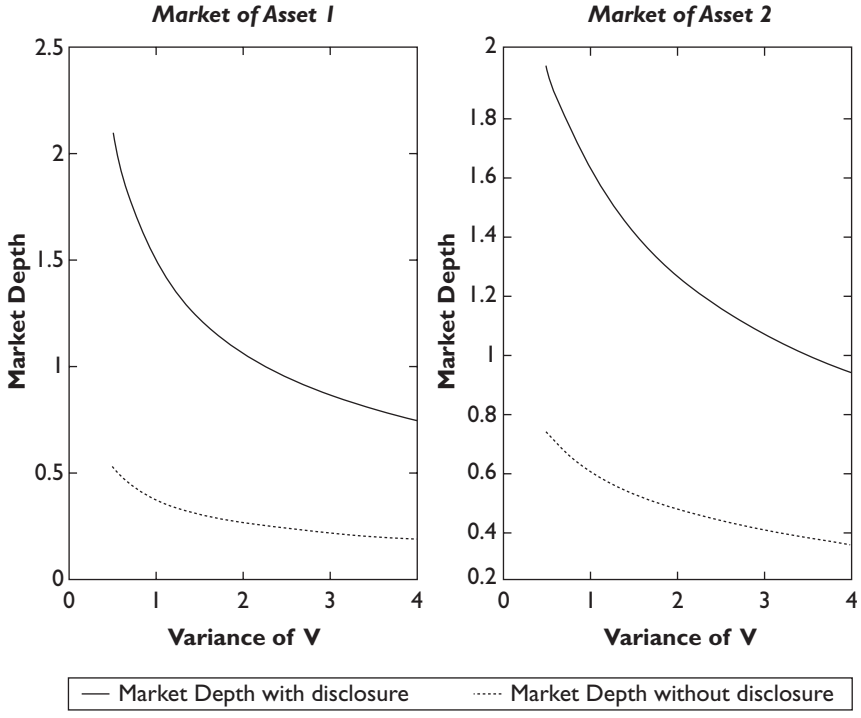
The price schedules defined in Proposition 1 show that the volume needed to move the price p_j by one unit is $\frac{1}{\lambda_j}$. In finding the equilibrium, I solve for λ_j and I obtain that market depths in the two markets equal to

$$\frac{1}{\lambda_1} = 3U\sqrt{\frac{V_{\omega_1}}{V_v(U(2U + V_\varepsilon V_\varepsilon - 6V_v V_\varepsilon V_\varepsilon^2)}}$$

$$\frac{1}{\lambda_2} = 3U\sqrt{\frac{V_{\omega_2}}{K}}.$$

I will firstly analyze the impact of the disclosure of information on the market liquidity of the two markets. Therefore, in the case of both markets I consider the economy with and without the disclosure of private information. To obtain the case without disclosure I calculate the limit when the

Figure 29.1 Market Liquidity Effects of Disclosing Information in the Two Markets. Parameter Values: $V_e = 0.5, V_\varepsilon = 1, V_{\omega 1} = 0.5, V_{\omega 1} = 2$.



variance of the signal becomes very large. In this case the signal provides no information, so the managers use only their own private signals in setting the demand schedules.

As can be seen in Figure 29.1, I show that disclosing information about one asset improves the market liquidity in both markets. As expected, the disclosure of information reduces the asymmetry of information between market makers and informed traders. Consequently, the adverse selection problem of the market maker is less severe and therefore disclosure of information improves market liquidity. Since the two assets are correlated, the disclosure of information in the market of asset 1 affects the liquidity of the market of asset 2. The effect disclosing private information has on market liquidity depends not only on the asymmetry of information between managers and noise traders but also on the quality of the signal about the liquidation value of firm 1.

Proposition 2: *Market liquidity is higher in the market of asset 1 than the market liquidity of asset 2 if and only if*

