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Can an overconfident insider coexist with a representativeness heuristic insider?☆,☆☆

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ABSTRACT

This paper develops an insider trading model that incorporates the presence of rational, overconfident, and representativeness heuristic insiders. We find that the heuristic insider and overconfident insider trade more aggressively on their information than the rational insider, and that therefore, a higher probability exists for them to earn more profits. Furthermore, both higher heuristic bias of the heuristic insider and greater overconfidence of the overconfident insider lead to less expected profit for the rational insider and less expected loss for the noise trader. Moreover, in an equilibrium, both higher heuristic bias and greater overconfidence of an insider lead to a more efficient and stable market.

1. Introduction

This paper considers an extension of Kyle's (1985) framework and characterizes the optimal trading behavior of rational, overconfident, and representativeness heuristic insiders and their influence on the market. Abundant evidence in the literature shows that overconfident traders can survive in a competitive securities market (see, e.g., Hirshleifer and Luo, 2001; Wang, 1998; and Zhou, 2011) and numerous studies have examined the trading behavior of overconfident traders. For example, Wang (1998) and Glaser and Weber (2007) predict that traders who are overconfident on their information trade more. Benos (1998) and Kyle and Wang (1997) predict that rational traders will trade less when faced with an overconfident opponent. Zhou (2011) proves that when a market maker is overconfident, the rational insider would like to trade more aggressively and take advantage of the "mispricing" opportunities created by the market maker. Representativeness heuristic has been proposed by psychologists in their experiments as a type of psychological behavioral bias. Representativeness heuristic individuals place too much weight on their current information and too little on their prior knowledge. Numerous papers show that representativeness heuristic individuals exist in the financial market. For example, Chopra et al. (1992) suggest that traders overreact to current information. Barberis et al. (1998) construct a model that includes the representativeness heuristic to explain asset price overreaction to new information. In a related paper, Luo (2013) builds a dynamic competitive securities market model in which representativeness heuristic traders compete with rational traders and finds that heuristic traders can generate higher expected profit than rational traders.

Inspired by these studies, we address the following questions in this paper: What is the trading behavior of a rational insider in the market when faced by overconfident and heuristic insiders having the same private information? What is the effect of the co-existence of three types of insiders on the equilibrium results such as insiders' trading behavior, market depth, price efficiency, and insiders' profits? We find that when the overconfident insider is moderately overconfident and the heuristic insider has a moderately heuristic bias, a linear equilibrium exists. In the equilibrium, both the heuristic insider and overconfident insider trade more aggressively on their information than does the rational insider, and hence, they have a higher probability to earn more profits. Moreover, both higher heuristic bias of the heuristic insider and greater overconfidence of the overconfident insider lead to less expected profit for the rational insider and less expected loss for the noise trader. Furthermore, in an equilibrium, both higher heuristic bias and greater overconfidence of an insider lead to a more efficient and stable market.

This paper is structured as follows. Section 2 presents the model used in this paper, and Section 3 identifies the unique linear Nash equilibrium of the model. Section 4 gives the properties of linear equilibrium, and Section 5 concludes the paper.

2. The model

A single risky asset is traded in a competitive securities market. The ex-post liquidation value of the risky asset, denoted by v, is normally distributed with mean p_0 and variance σ_v^2. The market has five types of

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traders: rational insiders, overconfident insiders, heuristic insiders, noise traders, and competitive risk-neutral market makers. The quantity traded by noise traders is a random variable, denoted by u, with mean zero and variance σ_u^2. Before a trade takes place, no trader knows the payoff of the risky asset, but each insider (including the rational insider, overconfident insider, and heuristic insider.) observes the information signal with respect to the risky asset's payoff. The information signal is modeled as $\tilde{s}=v+\epsilon$, where the residual error ϵ is normally distributed with mean zero and variance σ_ϵ^2. We assume that v, u, and ϵ are mutually independent.

The rational insider can perceive the distribution of ϵ correctly, and after receiving the information signal, he updates his belief about the risky asset's mean and variance as follows:

$$E_r(v|\tilde{s}) = p_0 + \frac{\sigma_v^2}{\sigma_v^2+\sigma_\epsilon^2}(\tilde{s}-p_0), \tag{2.1}$$

$$Var_r(v|\tilde{s}) = \sigma_v^2 - \frac{\sigma_v^4}{\sigma_v^2+\sigma_\epsilon^2} = \frac{\sigma_v^2\sigma_\epsilon^2}{\sigma_v^2+\sigma_\epsilon^2}, \tag{2.2}$$

where subscript r represents the rational insider.

The overconfident insider believes that the variance of the residual error ϵ is smaller than the true residual error variance; that is, $Var_r(\epsilon)=\sigma_c^2<\sigma_\epsilon^2$.[1] Thus, the overconfident insider does not observe the residual error correctly and hence will update his belief about the risky asset after receiving the information signal:

$$E_o(v|\tilde{s}) = p_0 + \frac{\sigma_v^2}{\sigma_v^2+\sigma_c^2}(\tilde{s}-p_0), \tag{2.3}$$

$$Var_o(v|\tilde{s}) = \frac{\sigma_v^2\sigma_c^2}{\sigma_v^2+\sigma_c^2}, \tag{2.4}$$

where subscript o represents the overconfident insider.

