The Pennsylvania State University
The Graduate School
The Mary Jean and Frank P. Smeal College of Business Administration

FUND MANAGERS’ DISCLOSURES

A Dissertation in
Business Administration
by
Xin Jiang

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Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

August 2018
The dissertation of Xin Jiang was reviewed and approved* by the following:

Steven Huddart  
Committee Chair  
Smeal Chair Professor in Accounting  
Department Head of Accounting Department  
Dissertation Advisor

Dan Givoly  
Ernst & Young Professor of Accounting

Kai Du  
Assistant Professor of Accounting

Russell Cooper  
Distinguished Professor of Economics

*Signatures are on file in the Graduate School.
Abstract

It is unclear why some privately-informed fund managers publicly reveal private information before they have finished accumulating their position in a stock that they believe to be mis-valued. In this dissertation, I model a fund manager as an informed trader and propose a rational explanation for this phenomenon based on the differing importance to fund managers of short-term paper profits and long-term trading profits. I study an informed trader’s voluntary disclosure using a variant of a two-period Kyle (1985) model. The findings of this dissertation demonstrate that an informed trader’s public disclosure depends on the relative weight she places on short-term paper profits, i.e., her degree of short-termism. Above a threshold weight, she prefers to disclose. Further, the precision of the informed trader’s disclosure increases with her degree of short-termism. Short-termism on the part of the informed investor leads to (i) lower liquidity before disclosure, and (ii) higher price informativeness both before and after disclosure. I also examine the informed trader’s trading strategies when she is mandated to disclose her portfolio holdings immediately after her trades. In this case, it is optimal for the informed trader to inject a random component into her trade before disclosure in order to preserve some of her information advantage. Additionally, the extent to which the informed trader randomizes decreases with her degree
of short-termism.
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Acknowledgments

I am indebted to my dissertation committee, Steven Huddart, Dan Givoly, Kai Du, and Russell Cooper, for their guidance. In particular, I would like thank my chair, Steven Huddart. I cannot thank him enough for his patience and trust on me. Without his encouragement, I do not think I could survive so many challenges I faced during my graduate school. His passionate and great insights on research keep me and my research going at every moment of frustration. Additionally, I would like to extend my thanks to the faculty and my fellow Ph.D students in the Accounting Department for their comments and suggestions.
Dedication

This dissertation is dedicated to my lovely wife, Sijing, who provides me with tremendous emotional support throughout my PhD years. It is her care and understanding that encouraged me to survive every challenge that I faced in the past five years. I also want to dedicate my dissertation to my parents, Xicai and Enfang, who always encourage me to chase my own dream and live my own life. Finally, this dissertation is dedicated to my soon-to-be-born son, Henry. You are the most precious gift to your mother and I.
Chapter 1

Introduction

Earlier disclosure research has focused primarily on two issues: (i) how firms strategically make disclosures to the capital market, and (ii) the effect of those disclosures on firms’ information environments. In their survey of disclosure research, however, Beyer et al. (2010) argue that, while corporate disclosures are relatively well understood, there is little research on “third-party production of information.” In this dissertation, I study fund managers’ disclosures and how their disclosures affect firms’ information environment.

Investments in financial assets are increasingly undertaken through investment funds (i.e., mutual funds and hedge funds). According to the Federal Reserve’s Flow of Funds data, the total market value of the corporate equities held in the US amounted to $45.8 trillion at the end of 2017. Of this, $17.9 trillion was held by households including hedge funds and private equity funds and $10.8 trillion was held by mutual funds. Given the prevalence of mutual funds and hedge funds in today’s capital market, the trading and disclosure practices of fund managers, who make the day-to-day investment decisions for
funds, are worth studying.

In particular, an interesting phenomenon has arisen in which some fund managers often publicly “talk up their books” or “talk down their stocks.” That is, they publicly disclose their trading positions and express their opinions through media interviews and/or public presentations while continuing to accumulate their positions.\(^1\) Carl Icahn’s investment in Apple is one vivid demonstration of the possible interactions between fund managers’ disclosures and trades. On August 13, 2013, Icahn disclosed via Twitter that he had purchased a large share in Apple. In his tweet, Icahn said that Apple was “extremely undervalued.” Following his post, Apple’s shares price jumped to close nearly 5% higher than the previous trading day.\(^2\) In October 2013 and then again in January 2014, Icahn purchased additional blocks of Apple shares. He reached his maximum Apple shareholding on January 23, 2014. By the end of March 2016, Icahn had completely sold his holdings. His 32-month investment in Apple netted him approximately $2 billion.\(^3\)

Despite successes like Icahn’s, fund managers’ practice of voluntarily revealing private information to the public is puzzling given the proprietary costs associated with these voluntary disclosures. As Agarwal et al. (2013) and Aragon et al. (2013) have demonstrated, hedge funds incur significant and rapid losses if competitors learn about a fund manager’s trading strategy from her disclosure. Additionally, the well-established copycat fund industry actively seeks to replicate trading strategies based on information gleaned from

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\(^1\)Zhao (2017) was the first study that examined activists’ short-selling, a practice in which short-sellers publicly “talk down” stocks. The author found that this short-selling incurs significant market reactions.


funds’ regulatory filings and performance reported to the commercial database, among other sources. Although observing fund managers’ voluntary disclosures contradicts the fact that these managers face high proprietary costs, little theoretical research has examined fund managers’ disclosure incentives. My study is intended to provide a rational explanation to fund managers’ voluntary disclosure.

In my study, I model a fund manager as an informed trader and examine her public disclosure in a variant of the two-period Kyle (1985) model. A risk-neutral informed trader trades a risky asset at two trading dates and does not close her trading position until the payoff of the risky asset has been realized. The informed trader may publicly disclose her private information between two trading dates, i.e., at the interim date. A competitive, risk-neutral market maker sets the risky asset’s price equal to its expected value, which is contingent upon the net order flow at the trading date and upon any preceding public disclosures. The net order flow consists of the orders submitted by the informed trader and uninformed liquidity traders, whose demands are exogenous.

At each trading date, the informed trader weighs the long-term and short-term performances differently. The long-term performance is defined as the trading profit realized after the informed trader unwinds her trading position; the short-term performance is defined as the unrealized paper profit, which is measured at the end of each trading date. The degree of short-termism is then defined as the relative weight the informed trader places on the short-term performance.\(^4\) Incorporating the short-term performance into the informed

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\(^4\)The definition of short-termism is different from that of short-horizon in other studies such as Gao (2008). In Gao (2008), informed investors have short investment horizons so that they unwind their trading positions before the realization of the risky asset’s payoff. In my study, the informed trader holds the risky asset until the payoff realization. However, her investment performance is going to be evaluated over different lengths of periods.
trader’s objective function reflects the fact that fund managers have strong incentives to inflate their funds’ values at the end of the quarter or the year.

In my model, the informed trader’s disclosure is characterized by a disclosure policy that specifies whether the informed trader discloses her private information at the interim date and, if she does, the precision of her disclosure. I assume that the informed trader commits to her disclosure policy before privately observing the risky asset’s value. Admittedly, investors do not observe fund managers’ explicit commitments in the capital market. However, fund managers regularly disclose private information about their investments in periodic investor letters.\(^5\) In the letters, fund managers break down their current portfolio holdings and carefully explain the rationale behind their new investments.\(^6\) The regular appearance of letters from fund managers creates an expectation that a similarly informative letter will be provided moving forward. It is this practice that I describe in my model using the informed trader’s commitment to disclosing private information at the interim date. In this study, I show that the ex-ante commitment to disclosure is beneficial to some informed traders but not to others according to the degree of short-termism to which the informed trader is subject.

My findings suggest that the informed trader’s disclosure at the interim date has opposite effects on long-term and short-term performances of the investment portfolio. Public dis-

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\(^5\)Some funds make the letters circulate among their existing investors only, whereas other funds just publicly release their letters. Investors have access to the public letters via either the official website, e.g., Pershing Square Capital Management (https://www.pershingsquareholdings.com/company-reports/financial-statements/) or a third-part website that collects all publicly available investor letters in a timely manner, e.g., Vintage Value Investing (http://vintagevalueinvesting.com/complete-list-q2-2017-hedge-fund-letters-investors/).

\(^6\)Cassar et al. (2016) use a confidential database to study hedge funds’ investor letters. They find that hedge fund managers voluntarily disclose a wide array of information including holdings and future prospects in investor letters.
closure erodes the informed trader’s information advantage with respect to the risky asset’s fundamental value. Meanwhile, public disclosure accelerates the risky asset’s price discovery. In other words, the informed trader’s disclosure benefits short-term performance at the cost of long-term performance. When the increase in short-term performance outweighs the decrease in long-term performance, it is optimal for the informed trader to commit to disclosure upfront. Overall, I find that (i) the informed trader commits to disclosing her private information at the interim date if her degree of short-termism is greater than a threshold value, and (ii) the optimal precision of the informed trader’s disclosure increases with her degree of short-termism.

Additionally, I examine the impact of the informed trader’s short-termism on stock liquidity and price informativeness. A higher degree of short-termism motivates the informed trader to disclose more precise information after the first trading date. On one hand, disclosing precise private information alleviates information asymmetry at the second trading date. On the other hand, it makes the informed trader exploit her information rent rapidly by aggressively trading at the first trading date, which in turn increases informed trading relative to liquidity trading. As a result, I suggest that stock liquidity is low at the first trading date and high at the second trading date. Both aggressive trading at the first trading date and the ensuing public disclosure cause information to be revealed rapidly in prices. The result is enhanced price informativeness at both trading dates. The finding on price informativeness is of interest to regulators. Conventional wisdom holds that short-termism is undesirable and that it adversely affects long-term price efficiency, which is important
for efficient corporate investment decisions. Nevertheless, my study identifies a channel through which price efficiency increases due to informed trader’s short-termism.

The increasing importance of mutual funds and hedge funds has also attracted attention from regulators, who strive to identify ways to increase the transparency of fund operation. For example, in an effort to better monitor hedge funds, the Dodd-Frank Act amended the Investment Advisers Act in June 2011 to require hedge funds advisers to register with the Securities and Exchange Commission (SEC). Additionally, the new regulatory framework required advisers to privately report to the SEC about a number of factors, including their assets under management, trading and investment positions, and performance and changes in performance. More recently, the SEC issued investment company rules for “reporting modernization” in October 2016. These new rules increased the frequency with which SEC-registered advisers must disclose their portfolio holdings to the SEC from quarterly to monthly.

Given that the latest regulations focus on enhancing the transparency of fund managers’ portfolio holdings, I go on to study fund managers’ strategic trading given mandatory periodic disclosure of their portfolio holdings. Here, I continue to model the fund manager

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7 Investors who place a considerable weight on short-term profit are unable to accurately assess the benefits of actions that enhance corporate long-term profit potential but reduce short-term earnings. Hence, investors’ short-termism drive them to systematically undervalue firms that invest in long-term projects.


9 According to the new rules, the portfolio holding information is reported on a new form—Form N-PORT—which is filed on a non-public basis for two out of every three months. The portfolio holdings at the end of the third month will be public, but only after a lag that approximates the lag for existing public financial reports by registered investment companies.
as an informed trader who weighs her long-term and short-term performances differently. I find that the informed trader dissimulates her informative trading by injecting a random component into her market order before the public disclosure and that the scope of dissimulation decreases with the informed trader’s degree of short-termism. Finally, I extend my model by changing the inter-temporal pattern of the precision of the informed trader’s private information. Different from the previous analyses in which the informed trader receives her private information only at the beginning of date 1, in the extension, I assume that the informed trader receives a private signal at the beginning of each trading date. The inter-temporal pattern of the informed trader’s information flow is determined by the ratio of the precision of the private signals at two trading dates. The equilibrium analysis shows that, in addition to the degree of short-termism, the private signal’s precision ratio is a significant determinant of the informed trader’s trading strategies.

The dissertation proceeds as follows: Chapter 2 contains a literature review that situates my study within the larger body of existing literature. In Chapter 3, I study the informed trader’s voluntary disclosure in a setting in which she discloses a noisy signal about her private information between two trading dates. Chapter 4 analyzes the informed trader’s trading strategies around her mandatory disclosure of her portfolio holdings, and Chapter 5 concludes.
Chapter 2

Related Literature

2.1 Fund Managers’ Compensation and Short-Termism

Incorporating short-term performance into the fund manager’s objective function is the key to understanding the interim date disclosure by the fund manager. It is also a parsimonious way to capture fund managers’ incentives to improve their periodic investment performances.

Fund managers’ short-term incentives largely stem from compensation. Investors allocate capital to funds based on their perception of managers’ abilities, which is a function of fund performance. Good performance increases a manager’s income directly, through contractual incentive fees earned at the time of performance. It also increases a manager’s income indirectly, through higher future fees both from increased flows of new investment to the fund and from the mechanical increase in the fund’s asset base.

Early studies mostly focus on the indirect incentives embedded in the convex relation-
ship between mutual fund flows and performance. Funds with superior recent performance enjoy disproportionately large new money inflows, whereas funds with poor performance suffer smaller outflows. Some theoretical studies offer explanations for why the fund flow-performance relationship is convex. For example, Lynch and Musto (2003) argue that investment companies can exercise an option to abandon poorly performing strategies and/or fire bad managers. Since poor returns are not likely to be informative about future performance, investors will respond less strongly to bad performance, leading to the convexity in the fund flow-performance relationship. In a model of active portfolio management where high performance is rationally interpreted by investors as evidence of the manager’s superior ability, Berk and Green (2004) reproduce the convex fund flow-performance relationship by demonstrating that new money flows to the outperforming fund to the point at which future expected excess returns are competitive. On the empirical side, citing evidence from separate surveys of households that had made recent mutual fund purchases, Goetzmann et al. (1992) and Capon et al. (1996) note that past investment performance was the crucial input to the choice of which fund to acquire. Furthermore, Sirri and Tufano (1998) show that mutual funds earning the highest returns during an assessment period receive the largest rewards in terms of increased new investments. These additional contributions, in turn, increase compensation to the mutual funds’ managers as their rewards typically are determined as a percentage of the assets under management.

Given that virtually all mutual funds are affiliated with fund families, the convex fund flow-performance relationship makes the fund family engage in cross-fund subsidization. Gaspar et al. (2006) explain that it is a family strategy of allocating more scarce resources
(i.e., staff, research analysis, underpriced IPOs) to “star” funds because from a family perspective, the convexity implies that the expected assets of a fund family are higher if it produces one top performing and one bad performing fund than if it produces two average performing funds. As a result, a strong performance provides the fund manager with more resources within the fund family if she wins the tournament among her peer managers.

Only recently have researchers begun to examine mutual fund managers’ direct contractual incentives. In March 2005, SEC adopted a new rule requiring mutual funds to disclose their portfolio managers’ compensation details in the Statement of Additional Information (SAI). After manually collecting the information from the SAIs, Ma et al. (2018) find that mutual fund managers’ performance evaluation window ranges from one quarter to ten years, and the average evaluation window is three years. Similarly, Pozen (2015) also documents that bonuses in most large asset management firms are based on a combination of the performance over the most recent one, three, and five years.

Short-term performance, especially, annual performance is important to hedge fund managers as well. A substantial portion of the direct pay that a hedge fund manager receives comes from the incentive fees, which are similar to the option compensation awarded to corporate executives. The hedge fund managers’ incentive fees are paid based on the annual performance that exceeds pre-specified thresholds, which in turn are determined by the hurdle rate or the high-water mark provision.\(^{10}\) Prior studies suggest that hurdle rate and high-water mark provision provide hedge fund managers with incentives to perform better.

\(^{10}\) Incentive fees are paid if the year-end net asset value (NAV) exceeds the threshold NAV. With a hurdle rate provision, the threshold NAV equals year-beginning NAV \(\times (1 + \text{LIBOR})\), where LIBOR is the London Interbank Offered Rate. With a high-water-mark provision, the threshold NAV is the highest NAV of prior years.
For example, Arya and Mittendorf (2005) show theoretically that higher ability managers will accept a compensation package of options in lieu of cash as a means of signaling their higher abilities and separating themselves from managers with lesser abilities. By agreeing upon the contract with hurdle rate provision, hedge fund managers essentially put their pay on the line. Thus, these fund managers are expected to deliver superior performance. Panageas and Westerfield (2009) study the optimal portfolio choices of fund managers compensated by the high-water mark provision and suggest that managers with the high-water mark provision would work harder than those without such provision in order to preserve the value of all future options. Using a comprehensive hedge fund database, Agarwal et al. (2009) demonstrate that hedge funds with greater managerial incentives, proxied by the inclusion of high-water mark provision, are associated with superior performance. Lim et al. (2016) further quantify hedge fund managers’ direct incentive from the incentive fees as well as their indirect incentives from the convex fund flow-performance relationship. They find that, although direct incentives are themselves substantial, indirect incentives in the hedge fund industry comprise the majority of hedge fund managers’ total incentives.

Incorporating short-term performance into fund managers’ objective function not only captures their incentives to improve their periodic investment performances, but also allows my model to reproduce the previously documented finding that fund managers’ short-term incentives affect their trading strategies. For example, Bhattacharyya and Nanda (2013) develop a model of trading by an informed fund manager who is compensated on the basis of her fund’s short-term performance. They find that the fund manager has an incentive to pump her portfolio by buying securities she already holds. On the empirical side, Carhart
et al. (2002) and Bernhardt and Davies (2005) find that mutual fund managers inflate the quarter-end portfolio prices with last-minute purchases of stocks already held. Similar patterns are also found in the hedge fund industry. Using the pooled distribution of monthly hedge fund returns, Bollen and Pool (2009) identify a significant discontinuity: the number of small gains far exceeds the number of small losses. The discontinuity is caused at least in part by temporarily overstated returns. Additionally, Ben-David et al. (2013) find that stocks with high hedge fund ownership experience a surge in buying pressure in the last two hours of the quarter.

2.2 Fund Managers’ Disclosures

In my model, fund manager’s disclosure is assumed to be credible to the market so that it can affect the equilibrium price of the risky asset. Such an assumption is motivated by prior literature on the informational value of fund managers’ disclosures. For example, Kacperczyk et al. (2008) demonstrate that the return gap, which is the difference between the investors’ return and the buy-and-hold return of the portfolio disclosed in the most recent past, has significant predictive power for fund future performance. The disclosed portfolio holdings are also used to evaluate the fund manager’s ability. Kacperczyk and Seru (2007) estimate the fund managers’ reliance on public information (RPI) from the change in their portfolio holdings between two adjacent reporting dates. They demonstrate a significantly negative relationship between RPI and fund performance and between RPI and money flows from outside investors. By aggregating portfolio holdings of all actively managed equity mutual funds, Wermers et al. (2012) develop a measure for the fund managers’ stock
selection skill and find that it has return-forecasting power that is not subsumed by publicly available quantitative predictors. Regarding the hedge fund managers’ disclosure, Cassar et al. (2016) use a dataset of investor letters sent by hedge funds and document that hedge fund managers provide their investors with both quantitative and qualitative information about fund returns, holdings, performance attribution, and future prospects.

In my study, I use a two-period model of trading by an informed trader who values both long-term and short-term performances. This is the simplest setting where I can study how an informed trader’s disclosure interacts with her trades, which, in turn, affects the trade-off an informed trader faces between maximization of long-term and short-term performances. This stylized trade-off captures a variety of costs and benefits of fund managers’ disclosures that have been discussed in the prior empirical literature. Agarwal et al. (2015) show that increasing the mandatory disclosure frequency improves the stock liquidity. Disclosing holdings also allows investors to better monitor fund managers, which reduces the agency cost that can arise when fund managers’ actions are not observable. Portfolio disclosure, however, can be costly because it could reveal proprietary trading strategies of fund managers. Outside investors can free ride on disclosures of portfolio composition and cause a stock’s price to move before a fund manager finishes accumulating her trading position. As a result, a fund manager cannot fully benefit from her private information. For example, Frank et al. (2004) study the performance of “copycat” funds, that is, funds that purchase the same assets as actively managed funds as soon as their asset holdings are disclosed. They find that, after expenses, copycat funds earned statistically indistinguishable returns compared to the actively managed funds. Furthermore, Verbeek and Wang (2013) show
that the relative success of copycat funds significantly increased after 2004, when the SEC increased the frequency with which mutual funds reported their portfolio disclosure from semi-annually to quarterly. Similarly, for hedge funds, Shi (2017) documents that fund performance deteriorates after a hedge fund begins filing Form 13F and publicly discloses its portfolio holdings. Even if the trades inferred from the disclosure are liquidity driven, portfolio disclosure can still facilitate the front-running activity and allow the speculators to anticipate the disclosing fund’s future trades. The speculators then trade ahead of the disclosing fund and benefit from the temporary price change. For example, Shive and Yun (2013) find evidence that institutions front run and benefit from the predictability of mutual funds’ tradings.

2.3 Informed Trading

My study contributes to the theoretical literature studying the impact of disclosure on informed trading by demonstrating how short-termism affects the interactions between informed traders’ disclosures and trades.

