Information leakages, distribution of profits from informed trading, and last mover advantage

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Abstract

I model a market in which an insider is subject to a careful scrutiny by another agent (follower) who immediately observes the insider’s trading decisions and mimics the insider while trading on his own behalf. The follower can be interpreted as a broker or a high-frequency trader.

I show that if the follower is sufficiently good at detecting the insider (noise is small), then the follower absorbs a dominant fraction of the expected profits coming from informed trading. My model is able to explain why dollar returns on the trades of insiders can be quite moderate.

Additionally, I provide an extension and explain a sudden upsurge of HFT activity during a five-year period 2004-2009.

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1 Research questions

- Why corporate insiders earn low dollar profits?
- Why the emergence of HFT was so abrupt?

2 Context: dissimulation of insider trades

Vast literature including Huddart, Hughes, and Levine (2001) is dedicated to mixed strategies or “bluffing”.

- Insider hides information from the follower;
- Insider randomizes his trading decisions;
- Dynamic setting: random behavior in the first period is offset by trading in the following periods.

3 Short-swing profit liability

This liability is imposed by section 16 of SEC (1934).

- Insiders have to compensate the gains from round-trip transactions accomplished within a six-month time span;
- Insiders cannot costlessly unwind the undesirable positions that they previously create because of randomization;
- Disincentive from trading randomly

4 Von Stackelberg approach

- Static model in terms of trading,
- Only one auction, no mixed strategies,
- Making decisions sequentially
5 Key implications

The better the follower at observing insider’s decisions:

• ⇒ the more aggressive the amplification (higher $m$),
• ⇒ the more conservative the insider (lower $\beta$),

Extreme cases:

• Uninformed follower ⇒ all profits are seized by insider,
• Highly informed follower ⇒ seizes almost all profits while insider only transmits the information, consistent with empirical findings of Cziraki and Gider (2019)

6 Model

I offer a model with asymmetric information based on Kyle (1985). There are four agents in the model:

• Insider
• Noise traders
• Follower
• Perfectly competitive market maker

6.1 Sequence of decisions

\[
d \leftarrow \xi \sim N(0, \sigma_\xi^2), \text{ where } \xi \in \{d, w, z\}.
\]

• $t = 1 - 2\varepsilon$

  – True value of the asset $d$ is revealed to the insider;
  – The insider submits an order to buy/sell $x(d)$ shares;
  – The noise trader submits an order to buy/sell $x(d)$ shares;

• $t = 1 - \varepsilon$

  – The follower observes $x(d) + w$;
  – The follower submits an order to buy/sell $y [x(d) + w]$ shares;
  – The noise trader submits an order to buy/sell $z$ shares;

• $t = 1$
- The market maker observes $x(d) + w + y \left[ x(d) + w \right] + z$;
- The market maker sets the price and execute all the orders;

- $t = 2$: The true value $d$ is paid out.

6.2 Price setting: semistrong efficient

If order flow $s \equiv x + w + y + z = \hat{s}$, then the price at time 1:

$$p \equiv p_1 = E \left\{ d | x(d) + w + y \left[ x(d) + w \right] + z = \hat{s} \right\} =: g(\hat{s}),$$

$x(\cdot)$ and $g(\cdot)$ are the strategies of the two other players.

6.3 Optimal portfolio choices: leader

The insider (leader) knows that his trading choices affect the choices of the follower: additional price impact.

$$x(d) = \arg \max_x E \left[ x \cdot (d - g(x + y(x + w))) \left| x(d) + w = \hat{x} \right. \right],$$

$y(\cdot)$ and $g(\cdot)$ are the strategies of the two other players.

6.4 Optimal portfolio choices: follower

By the moment when the follower is making his decision, the insider (leader) has already declared his choice: conditioning

$$y(\hat{x}) = \arg \max_y E \left[ y \cdot (d - g(\hat{x} + y + z)) \left| x(d) + w = \hat{x} \right. \right],$$

$x(\cdot)$ and $g(\cdot)$ are the strategies of the two other players.

6.5 Equilibrium

Each player takes the strategies of the others as given. In equilibrium, the beliefs coincide with actual behavior.

Crucial remark: the leader does not assume that the order size of the follower is fixed, but instead the follower’s order size depends on his own order size.
7 Results

Only consider linear equilibria: $x = \beta d$, $y = m\hat{x}$, $p = \lambda\hat{s}$. There exists a unique linear equilibrium.

7.1 Equilibrium conditions

$$\beta = \frac{1}{2\lambda(1 + m)}.$$  

$$m = \frac{1}{2} \left[ \frac{1}{\lambda \left( \beta + \frac{\sigma_w^2}{\beta\sigma_d^2} \right)} - 1 \right],$$

$$\lambda = \frac{\beta(1 + m)\sigma_d^2}{\beta^2(1 + m)^2\sigma_d^2 + \sigma_z^2 + (1 + m)^2\sigma_w^2}.$$  

These equations imply:

$$Q(m) := m(1 + m)^2 = \frac{\sigma_z^2}{2\sigma_w^2} =: \frac{F}{2},$$

where $Q(\cdot)$ is invertible in closed form (Cardano, 1545).

7.2 Solution

Step 1: 

$$m = Q^{-1} \left( \frac{F}{2} \right).$$

Step 2: 

$$\lambda = \sqrt{\frac{1 + F}{(1 + m)^2 + F}} \cdot \frac{\sigma_d}{2\sigma_w},$$

Step 3: 

$$\beta = \frac{1}{2\lambda(1 + m)}.$$
Amplification coefficient $m$ as a function of $\rho^2 := \frac{\sigma^2}{\sigma_n^2} = \frac{F}{F+1}$

8 Extension: innovation and HFT

- Follower is interpreted as a potential HFT;
- By default, follower has no informational advantage;
- Follower observes $x + n$;
- Follower can buy additional signal about $x$: $x + n^*$;
- Noise part $n^*$ is independent of the noise $n$;
• Cost is proportional to the signal quality: $\Phi = \frac{\phi}{\text{Var}(n^*)}$.

$$x(d) + n \quad \uparrow \quad \begin{cases} \text{Insider noise} \\ \text{Exogenous noise} \end{cases} \quad \uparrow \quad y(x + n, x + n^*)$$

Observed by follower by default

Observed publicly and by the market maker

8.1 Technological progress and information-acquisition decisions

• Lower cost $\Rightarrow$ acquire more information,

• Low technology level $\Rightarrow$ acquire no information,

• Once technology reaches a certain level, a jump occurs in HFT activity: suddenly HFT finds it optimal to acquire considerable amount of information and to trade very actively;

• Consistent with observations of HFT trading volume

HFT volume in theory and in practice

Empirical data on HFT HFT volume, information quality ($F$) and amplification coefficient ($m$) depending on technology state

Break-down of profits depending on technology state

References


