(In)efficiency in Information Acquisition and Aggregation through Prices

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Motivation

- (In)efficiency in financial trading
  - limit orders
  - private information

- Endogeneity of traders’ private information
  - information collection/acquisition
  - attention

- Sand in wheels of financial markets
  - Tobin tax
  - various other policy proposals

- Reduction in cost of information
  - internet, big data, high-frequency trading
  - beneficial to society?
This Paper

- Model to investigate interaction
- (in)efficiency in trading
- (in)efficiency in information collection prior to trading
- Policy interventions
Findings

- **Exogenous** private information
  - Inefficiency in trading
    - pecuniary externality
    - information externality
  - both inefficiencies corrected with (non-linear) taxes/subsidies contingent on
    - price of financial asset
    - individual volume of trade
Findings

- **Endogenous** private information
  - *over-investment* in information acquisition
    - excessive sensitivity of eq. limit orders to private information
    - downward-sloping schedules
    - pecuniary externality prevails over info externality
  - *under-investment* in information acquisition
    - inefficiently low sensitivity of eq. limit orders to private information
    - upward-sloping schedules
    - info externality prevails over pecuniary externality

- No policy (measurable in price and individual volume of trade) inducing efficiency in both info acquisition and trading

- Efficiency in both info acquisition and trading possible when expenditure on info acquisition verifiable
Inefficiency in usage when info exogenous


Information acquisition in financial markets


Efficiency in Information acquisition

- Colombo, Femminis and Pavan (2014), Angeletos, Iovino, and La’O (2020),...

Impact of reduction in cost of information on performance of financial mkts

Plan

1. Introduction
2. Model
3. (In)efficiency in trading
4. (In)efficiency in info acquisition
5. Conclusions
Model
Unit-mass continuum of traders with payoff

$$\pi_i = \left( \begin{array}{c}
\theta \\
- p
\end{array} \right) - \left( \begin{array}{c}
\lambda
\end{array} \right) x_i^2$$

Representative investor with payoff

$$\Pi = \left( \begin{array}{c}
p - \alpha - u
\end{array} \right) - \left( \begin{array}{c}
\beta
\end{array} \right) \tilde{x}^2$$
Information and schedules

- Each trader observes private signal

\[
   s_i = \theta + f(y_i) (\eta + e_i)
\]

- Attention/information collection: \( y_i \in \mathbb{R}_+ \)

- cost \( C(y_i), C', C'' > 0 \)

- Trader \( i \)'s schedule

\[
   x_i = as_i + b - cp
\]

- Representative investor’s (inverse) supply

\[
   p = \alpha - u + \beta \bar{x}
\]

- \((\theta, u, \eta, (e_i)_{i \in [0,1]})\) independent and jointly Normal
Timing

- $t = 0$: traders choose $y_i$
- $t = 1$: traders observe $s_i$, representative investor observes $u$
- $t = 2$: limit orders
- $t = 3$: mkt clears
- $t = 4$: payoffs
Plan

1. Introduction

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4. (In)efficiency in info acquisition

5. Conclusions
Inefficiency in Trading
Equilibrium Use of Information

Proposition 1

Unique symmetric equilibrium. Sensitivity of eq demand schedules to private information:

\[ a^* = \frac{1}{\lambda} \frac{\tau_e y \tau_\eta (y \tau_\eta - \tau_\omega(a^*))}{y^2 \tau_\eta^2 (\tau_\omega(a^*) + \tau_e + \tau_\theta) - \tau_\omega(a^*) \tau_e (\tau_\theta + 2y \tau_\eta)} \]

where

\[ \tau_\omega(a^*) \equiv \frac{\beta^2 a^* y \tau_u \tau_\eta}{(\beta^2 a^* \tau_u + y \tau_\eta)} \]

is precision of endogenous signal

\[ z \equiv \theta + f(y) \eta - \frac{u}{\beta a^*} \]

contained in eq. price.
Team Problem

planner controls traders’ limit orders but cannot transfer info from one trader to another

chooses orders $x_i = as_i + b - cp$ to max total welfare

$$W \equiv \int_0^1 \left( \theta x_i - \frac{\lambda}{2} x_i^2 \right) \, di + \left( u - \alpha - \beta \frac{\bar{x}}{2} \right) \bar{x}.$$
Proposition 2

Team problem has unique solution. Efficient sensitivity of traders’ demand schedules to private information:

\[
a^T = \frac{1}{\lambda} \frac{\tau_\epsilon y \tau_\eta (y \tau_\eta - \tau_\omega(a^T))}{y^2 \tau_\eta^2 (\tau_\omega(a^T) + \tau_\epsilon + \tau_\theta) - \tau_\omega(a^T) \tau_\epsilon (\tau_\theta + 2y \tau_\eta) + \Xi(a^T) + \Delta(a^T)}
\]

Given \(a^T, \hat{c}^T\) and \(\hat{b}^T\) given by same functions as in eq.

- \(\Xi(a) > 0\): pecuniary externality
  - traders do not internalize co-movement of trades with aggregate shocks

- \(\Delta(a) < 0\): information externality
  - traders do not internalize informational content of prices
Efficient Use of Information

- Efficient schedules \( x_i = a^T s_i + \hat{b}^T - \hat{c}^T p \)

- downward-sloping when pecuniary externality prevails:
  \[ \hat{c}^T > 0 \iff \Xi(a^T) + \Delta(a^T) > 0 \]

- upward-sloping when info externality prevails
  \[ \hat{c}^T < 0 \iff \Xi(a^T) + \Delta(a^T) < 0 \]
Proposition 3

Efficient trading can be induced through combination of linear-quadratic tax on volume of trade along with proportional subsidy/tax on price:

\[ T(x_i, p) = \frac{\delta}{2}x_i^2 + (pt_p - t_0)x_i \]
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Inefficiency in Info Acquisition

Proposition 4

Let $y^T$ denote socially optimal quality of private information. Suppose traders constrained to submit efficient demand schedules (for $y^T$). When efficient demands are downward-sloping, quality of private information acquired in eq. higher than $y^T$. Opposite true when efficient demand schedules upward-sloping.
Proposition 5

Suppose planner uses policy that induces efficiency in trading when info is exogenous. Traders acquire information of quality other than \( y^T \) and then submit inefficient demand schedules.
Proposition 6

There exists no (differentiable) policy $T(x_i, p)$ inducing efficiency in both info acquisition and trading.

- Any smooth policy inducing efficiency in trading induces traders to misperceive marginal value of private information.

- Efficiency in both info acquisition and trading:

  - unorthodox policies where tax bill
    - non-smooth in $(x_i, p)$
    - contingent on information other than $x_i$ and $p$ (e.g., distribution of trades and/or ex-post profitability $\theta$).
Proposition 7

Suppose expenditure on info acquisition $y_i$ verifiable. There exist (differentiable) policies $T(x_i, p, y_i)$ inducing efficiency in both trading and information acquisition.
Conclusions

- Inefficiency in trading
  - pecuniary externality
  - info externality

- Exogenous (private) information
  - inefficiency can be corrected with tax on volume of trade + subsidy on price

- Endogenous (private) information
  - non-existence of (canonical policies) inducing efficiency in both trading and info acquisition

- Efficiency in both info acquisition and trading possible with verifiable acquisition

- Future work:
  - financial decisions interacting with real decisions
  - multiple assets
  - dynamics
THANKS!