Benabou and Laroque (1992) examine an information-based, reputation model of manipulation in which an insider sometimes issues an earnings forecast to tell the truth in order to build a reputation and sometimes lies and manipulates. The insider might issue a favorable (unfavorable) forecast when in fact she has observed unfavorable (favorable) news. Bagnoli and Lipman (1996) develop a model of action-based manipulation where the manipulator takes a trading position, announces a takeover bid, unwinds her position and cancels the takeover bid. Since the market cannot tell if the bid is serious, the market price
of the target firm’s stock rises, generating profits for the manipulator. Fishman and Hagerty (1995) study a two-period model where an informed trader only possesses private information with a certain probability. While an informed informed trader will never manipulate the market in their model, an uninformed informed trader can manipulate the market by disclosing her trade, since the market may mistakenly believe that the uninformed informed trader is informed. In a similar model, but in which an insider is surely informed, John and Narayanan (1997) find that when the insider is required to disclose her trade ex post, she has an incentive to trade against her private information (i.e., buying when she has bad news and selling when she has good news) to maintain her information advantage for a longer period.

There are important differences between these studies and mine. In particular, Benabou and Laroque (1992) assume that the insider is a price-taker so that only her announcements but not her trades affect prices. In contrast, the informed trader trades in a speculative market in my study and both her disclosure and trades can affect prices. Additionally, in Benabou and Laroque (1992) and Bagnoli and Lipman (1996), the informed trader makes a fraudulent disclosure (i.e., a false earnings forecast and a false takeover bid). Nevertheless, the informed trader’s disclosure is deemed truthful in my study. Further, different from the insider in John and Narayanan (1997), the informed trader in my model trades in the same direction of her private information both before and after her disclosure.

\[\text{The informed trader's public disclosure is deemed truthful if there is a positive probability associated with the informed trader's privately observed value of the risky asset. In practice, various regulatory authorities often impose and enforce stringent rules against fraudulent disclosure. For instance, New York Stock Exchange (NYSE) Rule 435(5) prohibits the circulation of false or misleading rumors “of a sensational character which might reasonably be expected to effect market conditions”. National Association of Securities Dealers (NASD) Rule 5120(e) prohibits the circulation of any information that is false or misleading or which would improperly influence the market price of a security. In addition, SEC Rule 10b-5 also applies to false or misleading rumors that are considered manipulative.}\]
My study is most closely related to Huddart et al. (2001). They extend Kyle (1985) model to account for immediate holdings disclosure and show that the only possible linear equilibrium in this setting is one with a mixed strategy. They also find that the mandatory informed trading disclosure accelerates the price discovery process and increases market liquidity. Extending Huddart et al. (2001), Zhang (2004) shows that when the informed trader is risk averse, trade disclosure can reduce market efficiency as the risk-averse investor will face less price risk in the later period when she unwinds her trading position. Thus, the informed trader does not trade in a hurry and her private information is revealed more slowly than the case of the risk-averse informed trader without the mandatory disclosure requirement. Gong and Liu (2012) extend the Huddart et al. (2001) to a setting with a couple of homogeneously informed traders and study the influences of public disclosure and competition among informed traders on informed trading. They find that as trading frequency increases, private information will be revealed in opening trades and the informed traders’ expected trading profits will approach to zero. In Huddart et al. (2001) and all subsequent studies, the informed trader aims to maximize the realized trading profit—that is, her long-term performance—only. However, in my study, the informed trader values both long-term and short-term performances. By choosing the trading and disclosure strategies, the informed trader makes trades off long-term against short-term performances.

George and Hwang (2015) also examine fund managers’ disclosure practices. They find that when a fund plays a greater role in providing liquidity to investors through redemption, the fund manager is more likely to prefer to disclose holdings voluntarily. After adding short-

\[12\text{In this setting, the informed trader optimally adds a normally distributed noise term to her trade and hence plays a mixed strategy. This added noise term prevents the market maker from fully observing the informed trader’s private information after observing the disclosure.}\]
term performance to the fund managers’ objective functions, my study explores implications of fund managers’ short-termism on their voluntary disclosures and trades. I find that, without assuming that a fund manager is subject to redemption pressure from investors, voluntary disclosure is optimal to a fund manager as long as the relative weight she places on short-term performance is high enough.

Assuming that a fund manager values both long-term and short-term performances, Pasquariello and Wang (2018) develop a static trading model and show that it is optimal for a fund manager to disclose a mixture of information about the risky asset fundamentals and her endowment in that asset. However, if disclosure always increases fund managers’ expected payoff as Pasquariello and Wang assert, then why do we only observe disclosures from a small group of fund managers in the capital market? To address this question, my study theorizes this empirical observation in a dynamic setting and shows that a fund manager will make a public disclosure only if her degree of short-termism is above a threshold value.
Chapter 3

Short-Termism and Fund Managers’ Voluntary Disclosure

In this chapter, I study and compare the informed trader’s strategies when the informed trader makes no disclosure with the strategies when she discloses some of her private information at the interim date. In the general model, there are two rounds of trade. The informed trader chooses her disclosure policy before any trading happens. If the disclosure policy the informed trader chose requires it, the informed trader makes a public disclosure between two rounds of trade. To develop the intuition for the general model, I first characterize the informed trader’s strategies (i) when disclosure is precluded, and (ii) when trading in the second round is precluded, but disclosure is allowed. I denote the informed trader’s strategy as a “trading-only” strategy in the first setting and a “disclosure-only” strategy in the second.
3.1 Baseline Model

I model an economy in which a risky asset (i.e., stock) is traded over two periods. The risky asset yields a liquidation value, $\tilde{v}$, which is normally distributed with prior mean $p_0$ and prior variance $\sigma_v^2$.\(^{13}\) Without a loss of generality, $p_0$ is assumed to be 0. There are three types of risk-neutral market participants: an informed trader who possesses a perfect private signal about the payoff of the risky asset; uninformed liquidity traders who enter the market to satisfy demands of liquidity; and a competitive market maker who sets the price at each trading date. Figure 3.1 illustrates the sequence of events.

\begin{itemize}
  \item The informed trader privately observes $v$
  \item The informed trader submits market order, $y_1$
  \item Liquidity traders submit market order, $z_1$
  \item The market maker observes aggregate order, $x_1 = y_1 + z_1$, and sets price, $p_1$.
  \item The informed trader submits market order, $y_2$
  \item Liquidity traders submit market order, $z_2$
  \item The market maker observes aggregate order, $x_2 = y_2 + z_2$, and sets price, $p_2$.
  \item $v$ is realized.
\end{itemize}

Figure 3.1: Trading-Only Model Timeline

This figure depicts the sequence of events in the baseline model where the informed trader adopts the trading-only strategy. In particular, the informed trader trades at dates 1 and 2. She does not disclose any information to the market.

There are four discrete dates, indexed by $t \in \{0, 1, 2, 3\}$. The informed trader begins with zero endowment in the risky asset. Before date 1, the informed trader privately observes the payoff of the risky asset, $v$. At dates 1 and 2, the stock market opens. Trading in the

\(^{13}\)I use a tilde ($\tilde{}$) to signify an exogenous random variable throughout my subsequent analysis.
stock market is modeled as in Kyle (1985). The informed trader maximizes her expected payoff by placing an order to buy or sell \( \tilde{y}_t \) shares of the risky asset at the beginning of date \( t, t \in \{1, 2\} \). The market maker receives these orders along with those of liquidity traders whose exogenously-generated demands, \( \tilde{z}_t \), are normally distributed with mean 0 and variance \( \sigma^2_z \). After observing the net order flow, \( x_t = y_t + z_t \), the market maker sets the price \( p_t \) equal to the posterior expectation of \( \tilde{v} \). At date 3, the payoff of the risky asset, \( v \), is realized. All random variables \( \{ \tilde{v}, \tilde{z}_1, \tilde{z}_2 \} \) are assumed to be mutually independent. The structure of the economy and decision processes leading up to the informed trader’s demand as well as the market maker’s equilibrium price are common knowledge.

In Kyle (1985) as well as many subsequent theoretical studies of insider trading, the informed trader’s payoff is determined by the realized trading profit only. However, in practice, fund managers’ payoff are found to be affected as well by the short-term investment performance, which is the paper profit measured before fund managers closes their trading positions. Existing studies have documented that both mutual fund and hedge fund managers’ compensations are at least partly determined by funds’ short-term performances. To better capture the informed trader’s multifaceted incentives, in my model, I modify the informed trader’s objective function in the standard Kyle (1985) model and assume that the informed trader’s payoff is affected by both the realized trading profit and the unrealized paper profit. Because trading profit is realized after the informed trader closes her trading position in the risky asset at date 3, in the subsequent analysis, I use the term “trading profit” and “long-term performance” interchangeably. Using \( \pi^{LT}_t \) to denote the portion of the informed trader’s total trading profit directly attributable to her date \( t \) trade, I denote
the total trading profit as

\[ \pi^{LT} = \pi_1^{LT} + \pi_2^{LT} = y_1(v - p_1) + y_2(v - p_2). \] (3.1)

Following Bhattacharyya and Nanda (2013) and Pasquariello and Wang (2018), I measure the paper profit at the end of each trading date \( t \). The term “paper profit” is used interchangeably with “short-term performance.”

\[ \pi^{ST} = y_0(p_1 - p_0) + y_1(p_2 - p_1) = y_1(p_2 - p_1). \] (3.2)

The second equality follows from the assumption that the informed trader’s initial endowment of the risky asset is zero, \( y_0 = 0 \).

The informed trader’s payoff is then measured as the weighted average of the long- and short-term performance. The relative weight the informed trader places on the short-term performance is referred as her degree of short-termism and is denoted by \( r \) in the model. I further assume that the informed trader’s degree of short-termism is common knowledge among market participants.

At each trading date, the informed trader strategically chooses the size of her market order, \( y_t \), to maximize her expected payoff. She makes the decision knowing not only her private information but also past quantities traded and past prices. Letting \( W_t \) denote the

\[ W_t = p_t(y_{t-1} + y_t) - p_t y_t - p_{t-1} y_{t-1} = y_{t-1}(p_t - p_{t-1}). \]

The paper profit is measured in the similar manner when the informed trader takes the short position in the risky asset.
informed trader’s payoff at date $t$ and all subsequent trading dates, the decisions of the informed trader are characterized as follows:

$$y_1^* \in \arg \max_{y_1} E[W_1 | v], \quad (3.3)$$

$$y_2^* \in \arg \max_{y_2} E[W_2 | v, p_1, y_1], \quad (3.4)$$

where

$$W_1 = y_1(v - p_1) + y_2^*(v - p_2) + ry_1(p_2 - p_1), \quad (3.5)$$

$$W_2 = y_2(v - p_2) + ry_1^*(p_2 - p_1), \quad (3.6)$$

and $y_1^*$ ($y_2^*$) denotes the informed trader’s optimal demand for the risky asset at date 1 (date 2).

A competitive market maker sets the market price at each trading date based on all publicly available information. In this subsection, I assume that the informed trader does not make any public disclosure. The market maker’s information set then only consists of net order flows at dates 1 and 2, $x_1$ and $x_2$, respectively. As a result, prices are set as follows:

$$p_1 = E[\hat{v} | x_1], \quad p_2 = E[\hat{v} | x_1, x_2]. \quad (3.7)$$

Let the informed trader’s trading strategies and the market maker’s pricing rules be sets
of real-valued functions $Y = \{Y_1, Y_2\}$ and $P = \{P_1, P_2\}$ such that, given an initial price $p_0$,

$$y_1 = Y_1(v), \quad y_2 = Y_2(p_1, y_1, v), \quad p_1 = P_1(x_1), \quad p_2 = P_2(x_1, x_2).$$

### 3.1.1 Equilibrium for the Trading-Only Strategy

An equilibrium of this trading game in which the informed trader adopts the trading-only strategy and therefore makes no public disclosure throughout the trading is given by a strategy profile $\{y_1^*, y_2^*, p_1^*, p_2^*\}$, such that

1. Taking $(p_1^*, p_2^*)$ as given, $(y_1^*, y_2^*)$ maximizes the informed trader’s expected payoff over both trading dates; and

2. Taking $(y_1^*, y_2^*)$ as given, the market maker sets $p_1^*$ and $p_2^*$ to break even at each trading date.

The following proposition formally characterizes the strategies of the informed trader and market maker in the economy where the informed trader adopts the trading-only strategy. All proofs are in the Appendix A.

**Proposition 3.1 (Equilibrium for the Trading-Only Strategy)**

For any $\sigma_v$, $\sigma_z$ and $r > 0$, there exists a unique linear equilibrium characterizing the
strategies of the informed trader \((y_1, y_2)\) and market maker \((p_1, p_2)\) as follows:

\[
y_1 = \beta_1^T v, \tag{3.8}
\]

\[
y_2 = \alpha_2^T + \beta_2^T (v - p_1) + \gamma_2^T [y_1 - E(y_1|x_1)], \tag{3.9}
\]

\[
p_1 = \lambda_1^T x_1, \tag{3.10}
\]

\[
p_2 = p_1 + \lambda_2^T [x_2 - E(x_2|x_1)]. \tag{3.11}
\]

The parameters \(\beta_1^T, \beta_2^T, \gamma_2^T, \lambda_1^T\) and \(\lambda_2^T\) satisfy the second order conditions \(\lambda_2^T > 0\) and

\[
4(1+r)(1+r\beta_1^T \lambda_1^T)\lambda_2^{T^2} - [(2 + r + r\beta_1^T \lambda_1^T)\lambda_2^T - \lambda_1^T]^2 > 0,
\]

and the following equation system:

\[
\beta_1^T = \frac{(2 + r + r\beta_1^T \lambda_1^T) \lambda_2^T - \lambda_1^T}{4(1+r) (1+r\beta_1^T \lambda_1^T) - [(2 + r + r\beta_1^T \lambda_1^T) \lambda_2^T - \lambda_1^T]^2}, \tag{3.12}
\]

\[
\beta_2^T = \frac{1}{2\lambda_2^T}, \tag{3.13}
\]

\[
\gamma_2^T = \frac{r}{2}, \tag{3.14}
\]

\[
\lambda_1^T = \frac{\beta_1^T \sigma_v^2}{(\beta_1^T)^2 \sigma_v^2 + \sigma_z^2}, \tag{3.15}
\]

\[
\lambda_2^T = \frac{(\beta_2^T + \beta_1^T \gamma_2^T) \Sigma_1}{(\beta_2^T + \beta_1^T \gamma_2^T)^2 \Sigma_1 + \sigma_z^2}, \tag{3.16}
\]

\[
\Sigma_1 = \frac{\sigma_v^2 \sigma_z^2}{(\beta_1^T)^2 \sigma_v^2 + \sigma_z^2}. \tag{3.17}
\]

In Proposition 3.1, the superscript \(T\) indicates that all parameters are derived in the economy where the informed trader adopts the trading-only strategy. In the proof of Proposition 3.1, (3.12)-(3.17) can be solved for unique values of \(\lambda_1^T, \lambda_2^T\) and \(\beta_2^T\) in terms of exogenous parameters and \(\beta_1^T\). Moreover, \(\beta_1^T = \sqrt{a^* \cdot \frac{\sigma_z}{\sigma_v}}\), where \(a^*\) is defined implicitly as the
solution to $G(a^*; r) = 0$, where the function $G$ is defined by

$$G(a; r) = \sqrt{a} \left[ 4(a + 1) + r^2(a - 1) \right] - (1 - a) \left[ (r + 2) + 2a(r + 1) \right] \sqrt{4 + (4 + r^2)a}. \quad (3.18)$$

Even though $a^*$ is defined implicitly, the unique positive value of $a^*$ that satisfies $G(a^*; r) = 0$ can be easily calculated for any particular set of exogenous parameters. The solved $a^*$, along with values for $\sigma_v$ and $\sigma_z$, determine $\beta_1^T$, which in turn determines the values for other endogenous variables.

Three notable observations emerge from Proposition 3.1. First, the expressions for $y_1$ and $y_2$ reflect that the informed trader’s trading strategy is a function of her information advantage relative to the market maker. At date 2, the informed trader is able to exploit two sources of information advantage: (i) the information about the payoff of the risky asset, which is captured by $v - p_1$, and (ii) the information about the size of the informed trader’s order at date 1, which is captured by $y_1 - E(y_1|x_1)$. The dependence of $y_2$ on $y_1$ results from the incorporation of short-term performance in the informed trader’s objective function.

The second observation is about $\gamma_2^T$, which measures the intensity with which the informed trader exploits her information advantage about $y_1$. In the proof, I find that $\gamma_2^T = r/2$. When $r = 0$, the expression for $y_2$ conforms to the one in a standard Kyle (1985) two-period model. As $r$ increases, the informed trader’s payoff depends more on her short-term performance and she trades more aggressively at date 2 to pump up or down $p_2$ in the direction of her existing position in the risky asset, $y_1$.

Finally, the expression for $p_2$ shows that, when setting the market price at date 2, the
market maker takes into consideration the time series correlation in the net order flows (i.e., \(E(x_2|x_1) \neq 0\)). The correlation in the net order flows affects \(p_2\) through the term \(\lambda_2^T [x_2 - E(x_2|x_1)]\). The term multiplying \(\lambda_2^T\) represents the unexpected net order flow at date 2. Direct computation demonstrates that the market maker’s posterior expectation of \(x_2\) increases with the informed trader’s degree of short-termism, i.e., \(E(x_2|x_1) = rE(y_1|x_1)\).

**Corollary 3.1**

Given \(r > 0\) and \(a^*\) satisfies \(G(a^*;r) = 0\), if an informed trader adopts the trading-only strategy:

1. The informed trader’s trading intensities increase with her degree of short-termism at dates 1 and 2, i.e., \(\partial \beta_T^t / \partial r > 0, t \in \{1, 2\}\).

2. The expected long-term performance attributable to the informed trader’s date 1 trade increases with her degree of short-termism, i.e., \(\partial E[\pi_{LT,1}^T]/\partial r > 0\), where

   \[
   E[\pi_{LT,1}^T] = \frac{\sqrt{a^*}}{a^* + 1} \sigma_v \sigma_z. \tag{3.19}
   \]

3. The expected long-term performance attributable to the informed trader’s date 2 trade decreases with her degree of short-termism, i.e., \(\partial E[\pi_{LT,2}^T]/\partial r < 0\), where

   \[
   E[\pi_{LT,2}^T] = \frac{1}{\sqrt{a^*(4 + r^2)} + 4} \sigma_v \sigma_z. \tag{3.20}
   \]

4. The expected short-term performance increases with her degree of short-termism, i.e.,
\[ \partial E \left[ \pi_{ST,T} \right] / \partial r > 0, \text{ where} \]

\[ E \left[ \pi_{ST,T} \right] = \frac{\sqrt{a^*}}{2(a^* + 1)} \left( 1 + r \sqrt{\frac{a^*}{a^*(4 + r^2) + 4}} \right) \sigma_v \sigma_z. \] (3.21)

As \( r \) increases, the informed trader trades aggressively to exploit both sources of her information advantage at date 2: the information about the payoff of the risky asset and the information about the informed trader’s existing position in the risky asset. It is interesting that even though the informed trader does not make any public disclosure, aggressive trading serves a purpose similar to the disclosure. In particular, the informed trader’s date 2 trade moves \( p_2 \) in the direction of the risky asset’s fundamental value.\(^{15}\)

The price movement at date 2 has opposite effects on the informed trader’s expected payoff. It increases the expected short-term performance but decreases the expected long-term performance attributable to the informed trader’s date 2 trade. To partially offset the negative impact on the long-term performance, the informed trader trades more aggressively at date 1. She, therefore, exploits her information advantage about the risky asset’s fundamental value more intensively at date 1 than she would exploit in the standard Kyle (1985) two-period model. The informed trader’s aggressive trading at date 1, thus, increases the expected long-term performance attributable to the informed trader’s date 1 trade.

\(^{15}\)In equilibrium, the informed trader does not trade against her private information at date 1. Thus, the direction of risky asset value is the same as the direction of the informed trader’s trade at date 1, \( y_1 \).
3.1.2 Equilibrium for the Disclosure-Only Strategy

I now characterize the informed trader’s and the market maker’s strategies if the informed trader commits to disclosing a public signal, $\tilde{s}$, prior to trading at date 2:

$$\tilde{s} = \tilde{v} + \tilde{\epsilon}, \quad \text{with } \tilde{\epsilon} \sim N(0, \sigma^2_\epsilon).$$ (3.22)

For example, $\tilde{s}$ can be thought of as fund managers’ comments about the future perspective of the stock in which they invest. The variance of the error term in the signal $\tilde{s}$, $\sigma^2_\epsilon$, is inversely related to the precision of the informed trader’s disclosure. A smaller $\sigma^2_\epsilon$ signifies that $\tilde{s}$ is more informative about the payoff of the risky asset. More precise disclosure can be achieved by a more active presence in the media or by releasing more accurate data.

To differentiate the performance impact of aggressive trading and interim date disclosure, I assume that no trading occurs at date 2 when the informed trader adopts the disclosure-only strategy. Figure 3.2 illustrates the revised sequence of events.

At date 0, the informed trader commits to her disclosure policy and publicly announces $\sigma^2_\epsilon$. Before trading at date 1, the informed trader privately observes the value of the risky asset, $v$. At date 1, the market opens and both the informed trader and uninformed liquidity traders trade the risky asset. The informed trader publicly discloses a signal $s$ after trading at date 1. The payoff of the risky asset is realized at date 3. The market maker sets the price based on the observed net order flow and any informed trader’s public signal.

