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:

- $\Rightarrow$ the more aggressive the amplification (higher m),
- $\Rightarrow$ the more conservative the insider (lower β),

Extreme cases:

- Uninformed follower $\Rightarrow$ all profits are seized by insider,
- Highly informed follower $\Rightarrow$ 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

$$\underbrace{\underbrace{x(d) + \underset{\substack{\uparrow\\ \text{Exogenous noise}}}{w}}_{\text{Observed by follower}} + y\left[x(d) + w\right] + \underset{\substack{\uparrow\\ \text{Exogenous noise}}}{z}}_{\text{Observed by the market maker}}, \text{ where } w + z =: n,$$

d – true asset value, $\xi \sim N(0, \sigma_\xi^2)$, 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 $y\left[x(d) + w\right]$ 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:

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

$x(\cdot)$ 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.

$$x(d) = \arg\max_{x} \mathrm{E}\left[x \cdot \underbrace{(d - g(x + y(x + w) + z))}_{\text{gains per unit of asset}} \middle| d \right],$$

$y(\cdot)$ 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

$$y(\hat{x}) = \arg\max_{y} \mathrm{E}\left[y \cdot \underbrace{(d - g(\hat{x} + y + z))}_{\text{gains per unit of asset}} \middle| x(d) + w = \hat{x} \right],$$

$x(\cdot)$ 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:

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

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

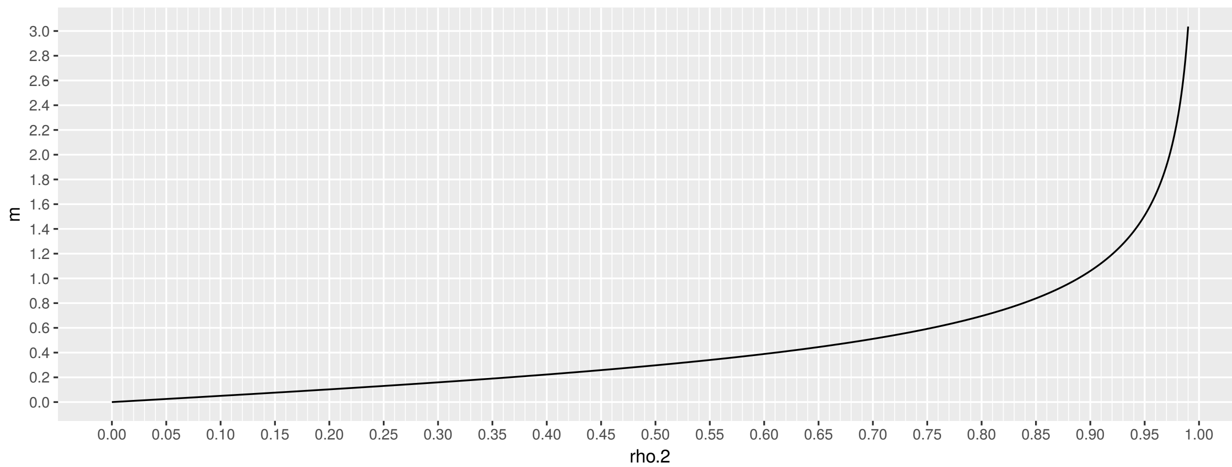
7.2 Solution

Step 1: $$m = Q^{-1}\left(\frac{\mathcal{F}}{2}\right),$$

Step 2: $$\lambda = \underbrace{\sqrt{\frac{1+\mathcal{F}}{(1+m)^2+\mathcal{F}}}}_{\lambda_{\text{relative}}} \cdot \underbrace{\frac{\sigma_d}{2\sigma_n}}_{\lambda_{\text{Static Kyle}}},$$

