(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?
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/subsides 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 efficient schedules
    - pecuniary externality prevails over info externality
  - *under-investment* in information acquisition
    - inefficiently low sensitivity of eq. limit orders to private information
    - upward-sloping efficient 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 by conditioning policy on
  - aggregate volume of trade
  - expenditure on info acquisition (when verifiable)
(In)efficiency in usage of info when info exogenous

Contribution: endogeneity of info

Information acquisition in financial markets

Contribution: welfare analysis

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

Contribution: aggregation

Reduction in cost of info and effect on financial mkts
Plan

1. Introduction
2. Model
3. (In)efficiency in trading
4. (In)efficiency in info acquisition
5. Conclusions
Model
Model

- Unit-mass continuum of traders with payoff

\[ \pi_i = \left( \begin{array}{cc} \theta - p \\ \text{common value - price} \end{array} \right) x_i - \lambda \frac{x_i^2}{2} \]

- Representative liquidity supplier with payoff

\[ \Pi = \left( p - (\alpha - u) \right) \tilde{x} - \beta \frac{\tilde{x}^2}{2} \]
Information and schedules

- Each trader observes private signal
  \[ s_i = \theta + f(y_i) (\eta + e_i) \]
  with \( f' < 0 \)

- Attention/information collection: \( y_i \in \mathbb{R}_+ \)
  - cost \( C(y_i) \), with \( C', C'' > 0 \)

- Trader \( i \)'s schedule
  \[ x_i = a s_i + \hat{b} - \hat{c} p \]

- Liquidity supplier’s (inverse) supply
  \[ p = \alpha - u + \beta \bar{x} \]

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

- $t = 0$: traders choose $y_i$
- $t = 1$: traders observe $s_i$, representative supplier observes $u$
- $t = 2$: limit orders
- $t = 3$: mkt clears
- $t = 4$: payoffs
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(In)eiciency in Trading
Proposition 1

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

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

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.
(Decentralized) Efficient Use of Information

- Team Problem

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

- chooses schedules $x_i = as_i + \hat{b} - \hat{c}p$ to max total welfare

$$W \equiv \int_0^1 \left( \theta x_i - \frac{\lambda}{2} x_i^2 \right) di + \left( u - \alpha - \beta \frac{\tilde{x}}{2} \right) \tilde{x}.$$
Efficient Use of Information

Proposition 2

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

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

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
  \[
  \hat{c}^T < 0 \iff \Xi(a^T) + \Delta(a^T) < 0
  \]
Policy

Proposition 3

Efficient trading can be induced through combination of linear-quadratic tax on individual volume of trade along with ad-valorem subsidy/tax linear in price

\[ T(x_i, p) = \frac{\delta}{2} x_i^2 - t_0 x_i + pt_p x_i \]
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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, traders over-invest in info acquisition. Opposite true when efficient demand schedules upward-sloping.
Proposition 5

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

- Any policy inducing efficiency in trading creates wedge between private and social (marginal) value info.
Possibility result #1

Proposition 6

Efficiency in both info acquisition and trading induced by conditioning marginal tax rates on aggregate volume of trade

\[ T^*(x_i, \tilde{x}, p) = \frac{\delta}{2} x_i^2 - t_0 x_i + pt_p x_i + (t_x^* \tilde{x}) x_i \]

- Contingency on aggregate volume of trade: extra flexibility in eliminating discrepancy between marginal benefit and marginal cost of expanding trade around efficient level

- Possibility to eliminate wedge between private and social (marginal) benefit of info, without breaking efficiency of trade
Proposition 7

Suppose expenditure on info acquisition $y_i$ verifiable. Efficiency in both info acquisition and trade induced by policy

$$T^{tot}(x_i, p, y_i) = \frac{\delta}{2}x_i^2 - t_0x_i + pt_px_i - Ay_i.$$ 

- Subsidy on info acquisition ($A > 0$) when agents under-invest
- Tax on info acquisition ($A < 0$) when agents over-invest
Conclusions

- Inefficiency in trading
  - pecuniary externality
  - info externality

- Exogenous (private) information
  - inefficiency corrected with (linear-quadratic) tax on individual volume of trade + ad-valorem tax/subsidy linear in price

- Endogenous (private) information
  - nature of inefficiency in trade $\rightarrow$ inefficiency in info acquisition
  - non-existence of (canonical policies) inducing efficiency in both trading and info acquisition

- Efficiency in both info acquisition and trading possible with taxes contingent
  - aggregate volume of trade
  - verifiable acquisition

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