The following proposition characterizes the strategies of the informed trader and market maker in the economy where the informed trader adopts the disclosure-only strategy.
The informed trader commits to her disclosure policy and publicly announces $\sigma^2$. The informed trader privately observes $v$. The informed trader submits market order, $y_1$; Liquidity traders submit market order, $z_1$; The market maker observes aggregate order, $x_1 = y_1 + z_1$, and sets price, $p_1$. $v$ is realized.

Figure 3.2: Disclosure-Only Model Timeline

This figure depicts the sequence of events in the model where the informed trader adopts the disclosure-only strategy. In particular, the informed trader trades at date 1 and publicly discloses her private information after date 1. No trading occurs at date 2.

**Proposition 3.2 (Equilibrium for the Disclosure-Only Strategy)**

Given that the informed trader chooses the optimal $\sigma^2$, for any $\sigma_v, \sigma_z$, and $r > 0$, there exists a unique (linear) equilibrium characterizing the strategies of the informed trader ($y_1$) and market maker ($p_1, p_2$) as follows:

\[
y_1 = \beta^D_1 v,
\]

\[
p_1 = \lambda^D_1 x_1,
\]

\[
p_2 = (1 - \lambda^D_2)p_1 + \lambda^D_2 s,
\]

where

\[
\beta^D_1 = \frac{\sigma_z}{\sigma_v}, \quad \lambda^D_1 = \frac{1}{2} \frac{\sigma_v}{\sigma_z}, \quad \lambda^D_2 = \frac{\sigma_v^2}{2\sigma_v^2 + \sigma_z^2}.
\]

In Proposition 3.2, the superscript $D$ indicates all parameters are derived in the economy.
where the informed trader adopts the disclosure-only strategy. Before proceeding, I first calculate the informed trader’s expected long-term and short-term performances resulting from the disclosure-only strategy. Using the trading strategy, $y_1$, and pricing functions, $p_1$ and $p_2$, characterized in Proposition 3.2, I have:

\[
E\left[ \pi_{1,LT,D}^1 \right] = E\left[ y_1(v - p_1) \right] = \frac{1}{2}\sigma_v\sigma_z, \quad \text{and} \quad (3.26)
\]

\[
E\left[ \pi_{1,ST,D}^1 \right] = E\left[ y_1(p_2 - p_1) \right] = \frac{\sigma_v^2}{2(2\sigma_v^2 + \sigma_z^2)}\sigma_v\sigma_z. \quad (3.27)
\]

From the above, I find that the informed trader’s interim date disclosure only affects the expected short-term performance. It is straightforward to show that if the informed trader adopts the disclosure-only strategy, she maximizes her expected payoff by fully revealing her private information to the market, i.e., $\sigma_{\epsilon}^2 = 0$.\textsuperscript{16} When $\sigma_{\epsilon}^2 = 0$, I find that both the expected long-term and short-term performances remain constant and do not vary with the informed trader’s degree of short-termism:

\[
E\left[ \pi_{1,LT,D}^1 \right] = E\left[ \pi_{1,ST,D}^1 \right] = \frac{1}{2}\sigma_v\sigma_z. \quad (3.28)
\]

### 3.1.3 Comparison Between Trading and Disclosure

In this subsection, I compare the trading intensity, the marginal cost of trading, and the expected long-term and short-term performances between the (i) trading-only, and (ii)

\[\sigma_{\epsilon}^2 \in \arg \max_{\sigma_{\epsilon}^2} E\left[ \pi_{1,LT,D}^1 + r\pi_{1,ST,D}^1 \right] = \arg \max_{\sigma_{\epsilon}^2} \left[ \frac{1}{2} + \frac{r\sigma_v^2}{2(2\sigma_v^2 + \sigma_z^2)} \right] \sigma_v\sigma_z.\]
disclosure-only strategies of the informed trader.

**Proposition 3.3**

If an informed trader adopts either trading-only or disclosure-only strategy, the following orderings apply:

1. **Trading intensity at date 1:**
   
   \( \beta_1^T < \beta_1^D. \)

2. **Marginal cost of trades at date 1:**
   
   \( \lambda_1^T < \lambda_1^D. \)

3. **Expected long-term performance:**
   
   \[ E \left[ \pi_{1 LT,T} \right] \ < \ E \left[ \pi_{1 LT,D} \right] , \quad E \left[ \pi_{1 LT,T} + \pi_{2 LT,T} \right] > E \left[ \pi_{1 LT,D} \right]. \]

4. **Expected short-term performance:**
   
   \[ E \left[ \pi_{ST,T} \right] \ < \ E \left[ \pi_{ST,D} \right]. \]

5. **The informed trader’s expected payoff:**
   
   \[ E \left[ \pi_{1 LT,T} + \pi_{2 LT,T} + r \pi_{ST,T} \right] > E \left[ \pi_{1 LT,D} + r \pi_{ST,D} \right]. \]
To fully exploit the information advantage about the risky asset’s fundamental value, the informed trader prefers spreading her trading volume over different periods. However, if the informed trader adopts the disclosure-only strategy and discloses all her information after date 1, she has no profitable trading opportunities at date 2. As a result, she exploits her information advantage intensively and trades more aggressively at date 1 than she does with the trading-only strategy, $\beta_T^T < \beta_T^D$. The informed trader’s aggressive trading, in turn, increases informative tradings relative to liquidity tradings at date 1. Thus, given that the informed trader adopts the disclosure-only strategy, the market maker is subject to higher adverse selection cost and increases the price responsiveness to the net order flow at date 1, $\lambda_T^T < \lambda_T^D$.

Because of the difference in the marginal trading costs at date 1, the expected trading profit is lower with trading-only strategy, $E \left[ \pi_{1T,T}^{LT,T} \right] < E \left[ \pi_{1T,D}^{LT,D} \right]$, implying lower expected trading costs to uninformed liquidity traders in this period. However, adopting the trading-only strategy allows the informed trader to follow a dynamic trading strategy and to better exploit her information advantage. As a result, the expected total trading profit is higher if the informed trader adopts the trading-only strategy, i.e., $E \left[ \pi_{1T,T}^{LT,T} + \pi_{2T,T}^{LT,T} \right] > E \left[ \pi_{1T,D}^{LT,D} \right]$.

Although aggressive tradings at date 2 and the interim date disclosure serve similar purposes to move $p_2$ towards the risky asset’s fundamental value and to enhance the short-term performance at the end of date 2, they are not perfect substitutes. In particular, trading aggressively provides the informed trader with the camouflage of liquidity traders, whereas a full disclosure at the interim date conveys perfectly to the market the risky asset’s fundamental value. The expected short-term performance is higher if the informed trader
adopts the disclosure-only strategy and sets $p_2$ equal to $v$, i.e., $E[\pi^{ST,T}] < E[\pi^{ST,D}]$.

Previous analyses suggest that trading-only and disclosure-only strategies have comparative advantages. Although the informed trader expects a greater short-term performance if she were to adopt the disclosure-only strategy, the expected increase in payoff from a strong short-term performance is outweighed by the informed trader’s expected payoff loss from a weak long-term performance. The last part of Proposition 3.3 states that the trading-only strategy is a dominant strategy and that the informed trader would obtain a higher expected payoff from adopting the trading-only strategy.

### 3.2 General Model

In this section, I remove the restriction that the informed trader does not trade at date 2 and let her adopt a general strategy to maximize the expected payoff. According to the new strategy, the informed trader commits to her disclosure policy and publicly announces $\sigma^2$ at date 0. After privately learning the payoff of the risky asset, $v$, the informed trader trades the risky asset along with uninformed liquidity traders at both dates 1 and 2. Between these two trading dates, the informed trader publicly discloses a signal $s$ with the pre-committed $\sigma^2$. The payoff of the risky asset is realized at date 3. The revised sequence of the events is shown in Figure 3.3.

#### 3.2.1 Equilibrium for A General Strategy

Proposition 3.4 characterizes the strategies of the informed trader and market maker in the economy where the informed trader adopts a general strategy, given that the informed
• The informed trader commits to her disclosure policy and publicly announces $\sigma^2$.  

• The informed trader privately observes $v$.  

• The informed trader submits market order, $y_1$;  

• Liquidity traders submit market order, $z_1$;  

• The market maker observes aggregate order, $x_1 = y_1 + z_1$, and sets price, $p_1$.  

• The informed trader discloses signal, $s$.  

• The informed trader submits market order, $y_2$;  

• Liquidity traders submit market order, $z_2$;  

• The market maker observes aggregate order, $x_2 = y_2 + z_2$, and sets price, $p_2$.  

$\bullet$ $v$ is realized.

Figure 3.3: General Model Timeline

This figure depicts the sequence of events in the model where the informed trader adopts a general strategy. In particular, the informed trader trades at date 1 and date 2. Additionally, she publicly discloses some of her private information between two trading dates.

trader chooses the optimal $\sigma^*_2$.

**Proposition 3.4 (Equilibrium for a General Strategy)**

Given that the informed trader chooses the optimal $\sigma^*_2$ which satisfies $\sigma^*_2 < \frac{4(1 + r)}{4 + 3r} \sigma_v$, there exists a unique (linear) equilibrium characterizing the strategies of the informed trader $(y_1, y_2)$ and market maker $(p_1, p_2)$ as follows:

\[
y_1 = \beta_1^G v, \tag{3.29}
\]

\[
y_2 = \alpha_2^G + \beta_2^G [v - E(v|x_1, s)] + \gamma_2^G [y_1 - E(y_1|x_1, s)], \tag{3.30}
\]

\[
p_1 = \lambda_1^G x_1, \tag{3.31}
\]

\[
p_1^* = (1 - \phi)p_1 + \phi s, \tag{3.32}
\]

\[
p_2 = p_1^* + \lambda_2^G [x_2 - E(x_2|x_1, s)]. \tag{3.33}
\]
The endogenous parameters $\beta_1^G$, $\beta_2^G$, $\gamma_2^G$, $\phi$, $\lambda_1^G$ and $\lambda_2^G$ satisfy the second order conditions $\lambda_2^G > 0$ and $(r\lambda_2^G)^2 + [\lambda_1^G (1 - r\beta_1^G \lambda_2^G) (1 - \phi)]^2 - 2\lambda_1^G \lambda_2^G [2 + r + r\phi + r^2 \beta_1^G \lambda_2^G (1 - \phi)] < 0$, and the following equation system:

$$\beta_1^G = -\frac{\lambda_2^G (2 + r) + (1 - r\beta_1^G \lambda_2^G) [r\lambda_2^G \phi - \lambda_1^G (1 - \phi)(1 - (1 - r\beta_1^G \lambda_2^G) \phi)]}{(r\lambda_2^G)^2 + [\lambda_1^G (1 - r\beta_1^G \lambda_2^G) (1 - \phi)]^2 - 2\lambda_1^G \lambda_2^G [2 + r + r\phi + r^2 \beta_1^G \lambda_2^G (1 - \phi)]},$$

(3.34)

$$\beta_2^G = \frac{1}{2\lambda_2^G},$$

(3.35)

$$\gamma_2^G = \frac{r}{2},$$

(3.36)

$$\lambda_1^G = \frac{\beta_2^G \sigma_v^2}{(\beta_2^G \sigma_v)^2 + \sigma_z^2},$$

(3.37)

$$\phi = \frac{\sigma_v^2 \sigma_z^2}{\sigma_v^2 [(\beta_2^G \sigma_v)^2 + \sigma_z^2] + \sigma_v^2 \sigma_z^2},$$

(3.38)

$$\lambda_2^G = \frac{(\beta_2^G + \beta_1^G \gamma_2^G) \sigma_v^2 \sigma_z^2}{\sigma_v^2 [(\beta_2^G + \beta_1^G \gamma_2^G)^2 \sigma_v^2 + \sigma_z^2] + \sigma_v^2 [(\beta_2^G \sigma_v)^2 + \sigma_z^2]},$$

(3.39)

In Proposition 3.4, the superscript $G$ indicates that all parameters are derived in the economy where the informed trader adopts a general strategy. Similar with procedures outlined in the proof of Proposition 3.1, in the proof of Proposition 3.4, (3.34)-(3.39) can be solved for unique values of $\beta_2^G$, $\phi$, $\lambda_1^G$ and $\lambda_2^G$ in terms of exogenous parameters and $\beta_1^G$. Moreover, $\beta_1^G = \sqrt{a^* \cdot \frac{\sigma_v}{\sigma_z}}$, where $a^*$ is defined implicitly as the solution to $H(a^*; r, h) = 0$ and $h$ denotes the optimal signal-to-noise ratio, $\frac{\sigma_v^2}{\sigma_z^2}$. The function $H$ is explicitly defined.
by:

$$H(a; r, h) \equiv \sqrt{a(a + 1)[M - r^2(1 + h)]} + \sqrt{M}[2(1 + r)(a - 1)(1 + h + a)^2 + r(a + 1)(1 + h - a)],$$

(3.40)

where $M = (4 + r^2)a + 4(h + 1)$. For any $r > 0$ and $h > \frac{4 + 3r}{4(1 + r)}$, the unique positive value of $a^*$ that satisfies $H(a^*; r, h) = 0$ can be easily solved. The solved $a^*$, along with values for $\sigma_v$, $\sigma_z$, and $\sigma_\epsilon^*$, determine $\beta^*_G$, which in turn determines the values for other endogenous variables.

Before studying the informed trader’s optimal disclosure, I calculate the informed trader’s expected long-term and short-term performances if she adopts a general strategy. Using the trading strategies, $y_1$ and $y_2$, and pricing functions, $p_1$ and $p_2$, characterized in Proposition 3.4, I summarize the results in the following Corollary 3.2.

**Corollary 3.2**

Given $r > 0$ and $a^*$ satisfies $H(a^*; r, h) = 0$ and $h = \frac{\sigma_v^2}{\sigma_\epsilon^2}$, if the informed trader adopts a general strategy:

1. The expected long-term performance attributable to the informed trader’s date 1 trade is given by

$$E \left[ \pi^{LT,G}_1 \right] = \frac{\sqrt{a^*}}{a^* + 1} \sigma_v \sigma_z. \hspace{1cm} (3.41)$$

2. The expected long-term performance attributable to the informed trader’s date 2 trade is given by

$$\left[ \pi^{LT,G}_2 \right] = \frac{1}{\sqrt{a^*(4 + r^2) + 4(1 + h)}} \sigma_v \sigma_z. \hspace{1cm} (3.42)$$
3. The expected short-term performance is given by

$$
\pi^{ST,G} = \frac{\sqrt{a^*}}{2(1 + a^* + h)} \left(1 + \frac{2h}{1 + a^* + r} \sqrt{\frac{a^*}{a^*(4 + r^2) + 4(1 + h)}}\right) \sigma_v \sigma_z. \quad (3.43)
$$

It is intuitive to find that when $h = 0$, i.e., $\sigma^*_t \rightarrow +\infty$, the informed trader’s expected long-term and short-term performances associated with a general strategy conform to those in Corollary 3.1 in which the informed trader adopts the trading-only strategy.

### 3.2.2 Optimal Disclosure

As I noted earlier, the equilibrium in Proposition 3.4 is conditional on the fact that the informed trader commits to disclosing a signal $s$ with the optimal $\sigma^*_t$. In this subsection, I discuss the property of the optimal $\sigma^*_t$ and, more importantly, the condition under which the informed trader’s interim date disclosure is optimal.

In the equilibrium for the informed trader’s general strategy, I denote the optimal signal-to-noise ratio, $\frac{\sigma^2}{\sigma^*_t}$, by $h$. To derive the optimal $\sigma^*_t$ is, thus, equivalent to deriving the optimal signal-to-noise ratio, $h^*$. The objective of the informed trader is to maximize her expected payoff. Substituting the expected long-term and short-term performance characterized in Corollary 3.2 yields the following problem for the informed trader

$$
\max_h \left\{ \frac{\sqrt{a}}{a + 1} + \frac{1}{\sqrt{M}} + \frac{r \sqrt{a}}{2(1 + a + h)} \left(1 + \frac{2h}{1 + a + r \sqrt{a} M}\right) \right\}, \quad (3.44)
$$

where $M = a(4 + r^2) + 4(1 + h)$. After solving for the first order condition for $h$, I characterize the informed trader’s optimal choice of $h$ in the following proposition.
Proposition 3.5

Given \( r > 0 \) and \( 0 < a < 1 \), an informed trader chooses \( h \) such that

\[
h = -1 + a \left[ -2 + \left( 7 + 3\sqrt{6} \right) r^2 \right],
\]

(3.45)

where \( a \) satisfies both \( H(a; r, h) = 0 \) and second order conditions stated in Proposition 3.4.

According to Proposition 3.5, \( h \), the optimal signal-to-noise ratio, depends on the informed trader’s degree of short-termism, \( r \), both directly and indirectly through \( a \), the scalar of the informed trader’s trading intensity at date 1. On one hand, as \( r \) increases, the informed trader is going to disclose a more precise signal at the interim date to enhance the short-term performance by moving \( p_2 \) in the direction of the true \( v \). On the other hand, knowing that an upcoming interim date disclosure will compromise any private information advantage, the informed trader responds to an increase in the public signal precision by trading more aggressively at date 1, which, in turn, reduces the residual uncertainty from the market maker’s perspective. Corollary 3.3 summarizes the relation between the precision of the informed trader’s interim date disclosure and her short-termism.

Corollary 3.3

If the informed trader adopts a general strategy, the precision of her interim date disclosure increases with her degree of short-termism, i.e., \( \frac{\partial(1/\sigma_r^2)}{\partial r} > 0 \).

Whether the informed trader voluntarily commits to the interim date disclosure depends on whether her expected payoff is greater with disclosure than without. Provided that the informed trader’s disclosure-only strategy is dominated by the trading-only strategy, the
optimality of the disclosure is eventually determined by the comparison between the trading-only strategy and a general strategy. The same exogenous parameters imply different values for the endogenous parameters depending on the informed trader’s strategy choice. Given the results in Corollary 3.1 and Corollary 3.2, the informed trader’s expected payoffs are re-written as follows:

\[ E[W_T] = T(r)\sigma_v\sigma_z, \quad E[W^G] = G(r)\sigma_v\sigma_z, \quad (3.46) \]

where

\[ T(r) = \frac{\sqrt{a^T}}{a^T + 1} + \frac{1}{\sqrt{a^T(4 + r^2) + 4}} + \frac{r\sqrt{a^T}}{2(1 + a^T)} \left( 1 + r\sqrt{\frac{a^T}{a^T(4 + r^2) + 4}} \right), \quad (3.47) \]

\[ G(r) = \frac{\sqrt{a^G}}{a^G + 1} + \frac{1}{\sqrt{a^G(4 + r^2) + 4(1 + h)}} + \frac{r\sqrt{a^G}}{2(1 + a^G + h)} \left( 1 + \frac{2h}{1 + a^G} + r\sqrt{\frac{a^G}{a^G(4 + r^2) + 4(1 + h)}} \right). \quad (3.48) \]

Consistent with the findings in George and Hwang (2015), the separable form of the payoff function suggests whether the interim date disclosure is optimal is not affected by \( \sigma_v \) or \( \sigma_z \). In other words, the informed trader’s interim date disclosure decision does not depend on characteristics of the capital market such as the scale of the information asymmetry about the payoff of the risky asset and the extent of the camouflage provided by uninformed liquidity traders. What matters to the informed trader’s disclosure is only her degree of short-termism, \( r \).

Due to the dynamics and complex procedures involved in solving for equilibria in Propo-
sition 3.1 and 3.4, I am unable to make general statement about how the informed trader’s short-termism affects her interim date disclosure. Instead, I provide some intuition for the general case by numerically compare the informed trader’s expected payoff between the trading-only strategy and the general strategy. For simplicity, I set the variance of the risky asset’s value, $\sigma_v^2$, and the variance of liquidity traders’ net order flow, $\sigma_z^2$, equal to 1 throughout the subsequent analysis. The key exogenous parameter in the model is $r$, the informed trader’s degree of short-termism. In the simulation analysis, $r$ is chosen from the range between 1 and 3, with the increment being 0.001.

The numerical results are plotted in Figure 3.4. This figure shows that it is optimal for the informed trader to commit to the interim date disclosure if she has a medium-to-high degree of short-termism. This is because the expected increase in the short-term performance from trading at $p_2$ that has adjusted more fully to $v$ outweighs the expected benefit to exploiting the information advantage about $v$ by remaining silent through the course of trading. However, if the informed trader’s degree of short-termism is low, interim date disclosure is not optimal. The expected benefit of a higher trading profit outweighs that of having a rosy-looking short-term performance at the end of date 2.

3.2.3 Capital Market Consequences

Short-termism affects the informed trader’s trading and disclosure decisions. It also has implications for assessing stock liquidity and price informativeness.