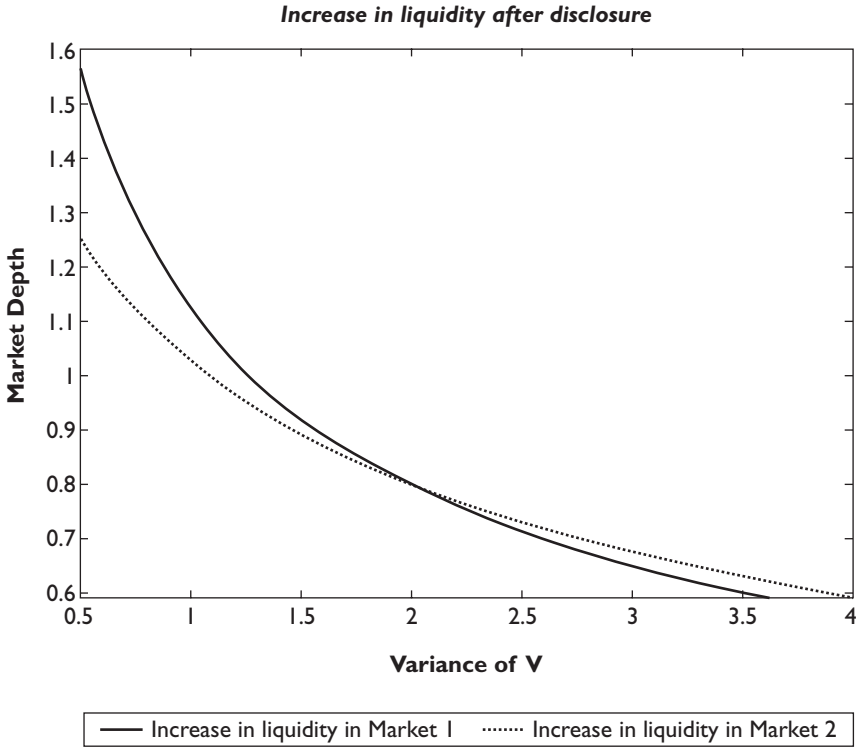
$$\frac{V_{\omega_1}}{V_{\omega_2}} > \frac{V_v(U(2U + V_e V_\varepsilon) - 6V_v V_e V_\varepsilon^2)}{K}.$$

I compare market liquidity in the two markets and show that the market of asset 1 is more liquid if the ratio of the amount of noise in market 1 to the amount of noise in market 2 is sufficiently high. This suggests that when firm 1 releases information about the liquidation of value of their shares, this reduces the asymmetry of information and therefore improves market liquidity in this market. However, the disclosure of information in the market of the first asset also reduces the asymmetry of information in the second market and therefore also increases market liquidity in the second market.

Should the first firm not disclose information, the market liquidity of each market will depend only on the asymmetry of information between managers and noise traders. When the first firm discloses information about its liquidation value it affects this asymmetry of information between managers and noise traders. This effect depends on the quality of the signal about the liquidation value of the asset (i.e., on the variance of the noise introduced by the firm), but it is not the same in the two markets and for the two managers.

In the market of asset 1, the lower the variance of the signal's noise V_ε the lower the asymmetry of information about the liquidation value of the asset between manager M_1 and the noise traders. So the higher disclosure decreases the informational advantage of first manager M_1. However, manager M_2 improves his informational advantage. He had private information about the liquidation value of asset 2 (and since the assets are correlated he could use it as private information about asset 1), but now he can also use the information disclosed by firm 1. So the quality of his private information improves. In the market of asset 2, the effects are similar. However, the effect of a reduction in the asymmetry of information between manager M_2 and the noise traders caused by the disclosure of information about the liquidation value of asset 1 is now not so strong. The reason is that the signal s as a signal about the liquidation value of asset 2 is noisier than when we use it as a signal about the liquidation value of asset 1. Also, manager M_1

Figure 29.2 Comparison of the Increase in Liquidity after Disclosure of the Signal About the Liquidation Value of Firm 1. Parameter Values: $V_e = 0.5, V_\varepsilon = 1, V_{\omega 1} = 0.5, V_{\omega 1} = 2$.



uses the signal s as a signal about the liquidation value of asset 2, but in this case too the quality of this signal is poorer.

As can be seen in Figure 29.2, the increase in market liquidity as a result of the release of a public signal about the liquidation value of the asset can be higher either in market 1 or in market 2, depending on the amount of the noise trading in the two markets and on the asymmetry of information about the liquidation values of the two assets. The increase in liquidity in market 1 is higher only if the amount of noise trading in market 2 is relatively small in comparison with the amount of noise trading in market 1. As can be seen in Figure 29.2, when all other things are equal, the asymmetry of information about the liquidation value of the asset determines whether the impact of disclosure of information is higher in the market where the signal is disclosed or in the other market. When the

asymmetry of the liquidation value is low in both markets (V_v is low) and there is not too much noise trading, the increase in liquidity after disclosure is higher in the first market. As asymmetry climbs above a given threshold, the increase in liquidity becomes higher in the second market. This result is a consequence of the relative asymmetry of information of the managers with respect to the noise traders.

CONCLUSION

I study the effect the disclosure of information in one market has on the market performance in the markets of correlated assets. I develop a two-asset model similar to Kyle (1985) and I show that the disclosure of a signal about the liquidation value of one asset affects the market liquidity of both the market in which this asset is traded and the market in which a correlated asset is traded. Disclosure of information increases market liquidity in both markets, but the impact of disclosure in the two markets depends on the relative amount of noise trading, the variance of the liquidation values of the two assets, and the quality of the signal about the liquidation value.

