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## International Review of Economics and Finance

journal homepage: [www.elsevier.com/locate/iref](http://www.elsevier.com/locate/iref)

# Asymmetric information, heterogeneous prior beliefs, and public information <sup>☆</sup>, <sup>☆</sup> <sup>☆</sup>

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## ARTICLE INFO

## Article history:

Received 4 February 2016

Received in revised form

7 July 2016

Accepted 7 July 2016

Available online 14 July 2016

## JEL classification:

G12

G14

D82

D43

C72

## Keywords:

Public disclosure

Insider trading

Price discovery

Heterogeneous prior beliefs

Granger causality

## ABSTRACT

We present a dynamic trading model that assumes traders face not only asymmetric information but also heterogeneous prior beliefs under a mandatory public disclosure requirement. We find that the overconfident insider chooses to trade in an alternating way in the sense that he underreacts to his information in the first period, overreacts in the second, underreacts in the third, overreacts in the fourth, and so on. The irrational insider trades in this way not only to dissimulate his information but also to equalize his profits across periods. The coexistence of public disclosure and heterogeneous prior beliefs leads to large and fluctuant trading volumes, and the more underconfident the insider is, the greater is the degree of fluctuation. Also, contrarian and momentum trading arise endogenously as a result of the insider's irrationality and the public disclosure. Finally, we present the economic explanation for our model by giving the Granger causality relationship between the amended price series and the insider's trading order series.

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## 1. Introduction

Over the past two decades there has been an increasing volume of trading in securities. Zhang and Zhang (2015) found that the value of equities, options, and futures traded on national securities exchanges increased from \$2.23 trillion in 1990 to \$43.94 trillion in 2006. Trading volume plays a critical role in financial markets. The literature on stock trading volume is extensive.

<sup>☆</sup> The authors would like to thank the Editors and anonymous referees for their many helpful comments and suggestions.

<sup>☆☆</sup> The first version of this paper is available on line at <http://arxiv.org/abs/1105.2414>. This paper is a part of Hong Liu's doctoral dissertation (2008). We thank Deqing Zhou for some useful discussions. We would also like to thank Jiaan Yan, Jianming Xia, and other seminar participants at the Institute of Applied Mathematics, AMSS, CAS. The first-named author is grateful for the financial support from the National Natural Science Foundation of China (No. 10721101) and China's National 973 Project (No. 2006CB805900). The second named author is grateful for the financial support from the National Natural Science Foundation of China (No. 11201060, 11471069 and No. 11126107) and China Scholarship Council under Grant No. 201406625063. The second named author is grateful for the financial support from the National Natural Science Foundation of China (No. 11201060, 11471069 and No. 11126107) and China Scholarship Council under Grant No. 201406625063. The second author also would like to thank Hengfu Zou, Dingsheng Zhang, and other seminar participants at the Central University of Finance and Economics.

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There are many empirical studies on the relationship between trading volume and price changes, earnings announcements, and serial correlation in returns.<sup>1</sup> Except for the extremely large trading volumes, anybody who has a casual look at the security or stock markets would also be amazed by the sharp fluctuations of financial markets, such as the fluctuations in the trading volumes, the prices, and the short-term aggressive trading. Ren and Zhou (2010) used the data of the Shanghai Stock Exchange Composite Index (SSEC) from January 2003 to April 2009 to show the fluctuation feature of trading volumes. Some other scholars have also given data and empirical results to show the non-stationarity property of the trading volume; see Chen (2012) and Andersen (1996) for examples. Yet to the best of our knowledge, these fluctuation features of trading volume and price have rarely been studied in theoretical finance, perhaps for the reason that they seem close to the irrational behavior of traders and cannot be explained by rational expectations. In this study we examine these fascinating features of the market and address the implications for the financial markets of irrational behavior by developing a trading model to characterize the optimal behavior of an irrational insider who possesses a long-lived source of private information about the fundamental value of a security under mandatory disclosure requirements.