---

\[17\] I find that the threshold degree of short-termism, $r = 1.277$, from the numerical analysis. When the informed trader’s degree of short-termism is higher than the threshold value, it is optimal for her to commit to the interim date disclosure. Otherwise, it is optimal for the informed trader to remain silent.
Figure 3.4: Plot of Informed Trader’s Expected Payoff

This figure plots the informed trader’s expected payoff for different values of \( r \), the informed trader’s degree of short-termism. The solid line depicts the variation in the informed trader’s expected payoff if she adopts a general strategy (i.e., partial disclosure). The dashed line depicts the variation in the informed trader’s expected payoff if she adopts the trading-only strategy (i.e., no disclosure).

the current and future period trading profit. In my model, I incorporate the short-term incentive into the informed trader’s objective function, which creates an additional tension between long-term and short-term performances.

When evaluating the trading strategies at date 1, the informed trader knows that either aggressive trading at date 2 or the interim date disclosure will accelerate the decay of any information advantage about the risky asset’s fundamental value. Moreover, as the informed trader’s degree of short-termism increases, the informed trader would either trade more aggressively at date 2 or disclose a more precise signal before trading at date
2. Anticipating this effect, the informed trader trades more aggressively and exploits her information advantage more intensive at date 1. The informed trader’s aggressive trading increases informative trading relative to liquidity trading in this period. As a result, market liquidity decreases and price informativeness increases with $r$ at date 1.

At date 2, the information asymmetry is less severe, due to either the informed trader’s interim date disclosure or an increase in the amount of private information revealed through net order flow by the informed trader’s aggressive trading strategy. Thus, both market liquidity and price informativeness increases with $r$ at date 2.

In my study, stock liquidity at date $t$ is defined by $1/\lambda_t$, the reciprocal of the marginal trading cost of trading at date $t$. And price informativeness at date $t$ is measured by the reciprocal of the conditional variance, $1/\text{Var} [\tilde{v} | \mathcal{I}_t^{\text{Public}}]$, where $\mathcal{I}_t^{\text{Public}}$ denotes all publicly available information at date $t$. The more information the price reveals, the higher this measure will be. The conditional variance, $\text{Var} [\tilde{v} | \mathcal{I}_t^{\text{Public}}]$, reflects the risk uninformed liquidity traders face when trading the risky asset and it is zero if all public information allows any market participant to perfectly predict the payoff of the risky asset. The effects of the informed trader’s degree of short-termism on market liquidity and price informativeness are summarized in the following corollary.

**Corollary 3.4**

*If the informed trader adopts either the trading-only strategy or a general strategy,*

1. *At date 1, stock liquidity decreases with her degree of short-termism, i.e., $\frac{\partial (1/\lambda_1)}{\partial r} < 0$.*

2. *At date 2, stock liquidity increases with her degree of short-termism, i.e., $\frac{\partial (1/\lambda_2)}{\partial r} > 0$.***
3. At both dates 1 and 2, price informativeness increases with her degree of short-termism, i.e.,
\[ \frac{\partial (1/ \text{Var}[\tilde{v} | T_{Public}^t])}{\partial r} > 0, \quad t \in \{1, 2\}. \]

Finally, I compare capital market consequences between the informed trader’s trading-only strategy and the general strategy. The numerical results are plotted in Figure 3.5 and 3.6.

I find that the informed trader’s short-termism has greater impacts on both stock liquidity and price informativeness if she adopts a general strategy. The difference in the capital market consequence once again reflects the fact that aggressive trading and public disclosure are not perfect substitute, although they serve the similar purpose to enhance the informed trader’s short-term performance. As argued before, aggressive trading provides the informed trader with the camouflage of liquidity traders, whereas public disclosure conveys the information about the risky asset’s fundamental value more directly to the market.

3.3 Summary

Some fund managers publicly disclose private information even before they have finished accumulating their trading position. In this chapter, I show that short-termism can induce the behavior within the familiar two-period strategic trading model based on Kyle (1985). My model captures the interaction between the informed trader’s disclosure and trading decisions. The informed trader’s payoff is determined by the weighted average of long-term performance (i.e., trading profit) and short-term performance (i.e., paper profit). I analyze the informed trader’s trading and disclosure strategies and the stock prices arising in equilibrium. I find that the informed trader’s interim date disclosure is critically dependent
on the relative weight she places on the short-term performance, i.e., her degree of short-termism.

If the degree of short-termism is low, the informed trader is better off not disclosing any of her information before she has finished accumulating her position. Disclosure would reduce the informed trader’s trading profit associated with fully exploiting her information advantage. However, if the degree of short-termism is above a threshold value, the interim date disclosure improves the informed trader’s payoff. From her perspective, disclosure increases the short-term performance at the cost of her long-term performance.

Regulators claim that short-termism is undesirable because it adversely affect price discovery. The regulators’ concern is demonstrated by the passage of “short-swing profit rule” that prohibits corporate insiders from profiting from buying and selling the same security within a six-month period. An informed trader’s short-termism can motivate her to disclose some of her private information about a stock. The public disclosure alters the informed trader’s trading strategies and helps her avoid the adverse price movement. Short-termism induces more aggressive trading and public disclosure. In turn, private information is reflected more rapidly in price. Short-termism can, therefore, improve market efficiency.
Figure 3.5: Plot of Stock Liquidity and Short-Termism

The above figures plot stock liquidity for different values of $r$, the informed trader’s degree of short-termism (a) at date 1, and (b) at date 2. Stock liquidity at date $t$ is measured as $1/\lambda_t$, the reciprocal of the marginal cost of trade at date $t$. The solid line depicts the variation in stock liquidity if the informed trader adopts a general strategy (i.e., partial disclosure). The dashed line depicts the variation in stock liquidity if the informed trader adopts the trading-only strategy (i.e., no disclosure).
Figure 3.6: Plot of Price Informativeness and Short-Termism

The above figures plot price informativeness for different values of $r$, the informed trader’s degree of short-termism (a) at date 1, and (b) at date 2. Price informativeness at date $t$ is measured as $1/Vnr[\tilde{v}|\mathcal{I}_t^{\text{public}}]$, where $\mathcal{I}_t^{\text{public}}$ denotes all publicly available information date date $t$. The solid line depicts the variation in price informativeness if the informed trader adopts a general strategy (i.e., partial disclosure). The dashed line depicts the variation in price informativeness if the informed trader adopts the trading-only strategy (i.e., no disclosure).
Chapter 4

Mandatory Disclosure of Fund Managers’ Trades

4.1 Introduction

Despite the fact that fund managers have discretion over the form and the content of their voluntary disclosures, regulators’ attempts to enhance the transparency of the investment management industry have focused on the disclosure of investment funds’ holdings. In the model discussed in the last chapter, regulators did not mandate fund managers to disclose their private information, $s$, nor did they prevent those managers from disclosing $s$ as long as their disclosures were deemed truthful. Instead, regulators mandate fund managers to disclose $y_1$, the quantity of their date 1 trades after trading in the first period.

To complement and extend the analysis from the previous chapter, in this chapter, I examine fund managers’ strategic trading in relation to the disclosure of their trades.
Specifically, I consider a model in which there is a risky asset and a risk-free asset. In this model, there is a single informed trader who can be viewed as a stylized fund manager with superior investment knowledge. After the informed trader privately and perfectly learns the value of the risky asset, she trades with liquidity traders and a market maker on two trading dates. According to regulations, the informed trader must disclose the quantity of her trade after trading at date 1.

Disclosing a trading position causes an informed trader to trade differently than she would if she were not required to disclose her holdings in the risky asset. To prevent the market maker from inferring private information about the value of the risky asset, I have found that the informed trader dissimulates her informative trading at date 1 by adding a noise component to her market order. As Huddart et al. (2001) have shown, dissimulation maintains some of the informed trader’s information advantage until the end of date 2. Due to the assumption that the informed trader values both long-term and short-term performances, I propose that the random component of the informed trader’s date 1 trade is not always equal in distribution to that of liquidity traders’. Instead, its variance decreases with the informed trader’s degree of short-termism so that the informed trader would randomize her trade to a lesser extent when she places more weight on the short-term performance. Less randomization makes the informed trader’s trades more informative. However, it also causes the informed trader’s information advantage to decay in a faster manner. As a result, less randomization will increase the informed trader’s short-term performance at the expense of her long-term performance.

The effects of the informed trader’s short-termism on price informativeness and stock liq-
uidity are also studied in this chapter. A higher degree of short-termism causes the informed trader to randomize her trade to a lesser extent at the first trading date. Less randomization then makes the informed trader’s trade disclosures more informative regarding the value of the risky asset. A more informative disclosure reduces information asymmetry between the market and the informed trader, which in turn leads to a greater price informativeness and a higher stock liquidity at the second trading date. At the same time, a more informative disclosure also compromises the informed trader’s information advantage. Anticipating the negative effects of disclosure on her information advantage, the informed trader would exploit her information advantage before the disclosure by trading more aggressively on her private information. More aggressive trading, along with less randomization, increases informative trading relative to noise trading. As a result, when the informed trader puts more weight on short-term performance, stock liquidity is lower and price informativeness is higher at the first trading date.

In practice, it is unlikely that the fund manager would know in advance the exact value of the stock she is going to invest in. Although the fund manager has some superior insight about the stock which leads to her initial investment, learning the true value of the stock inevitably takes time. Therefore, I will extend the model to a setting in which the informed trader is not fully informed upfront. Instead, I will model a situation in which there is a flow of private information and the informed trader learns of different components of the value of the risky asset at the beginning of each of the two trading dates. In this iteration of the model, I find that, in addition to the degree of short-termism, the temporal pattern of the precision of private information is another important factor determining the informed
trader’s trading strategies. Specifically, I show that using a mixed-strategy or dissimulating trades at the first trading date constitutes an equilibrium strategy if and only if the ratio of the precision of the informed trader’s private information is below a threshold. Furthermore, the threshold itself is a function of the informed trader’s degree of short-termism.

The rest of the chapter proceeds as follows: In Section 4.2, I outline the equilibrium in a model where the informed trader receives her private information only at the beginning of date 1 and she is mandated to disclose her holdings in the risky asset between dates 1 and 2. Section 4.3 then provides comparative statistics for a number of situations related to the effects of the informed trader’s short-termism on the intensity of trading, stock liquidity, price informativeness and informed trader’s expected payoff. Section 4.4 extends the model from a case of once-and-for-all information arrival to a case in which private information arrives at different times throughout the trading period. Section 4.5 summarizes the results. All proofs can be found in Appendix B.

4.2 The Model

4.2.1 Model Setup

Following the Kyle (1985) model, the model I present here includes a single risky asset (i.e., the stock) whose uncertain liquidation value is represented by $\tilde{v}$, a normally distributed random variable with mean 0 and variance $\sigma_v^2$. The single risky asset is traded in the market with a single risk-neutral informed trader and many uninformative liquidity traders who trade for exogenous liquidity reasons, with the intermediation of a competitive market maker who sets the price at each trading date. The sequence of events is illustrated in
There are four discrete dates, indexed by $t \in \{0, 1, 2, 3\}$. The informed trader begins with zero endowments in the risky asset. Before date 1, the informed trader privately and perfectly learns the value of the risky asset, $v$. At dates 1 and 2, the informed trader chooses her demands for the risky asset, $y_1$ and $y_2$, respectively. These trades are made to maximize the informed trader’s expected payoff after she learns her private information, her own past demand for the risky asset and past market prices. Different from Kyle (1985) and most of its subsequent studies, in my study, the informed trader’s payoff is measured as the weighted average of her long- and short-term performance. Here, long-term performance refers to the informed trader’s realized trading profits after she unwinds her trading positions at date 3. Letting $\pi_t^{LT}$ denote the realized profits of the informed trader on positions acquired at date
$t$, the informed trader’s long-term performance, $\pi^{LT}$, is measured as

$$\pi^{LT} = \pi^{LT}_1 + \pi^{LT}_2 = y_1(v - p_1) + y_2(v - p_2). \tag{4.1}$$

Following Bhattacharyya and Nanda (2013) and Pasquariello and Wang (2018), I measure the informed trader’s short-term performance as the unrealized paper profit resulting from the inter-temporal price change. Letting $\pi^{ST}$ denote the informed trader’s short-term performance, I have

$$\pi^{ST} = y_0(p_1 - p_0) + y_1(p_2 - p_1) = y_1(p_2 - p_1). \tag{4.2}$$

The second equality follows from the assumption that the informed trader has no initial endowment in the risky asset, i.e., $y_0 = 0$.

The informed trader places different weights on long- and short-term performance. The relative weight on short-term performance is deemed as her degree of short-termism and is denoted by $r$ in the model. The informed trader’s degree of short-termism is assumed to be common knowledge in the market. Letting $W_t$ denote the informed trader’s payoff at date $t$ and all subsequent dates, the informed trader’s decisions are characterized as follows

$$y_1^* \in \arg \max_{y_1} E[W_1|v], \tag{4.3}$$

$$y_2^* \in \arg \max_{y_2} E[W_2|v, y_1, p_1], \tag{4.4}$$
where

\[ W_1 = y_1(v - p_1) + y_2^*(v - p_2) + y_1(p_2 - p_1), \quad (4.5) \]

\[ W_2 = y_2(v - p_2) + y_1^*(p_2 - p_1), \quad (4.6) \]

and \( y_1^* \) and \( y_2^* \) denote the solutions to (4.3) and (4.4), respectively.

Besides the informed trader, the uninformative liquidity traders also trade the risky asset in the market. I use \( z_1 \) and \( z_2 \) to denote the total order from liquidity traders at dates 1 and 2, respectively. I assume that \( z_1 \) and \( z_2 \) are independent normal random variables with mean 0 and variance \( \sigma_z^2 \).

Finally, a competitive market maker sets the market price at dates 1 and 2, \( p_1 \) and \( p_2 \), based on all public information. At date 1, the market maker can only observe the aggregate order flow from the informed trader and liquidity traders and he does not know which orders come from which trader. As a result, \( p_1 \) is set such that

\[ p_1 = E[v|x_1], \quad \text{where} \quad x_1 = y_1 + z_1. \quad (4.7) \]

After date 1, the informed trader discloses \( y_1 \). The public disclosure breaks down the aggregate order flow for the market maker, who then updates his evaluation of the risky asset as follows:

\[ p_1^* = E[v|y_1], \quad (4.8) \]

where \( p_1^* \) can be thought of as the pseudo-price that the market maker would have set for
date 1 if he had observed the informed trader’s orders, \( y_1 \), before the execution of trades at date 1. Although \( p_1^* \) is a pseudo-price at which no trade actually takes place, it is nevertheless important since it becomes the starting point for the market maker to set \( p_2 \) for date 2. In other words, the market maker once again only observes the aggregate order flow, \( x_2 \), at date 2 and \( p_2 \) is set in the following way:

\[
p_2 = E[v|y_1, x_2], \quad \text{where } x_2 = y_2 + z_2.
\]  

(4.9)

### 4.2.2 Characterization of the Equilibrium

The informed trader has perfect information about the liquidation value of the risky asset. The mandatory disclosure requirement provides the informed trader with an incentive to dissimulate her trade by injecting a random component to her market order at date 1 so that the market maker cannot perfectly infer the informed trader’s private information from the public disclosure. Dissimulation allows the informed trader to control the amount of private information to be revealed though the disclosure and determines her remaining information advantage to be exploited at the second trading date. Therefore, the informed trader’s decision about the extent to which she is going to randomize her trade at date 1 is a strategic one. Too much randomization will cause the informed trader to lose a lot from her date 1 trade and will make the price less informative. This, in turn, will reduce the informed trader’s short-term performance. However, too little randomization will cause the informed trader to lose her information advantage too early. Nevertheless, less randomization increases price informativeness, which will eventually benefit the informed
trader’s short-term performance.

An equilibrium is defined as an informed trading strategy \((y_1, y_2)\), and the market maker’s pricing strategy \((p_1, p_2)\), such that:

1. Taking \(p_1\) and \(p_2\) as given, \((y_1, y_2)\) maximizes the informed trader’s expected payoff at two trading dates; and

2. Taking \(y_1\) and \(y_2\) as given, the market maker sets \(p_1\) and \(p_2\) to break even at two trading dates.

Following Huddart et al. (2001), I show that an equilibrium exists in which the informed trader’s date 1 trade consists of an information-based linear component and a noise component, \(u_1\), where \(u_1\) is normally and independently distributed with mean 0 and variance \(\sigma_u^2\). The following proposition characterizes the informed trader’s and the market maker’s strategies in the economy in which the informed trader is mandated to disclose her holdings in the risky asset after trading at date 1 and prior to trading at date 2.

**Proposition 4.1**

For any \(\sigma_v\), \(\sigma_z\), and \(r > 0\), there exists a unique (linear) equilibrium characterizing the
strategies of the informed trader \((y_1, y_2)\) and the market maker \((p_1, p_2)\) as follows:

\[ y_1 = \beta_1 v + u_1, \quad \text{where } u_1 \sim (0, \Sigma_u), \quad (4.10) \]
\[ y_2 = \alpha_2 + \beta_2 (v - p^*_1), \quad (4.11) \]
\[ p_1 = \lambda_1 x_1, \quad (4.12) \]
\[ p^*_1 = \gamma_1 y_1, \quad (4.13) \]
\[ p_2 = p^*_1 + \lambda_2 (x_2 - \alpha_2), \quad (4.14) \]

where

\[ \beta_1 = \frac{\sigma_z}{\sigma_v} \frac{1 + r}{\sqrt{1 + (1 + r)^2}}, \quad (4.15) \]
\[ \beta_2 = \frac{\sigma_z}{\sigma_v} \sqrt{1 + (1 + r)^2}, \quad (4.16) \]
\[ \lambda_1 = \frac{1}{2\beta_1}, \quad (4.17) \]
\[ \lambda_2 = \frac{1}{2\beta_2}, \quad (4.18) \]
\[ \gamma_1 = 2\lambda_1, \quad (4.19) \]
\[ \Sigma_u = \frac{\sigma^2_z}{1 + (1 + r)^2}. \quad (4.20) \]

When \(r = 0\), Proposition 4.1 conforms to Proposition 2 in Huddart et al. (2001). One of their key findings is that the noise component in the informed trader’s date 1 trade is equal in distribution to that of liquidity traders’. By contributing equally to the trading volume at date 1, liquidity traders camouflage the informed trader’s trades. In my model,
the distribution equality no longer holds when the informed trader places weight on her short-term performance. In particular, (4.20) suggests that the variance of the informed trader’s noise trading decreases with her degree of short-termism, and that the informed trader randomizes her date 1 trade to a lesser extent when she places a larger weight on the short-term performance.

4.3 Comparative Statistics

In this section, I use the closed-form solution derived in the previous section to study the comparative statistics of trading intensity, stock liquidity and price informativeness. When the informed trader publicly discloses her holdings in the risky asset, she reveals some of her private information about the value of the risky asset to the market:

\[ T = \frac{y_1}{\beta_1} = v + \frac{1}{\beta_1} u_1. \]  

(4.21)

The precision of the informed trader’s disclosure is then measured as:

\[ \tau = \beta_1^2 \frac{1}{\sigma_u^2} = \frac{(1 + r)^2}{\sigma_v^2}. \]  

(4.22)

As the informed trader’s degree of short-termism increases, more private information will be revealed through public disclosures. Thus, the informed trader’s information advantage decreases after the disclosure. Understanding that she will lose significant information advantage after the disclosure, the informed trader exploits her information advantage more intensively before the disclosure by trading more aggressively on her private information
and by randomizing her trade to a lesser extent at date 1. The informed trader’s aggressive trading, along with decreased trade randomization, increases informative trading relative to noise trading at date 1. As a result, stock liquidity decreases and price informativeness increases.

**Corollary 4.1**

*Before an informed trader discloses her holdings in the risky asset,*

1. **The informed trader’s trading intensity increases with her degree of short-termism,** i.e., \( \frac{\partial \beta_1}{\partial r} > 0 \).

2. **Stock liquidity decreases with her degree of short-termism,** i.e., \( \frac{\partial (1/\lambda_1)}{\partial r} < 0 \).

3. **Price informativeness increases with her degree of short-termism,** i.e., \( \frac{\partial (1/\text{Var}[v|x_1])}{\partial r} > 0 \).

Since a higher degree of short-termism leads to a more precise disclosure on the part of the informed trader, there is less uncertainty about the value of the risky asset, \( v \), after the disclosure. Less uncertainty allows the market maker to set the price less sensitive to each unit of order flow. It would then be in the informed trader’s interest to keep trading more aggressively. Finally, the informed trader’s aggressive trading further increases price informativeness after the disclosure.

**Corollary 4.2**

*After an informed trader discloses her holdings in the risky asset,*

1. **The informed trader’s trading intensity increases with her degree of short-termism,** i.e., \( \frac{\partial \beta_2}{\partial r} > 0 \).
2. Stock liquidity increases with her degree of short-termism, i.e., \( \frac{\partial (1/\lambda_2)}{\partial r} < 0. \)

3. Price informativeness increases with her degree of short-termism, i.e., \( \frac{\partial (1/\text{Var}[v|y_1, x_2])}{\partial r} > 0. \)

4.4 Extension

In this section, I extend my model to two different settings. In the first extension, I assume that the informed trader is no longer fully informed upfront. Instead, she receives different pieces of information at different points in time. This is a noteworthy extension because, in practice, fund managers are unlikely to know the true value of the stock in which they are investing in advance. Learning the value of the stock takes time. It is plausible that, after learning the new information, the fund manager will find that the initial investment no longer seems profitable and would prefer unwinding her trading position before the payoff of the stock is realized.