The representativeness heuristic trader (heuristic insider), as mentioned in psychology literature, places too much weight on his current information signal and too little on his prior knowledge. We follow Fischer and Verracchia (1999) and Luo (2013) to model the heuristic traders' updated mean and variance, to obtain the heuristic insider's conditional mean and variance for the risky asset's payoff,[2]

$$E_h(v|\tilde{s}) = p_0 + m(E_r(v|\tilde{s})-p_0) = p_0 + \frac{m\sigma_v^2}{\sigma_v^2+\sigma_\epsilon^2}(\tilde{s}-p_0), \tag{2.5}$$

and

$$Var_h(v|\tilde{s}) = \sigma_v^2 + m(Var_r(v|\tilde{s})-\sigma_v^2) = \sigma_v^2 - \frac{m\sigma_v^4}{\sigma_v^2+\sigma_\epsilon^2}, \tag{2.6}$$

respectively, where subscript h represents the heuristic insider, m is a heuristic bias parameter, and $m>1$. The more parameter m is above 1, the more the heuristic bias. Moreover, assuming that $Var_h(v|\tilde{s})>0$, Eq. (2.6) implies that

$$m < 1 + \frac{\sigma_\epsilon^2}{\sigma_v^2}. \tag{2.7}$$

[1] This idea is based on Hirshleifer and Luo (2001).

[2] In this footnote, we indicate that the way representativeness heuristic is modeled is different from how overconfidence is characterized, just as Luo (2013) says in footnote 4 of page 156 in compare with a previous paper (Hirshleifer and Luo (2001)): the overconfident trader would overestimate the precision of the informational signal (i.e., $Var_r(\in)=\sigma_c^2<\sigma_\in^2$.) but has the same mean as the rational trader; while the heuristic trade can correctly estimate the precision of the informational signal, he adjusts or updates his posterior beliefs, including the mean and variance, in a manner that overweights the current information relative to the rational insider. From an economic perspective the representative heuristic insider is different from the overconfident insider who overestimates the precision of the informational signal. The purpose of this paper is to examine whether different types of insiders can co-exist in the market and their trading behaviors.

We can derive Eqs. (2.1), (2.2), (2.3), (2.4), (2.5), and (2.6) from the appendix Lemma 5.1.

We conform to the trading process of Luo (2001) and Liu and Zhang (2011). We assume two periods in the economy, period 0 and period 1. At period 0, trading takes place when the information signal is released. After observing the information signal, the rational insider, overconfident insider, and heuristic insider choose their trading quantities as $x=X(\tilde{s}), y=Y(\tilde{s})$, and $z=Z(\tilde{s})$, respectively, where X, Y, and Z are measurable functions representing respectively the trading strategies of the rational insider, the overconfident insider, and the heuristic insider. Then, the market makers determine the price $p=P(x+y+z+u)$ with measurable function P after receiving orders along with the noise traders' u (but not x, y, z, and u separately). The uncertainty is resolved at period 1 and the risky asset payoff is realized.

Let $\pi(X,P)=(v-p)x$, $\pi(Y,P)=(v-p)y$, and $\pi(Z,P)=(v-p)z$ denote the profit and E_r, E_o, and E_h, the expectations of the rational insider, overconfident insider, and heuristic insider, respectively, conditional on their information.

Definition 1. An equilibrium consists of the rational, overconfident, and heuristic insiders' trading strategies and the market makers' pricing rule (X, Y, Z, P) such that the following two conditions hold:

(1). Profit maximization:
For any alternate trading strategy X' of the rational insider,

$$E_r[\pi(X,P)|\tilde{s}] \geq E_r[\pi(X',P)|\tilde{s}];$$

for any alternate trading strategy Y' of the overconfident insider,

$$E_o[\pi(Y,P)|\tilde{s}] \geq E_o[\pi(Y',P)|\tilde{s}];$$

and

for any alternate trading strategy Z' of the heuristic insider,

$$E_h[\pi(Z,P)|\tilde{s}] \geq E_h[\pi(Z',P)|\tilde{s}].$$

(2). Market efficiency: $P(x+y+z+u)=E(v|x+y+z+u)$.

3. The unique linear equilibrium

In this section, we show that an equilibrium does exist in which rules X, Y, Z, and P are simple linear functions, as shown in the following theorem:

Theorem 3.1. *For* $1<m<\min\{1+\frac{\sigma_\epsilon^2}{\sigma_v^2}, 3-\frac{\sigma_v^2+\sigma_\epsilon^2}{\sigma_v^2+\sigma_c^2}\}$ *and* $\frac{\sigma_\epsilon^2-\sigma_v^2}{2}<\sigma_c^2<\sigma_\epsilon^2$, *there exists a unique linear Nash equilibrium, in which X, Y, and P are linear functions, with constants* $\alpha_0, \alpha_1, \beta_0, \beta_1, \gamma_0, \gamma_1, \gamma$, *and* λ, *such that*

$$x = X(\tilde{s}) = \alpha_0 + \alpha_1(\tilde{s}-p_0), \tag{3.1}$$

$$y = Y(\tilde{s}) = \beta_0 + \beta_1(\tilde{s}-p_0), \tag{3.2}$$

$$z = Z(\tilde{s}) = \gamma_0 + \gamma_1(\tilde{s}-p_0), \tag{3.3}$$

$$p = P(x+y+z+u) = \gamma + \lambda(x+y+z+u), \tag{3.4}$$

in which

$$\alpha_0 = \beta_0 = \gamma_0 = 0, \tag{3.5}$$