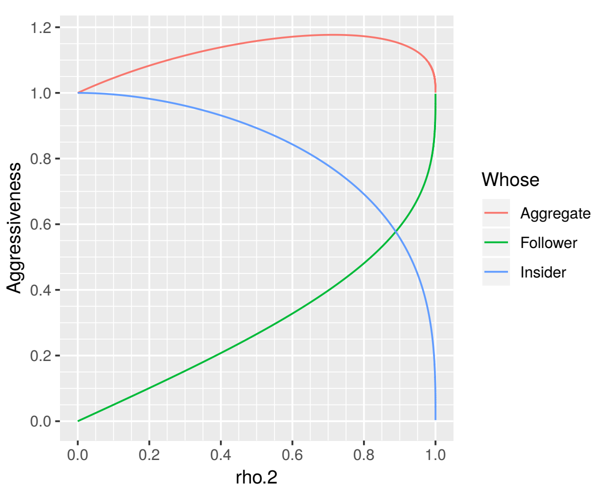
Step 3: $$\beta = \frac{1}{2\lambda(1+m)}.$$

Amplification coefficient m as a function of $\rho^2 := \frac{\sigma_z^2}{\sigma_n^2} \equiv \frac{\mathcal{F}}{\mathcal{F}+1}$

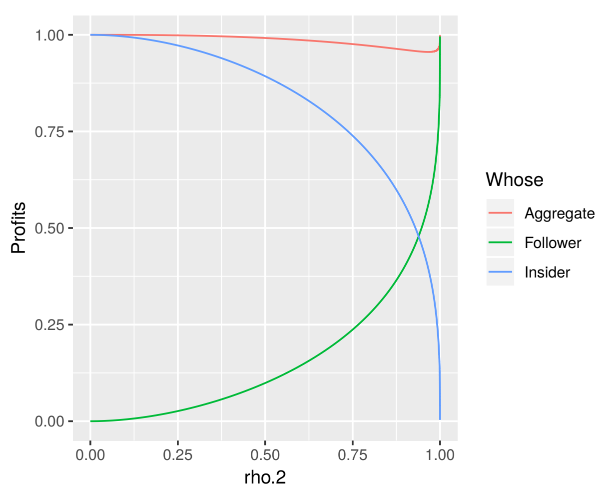


Aggressiveness, expected profits relative to benchmark (Kyle, 1985).

Aggressiveness $/\beta_{\text{Static Kyle}}$



Expected profits $/\pi_{\text{Static Kyle}}$



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;

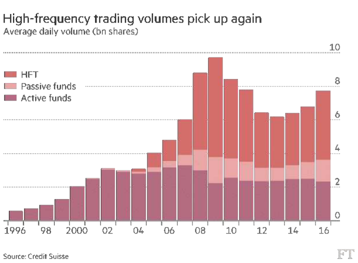
- Cost is proportional to the signal quality: $\Phi = \frac{\phi}{\mathrm{Var}(n^*)}$.

$$\underbrace{\underbrace{\underset{\text{Insider}}{\underset{\uparrow}{x(d)}} + \underset{\text{Exogenous noise}}{\underset{\uparrow}{n}}}_{\text{Observed by follower by default}} + \underset{\text{Follower}}{\underset{\uparrow}{y}}(x+n, \underbrace{x+n^*}_{\text{additional signal}})}_{\text{Observed publicly and by the market maker}}$$

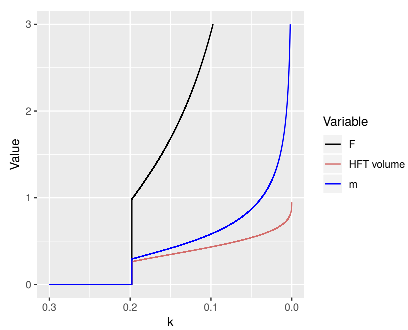
8.1 Technological progress and information-acquisition decisions

- 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

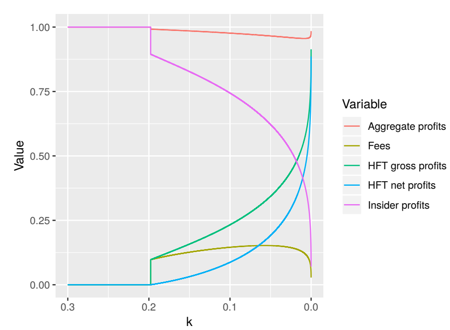
HFT volume in theory and in practice



Empirical data on HFT trading volume



HFT volume, information quality ($\mathcal{F}$) and amplification coefficient (m) depending on technology state



Break-down of profits depending on technology state

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