In the second extension, I grant some liquidity traders discretion about when to participate in market trading. When the liquidity traders are risk-neutral and unrestricted in allocating their trades across time, they trade strategically to minimize their trading costs. Knowing that liquidity traders are the source of trading profits for the informed trader and that the informed trader’s trading and disclosures affect stock liquidity, I am interested in studying how endogenizing liquidity trader’s trading decisions would affect the informed trader’s trading strategies.
4.4.1 Information Flow

The value of the risky asset is assumed to be the sum of two random variables: \( \tilde{v} = \tilde{v}_1 + \tilde{v}_2 \), where \( \tilde{v}_t \) is normally and independently distributed with mean 0 and variance \( \sigma^2_{v_t}, t \in \{1, 2\} \).

Figure 4.2 summarizes this sequence of events.

Before date 1, the informed trader privately learns \( v_1 \) and then trades the amount of \( y_1 \) of the risky asset along with the liquidity traders whose demand for the risky asset is denoted by \( z_1 \) at date 1. The market maker observes the aggregated order flow \( x_1 = y_1 + z_1 \) and sets the price at \( p_1 \). After date 1, the informed trader publicly discloses \( y_1 \) and then privately learns the second signal, \( v_2 \). At date 2, both the informed trader and liquidity traders trade the risky asset again at the price \( p_2 \). Finally, the payoff of the risky asset, \( v = v_1 + v_2 \), is realized at date 3.
In this extension, the ratio $\phi \equiv \frac{\sigma_{v2}}{\sigma_{v1}}$ captures how the informed trader’s information advantages are distributed over time. If $\phi = 0$, the model conforms to the baseline model in which the informed trader is fully informed before trading at date 1. If $\phi > 1$, then the informed trader’s knowledge about $v_2$ is more important and gives the informed trader more information advantage after public disclosure.

Following the procedures outlined in the model in the section 4.2, I first solve for a mixed-strategy equilibrium in which the informed trader randomizes her trade at date 1 by adding a noise component to her demand for the risky asset. The following proposition characterizes the mixed-strategy equilibrium when the informed trader gradually learns the value of the risky asset.

**Proposition 4.2 (Mixed-Strategy Equilibrium)**

Given $r > 0$ and $0 \leq \phi < \frac{1}{1 + r}$, in the economy where the informed trader gradually learns the value of the risky asset and is mandated to disclose her holdings in the risky asset after date 1, there exists a mixed-strategy equilibrium characterizing the strategies of the informed trader $(y_1, y_2)$ and the market maker $(p_1, p_2)$ as follows:

\[
y_1 = \beta_1 v_1 + u_1, \quad \text{where } u_1 \sim (0, \Sigma_u), \tag{4.23}
\]

\[
y_2 = \alpha_2 + \beta_2 (v - p_1^*), \tag{4.24}
\]

\[
p_1 = \lambda_1 x_1, \tag{4.25}
\]

\[
p_1^* = \gamma_1 y_1, \tag{4.26}
\]

\[
p_2 = p_1^* + \lambda_2 (x_2 - \alpha_2), \tag{4.27}
\]
where

$$\beta_1 = \frac{\sigma_z}{\sigma v_1} \frac{(1 + r) \sqrt{1 + \phi^2}}{\sqrt{1 + (1 + r)^2}}, \quad (4.28)$$

$$\beta_2 = \frac{\sigma_z}{\sigma v_1} \frac{\sqrt{1 + (1 + r)^2}}{\sqrt{1 + \phi^2}}, \quad (4.29)$$

$$\lambda_1 = \frac{1}{2 \beta_1}, \quad (4.30)$$

$$\lambda_2 = \frac{1}{2 \beta_2}, \quad (4.31)$$

$$\gamma_1 = 2 \lambda_1, \quad (4.32)$$

$$\sigma_u^2 = \frac{1 - (1 + r)^2 \phi^2}{1 + (1 + r)^2} \sigma_z^2. \quad (4.33)$$

When $\phi = 0$, the results of Proposition 4.2 are reduced to those in Proposition 4.1. When $\phi > 0$, I noticed that the mixed-strategy equilibrium exists so that the informed trader needs to randomize her date 1 trade if the condition $\phi < \frac{1}{1 + r}$ is met. If the informed trader does not randomize at all at date 1, her long-term performance will be negatively affected because the informed trader is no longer able to exploit $v_1$ fully with a dynamic trading strategy. Meanwhile, adding no noise to her date 1 trade improves the informed trader’s short-term performance because the market maker learns more private information from the informed trader’s public disclosure and the inter-temporal price change is in the informed trader’s favor.

This argument helps us better understand the inequality, $\phi < \frac{1}{1 + r}$. In particular, on the left-hand side, $\phi$ indicates the relative importance of trading on $v_2$ relative to trading on $v_1$ and measures the informed trader’s disincentive to randomize her trade at date 1. On the
right-hand side, $\frac{1}{1+r}$ is inversely related to the informed trader’s degree of short-termism. It also measures the informed trader’s incentive to randomize at date 1 and to exploit her information advantage about $v_1$ in two periods. The randomization is therefore the equilibrium strategy if the informed trader’s incentive (i.e., $\frac{1}{1+r}$) outweighs her disincentive (i.e., $\phi$). When the relation between $\phi$ and $\frac{1}{1+r}$ reverses, there exists a pure-strategy equilibrium that is formally characterized in the following proposition.

**Proposition 4.3 (Pure-Strategy Equilibrium)**

*Given $r > 0$ and $\phi \geq \frac{1}{1+r}$, in the economy where the informed trader gradually learns the value of the risky asset and is mandated to disclose her holdings in the risky asset after date 1, there exists a mixed-strategy equilibrium characterizing the strategies of the informed trader $(y_1, y_2)$ and the market maker $(p_1, p_2)$ as follows:*

\[ y_1 = \beta_1 v_1, \]  
\[ y_2 = \alpha_2 + \beta_2 (v - p_1^*), \]  
\[ p_1 = \lambda_1 x_1, \]  
\[ p_1^* = \gamma_1 y_1, \]  
\[ p_2 = p_1^* + \lambda_2 (x_2 - \alpha_2), \]

*where*

\[ \beta_1 = \frac{\sigma_z}{\sigma_{v_1}}, \beta_2 = \frac{\sigma_z}{\sigma_{v_2}}, \lambda_1 = \frac{1}{2\beta_1}, \lambda_2 = \frac{1}{2\beta_2}, \gamma_1 = \frac{1}{\beta_1}. \]

The above proposition shows that the pure-strategy equilibrium exists if and only if
\[ \phi \geq \frac{1}{1+r}. \] The right-hand side, \( \frac{1}{1+r} \), reaches its maximum, 1, when \( r = 0 \). Thus, as long as the informed trader has a nonzero degree of short-termism, the pure-strategy equilibrium exists if \( \phi > 1 \). This suggests that \( v_2 \) should be at least as important as \( v_1 \) in determining the informed trader’s trading strategies. Such a condition ensures that there are nontrivial amounts of uncertainty about \( v \) unresolved after the informed trader’s disclosure and that the informed trader maintains enough information advantage when she trades at date 2.

According to the pure-strategy equilibrium, the informed trader does not add noise to her date 1 trade, and her interim date disclosure decouples the periods. It is easy to find that the expressions for \( \beta_s \) and \( \lambda_s \) correspond to those to two single-period Kyle (1985) model and that they are not affected by the informed trader’s degree of short-termism, \( r \).^{18}

### 4.4.2 Discretionary Liquidity Traders

Until this point, liquidity traders are assumed to mechanically participate in market trading and to have no control over the timing of their trades. In the second extension of the baseline model, I relax this assumption by endowing some liquidity traders with the ability to allocate their trades across two trading dates. These liquidity traders are referred as discretionary liquidity traders.

The sequence of events is the same as that in the baseline model. The difference lies in the composition of the liquidity traders’ order flows. Following Bushman et al. (1997), I assume that there are \( L \) uninformed liquidity traders in the model. Each liquidity trader receives

\[ E[x_{2|y_1}] = \alpha_2 = ry_1. \] However, the effect of the informed trader’s short-termism on the aggregate order flow is anticipated by the market maker. As a result, only the unexpected portion of the date 2 aggregate order flow, \( x_2 - \alpha_2 \), will affect the equilibrium price at date 2.

---

^{18} In fact, a greater \( r \) only leads to higher expected aggregate order flow at date 2, i.e., \( E[x_{2|y_1}] = \alpha_2 = ry_1 \). However, the effect of the informed trader’s short-termism on the aggregate order flow is anticipated by the market maker. As a result, only the unexpected portion of the date 2 aggregate order flow, \( x_2 - \alpha_2 \), will affect the equilibrium price at date 2.
two independent liquidity shocks, $z_{1j}$ and $z_{2j}$, $j = 1, 2 \ldots L$. The $z_j$s are independent standard normal random variables. Furthermore, I assume that $D$ out of $L$ liquidity traders are discretionary liquidity traders. These discretionary liquidity traders can observe both liquidity shocks $z_{1j}$ and $z_{2j}$ before trading at date 1 and then they allocate their liquidity trades between dates 1 and 2. In particular, to minimize her expected trading costs over two trading dates, a discretionary liquidity trader must select $\delta^*$ such that she will trade $\delta^*(z_{1j} + z_{2j})$ at date 1 and $(1 - \delta^*)(z_{1j} + z_{2j})$ at date 2. Given that the cost per share of trading at date $t$ is $p_t - v$, the discretionary liquidity trader $j$’s objective function is

$$\min_{\delta} E \left[ \delta(z_{1j} + z_{2j})(p_1 - v) + (1 - \delta)(z_{1j} + z_{2j})(p_2 - v) \right].$$

(4.40)

Finally, letting $z_1$ and $z_2$ denote the aggregate liquidity trades at dates 1 and 2, respectively, I have:

$$z_1 = \sum_{j=1}^{D} \delta(z_{1j} + z_{2j}) + \sum_{j=D+1}^{L} z_{1j},$$

(4.41)

$$z_2 = \sum_{j=1}^{D} (1 - \delta)(z_{1j} + z_{2j}) + \sum_{j=D+1}^{L} z_{2j}.$$  

(4.42)

After endogenizing the timing of some liquidity traders’ trades, I find that both the informed trader’s trading strategies and the market maker’s pricing strategies are no longer in equilibrium in this new setting. Suppose that both the informed trader and the market maker follow the same strategies characterized in Proposition 4.1 – that is, the discretionary liquidity traders understand that they face higher trading costs at date 1 than at date 2.
Therefore, they shift their liquidity trades from date 1 to date 2, resulting in less aggregate liquidity trading at date 1. Given that liquidity trading camouflages informed trading, when the aggregate liquidity trading decreases, the market maker can infer more of the informed trader’s private information from the aggregate order flow at date 1 and can increase $\lambda_1$ to make the price more sensitive to the aggregate order flow. Furthermore, due to the reduced information asymmetry he faces after date 1, the market maker can decrease $\lambda_2$ at date 2. Understanding the market maker’s adjustments, the informed trader has incentive to deviate from her equilibrium trading strategies by trading less on her private information at date 1 but trading more aggressively at date 2. Such a deviation will increase the informed trader’s expected payoff over two trading periods.

When characterizing the equilibrium in the new setting, I must take the discretionary liquidity traders’ trading decisions into consideration. A new equilibrium is then defined as an informed trader’s trading strategies $(y_1^*, y_2^*)$, discretionary liquidity traders’ strategy $\delta^*$, and pricing functions $(p_1^*, p_2^*)$, such that

1. Taking $(\delta^*, p_1^*, p_2^*)$ as given, $(y_1^*, y_2^*)$ maximize the informed trader’s expected payoff over both trading dates; and

2. Taking $(\delta^*, y_1^*, y_2^*)$ as given, the market maker sets $p_1^*$ and $p_2^*$ to break even at each trading date; and

3. Taking $(y_1^*, y_2^*, p_1^*, p_2^*)$ as given, $\delta^*$ minimizes the discretionary liquidity trader’s expected trading costs over both trading dates.

Given that discretionary liquidity traders optimally allocate their trades between two
trading dates, the following proposition characterizes the strategies of the informed trader and the market maker

**Proposition 4.4**

For a given $\delta$, there exists a unique (linear) equilibrium characterizing the strategies of the informed trader $(y_1, y_2)$ and the market maker $(p_1, p_2)$ as follows:

\begin{align*}
y_1 &= \beta_1 v + u_1, \quad \text{where } u_1 \sim (0, \Sigma_u), \quad (4.43) \\
y_2 &= \alpha_2 + \beta_2 (v - p_1^*), \quad (4.44) \\
p_1 &= \lambda_1 x_1, \quad (4.45) \\
p_1^* &= \gamma_1 y_1, \quad (4.46) \\
p_2 &= p_1^* + \lambda_2 (x_2 - \alpha_2), \quad (4.47)
\end{align*}

where

\begin{align*}
\beta_1 &= \frac{1 + r \ Var(z_1)}{M \ \sigma_v}, \quad (4.48) \\
\beta_2 &= \frac{1}{2\lambda_2}, \quad (4.49) \\
\lambda_1 &= \frac{(1 + r)\sigma_v}{2M}, \quad (4.50) \\
\lambda_2 &= \frac{\sigma_v}{2M^2}, \quad (4.51) \\
\gamma_1 &= \frac{(1 + r)\sigma_v}{M}, \quad (4.52) \\
\Sigma_u &= \frac{Var(z_1)Var(z_2|z_1)}{M^2}, \quad (4.53)
\end{align*}
and

\[ Var(z_1) = 2\delta^2 D + L - D, \]  
\[ Var(z_2|z_1) = \frac{4D^2\delta^2(1-\delta)^2}{2\delta^2 D + L - D}, \]  
\[ M^2 = Var(z_2|z_1) + (1 + r)^2 Var(z_1). \]

In Proposition 4.4, \( \Sigma_u \) captures the extent to which the informed trader randomizes her trade at date 1. \( \Sigma_u \) conforms to that in Proposition 4.1 with two additional features: (i) the variations in liquidity trading are different at two trading dates, i.e., \( Var(z_1) \neq Var(z_2) \) and (ii) liquidity trade has nonzero time-series correlation, i.e., \( \text{Cov}(z_1, z_2) = 2\delta(1 - \delta)D \). Through the term \( M \), these two features influence both the intensity with which the informed trader’s information advantage is exploited and equilibrium price sensitivities to the aggregate flows.

The objective of discretionary liquidity traders is to minimize their expected trading costs. Substituting \( p_1 \) and \( p_2 \) from Proposition 4.4 into the discretionary liquidity traders’ cost minimization problem as specified in (4.40) yields the following problem for each discretionary liquidity trader

\[ \min_{\delta} \left[ \lambda_1 \delta^2 + \lambda_2 \left( (1 - \delta)^2 - \gamma_1 \delta(1 - \delta) \right) \right] (z_{1j} + z_{2j})^2. \]  

The first term, \( \lambda_1 \delta^2 \), captures the cost of trading at date 1, which increases with \( \lambda_1 \). The term multiplying \( \lambda_2 \) captures the effect of discretionary liquidity trading on \( p_2 \). The term, \( (1 - \delta)^2 \), represents the pricing effect of the total discretionary liquidity trading at date
2. Finally, the term, $\gamma_1 \delta (1 - \delta)$, reflects the impact of the *expected* discretionary liquidity trading. After the informed trader discloses her holdings in the risky asset, the market maker anticipates the amount of discretionary liquidity trading at date 2 based on the time-series correlation in the liquidity trading and adjusts $p_2$ accordingly. Therefore, only the *unexpected* discretionary liquidity trading has a pricing effect at date 2. The discretionary liquidity trader’s optimal choice of $\delta$ is characterized in the following corollary:

**Corollary 4.3**

Given $\lambda_1$, $\lambda_2$, and $\gamma_1$, a discretionary liquidity trader chooses $\delta$ such that

$$
\delta = \frac{(2 + \gamma_1) \lambda_2}{2[\lambda_1 + (1 + \gamma_1) \lambda_2]} = \frac{1 + \lambda_2}{2(1 + \lambda_2) + r}.
$$

(4.58)

The proportion of discretionary liquidity trading traded at date 1, $\delta$, depends on both market liquidity at date 2, $\lambda_2$, and the informed trader’s degree of short-termism, $r$. It is clear from Proposition 4.4 that when the informed trader values her short-term performance, stock liquidity is always higher at date 2. From Corollary 4.3, we also learn that $\delta$ is less than $\frac{1}{2}$ when $r > 0$. This means that discretionary liquidity traders are attracted to periods of higher liquidity because greater liquidity lowers trading costs.

### 4.5 Summary

In this chapter, I have studied fund managers’ trading strategies around the mandatory disclosure of their portfolio holdings. Building on Kyle (1985) and Huddart et al. (2001), I develop a model that allows mandatory disclosure of informed traders who value and place
different weights on long-term and short-term performances.

Similar to Huddart et al. (2001), I find that when the informed trader is fully informed about the value of the risky asset, she will optimally randomize her trade before public disclosure by adding a noise component to her market order. Furthermore, the extent to which the informed trader randomizes her trade decreases with her degree of short-termism, which is the relative weight the informed trader places on short-term performance. However, if the informed trader gradually learns the value of the risky asset and receives two private signals throughout the course of trading, randomization is not always her equilibrium strategy. Further, I show that, when knowing the second private signal is as important as knowing the first one, the informed trader will stop randomizing her trade at date 1.

My model also yields several predictions about the effects of the informed trader’s short-termism on stock liquidity and price informativeness. First, when the informed trader has a higher degree of short-termism, I find that the informed trader trades more aggressively on her private information both before and after she publicly discloses her holdings in the risky asset. Second, I find that the stock liquidity decreases (increases) with the informed trader’s degree of short-termism before (after) the disclosure. Finally, I demonstrate that price informativeness increases with the informed trader’s short-termism both before and after public disclosure.
Chapter 5

Conclusion and Future Research

Recently, an interesting phenomenon has arisen in which some fund managers publicly and voluntarily disclose their private information before they have finished accumulating their trading positions in a stock that they believe to be mis-valued. Such a phenomenon is puzzling because public disclosure costs the disclosing fund manager her information advantage as well as her future trading profit.

The first goal of this dissertation has been to offer a rational explanation for this puzzle. In the third chapter, I model a fund manager as an informed trader who values and puts different weight on long-term *realized* trading profits and short-term *unrealized* paper profits. I show that short-termism can induce an informed trader’s voluntary disclosure within the two-period strategic trading model based on Kyle (1985). By strategically choosing her disclosure policy—namely, whether to disclose some private information between two trading dates and the disclosure precision if she chooses to disclose—the informed trader deliberately balances her long-term performance with her short-term performance. My findings suggest
that voluntary disclosure is optimal to the informed trader if the relative weight she places on the short-term performance, i.e., her degree of short-termism, is greater than a threshold.

Further analyses show that both stock liquidity and price informativeness increase after the informed trader’s disclosure. This finding alone is noteworthy because fund managers’ short-termism is often blamed for corporate myopia. For example, Agarwal et al. (2018) found that pressure from mutual fund managers to report good investment performance in the short run hinders corporate investment in innovative projects that hurt short-term profits but generate value in the long run. My study, however, documents one positive effect of fund managers’ short-termism: improvement in market efficiency by inducing fund managers’ voluntary disclosure in the course of trading.

Given the importance of investment funds in today’s capital market, regulators have sought different ways to strengthen the oversight of fund operations. The latest efforts have included increasing the frequency with which mutual fund managers are mandated to report their portfolio holdings. The second and third goals of my dissertation were to determine how mandatory disclosure requirements influence fund managers’ strategic tradings and to establish whether new regulations fulfill regulators’ intention to reduce information asymmetry between fund managers and fund investors. I conduct this analysis in the fourth chapter of the text. The model that I develop in that chapter parallels the model outlined in Chapter 3, except in terms of the content of the informed trader’s disclosures. Instead of disclosing a noisy signal about the informed trader’s private information, she discloses her holdings in the risky asset between two trading dates. Consistent with the findings in Huddart et al. (2001), I find that the informed trader randomizes her trade before disclo-
sure. Furthermore, the informed trader will randomize her trade to a lesser extent when she has a greater degree of short-termism. Finally, comparative statistics show that both stock liquidity and price informativeness increase after public disclosure. This evidence supports the idea that the mandatory disclosure of portfolio holdings reduces information asymmetry between the fund managers and investors.

The analyses presented in this dissertation are my initial attempts at understanding the interactions between fund managers’ disclosures and strategic trading. In future research, I plan to extend my analysis to a number of new settings. In all of the models studied in this dissertation, there is only one informed trader who is either fully informed upfront or gradually learns about the value of the risky asset as trading progresses. In the future, I plan to replicate the study in a setting where there are multiple informed traders who possess different pieces of private information. When there are multiple informed traders, they not only compete but also learn from one another. Informed traders’ disclosures then serve as the communication devices that promote mutual learning and coordinates strategic tradings among informed traders.