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REFERENCES

Admati, A. (1985) A Noisy Rational Expectations Equilibrium for Multi-Asset Securities Markets. *Econometrica*, 53(3): 629–657.

Admati, A. and Pfleiderer, P. (1990) Direct and Indirect Sale of Information. *Econometrica*, 58(4): 901–928.

Baruch, S., Karolyi, A., and Lemmon, M. (2007) Multi-market Trading and Liquidity: Theory and Evidence. *Journal of Finance* 62(5): 2169–2200.

Bernhardt, D. and Taub, B. (2008) Cross-Asset Speculation in Stock Markets, *Journal of Finance*, 63(5): 2385–2427

Bhushan, R. (1991) Trading Costs, Liquidity, and Asset Holdings. *Review of Financial Studies*. 4(2): 343–360.

Botosan, C.A. (1997) Disclosure Level and the Cost of Equity Capital. *The Accounting Review*, 72(3): 323–349.

Caballé, J. and Krishnan, M. (1994) Imperfect Competition in a Multi-Security Market with Risk Neutrality. *Econometrica*, 62(3): 695–704.

Chan, K. (1993) Imperfect Information and Cross-Autocorrelation among Stock Prices. *Journal of Finance*, 48(3): 1211–1230.

Chowdhry, B. and Nanda, V. (1991) Multimarket Trading and Market Liquidity. *Review of Financial Studies*, 4(3): 483–511.

Diamond, D. (1985) Optimal Release of Information by Firms. *Journal of Finance*, 40(4): 1071–1094.

Diamond, D. and Verrecchia, R. (1991) Disclosure, Liquidity, and the Cost of Capital. *Journal of Finance*, 46(4): 1325–1355.

Fishman, M.J. and Hagerty, K.M. (1989) Disclosure Decisions by Firms and the Competition for Firm Efficiency. *Journal of Finance*, 44(3): 633–646.

Grossman, S. and Stiglitz, J. (1980) On the Impossibility of Informationally Efficient Markets. *American Economic Review*, 70(3): 393–408.

Huddart, S., Hughes, J.S., and Brunnermeier, M. (1999) Disclosure Requirements and Stock Exchange Listing Choice in an International Context. *Journal of Accounting and Economics*, 26(1): 237–269.

Kim, O. and Verrecchia, R. (1994) Market Liquidity and Volume Around Earnings Announcements. *Journal of Accounting and Economics*, 17(1): 41–68.

Kodres, L. and Pritsker, M. (2002) A Rational Expectations Model of Financial Contagion. *Journal of Finance*, 57(2): 769–799.

Kyle, A. (1985) Continuous Auctions and Insider Trading. *Econometrica*, 53(6): 1315–1335.

Kyle, A. (1989) Informed Speculators with Imperfect Competition. *Review of Economic Studies*, 56(3): 317–356.

Kyle, A. and Xiong, W. (2001) Contagion as a Wealth Effect. *Journal of Finance*, 56(4): 1401–1440.

Narayanan, R. (2000) Insider Trading and the Voluntary Disclosure of Information by Firms. *Journal of Banking and Finance*, 24(3): 395–425.

Pagano, M. (1989) Trading Volume and Asset Liquidity. *Quarterly Journal of Economics* 104(2): 255–274.

Pasquariello, P. (2007) Imperfect Competition, Information Heterogeneity, and Financial Contagion. *Review of Financial Studies*, 20(2): 391–426.

Pasquariello, P. and Vega, C. (2009) Strategic Cross-Trading in the U.S. Stock Market. Working paper, Ross School of Business, University of Michigan. Available at: http://ssrn.com/abstract=1333747

Seiler, P. and Taub, B. (2008) The Dynamics of Strategic Information Flows in Stock Markets. *Finance and Stochastics*, 12(1): 43–82.

Subrahmanyam, A. (1991) A Theory of Trading in Stock Index Futures. *Review of Financial Studies*, 4(1): 17–51.

Verrechia, R.E. (1983) Discretionary Disclosure. *Journal of Accounting and Economics*, 5(4): 179–194.

Yuan, K. (2005) Asymmetric Price Movements and Borrowing Constraints: A Rational Expectations Equilibrium Model of Crisis, Contagion, and Confusion. *Journal of Finance*, 60(1): 379–411.

Zhou, C. (1998) Dynamic Portfolio Choice and Asset Pricing with Differential Information. *Journal of Economic Dynamics and Control*, 22(7): 1027–1051.