In his pioneering and insightful paper, Kyle (1985) introduced a dynamic model of inside trading where a risk-neutral insider receives only one signal and the fundamental asset value does not change over time.<sup>2</sup> Through trade, the insider progressively releases his private information to the market as he exploits his informational advantage. Holden and Subrahmanyam (1992) and Foster and Viswanathan (1996) considered a market with multiple competing insiders and they showed that competition among insiders accelerates the release of their private information. Back (1992) formalized and extended the model by showing the existence of a unique equilibrium beyond the Gaussian-linear framework. Huddart, Hughes, and Levine (2001) presented an insider's equilibrium trading strategy in a multiperiod rational expectations framework based on Kyle (1985) and embodied the requirement that the insider must publicly disclose his stock trades after the fact.<sup>3</sup> W. D. Zhang (2008) extended Huddart et al. (2001) by allowing for competition among identical informed agents and the existence of outsiders, respectively. All the papers mentioned above have the assumption that the insider is rational. Some interesting questions are: what is the behavior of an irrational insider under mandatory disclosure requirements, and do overconfident (underconfident) traders always overreact (underreact) to their own private information? Thus, we use the framework of Kyle (1985) to study the optimal behaviors of an irrational insider and address their impact on the market under the mandatory disclosure requirements.<sup>4</sup>

There is abundant evidence to show that investors and managers are prone to overconfidence in the sense that they overestimate the precision of their private information. In the past few years, a lot of researchers have studied markets that include the presence of irrational traders. Odean (1998) and then Gervais and Odean (2001) developed a multiperiod model where the overconfidence of noise traders increases as they attribute high returns in bull markets to their trading skills and they predicted that high total market returns make some investors overconfident about the precision of their information. Benos (1998) explicitly modeled investor behavior in financial markets allowing for traits linked to a notion of imperfect rationality. He studied an extreme form of posterior overconfidence where some risk-neutral investors overestimate the precision of their private information. In addition, Kyle and Wang (1997) and Wang (1997) considered the case of heterogeneous prior beliefs. The former considered heterogeneous prior beliefs in their study of the survival of irrational traders in a duopoly context while the latter examined the implication of overconfidence for delegated fund management in both learning and evolutionary game models. Harris and Raviv (1993) and Wang (1998) used heterogeneous prior beliefs to explain the enormity of volume traded each day. A consistent finding is that the more overconfident investors overreact to their private information and trade more aggressively whereas in this study we try to provide a model to show that the overconfident investor does not always overreact to his information. Instead, he chooses to trade in an alternating way to equalize the profits across periods.

We consider a model in which traders face both asymmetric information and heterogeneous prior beliefs, with the requirement that the insider publicly disclose his stock trades after the fact. Heterogeneity arises because traders have different distribution assumptions about an informed trader's private signal; that is, the traders agree to disagree with the precision of the signal. Using the same description as Wang (1998), a trader is overconfident if his distribution of the signal is too tight and underconfident if it is too loose.

Our model indicates that in order to maintain information superiority and diminish the ability of the market makers to draw inferences from disclosure, the irrational insider uses a mixed strategy in every round except the last one. The overconfident insider chooses to trade in an alternating way in the sense that he underreacts to his information in the first period, overreacts

<sup>1</sup> For examples, Karpoff (1987) provided a thorough survey on the empirical relationship between volume and contemporaneous price changes. Statman, Thorley, and Vorkink (2006) used monthly data from the NYSE/AMEX from 1962 to 2001 and provided evidence that trading activity is positively related to lagged returns for many months. Kyle (1985) and Admati and Pfleiderer (1988), among others, considered non-competitive models of stock trading in which a few investors have superior information about a stock and trade strategically to maximize profits.

<sup>2</sup> Holden and Subrahmanyam (1994), Zhang (2004), and others have given the risk-averse informed trader case based on the model of Kyle (1985). For the non-normality case, see Rochet and Vila (1994). The work of Kyle (1985) has led to a large body of literature that is covered well in Vives (2010).

<sup>3</sup> The Sarbanes-Oxley Act, which was passed by Congress on July 25, 2002, requires insiders of a firm to report any equity transactions they conduct to the Securities and Exchange Commission (SEC) not later than two business days following the transaction. The insiders' reports are filed after the trade is completed and are publicly available immediately upon receipt by the SEC.

<sup>4</sup> Gong and Zhou (2010) improved the Kyle (1985) model by considering the case where the insider can affect the pricing rule in a dynamic trading model. They found that, although the equilibrium for a risk-neutral insider is different from that in Kyle (1985), the limiting result is the same whether or not the insider can affect the market maker's decision on the limit as the trading frequency approaches infinity. However, a new finding is that, when there are two risk-neutral insiders with the same private information in the market, both the equilibrium and the limiting result are different to the corresponding results of Holden and Subrahmanyam (1992). The problem in this paper needs to be studied using the framework of Gong and Zhou (2010).

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