Finally, when fund managers “talk down their stocks” or “talk up their books” in the capital market, they do not share their opinions about the future performance of every stock in their portfolio with the market. Instead, they focus on a single stock most of time. As a result, I plan to investigate informed traders’ disclosures in a setting where the traders’ portfolios contain multiple risky assets. Assets with different rates of return will contribute differently to the informed trader’s long- and short-term investment performances. In this new setting, the informed trader not only trades multiple assets, but also strategically
choose the risky asset about which she is willing to disclose some private information in the course of trading.
Bibliography


Appendix A

Proofs for Chapter 3

Proof of Proposition 3.1:

To solve for a linear equilibrium, the market maker makes an educated guess about the informed trader’s demand at date $t$, $t \in \{1, 2\}$:

$$y_1 = \hat{\beta}_1 v,$$

$$y_2 = \hat{\alpha}_2 + \hat{\beta}_2 (v - p_1) + \hat{\gamma}_2 [y_1 - E(y_1|x_1)].$$

And from the informed trader’s perspective, she conjectures the market maker’s pricing rules in the following manner:

$$p_1 = \hat{\lambda}_1 x_1,$$

$$p_2 = p_1 + \hat{\lambda}_2 [x_2 - E(x_2|x_1)].$$
Applying the principal of backward induction, I can write the informed trader’s date 2 optimization problem given $y_1, p_1$ as

$$y_2 \in \arg \max_{y_2} E[y_2(v - p_2) + r y_1(p_2 - p_1)|v, p_1, y_1],$$

where

$$E[y_2(v - p_2) + r y_1(p_2 - p_1)|v, p_1, y_1]$$

$$= E\left\{ y_2 \left[ v - p_1 - \hat{\lambda}_2(x_2 - E(x_2|x_1)) \right] + r y_1 \hat{\lambda}_2 \left[ x_2 - E(x_2|x_1) \right] | v, p_1, y_1 \right\}$$

$$= y_2 \left[ v - p_1 - \hat{\lambda}_2(y_2 - E(y_2|x_1)) \right] + r y_1 \hat{\lambda}_2 \left[ y_2 - E(y_2|x_1) \right].$$

Solving the first-order condition for $y_2$ yields:

$$y_2 = \frac{v - p_1}{2 \hat{\lambda}_2} + \frac{r}{2} y_1 + \frac{1}{2} E(y_2|x_1). \quad (A.1)$$

And the second-order condition is satisfied when $\hat{\lambda}_2 > 0$. Taking the conditional expectation of both sides of equation (A.1) given $x_1$ yields $E(y_2|x_1) = r E(y_1|x_1)$. Equation (A.1) then is re-written as

$$y_2 = r E(y_1|x_1) + \frac{v - p_1}{2 \hat{\lambda}_2} + \frac{r}{2} y_1 + E(y_1|x_1). \quad (A.2)$$

which implies

$$\hat{\alpha}_2 = r E(y_1|x_1), \quad \hat{\beta}_2 = \frac{1}{2 \hat{\lambda}_2}, \quad \gamma_2 = \frac{r}{2}.$$
Given the conjectured informed trader’s demand at date 1 is \( y_1 = \hat{\beta}_1 v \), the intercept, \( \hat{\alpha}_2 \), could be further derived as

\[
\hat{\alpha}_2 = r E(y_1|x_1) = r \hat{\beta}_1 E(v|x_1) = r \hat{\beta}_1 p_1,
\]

and

\[
W_2(v, p_1, y_1) = E[y_2(v - p_2) + r y_1(p_2 - p_1)|v, p_1, y_1]
\]

\[
= \frac{1}{4 \hat{\lambda}_2}[(v - p_1) + r \hat{\beta}_1 \hat{\lambda}_2 p_1 + r \hat{\lambda}_2 y_1]^2 - r^2 \hat{\beta}_1 \hat{\lambda}_2 p_1 y_1.
\]

At date 1, the informed trader’s optimization problem is written as

\[
y_1 \in \arg \max_{y_1} E[y_1(v - p_1) + W_2(v, p_1, y_1)|v].
\]

Substituting the conjectured \( p_1 = \hat{\lambda}_1 x_1 \) into the above optimization problem and solving the first-order condition for \( y_1 \) yield:

\[
y_1 = \frac{(2 + r + r \hat{\beta}_1 \hat{\lambda}_1) \hat{\lambda}_2 - \hat{\lambda}_1}{4(1 + r)(1 + r \hat{\beta}_1 \hat{\lambda}_1) \hat{\lambda}_2^2 - \left[(2 + r + r \hat{\beta}_1 \hat{\lambda}_1) \hat{\lambda}_2 - \hat{\lambda}_1\right]^2} \cdot v,
\]

which implies:

\[
\hat{\beta}_1 = \frac{(2 + r + r \hat{\beta}_1 \hat{\lambda}_1) \hat{\lambda}_2 - \hat{\lambda}_1}{4(1 + r)(1 + r \hat{\beta}_1 \hat{\lambda}_1) \hat{\lambda}_2^2 - \left[(2 + r + r \hat{\beta}_1 \hat{\lambda}_1) \hat{\lambda}_2 - \hat{\lambda}_1\right]^2}.
\]
The second-order condition is satisfied when:

\[
4(1 + r)(1 + r\hat{\beta}_1\hat{\lambda}_1)\hat{\lambda}_2^2 - \left[(2 + r + r\hat{\beta}_1\hat{\lambda}_1)\hat{\lambda}_2 - \hat{\lambda}_1\right]^2 > 0.
\] (A.3)

In the next, I am going to solve for parameters used in the conjectured pricing rules, \(\hat{\lambda}_1\) and \(\hat{\lambda}_2\). By projection theorem:

\[
\hat{\lambda}_1 = \frac{\text{Cov}(v, x_1)}{\text{Var}(x_1)} = \frac{\hat{\beta}_1\sigma_v^2}{\hat{\beta}_2\sigma_v^2 + \sigma_z^2},
\]

\[
\hat{\lambda}_2 = \frac{\text{Cov}(v, x_2|x_1)}{\text{Var}(x_2|x_1)} = \frac{(\hat{\beta}_2 + \hat{\beta}_1\hat{\gamma}_2)\Sigma_1}{(\hat{\beta}_2 + \hat{\beta}_1\hat{\gamma}_2)^2\Sigma_1 + \sigma_z^2},
\]

where

\[
\Sigma_1 = \text{Var}[\tilde{v}|\tilde{x}_1] = \frac{\sigma_v^2\sigma_z^2}{\hat{\beta}_1^2\sigma_v^2 + \sigma_z^2}.
\]
Finally, all of endogenous parameters \( \{ \hat{\beta}_1, \hat{\beta}_2, \hat{\gamma}_2, \hat{\lambda}_1, \hat{\lambda}_2 \} \) are solved with the following equation system:

\[
\begin{align*}
\hat{\beta}_1 &= \frac{(2 + r + \hat{\beta}_1 \hat{\lambda}_1) \hat{\lambda}_2 - \hat{\lambda}_1}{4(1 + r)(1 + r \hat{\beta}_1 \hat{\lambda}_1) \hat{\lambda}_2^2 - [(2 + r + \hat{\beta}_1 \hat{\lambda}_1) \hat{\lambda}_2 - \hat{\lambda}_1]^2} \\
\hat{\beta}_2 &= \frac{1}{2 \lambda_2} \\
\hat{\gamma}_2 &= \frac{r}{2} \\
\hat{\lambda}_1 &= \frac{\hat{\beta}_1 \sigma_v^2}{\hat{\beta}_1^2 \sigma_v^2 + \sigma_z^2} \\
\hat{\lambda}_2 &= \frac{(\hat{\beta}_2 + \hat{\beta}_1 \hat{\gamma}_2) \Sigma_1}{(\hat{\beta}_2 + \hat{\beta}_1 \hat{\gamma}_2)^2 \Sigma_1 + \sigma_z^2} \\
\Sigma_1 &= \frac{\sigma_v^2 \sigma_z^2}{\hat{\beta}_1^2 \sigma_v^2 + \sigma_z^2}
\end{align*}
\]

Equations (A.5), (A.6), (A.8) and (A.9) together yield:

\[
\hat{\lambda}_2 = \frac{\sigma_v}{\sqrt{(4 + r^2) \hat{\beta}_1^2 \sigma_v^2 + 4 \sigma_z^2}}. 
\]

Plugging equations (A.7) and (A.10) into equation (A.4) yields:

\[
\hat{\beta}_1 \frac{\sigma_v}{\sigma_z} \left[ (4 + r^2) \frac{\beta_1^2 \sigma_v^2}{\sigma_z^2} + (4 - r^2) \right] = \sqrt{4 + (4 + r^2) \hat{\beta}_1^2 \sigma_v^2 \left( 1 - \frac{\beta_1^2 \sigma_v^2}{\sigma_z^2} \right)} \left[ (r + 2) + 2(r + 1) \hat{\beta}_1^2 \sigma_v^2 \right].
\]

(A.11)

I define \( a \equiv \frac{\beta_1^2 \sigma_v^2}{\sigma_z^2} \). After substituting it into (A.11), I get:

\[
G(a; r) \equiv \sqrt{a} \left[ 4(a + 1) + r^2(a - 1) \right] - (1 - a) \left[ (r + 2) + 2a(r + 1) \right] \sqrt{4 + (4 + r^2)a}. 
\]

(A.12)
This is a necessary condition. If a linear equilibrium exists, then $\hat{\beta}_1$ is given by $\sqrt{a^*} \cdot \frac{\sigma_v}{\sigma_z}$, where $a^* > 0$ solves $G(a^*; r) = 0$; and values for the remaining endogenous variables are (uniquely) determined by the equations system above.

In order for the second-order condition (A.3) to be satisfied, $a^*$ should be in the range $\left(\frac{r^2}{r^2 + 4}, 1\right)$. For any $r > 0$, at least one solution to $G = 0$ exists in this range. It is because $G$ is continuous and

$$G\left(\frac{r^2}{r^2 + 4}, \cdot \right) = -\frac{8 \left[4 + r^2(r + 2)\right]}{(4 + r^2)^{3/2}} < 0,$$

$$G(1; \cdot) = 8 > 0.$$  

Let $a^* > 0$ be such a solution and re-write equation (A.4) as

$$\hat{\beta}_1 \frac{\sigma_v}{\sigma_z} = \frac{2a^*(r + 1) + (r + 2) - \sqrt{(4 + r^2)a^{*2} + 4a^*}}{(a^* + 1)S},$$

(A.13)

where

$$S = \frac{[4 + 4a^*(1 + r)] \sqrt{4a^* + a^{*2}(4 + r^2)} - \left[\sqrt{4a^* + a^{*2}(4 + r^2)} - r\right]^2}{(1 + a^*)^2 \left[4 + a^*(4 + r^2)\right]}.$$  

The second-order condition (A.3) is satisfied when $S > 0$. Since

$$[2a^*(r + 1) + (r + 2)]^2 - [4 + r^2]a^{*2} + 4a^* = (1 + a^*) \left[4 + 4(2a^* + 1)r + (1 + 3a^*)r^2\right] > 0.$$  

The numerator of equation (A.13) is positive. Therefore, the sign of $S$ is the same as the
sign of \( \hat{\beta}_1 \) in equilibrium. This means that satisfying the second-order condition (A.3) is equivalent to selecting the positive root of \( a^* \) in determining \( \hat{\beta}_1 \) according to \( \hat{\beta}_1 = \sqrt{a^* \cdot \frac{\sigma_z}{\sigma_v}} \).

Taking these facts together implies that (i) any solution to \( G = 0 \) is an equilibrium provided that its positive root is used in determining \( \hat{\beta}_1 \), and (ii) at least one equilibrium exists for any \( r > 0 \).

I next show that, for any \( r > 0 \), equilibrium is unique. This is done by demonstrating that \( \frac{\partial G(a^*:r)}{\partial a} > 0 \) when evaluated at a solution \( a^* \). Since the function \( G \) is continuous, this condition implies that \( G \) crosses the \( a \)-axis only once. To verify, differentiate \( G \)

\[
\frac{\partial G}{\partial a} = \frac{3a(4 + r^2) + (4 - r^2)}{2\sqrt{a}} + [4a(r + 1) - r]\sqrt{4 + a(4 + r^2)} - \frac{(1 - a)(4 + r^2)(2 + r + 2a(1 + r))}{2\sqrt{4 + a(4 + r^2)}}. \tag{A.14}
\]

At a solution \( a^* \),

\[
(1 - a) [(r + 2) + 2a(r + 1)] = \frac{\sqrt{a} \ [4(a + 1) + r^2(a - 1)]}{\sqrt{4 + a(4 + r^2)}}. \tag{A.15}
\]

Substituting it to the third term of equation (A.14) yields

\[
\frac{\partial G}{\partial a} = \frac{3a(4 + r^2) + (4 - r^2)}{2\sqrt{a}} + [4a(r + 1) - r]\sqrt{4 + a(4 + r^2)} - \frac{(4 + r^2)\sqrt{a} \ [4(a + 1) + r^2(a - 1)]}{2 \ [4 + a(4 + r^2)]}
> \frac{4(a + 1) + r^2(a - 1)}{2\sqrt{a}} + [4a(r + 1) - r]\sqrt{4 + a(4 + r^2)}
= \frac{[(r + 2) - a(4 + r) + 2a^2(3r + 5)] \sqrt{4 + a(4 + r^2)}}{2a}. \tag{A.16}
\]

The sign of \( \frac{\partial G}{\partial a} \) is, therefore, the same as the sign of \( [(r + 2) - a(4 + r) + 2a^2(3r + 5)] \).
tedious calculation shows that

\[
\frac{\partial G}{\partial a} = \left( r + 2 - a(4 + r) + 2a^2(3r + 5) \right) \frac{\sqrt{4 + a(4 + r^2)}}{2a} > 0.
\]

To conclude, \( \frac{\partial G}{\partial a} \) is positive in equilibrium, which implies that the equilibrium is unique in the affine class.

**Proof of Corollary 3.1:**

Before proceeding to prove the claims in Corollary 1, I first examine the relation between \( a \) and \( r \). Applying the implicit function theorem, I have

\[
a'(r) = -\frac{G_r(a; r)}{G_a(a; r)},
\]

where

\[
G_r(a; r) = \frac{2(a - 1) \left[ 2 + a(r^2 + r + 6) + r\sqrt{a^2(4 + r) + 4a} \right]}{\sqrt{a(4 + r^2) + 4}}.
\]

In the Proof of Proposition 1, I show that: (i) \( a < 1 \), and (ii) \( G_a(a; r) > 0 \). Therefore, \( a'(r) > 0 \).

Part (1) of Corollary 3.1:

\[
\frac{\partial \beta_1}{\partial r} = a'(r) \frac{\sigma_z}{\sigma_v} > 0, \quad \frac{\partial \beta_2}{\partial r} = \frac{2ra + (4 + r^2) a'(r) \sigma_z}{4\sqrt{4 + (4 + r^2)a} \sigma_v} > 0.
\]
Part (2) of Corollary 3.1: Note that $E\left[\pi_{1,LT,T}\right] = \frac{\sqrt{a}}{a+1}\sigma_v\sigma_z$, then

$$\frac{\partial E\left[\pi_{1,LT,T}\right]}{\partial r} = \frac{(1-a)a'(r)}{2\sqrt{a}(1+a)^2}\sigma_v\sigma_z > 0.$$ 

Part (3) of Corollary 3.1: Note that $E\left[\pi_{2,LT,T}\right] = \frac{1}{\sqrt{(4+r^2)a+4}}\sigma_v\sigma_z$, then

$$\frac{\partial E\left[\pi_{2,LT,T}\right]}{\partial r} = \frac{-2ar + (4+r^2)a'(r)}{2\left[4+(4+r^2)a\right]^{3/2}}\sigma_v\sigma_z < 0.$$ 

Part (4) of Corollary 3.1: Note that $E\left[\pi_{ST,T}\right] = \frac{\sqrt{a}}{2(a+1)}\left(1 + r\sqrt{\frac{a}{a(4+r^2)+4}}\right)\sigma_v\sigma_z$, then

$$\frac{\partial E\left[\pi_{ST,T}\right]}{\partial r} = \frac{g(a,r)}{4\sqrt{a(1+a)^2}}\sigma_v\sigma_z > 0,$$

where

$$g(a,r) = (1-a)\left(1 + r\sqrt{\frac{a}{a(4+r^2)+4}}\right) + \frac{4\sqrt{a}(1+a)\left[2a(1+a) + ra'(r)\right]}{[a(4+r^2)+4]^{3/2}}.$$ 

**Proof of Proposition 3.2:**

To solve for a linear equilibrium, the market maker makes an educated guess with respect to the informed trader’s demand at date 1, $y_1 = \hat{\beta}_1 v$. From the informed trader’s perspective,
she conjectures the market maker’s pricing rules at dates 1 and 2:

\[
p_1 = E[v|x_1] = \hat{\lambda}_1 x_1, \]
\[
p_2 = E[v|x_1, s] = (1 - \hat{\lambda}_2)p_1 + \hat{\lambda}_2 s. \]

Substituting the conjectured pricing rules in the objective function yields:

\[
E[y_1(v - \hat{\lambda}_1 x_1) + ry_1\hat{\lambda}_2(s - \hat{\lambda}_1 x_1)|v] = (1 + r\hat{\lambda}_2)y_1(v - \hat{\lambda}_1 y_1). \]

By setting the first order condition equal to zero, we have \( y_1 = \frac{1}{2\hat{\lambda}_1}v \), which implies

\[
\hat{\beta}_1 = \frac{1}{2\hat{\lambda}_1}. \tag{A.17} \]

Using the projection theorem, I could write down the expressions for both \( \hat{\lambda}_1 \) and \( \hat{\lambda}_2 \) such that

\[
\hat{\lambda}_1 = \frac{\text{Cov}(v, x_1)}{\text{Var}(x_1)} = \frac{\hat{\beta}_1 \sigma_v^2}{\sigma^2_v + \sigma_\epsilon^2}, \tag{A.18}
\]
\[
\hat{\lambda}_2 = \frac{\text{Cov}(v, s|x_1)}{\text{Var}(s|x_1)} = \frac{\sigma_\epsilon^2 \sigma_z^2}{\sigma^2_\epsilon (\beta_1^2 \sigma_v^2 + \sigma_z^2) + \sigma^2_\epsilon \sigma_z^2}. \tag{A.19}
\]

Plugging equation (A.17) into equations (A.18) and (A.19) yields

\[
\hat{\beta}_1 = \frac{\sigma_\epsilon}{\sigma_v} ; \quad \hat{\lambda}_1 = \frac{\sigma_v}{2\sigma_z} ; \quad \hat{\lambda}_2 = \frac{\sigma_v^2}{2\sigma_\epsilon^2 + \sigma_\epsilon^2}. \]
Proof of Proposition 3.3:

To prove the claims listed in the Proposition 3.3, I refer to the range of the equilibrium \( a \) characterized in the Proposition 3.1:

\[
\frac{r^2}{r^2 + 4} < a < 1.
\]

Part (1) of Proposition 3.3:

\[
\beta_1^T = \sqrt{\frac{a}{a + 1}} \frac{\sigma_z}{\sigma_v} < \frac{\sigma_z}{\sigma_v} = \beta_1^D.
\]

Part (2) of Proposition 3.3:

\[
\lambda_1^T = \frac{\sqrt{a}}{a + 1} < \frac{1}{2} = \lambda_1^D.
\]

Part (3) of Proposition 3.3:

\[
E\left[ \pi_{LT,T} \right] = \frac{\sqrt{a}}{a + 1} \sigma_v \sigma_z < \frac{1}{2} \sigma_v \sigma_z = E\left[ \pi_{LT,D} \right],
\]

\[
E\left[ \sum_{t=1}^{2} \pi_{LT,T} \right] = \left[ \frac{\sqrt{a}}{a + 1} + \frac{1}{\sqrt{(4 + r^2)(a + 4)}} \right] \sigma_v \sigma_z > \left[ \frac{\sqrt{a}}{a + 1} + \frac{\sqrt{1/a}}{2} \right] \sigma_v \sigma_z > \frac{1}{2} \sigma_v \sigma_z = E\left[ \pi_{LT,D} \right].
\]

Part (4) of Proposition 3.3:

Given that \( E\left[ \pi_{ST,T} \right] = \frac{\sqrt{a}}{2(a + 1)} \left( 1 + r \sqrt{\frac{a}{a(4 + r^2) + 4}} \right) \sigma_v \sigma_z \) and \( \frac{r^2}{r^2 + 4} < a < 1, \)

\[
r \sqrt{\frac{a}{a(4 + r^2) + 4}} < r \sqrt{\frac{1}{4 + r^2}} < 1.
\]
It is apparent that
\[ E \left[ \pi^{ST,T} \right] < \frac{1}{2} \sigma_v \sigma_z = E \left[ \pi^{ST,D} \right]. \]

Part (5) of Proposition 3.3:

If the informed trader adopts the trading-only strategy, her expected payoff is expressed as
\[ E \left[ \sum_{t=1}^{2} \pi^{LT,T}_t + r \pi^{ST,T} \right] \]
\[ = \left[ \frac{\sqrt{a}}{a + 1} + \frac{1}{\sqrt{(4 + r^2)a + 4}} + r \frac{\sqrt{a}}{2(a + 1)} \left( 1 + r \frac{a}{a(4 + r^2) + 4} \right) \right] \sigma_v \sigma_z. \]

If the informed trader adopts the disclosure-only strategy, her expected payoff is expressed as
\[ E \left[ \pi^{LT,D}_1 + r \pi^{ST,D} \right] = \frac{1}{2}(1 + r) \sigma_v \sigma_z. \]

Tedious calculation shows that
\[ E \left[ \sum_{t=1}^{2} \pi^{LT,T}_t + r \pi^{ST,T} \right] > E \left[ \pi^{LT,D}_1 + r \pi^{ST,D} \right]. \]

**Proof of Proposition 3.4:**

To solve for the linear equilibrium, the market maker makes an educated guess regarding the informed trader’s demand at date \( t, t \in \{1, 2\} \):

\[ y_1 = \hat{\beta}_1 v, \]
\[ y_2 = \hat{\alpha}_2 + \hat{\beta}_2(v - p_t^*) + \hat{\gamma}_2[y_1 - E(y_1|x_1, s)], \]
where \( p_1^* = E[v|x_1, s] = (1 - \phi)p_1 + \phi s \). Similarly, the informed trader conjectures the market maker’s pricing rules as follows:

\[
p_1 = \hat{\lambda}_1 x_1,
\]

\[
y_2 = p_1^* + \hat{\lambda}_2 [x_2 - E(x_2|x_1, s)].
\]

Applying the principal of backward induction, I write the informed trader’s date 2 optimization problem given \( y_1 \) and \( p_1 \) as:

\[
y_2 \in \arg \max E[y_2(v - p_2) + ry_1(p_2 - p_1)|v, s, p_1, y_1].
\]

where

\[
E[y_2(v - p_2) + ry_1(p_2 - p_1)|v, s, p_1, y_1]
= E \left[ y_2 \left[ v - p_1^* - \hat{\lambda}_2(x_2 - E(x_2|x_1, s)) \right] + ry_1 \left[ p_1^* + \hat{\lambda}_2(x_2 - E(x_2|x_1, s)) - p_1 \right] |v, s, p_1, y_1 \right] 
= y_2 \left[ v - p_1^* - \hat{\lambda}_2(y_2 - E(y_2|x_1, s)) \right] + ry_1 \left[ p_1^* + \hat{\lambda}_2(y_2 - E(y_2|x_1, s)) - p_1 \right].
\]

Solving the first-order condition for \( y_2 \) yields:

\[
y_2 = \frac{1}{2} E(y_2|x_1, s) + \frac{1}{2\hat{\lambda}_2}(v - p_1^*) + \frac{r}{2} y_1.
\]

And the second-order condition is satisfied when \( \hat{\lambda}_2 > 0 \). Taking the conditional expectation of both sides of equation (A.21) given \( x_1 \) and \( s \) yields \( E(y_2|x_1, s) = r E(y_1|x_1, s) \). Equation
(A.21) then is re-written as

\[ y_2 = rE(y_1|x_1, s) + \frac{1}{2\lambda_2} (v - p_1^*) + \frac{r}{2} [y_1 - E(y_1|x_1, s)], \quad (A.22) \]

which implies

\[ \hat{\alpha}_2 = rE(y_1|x_1, s), \quad \hat{\beta}_2 = \frac{1}{2\lambda_2}, \quad \hat{\gamma}_2 = \frac{r}{2}. \]

Given the market maker’s conjectured informed trader’s market order at date \( t = 1 \), \( y_1 = \hat{\beta}_1 v \), the intercept, \( \hat{\alpha}_2 \), is derived as

\[ \hat{\alpha}_2 = rE(y_1|x_1, s) = r\hat{\beta}_1 p_1^*, \]

and

\[
W_2(v, s, p_1, y_1) = E[y_2(v - p_2) + ry_1(p_2 - p_1)|v, s, p_1, y_1] \\
= \frac{1}{4\lambda_2} \left\{ r^2 y_1^2 \hat{\lambda}_2^2 + 2ry_1 \hat{\lambda}_2 \left[ v - 2p_1 + \left( 1 - r\hat{\beta}_1 \hat{\lambda}_2 \right) p_1^* \right] + \left[ v - \left( 1 - r\hat{\beta}_1 \hat{\lambda}_2 \right) p_1^* \right]^2 \right\}.
\]

The informed trader’s expected payoff at the beginning of the date 1 can be expressed as

\[ E[y_1(v - p_1) + W_2(v, s, p_1, y_1)|v]. \]

After substitutions for \( p_1, p_1^* \) and \( x_1 = y_1 + z_1 \), maximization of date 1 expected payoff with respect to \( y_1 \) gives:

\[ y_1 = \hat{\beta}_1 v, \]
where

$$
\hat{\beta}_1 = -\frac{\hat{\lambda}_2 (2 + r) + (1 - r\hat{\beta}_1\hat{\lambda}_2) \left[r\hat{\lambda}_2\hat{\phi} - \hat{\lambda}_1 \left(1 - \hat{\phi}\right) \left(1 - (1 - r\hat{\beta}_1\hat{\lambda}_2)\hat{\phi}\right)\right]}{r^2\hat{\lambda}_2^2 + \hat{\lambda}_1^2 \left(1 - r\hat{\beta}_1\hat{\lambda}_2\right)^2 \left(1 - \hat{\phi}\right)^2 - 2\hat{\lambda}_1\hat{\lambda}_2 \left[2 + r + r\hat{\phi} + r^2\hat{\beta}_1\hat{\lambda}_2 \left(1 - \hat{\phi}\right)\right]},
$$

and the second-order condition is

$$
r^2\hat{\lambda}_2^2 + \hat{\lambda}_1^2 \left(1 - r\hat{\beta}_1\hat{\lambda}_2\right)^2 \left(1 - \hat{\phi}\right)^2 - 2\hat{\lambda}_1\hat{\lambda}_2 \left[2 + r + r\hat{\phi} + r^2\hat{\beta}_1\hat{\lambda}_2 \left(1 - \hat{\phi}\right)\right] < 0.
$$

In the next, I am going to solve for parameters used in the conjectured pricing rules, $\phi$, $\hat{\lambda}_1$, and $\hat{\lambda}_2$. By projection theorem,

$$
\hat{\lambda}_1 = \frac{\text{Cov}(v, x_1)}{\text{Var}(x_1)} = \frac{\hat{\beta}_1\sigma_v^2}{\hat{\beta}_1^2\sigma_v^2 + \sigma_z^2},
$$

$$
\hat{\phi} = \frac{\text{Cov}(v, s|x_1)}{\text{Var}(s|x_1)} = \frac{\sigma_v^2\sigma_z^2}{\sigma_v^2\left(\hat{\beta}_1^2\sigma_v^2 + \sigma_z^2\right) + \sigma_z^2\sigma_v^2},
$$

$$
\hat{\lambda}_2 = \frac{\text{Cov}(v, x_2|x_1, s)}{\text{Var}(x_2|x_1, s)} = \frac{\left(\hat{\beta}_2 + \hat{\beta}_1\hat{\gamma}_2\right)\text{Var}(v|x_1, s)}{\left(\hat{\beta}_2 + \hat{\beta}_1\hat{\gamma}_2\right)^2\text{Var}(v|x_1, s) + \sigma_z^2},
$$

where

$$
\text{Var}(v|x_1, s) = \frac{\sigma_v^2\sigma_z^2}{\sigma_v^2\left(\hat{\beta}_1^2\sigma_v^2 + \sigma_z^2\right) + \sigma_z^2\sigma_v^2}.
$$

Finally, the endogenous parameters $\{\hat{\beta}_1, \hat{\beta}_2, \hat{\phi}, \hat{\lambda}_1, \hat{\lambda}_2\}$ are solved with following equation
system:

\[
\begin{align*}
\hat{\beta}_1 &= -\frac{\lambda_2 (2 + r) + (1 - r\hat{\lambda}_1 \lambda_2) \left[ r\hat{\lambda}_2 \phi - \hat{\lambda}_1 \left( 1 - \hat{\phi} \right) \left( 1 - (1 - r\hat{\lambda}_1 \lambda_2) \phi \right) \right]}{r^2\lambda_2^2 + \lambda_1^2 \left( 1 - r\hat{\lambda}_1 \lambda_2 \right)^2 \left( 1 - \hat{\phi} \right)^2 - 2\lambda_1 \lambda_2 \left[ 2 + r + r\phi + r^2\hat{\lambda}_1 \lambda_2 \left( 1 - \phi \right) \right]} \quad (A.23) \\
\hat{\beta}_2 &= \frac{1}{2\lambda_2} \quad (A.24) \\
\hat{\gamma}_2 &= \frac{r}{2} \quad (A.25) \\
\hat{\lambda}_1 &= \frac{\hat{\lambda}_1 \sigma_v^2}{\beta_1 \sigma_v^2 + \sigma_z^2} \quad (A.26) \\
\hat{\phi} &= \frac{\sigma_v^2 \sigma_z^2}{\sigma_\epsilon^2 \left( \beta_1 \sigma_v^2 + \sigma_z^2 \right) + \sigma_v^2 \sigma_z^2} \quad (A.27) \\
\hat{\lambda}_2 &= \frac{\left( \hat{\lambda}_2 + \hat{\lambda}_1 \hat{\gamma}_2 \right) \sigma_v^2 \sigma_\epsilon^2}{\sigma_\epsilon^2 \left( \beta_2 + \hat{\lambda}_1 \hat{\gamma}_2 \right)^2 \sigma_v^2 + \sigma_z^2 + \sigma_v^2 \left( \beta_1 \sigma_v^2 + \sigma_z^2 \right)} \quad (A.28)
\end{align*}
\]

Equations (A.24), (A.25) and (A.28) together yields

\[
\hat{\beta}_2 = \frac{1}{2} \sqrt{(4 + r^2) \beta_1^2 + 4\sigma_v^2 \left( \frac{1}{\sigma_v^2} + \frac{1}{\sigma_\epsilon^2} \right)}.
\quad (A.29)
\]

According to equation (A.28), it is easy to show that

\[
\hat{\lambda}_2 = \sqrt{\frac{\sigma_v^2 \sigma_\epsilon^2}{4\sigma_z^2 \sigma_v^2 + \sigma_\epsilon^2 + (4 + r^2) \beta_1^2 \sigma_v^2 \sigma_z^2}}.
\quad (A.30)
\]

To show the existence and uniqueness of the equilibrium defined by the proposition, I use the expressions from \(\hat{\lambda}_1, \hat{\lambda}_2\) and \(\hat{\phi}\) to derive an equation involving \(\hat{\beta}_1\) and exogenous parameters, \(\sigma_v^2, \sigma_z^2\) and \(\sigma_\epsilon^2\). For the convenience of notation, I let \(a \equiv \beta_1^2 \sigma_v^2 \sigma_z^2 \) and \(h \equiv \frac{\sigma_v^2}{\sigma_\epsilon^2} \).
This equation is given by:

\[
H(a; h, r) \equiv a^{1/2} (a + 1) \left[ M - r^2 (1 + h) \right] + M^{1/2} \left[ 2(1 + r)(a - 1)(a + h + 1)^2 + r(a + 1)(1 + h - a) \right] = 0,
\]

where \( M = (4 + r^2)a + 4(h + 1) \). This equation has roots in the following ranges: \((-\infty, 0)\), \([0, 1]\), \((1, \infty)\). However, only values of \( a \) in the range \([0, 1]\) meet the second-order conditions described above.

For any \( r > 0 \), at least one solution to \( H = 0 \) exists in the range \([0, 1]\) because \( H \) is continuous. Furthermore, it is easy to note that when \( a = 0 \),

\[
H(0; \cdot) = -2(1 + h)^{3/2} [2 + r + 2h(1 + r)] < 0.
\]

Whereas when \( a = 1 \),

\[
H(1; \cdot) = 16 + 2h \left[ 4 + r \left( \sqrt{r^2 + 4h + 8} - r \right) \right] > 0.
\]

To see that, for any \( r > 0 \), there is a unique solution in the range \([0, 1]\), it suffices to show that \( H \) is monotonic in the range. Otherwise, if the solution is not unique, the slope must change the sign. Differentiation of \( H(a; \cdot) \) with respect to \( a \) gives

\[
\frac{\partial H(a; \cdot)}{\partial a} = a^{1/2} (a + 1)(4 + r^2) + \left[ a^{1/2} + \frac{(a + 1)}{2a^{1/2}} \right] [a(4 + r^2) + (1 + h)(4 - r^2)] + M^{1/2} \left\{ 6a^2(1 + r) + 2a \left[ 2 + r + 4h(1 + r) \right] + \left[ (h + 1)(2h^2 + h - 2) - h \right] \right\}
\]

\[
+ \frac{1}{2} \frac{\partial M}{\partial a} M^{-1/2} \left[ (a + 1)(1 + h - a)r + 2(1 + r)(a - 1)(a + h + 1)^2 \right]. \quad (A.32)
\]
At a solution $a^*$, 

$$(a+1)(1+h-a)r + 2(1+r)(a-1)(a+h+1)^2 = -a^{1/2}M^{-1/2}(a+1) \left[ a(4 + r^2) + (1 + h)(4 - r^2) \right].$$

Moreover, $\frac{\partial M}{\partial a} = 4 + r^2$. Equation (A.32) is then re-written as

$$\frac{\partial H(a; \cdot)}{\partial a} = a^{1/2}(a + 1)(4 + r^2) + a^{1/2} \left[ 1 + \frac{2(a + 1)(h + 1)}{aM} \right] \left[ a(4 + r^2) + (1 + h)(4 - r^2) \right] + M^{1/2} \left\{ 6a^2(1+r) + 2a \left[ 2 + r + 4h(1+r) \right] + \left[ (r+1)(2h^2 + h - 1) - h \right] \right\}.$$ (A.33)

Equation (A.33) is positive if $(r + 1)(2h^2 + h - 2) - c > 0$. In turn, a sufficient condition for this to be true is $\sigma^2_\epsilon < \frac{4(1 + r)}{4 + 3r} \sigma^2_\nu$. Thus, for given $r$ and $\sigma^2_\epsilon$, there exists a unique $\beta_1$ characterizing the informed trader’s strategy where $0 < \frac{\beta_1^2 \sigma^2_\nu}{\sigma^2_z} < 1$.

**Proof of Corollary 3.3:**

Differentiate the expression of $h$ characterized in Proposition 3 with respect to $r$ yields

$$\frac{\partial h}{\partial r} = (7 + 3\sqrt{6})ar + \frac{a'(r)}{2} \left[ (7 + 3\sqrt{6})r^2 - 2 \right].$$

Thus, the sign of $\frac{\partial h}{\partial r}$ is determined by the sign of $a'(r)$, where

$$a'(r) = \frac{H_r(a; r, h)}{H_a(a; r, h)},$$
and the function $H$ is characterized in Proposition 3.4.

$$H_r(a; r, h) = -2\sqrt{a}(1 + a)(1 + h - a)r + [(a + 1)(1 + h - a) + 2(a - 1)(1 + h + a)^2] \sqrt{M} - \frac{\sqrt{a}(a + 1)}{M} \left[ M - r^2(1 + h) \right], \quad (A.34)$$

where $M = a(4 + r^2) + 4(h + 1)$.

Given $0 < a < 1$ and the second order condition in Proposition 3.4, I find that $H_r(a; r, h) < 0$. Additionally, it has been shown in the proof of Proposition 3.4 that $H_a(a; r, h) > 0$. As a result, $a'(r) > 0$, which in turn suggests $\partial h / \partial r > 0$. Since $h = \sigma_v^2 / \sigma^2_e$, it is apparent that $\partial (1/\sigma^2_e) / \partial r > 0$.

**Proof of Corollary 3.4:**

If the informed trader adopts the trading-only strategy:

$$\lambda_1 = \frac{\sqrt{a} \, \sigma_v}{a + 1 \, \sigma_z},$$

$$\lambda_2 = \frac{1}{\sqrt{(4 + r^2)a + 4 \, \sigma_z}} \frac{\sigma_v}{\sigma_e},$$

$$\text{Var}[\tilde{v}|\mathcal{I}^\text{Public}_1] = \frac{\sigma_v^2}{a + 1},$$

$$\text{Var}[\tilde{v}|\mathcal{I}^\text{Public}_2] = \frac{1}{2(1 + a)} \left( 1 - r \sqrt{\frac{a}{(4 + r^2)a + 4}} \right).$$
Differentiating the above expressions with respect to \( r \) yields

\[
\frac{\partial (1/\lambda_1)}{\partial r} = \frac{(a - 1)a'(r)}{2a^{3/2}} < 0,
\]

\[
\frac{\partial (1/\lambda_2)}{\partial r} = \frac{2ar + (4 + r^2)a'(r)}{2\sqrt{(4 + r^2)a + 4}} > 0,
\]

\[
\frac{\partial (1/\text{Var}[\tilde{v}|I_{\text{Public}}])}{\partial r} = a'(r) > 0,
\]

\[
\frac{\partial (1/\text{Var}[\tilde{v}|I_{\text{Public}}])}{\partial r} = \frac{2a'(r)}{1 - r\sqrt{(4 + r^2)a + 4}} + \frac{4(1 + a)[2a(1 + a) + ra'(r)]}{\sqrt{(4 + r^2)a + 4}(1 - r\sqrt{(4 + r^2)a + 4})^2[(4 + r^2)a + 4]^2} > 0.
\]

If the informed trader adopts a general strategy:

\[
\lambda_1 = \frac{\sqrt{a}\, \sigma_v}{a + 1\, \sigma_z},
\]

\[
\lambda_2 = \frac{1}{\sqrt{(4 + r^2)a + 4(h + 1)}\, \sigma_z},
\]

\[
\text{Var}[\tilde{v}|I_{\text{Public}}] = \frac{\sigma_v^2}{a + 1},
\]

\[
\text{Var}[\tilde{v}|I_{\text{Public}}] = 1 - \frac{M(1 + 2a + 2h + r \frac{a}{M})^2}{f(a, h, r)},
\]
where $M = a(4 + r^2) + 4(h + 1)$ and

$$f(a, h, r) = 2(1+a+h) \left[ 4(1 + h)(1 + 2h) + 2a^2(4 + r^2) + a \left[ 12 + r^2 + 2h(8 + r^2) \right] + r\sqrt{aM} \right].$$

Differentiating the above expressions with respect to $r$ yields the results stated in Corollary 3.4.
Appendix B

Proofs for Chapter 4

Proof of Proposition 4.1:

To solve for a linear equilibrium, the market maker makes an educated guess about the informed trader’s demand at date \( t, t \in \{1, 2\} \):

\[
y_1 = \hat{\beta}_1 v + u_1,
\]

\[
y_2 = \hat{\alpha}_2 + \hat{\beta}_2(v - p^*_1),
\]

where \( p^*_1 = E[v|y_1] = \hat{\gamma}_1 y_1 \) represents the market maker’s updated belief after the informed trader discloses her first period demand for the risky asset. And from the informed trader’s perspective, she conjectures the market maker’s pricing rules in the following manner:

\[
p_1 = \hat{\lambda}_1 x_1,
\]

\[
p_2 = p^*_1 + \hat{\lambda}_2[x_2 - E(x_2|y_1)] = p^*_1 + \hat{\lambda}_2(x_2 - \hat{\alpha}_2).
\]
Applying the principal of backward induction, I can write the informed trader's date 2 optimization problem given \( y_1, p_1 \) as

\[
y_2 \in \arg \max_{y_2} E[y_2(v - p_2) + ry_1(p_2 - p_1)|v, p_1, y_1],
\]

where

\[
E[y_2(v - p_2) + ry_1(p_2 - p_1)|v, p_1, y_1]
\]
\[
= E\{y_2[v - p^*_1 - \hat{\lambda}_2(x_2 - \hat{\alpha}_2)] + ry_1[p^*_1 + \hat{\lambda}_2(x_2 - \hat{\alpha}_2) - p_1]|v, p_1, y_1\}
\]
\[
= y_2[v - p^*_1 - \hat{\lambda}_2(y_2 - \hat{\alpha}_2)] + ry_1[p^*_1 + \hat{\lambda}_2(y_2 - \hat{\alpha}_2) - p_1].
\]

Solving the first-order condition for \( y_2 \) yields:

\[
y_2 = \frac{v - p^*_1}{2\hat{\lambda}_2} + \frac{r}{2} y_1 + \frac{1}{2} \hat{\alpha}_2. \tag{B.1}
\]

And the second-order condition is satisfied when \( \hat{\lambda}_2 > 0 \). Matching the coefficients in (B.1) with the ones in the market maker’s conjecture yields

\[
\hat{\alpha}_2 = ry_1, \quad \hat{\beta}_2 = \frac{1}{2\lambda_2}.
\]
Given that \( y_2 = r y_1 + \frac{v - p_1^*}{2\lambda_2} \), the informed trader’s expected payoff at date 2 is

\[
W_2(v, p_1, y_1) = E[y_2(v - p_2) + ry_1(p_2 - p_1)|v, p_1, y_1] = \frac{1}{4\lambda_2} (v - p_1^*)^2 + ry_1(v - p_1).
\]

At date 1, the informed trader’s optimization problem is written as

\[
y_1 \in \arg \max_{y_1} E[y_1(v - p_1) + W_2(v, p_1, y_1)|v].
\]

Substituting the conjectured \( p_1 = \hat{\lambda}_1 x_1 \) into the above optimization problem and solving the first-order condition for \( y_1 \) yield:

\[
\left( 1 + r - \frac{\hat{\gamma}_1 x_1}{2\lambda_2} \right) v = \left[ 2\hat{\lambda}_1 (1 + r) - \frac{\hat{\gamma}_1^2}{2\lambda_2} \right] y_1.
\]

The second-order condition is

\[
2\hat{\lambda}_1 (1 + r) - \frac{\hat{\gamma}_1^2}{2\lambda_2} < 0. \tag{B.2}
\]

If the proposed mixed trading strategy,

\[
y_1 = \hat{\beta}_1 v + u_1,
\]

\[
u_1 \sim N(0, \Sigma_u),
\]
is to hold in equilibrium, then the informed trader must be indifferent across all values of $u_1$. Thus, I seek values of $\hat{\gamma}_1$, $\hat{\lambda}_1$, and $\hat{\lambda}_2$ such that $\hat{\lambda}_1 > 0$, $\hat{\lambda}_2 > 0$,

\[
1 + r - \frac{\hat{\gamma}_1}{2\hat{\lambda}_2} = 0, \quad (B.3)
\]
\[
2\hat{\lambda}_1(1 + r) - \frac{\hat{\gamma}_1^2}{2\hat{\lambda}_2} = 0. \quad (B.4)
\]

The above equations imply

\[
\hat{\lambda}_1 = \frac{\hat{\gamma}_1}{2}, \quad \hat{\lambda}_2 = \frac{\hat{\gamma}_1}{2(1 + r)}. \quad (B.5)
\]

In the next, I am going to solve for parameters used in the conjectured pricing rules, $\hat{\lambda}_1$, $\hat{\gamma}_1$, and $\hat{\lambda}_2$. By projection theorem:

\[
\hat{\lambda}_1 = \frac{\text{Cov}(v, x_1)}{\text{Var}(x_1)} = \frac{\hat{\beta}_1^2 \sigma_v^2}{\hat{\beta}_1^2 \sigma_v^2 + \Sigma_u + \sigma_z^2}, \quad (B.6)
\]
\[
\hat{\gamma}_1 = \frac{\text{Cov}(v, y_1)}{\text{Var}(y_1)} = \frac{\hat{\beta}_1 \sigma_v^2}{\hat{\beta}_1 \sigma_v^2 + \Sigma_u}, \quad (B.7)
\]
\[
\hat{\lambda}_2 = \frac{\text{Cov}(v, x_2|y_1)}{\text{Var}(x_2|x_1)} = \frac{\hat{\beta}_2 \Sigma_1}{\hat{\beta}_2 \Sigma_1 + \sigma_z^2}, \quad (B.8)
\]

where

\[
\Sigma_1 = \text{Var}[\bar{v}|\bar{y}_1] = \sigma_v^2 - \frac{\hat{\beta}_1^2 \sigma_v^4}{\hat{\beta}_1^2 \sigma_v^2 + \Sigma_u} = \sigma_v^2 - \frac{\hat{\gamma}_1^2 (\hat{\beta}_1^2 \sigma_v^2 + \Sigma_u)}. \quad (B.9)
\]

Combining (B.5), (B.6), and (B.7) implies

\[
\sigma_z^2 = \hat{\beta}_1^2 \sigma_v^2 + \Sigma_u. \quad (B.10)
\]
With (B.5) and (B.10), (B.9) reduces to

\[ \Sigma_1 = \sigma^2_v - 4(1 + r)^2 \hat{\lambda}_2^2 \sigma^2_z. \]  

(B.11)

Plugging \( \hat{\beta}_2 = \frac{1}{2\hat{\lambda}_2} \) into (B.8) yields

\[ \hat{\lambda}_2 = \frac{1}{2\sigma_z} \sqrt{\Sigma_1}. \]  

(B.12)

Substituting this value for \( \hat{\lambda}_2 \) into (B.11) yields:

\[ \Sigma_1 = \frac{\sigma^2_v}{1 + (1 + r)^2}. \]  

(B.13)

From equations (B.5)–(B.13), I solve for the values of \( \hat{\lambda}_1, \hat{\lambda}_2, \hat{\gamma}_1, \hat{\beta}_1, \hat{\beta}_2, \) and \( \Sigma_u \):

\[
\begin{align*}
\hat{\beta}_1 &= \frac{\sigma_z}{\sigma_v} \cdot \frac{1 + r}{\sqrt{1 + (1 + r)^2}} \\
\hat{\beta}_2 &= \frac{\sigma_z}{\sigma_v} \cdot \sqrt{1 + (1 + r)^2} \\
\hat{\lambda}_1 &= \frac{\sigma_v}{2\sigma_z} \cdot \frac{1 + r}{\sqrt{1 + (1 + r)^2}} \\
\hat{\lambda}_2 &= \frac{\sigma_v}{2\sigma_z} \cdot \frac{1}{\sqrt{1 + (1 + r)^2}} \\
\hat{\gamma}_1 &= 2\hat{\lambda}_1 \\
\Sigma_u &= \frac{\sigma^2_z}{1 + (1 + r)^2}
\end{align*}
\]
Proof of Proposition 4.2:

By repeating the procedures outlined in the proof of Proposition 4.1, I have

\( \hat{\alpha}_2 = ry_1, \hat{\beta}_2 = \frac{1}{2\lambda_2}, \hat{\lambda}_1 = \frac{\hat{\gamma}_1}{2}, \hat{\lambda}_2 = \frac{\hat{\gamma}_1}{2(1 + r)}. \)  \( \text{(B.14)} \)

Applying the projection theorem, I solve for parameters used in the market maker’s pricing functions, \( \hat{\lambda}_1, \hat{\gamma}_1, \) and \( \hat{\lambda}_2: \)

\[
\hat{\lambda}_1 = \frac{\text{Cov}(v, x_1)}{\text{Var}(x_1)} = \frac{\hat{\beta}_1 \sigma_{v_1}^2}{\hat{\beta}_1^2 \sigma_{v_1}^2 + \Sigma_u + \sigma_z^2}, \quad \text{(B.15)}
\]

\[
\hat{\gamma}_1 = \frac{\text{Cov}(v, y_1)}{\text{Var}(y_1)} = \frac{\hat{\beta}_1 \sigma_{v_1}^2}{\hat{\beta}_1^2 \sigma_{v_1}^2 + \Sigma_u}, \quad \text{(B.16)}
\]

\[
\hat{\lambda}_2 = \frac{\text{Cov}(v, x_2|y_1)}{\text{Var}(x_2|y_1)} = \frac{\hat{\beta}_2 \Sigma_1}{\hat{\beta}_2^2 \Sigma_1 + \sigma_z^2}, \quad \text{(B.17)}
\]

where

\[
\Sigma_1 = \text{Var} [\tilde{v}|\tilde{y}_1] = \sigma_{v_1}^2 + \sigma_{v_2}^2 - \frac{\hat{\beta}_1^2 \sigma_{v_1}^4}{\hat{\beta}_1^2 \sigma_{v_1}^2 + \Sigma_u} = \sigma_{v_1}^2 + \sigma_{v_2}^2 - \hat{\gamma}_1^2 (\hat{\beta}_1^2 \sigma_{v_1}^2 + \Sigma_u). \quad \text{(B.18)}
\]

Combining (B.14), (B.15), and (B.16) implies

\[
\sigma_z^2 = \hat{\beta}_1^2 \sigma_{v_1}^2 + \Sigma_u. \quad \text{(B.19)}
\]

With (B.14) and (B.19), (B.18) reduces to

\[
\Sigma_1 = \sigma_{v_1}^2 + \sigma_{v_2}^2 - 4(1 + r)^2 \hat{\lambda}_2^2 \sigma_z^2. \quad \text{(B.20)}
\]
Plugging \( \hat{\beta}_2 = \frac{1}{2\hat{\lambda}_2} \) into (B.17) yields

\[
\hat{\lambda}_2 = \frac{1}{2\sigma_z} \sqrt{\Sigma_1}.
\]  \hspace{1cm} \text{(B.21)}

Substituting this value for \( \hat{\lambda}_2 \) into (B.20) yields:

\[
\Sigma_1 = \frac{\sigma_{v1}^2 + \sigma_{v2}^2}{1 + (1+r)^2}
\]  \hspace{1cm} \text{(B.22)}

Using equations from (B.14) to (B.22), I solve for the values of \( \hat{\lambda}_1, \hat{\lambda}_2, \hat{\gamma}_1, \hat{\beta}_1, \hat{\beta}_2, \) and \( \Sigma_u \):

\[
\begin{align*}
\hat{\beta}_1 &= \frac{\sigma_z}{\sigma_{v1}} \cdot \frac{(1+r)\sqrt{1+\phi^2}}{\sqrt{1+(1+r)^2}} \\
\hat{\beta}_2 &= \frac{\sigma_z}{\sigma_{v1}} \cdot \frac{\sqrt{1+(1+r)^2}}{\sqrt{1+\phi^2}} \\
\hat{\lambda}_1 &= \frac{1}{2\hat{\beta}_1} \\
\hat{\lambda}_2 &= \frac{1}{2\hat{\beta}_2} \\
\hat{\gamma}_1 &= 2\hat{\lambda}_1 \\
\Sigma_u &= \frac{1 - (1+r)^2\phi^2}{1 + (1+r)^2\sigma_z^2}
\end{align*}
\]

where \( \phi = \frac{\sigma_{v2}}{\sigma_{v1}} \).

**Proof of Proposition 4.3:**

I once again repeat the procedures outlined in Proof of Proposition 4.1, I solve for the
parameters used in the informed trader’s demand for the risky asset at date 2 as follows

\[ \hat{\alpha}_2 = r y_1, \quad \hat{\beta}_2 = \frac{1}{2\lambda_2}. \]  
(B.23)

Given that \( y_2 = r y_1 + \frac{v - p_1}{2\lambda_2} \), the informed trader’s expected payoff at date 2 is

\[ W_2(v_1, v_2, p_1, y_1) = E[y_2(v - p_2) + r y_1(p_2 - p_1)|v, p_1, y_1] \]
\[ = \frac{1}{4\lambda_2} (v - p^*_1)^2 + r y_1(v - p_1). \]

At date 1, the informed trader’s optimization problem is written as

\[ y_1 \in \arg \max_{y_1} E[y_1(v - p_1) + W_2(v, p_1, y_1)|v_1]. \]

Substituting the conjectured \( p_1 = \hat{\lambda}_1 x_1 \) into the above optimization problem and solving the first-order condition for \( y_1 \) yield:

\[ y_1 = \frac{1 + r - \hat{\gamma}_1}{2\lambda_2} \cdot v_1, \]

which implies

\[ \hat{\beta}_1 = \frac{1 + r - \hat{\gamma}_1}{2(1 + r)\hat{\lambda}_1 - \frac{\hat{\gamma}_1^2}{2\lambda_2}}. \]  
(B.24)
The second-order condition is satisfied when:

\[ 2\hat{\lambda}_1(1 + r) - \frac{\hat{\gamma}_1^2}{2\hat{\lambda}_2} < 0. \]  

(B.25)

In the next, I am going to solve for parameters used in the conjectured pricing rules, \( \hat{\lambda}_1 \) and \( \hat{\lambda}_2 \). Applying projection theorem yields:

\[ \hat{\lambda}_1 = \frac{\text{Cov}(v, x_1)}{\text{Var}(x_1)} = \frac{\hat{\beta}_1 \sigma_{v_1}^2}{\hat{\beta}_1^2 \sigma_{v_1}^2 + \sigma_z^2}, \]  

(B.26)

\[ \hat{\gamma}_1 = \frac{\text{Cov}(v, y_1)}{\text{Var}(y_1)} = \frac{1}{\hat{\beta}_1}, \]  

(B.27)

\[ \hat{\lambda}_2 = \frac{\text{Cov}(v, x_2|y_1)}{\text{Var}(x_2|y_1)} = \frac{\hat{\beta}_2 \sigma_{v_2}^2}{\hat{\beta}_2^2 \sigma_{v_2}^2 + \sigma_z^2}. \]  

(B.28)

Using equations (B.23) to (B.28), I solve for the values of \( \hat{\lambda}_1, \hat{\lambda}_2, \hat{\gamma}_1, \hat{\beta}_1, \hat{\beta}_2 \), and \( \Sigma_u \):

\[ \hat{\beta}_1 = \frac{\sigma_z}{\sigma_{v_1}}, \quad \hat{\beta}_2 = \frac{\sigma_z}{\sigma_{v_2}}, \quad \hat{\lambda}_1 = \frac{1}{2\hat{\beta}_1}, \quad \hat{\lambda}_2 = \frac{1}{2\hat{\beta}_2}, \quad \hat{\gamma}_1 = \frac{1}{\hat{\beta}_1}. \]  

(B.29)

**Proof of Proposition 4.4:**

To solve for a linear equilibrium, the market maker makes an educated guess about the informed trader’s demand at date \( t, t \in \{1, 2\} \):

\[ y_1 = \hat{\beta}_1 v + u_1, \]

\[ y_2 = \hat{\alpha}_2 + \hat{\beta}_2(v - p_1^*), \]

where \( p_1^* = E[v|y_1] = \hat{\gamma}_1 y_1 \) represents the market maker’s updated belief after the informed
trader discloses her first period demand for the risky asset. And from the informed trader’s perspective, she conjectures the market maker’s pricing rules in the following manner:

\[
p_1 = \lambda_1 x_1,
\]

\[
p_2 = p_1^* + \lambda_2 [x_2 - E(x_2|y_1, z_1)] = p_1^* + \lambda_2 (x_2 - \hat{\alpha}_2 - E[z_2|z_1]).
\]

Applying the principal of backward induction, I can write the informed trader’s date 2 optimization problem given \(y_1, p_1\) as

\[
y_2 \in \arg \max_{y_2} E[y_2(v - p_2) + ry_1(p_2 - p_1)|v, p_1, y_1, z_1],
\]

where

\[
E[y_2(v - p_2) + ry_1(p_2 - p_1)|v, p_1, y_1, z_1]
\]

\[
= E\left\{y_2 \left[v - p_1^* - \lambda_2 (x_2 - \hat{\alpha}_2 - E[z_2|z_1])\right] + ry_1 \left[p_1^* + \lambda_2 (x_2 - \hat{\alpha}_2 - E[z_2|z_1]) - p_1\right]|v, p_1, y_1, z_1\right\}
\]

\[
= y_2 \left[v - p_1^* - \lambda_2 (y_2 - \hat{\alpha}_2)\right] + ry_1 \left[p_1^* + \lambda_2 (y_2 - \hat{\alpha}_2) - p_1\right].
\]

Solving the first-order condition for \(y_2\) yields:

\[
y_2 = \frac{v - p_1^*}{2\lambda_2} + \frac{r}{2}y_1 + \frac{1}{2}\hat{\alpha}_2.
\]

And the second-order condition is satisfied when \(\hat{\lambda}_2 > 0\). Taking the expectation of both sides of (B.30) conditional on \(\{y_1, z_1\}\) and matching the coefficients in (B.30) with those in
the conjectured demand, $y_2$, yield

\[ \hat{\alpha}_2 = r_1, \quad \hat{\beta}_2 = \frac{1}{2\lambda_2}. \]  

(B.31)

Given that $y_2 = r_1y_1 + \frac{v - p_1^*}{2\lambda_2}$, the informed trader’s expected payoff at date 2 is

\[ W_2(v, p_1, y_1, z_1) = \frac{1}{4\lambda_2} (v - p_1^*)^2 + r_1(y - p_1). \]  

(B.32)

At date 1, the informed trader determines her demand for the risky asset after solving for the following problem

\[ \max_{y_1} E[y_1(v - p_1) + W_2(v, p_1, y_1, z_1)|v]. \]  

(B.33)

Substituting the conjectured $p_1 = \hat{\lambda}_1x_1$ and $p_1^* = \hat{\gamma}_1y_1$ into the above optimization problem and solving the first-order condition for $y_1$ yield:

\[ \left(1 + r - \frac{\hat{\gamma}_1}{2\lambda_2}\right)v = \left[2\hat{\lambda}_1(1 + r) - \frac{\hat{\gamma}_1^2}{2\lambda_2}\right]y_1. \]  

(B.34)

And the second-order condition is

\[ 2\hat{\lambda}_1(1 + r) - \frac{\hat{\gamma}_1^2}{2\lambda_2} < 0. \]  

(B.35)
If the proposed mixed trading strategy,

\[ y_1 = \hat{\beta}_1 v + u_1, \]

\[ u_1 \sim N(v, \Sigma_u), \]

is to hold in equilibrium, then the informed trader must be indifferent across all values of \( u_1 \). Thus I seek values of \( \hat{\gamma}_1, \hat{\lambda}_1 \), and \( \hat{\lambda}_2 \) such that \( \hat{\lambda}_1 > 0, \hat{\lambda}_2 > 0, \)

\[ \hat{\lambda}_1 = \frac{\hat{\gamma}_1}{2}, \quad \hat{\lambda}_2 = \frac{\hat{\gamma}_1}{2(1 + r)}. \quad (B.36) \]

In the next, I am going to solve for parameters used in the conjectured pricing functions.

Applying projection theorem:

\[ \hat{\lambda}_1 = \frac{\text{Cov}(v, x_1)}{\text{Var}(x_1)} = \frac{\hat{\beta}_1 \sigma_v^2}{\beta_1 \sigma_v^2 + \Sigma_u + \text{Var}(z_1)}, \quad (B.37) \]

\[ \hat{\gamma}_1 = \frac{\text{Cov}(v, y_1)}{\text{Var}(y_1)} = \frac{\hat{\beta}_1 \sigma_v^2}{\beta_1 \sigma_v^2 + \Sigma_u}, \quad (B.38) \]

\[ \hat{\lambda}_2 = \frac{\text{Cov}(v, x_2|y_1, z_1)}{\text{Var}(x_2|y_1, z_1)} = \frac{\hat{\beta}_2 \text{Var}(v|y_1, z_1)}{\beta_2 \text{Var}(v|y_1, z_1) + \text{Var}(z_2|y_1, z_1)}, \quad (B.39) \]

where

\[ \text{Var}(z_1) = 2\delta^2 D + L - D, \quad (B.40) \]

\[ \text{Var}(z_2|y_1, z_1) = \frac{4D^2\delta^2(1 - \delta)^2}{2\delta^2 D + L - D}, \quad (B.41) \]

\[ \text{Var}(v|y_1, z_1) = \sigma_v^2 - \frac{\hat{\beta}_1^2 \sigma_v^4}{\beta_1^2 \sigma_v^2 + \Sigma_u} = \sigma_v^2 - \hat{\gamma}_1^2 (\hat{\beta}_1^2 \sigma_v^2 + \Sigma_u). \quad (B.42) \]
With (B.36)–(B.38), I re-write (B.42) as

\[
\text{Var}(v|y_1, z_1) = \sigma_v^2 - 4\hat{\lambda}_2^2 (1 + r)^2 \text{Var}(z_1).
\]  

(B.43)

Plugging \( \hat{\beta}_2 = \frac{1}{2\hat{\lambda}_2} \) into (B.39) yields

\[
\hat{\lambda}_2 = \frac{1}{2} \sqrt{\frac{\text{Var}(v|y_1, z_1)}{\text{Var}(z_2|y_1, z_1)}}.
\]  

(B.44)

After substituting (B.44) to (B.43), I have

\[
\text{Var}(v|y_1, z_1) = \sigma_v^2 - \frac{4\hat{\lambda}_2^2 (1 + r)^2 \text{Var}(z_1) \text{Var}(z_2|y_1, z_1)}{1 + (1 + r)^2 \text{Var}(z_1|y_1, z_1)}.
\]  

(B.45)

In the end, I solve for the values of \( \hat{\lambda}_1, \hat{\lambda}_2, \hat{\gamma}_1, \hat{\beta}_1, \hat{\beta}_2, \) and \( \Sigma_u \) in Proposition 4.4 from (B.36) to (B.45).
Xin (Daniel) Jiang

Department of Accounting  
Smeal College of Business  
The Pennsylvania State University  
University Park, PA 16802

Room 371A, Business Building  
University Park, PA 16802

+1 (814) 880-7832  
xin.jiang@psu.edu

Education

The Pennsylvania State University  
Ph.D., Accounting  
August 2013 - August 2018 (Expected)

Nankai University  
B.A., Finance  
August 2006 - June 2010

Research

Research Interests

Informed traders’ disclosure, corporate investment, earnings management, and debt contracting.

Job Market Paper

“Short-Termism and Informed Traders’ Disclosure”  
Committee: Steven Huddart (Chair), Dan Givoly, Kai Du, Russell Cooper (Economics).

Working Papers

“On the Connection between the Market Pricing of Accruals Quality and the Accruals Anomaly”, with Kai Du. Revising for the re-submission to *Contemporary Accounting Research*.


Work In Progress

“Investment, Accruals, and Aggregate Stock Returns”, with Kai Du

Teaching Experience

ACCT 211 – Financial and Managerial Accounting for Decision Making  
Summer 2014 (SRTE Rating: 5.94/7)

ACCT 404 – Managerial Accounting  
Summer 2015 (SRTE Rating: 6.67/7); Summer 2016 (SRTE Rating: 6/7)