(In)efficiency in Information Acquisition and Aggregation through Prices

Alessandro Pavan, Savitar Sundaresan, and Xavier Vives

August 29, 2023

This Paper

- Model to investigate interaction between inefficiency in

    - (financial) trading

    - information acquisition

- Welfare effects of historical reduction in cost of information

- More broadly: welfare analysis in economies with

    - endogenous dispersed information

    - aggregation of information through prices

Key Results

- Inefficiency in trading and information acquisition
  - learning externality
  - pecuniary externality

- Impossibility to induce efficiency in both trading and info acquisition through policies contingent on

  - price
  - individual volume of trade

- Optimal taxes/subsidies need to condition on

  - expenses on info acquisition (when verifiable)

  - aggregate volume of trade

- Welfare-detrimental effects of ad-valorem taxes

Plan

- Model

- Inefficiency in Trading

- Inefficiency in Acquisition

- Policy

- Conclusions

Model

Market Setup

- Homogeneous, perfectly divisible asset

  - gross value: θ

- Unit continuum of traders, $i \in [0, 1]$

  - individual demands: x_i

- Exogenous elastic asset supply
  - liquidity/noisy traders
  - central banks' operations
  - ...

Demand Side

Trader i's payoff:

$$\pi_i = \left(\underbrace{\theta}_{\text{common value}} - \underbrace{p}_{\text{price}} \right) \underbrace{x_i}_{\text{demand of } i} - \underbrace{\lambda}_{\text{trading cost}} \frac{x_i^2}{2}$$

Supply Side

Exogenous asset (inverse) supply:

$$p = \alpha - u + \beta \tilde{x}$$

with aggregate cost

$$\left(\underbrace{\alpha - u}_{\text{opportunity cost}} \right) \underbrace{\tilde{x}}_{\text{aggregate supply}} + \underbrace{\beta}_{\text{trading cost}} \frac{\tilde{x}^2}{2}$$

Examples:

- central bank liquidity supply/Treasury auctions
- price elastic "noise traders" (e.g. pension funds)
- Program traders using portfolio insurance strategies ($\beta < 0$)

Information

- θ and u not observable by traders when submitting limit orders

- Information collected by trader i prior to trading:

$$s_i = \theta + \varepsilon_i = \theta + f(\underbrace{y_i}_{\text{effort}})(\underbrace{\eta}_{\text{common}} + \underbrace{e_i}_{\text{idiosyncratic}})$$

- Effort $y_i \in \mathbb{R}_+$ costs $\mathcal{C}(y_i)$, with $\mathcal{C}', \mathcal{C}'' > 0$

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

Timing

- $t = 0$: traders acquire information

- $t = 1$ traders observe private signals and submit limit orders

- $t = 2$: market clears, trades implemented, payoffs

Inefficiency in Trading

Equilibrium Use of Information

- Fix precision of private information: $y_i = y$, all i

Proposition.

Unique linear equilibrium $x_i(p; s_i) = as_i + \hat{b} - \hat{c}p$

Sensitivity of eq. schedules to price, $\hat{c}$, can be positive (downward sloping demands) or negative (upward sloping demands) depending on primitives.

Welfare and Planner's Problem

- Ex-post welfare:

$$W \equiv \underbrace{\int_0^1 \left(\theta x_i - \frac{\lambda}{2} x_i^2 \right) di}_{\text{Trader Welfare}} - \underbrace{\left(\alpha - u + \beta \frac{\tilde{x}}{2} \right) \tilde{x}}_{\text{Cost of Supply}}$$

- Planner maximizes W by choosing demand schedules of same form as traders:
  $x_i(p; s_i) = a s_i + \hat{b} - \hat{c} p$

- Cannot transfer information across traders

- Fix precision of private information: $y_i = y$, all i

Proposition.

Efficient sensitivity to private information different from equilibrium one because of **learning + pecuniary externality**

Externalities

- **Learning externality**

  - traders do not internalize value of price informativeness to other traders

  - inefficiently low sensitivity of eq. schedules to private info

- **Pecuniary externality (originating in dispersion of information)**

  - traders do not internalize that their response to private information moves prices in non-fundamental manner, affecting other traders' demands through dependence of their limit orders on prices

  - over-sensitivity to private info!

  - isolated by looking at "curse economy" in which agents do not learn from prices but endowed with exogenous public signal of same precision as eq. one

Policy Inducing Efficient Trading

Proposition

Suppose private info is exogenous. Efficiency in trading induced by (non-linear) tax

$$T(x_i, p) = \underbrace{\frac{\delta}{2}x_i^2 \quad - \quad t_0 x_i}_{\text{linear-quadratic tax on volume}} \quad + \quad \underbrace{t_p \; p \; x_i}_{\text{ad-valorem tax}}$$

- **quadratic tax on volume**, $\frac{\delta}{2}x_i^2$: efficient sensitivity to private info, a^T

- **ad-valorem tax,** $t_p \; p \; x_i$: efficient sensitivity to price, $\hat{c}^T$

- **linear tax/subsidy on volume,** $t_0 x_i$: efficient ex-ante trade volume, $\hat{b}^T$

Inefficiency in Information Acquisition

Inefficiency in Information Acquisition

- y^T: efficient acquisition of private information

Proposition

Suppose traders forced to trade efficiently (given y^T)

- downward-sloping efficient schedules: traders **over-invest** in information

- upward-sloping efficient schedules: traders **under-invest** in information

- Hence, efficiency in trading does not guarantee efficiency in acquisition

Optimal Policy Mix

Optimal Policy Mix: Impossibility Result

Proposition

Generically, there exists no policy $T(x_i, p)$ measurable in

(a) price, p

(b) individual volume of trade, x_i

inducing efficiency in **both** information acquisition and trading

- Unique policy inducing efficient trading

  - creates wedge between private and social (marginal) value of information

Optimal Policy Mix: Possibility Result 1

Proposition

If acquisition **verifiable**, efficiency in **both** acquisition and trading through tax policy

$$T^{tot}(x_i, p, y_i) = \frac{\delta}{2}x_i^2 + (pt_p - t_0)x_i - Ay_i$$

- (non-linear) tax $\frac{\delta}{2}x_i^2 + (pt_p - t_0)x_i$

  - efficiency in **trading**

- subsidy/tax Ay_i on info purchases

  - efficiency in **acquisition**

Proposition

Suppose acquisition not verifiable. Efficiency in **both** acquisition and trading through tax policy

$$T^*(x_i, \tilde{x}, p) = \frac{\delta^*}{2} x_i^2 + (t_{\tilde{x}}^* \tilde{x} - t_0^*) x_i + t_p^* p x_i$$

where marginal rate contingent on **aggregate volume of trade**

- Dependence of marginal rate on aggregate volume of trade

    - uncertainty about $\tilde{x}$
    - additional value of information
    - permits planner to re-align incentives for acquisition while retaining efficiency in trading

Ad-valorem Taxes

Proposition

Suppose planner restricted to **ad-valorem taxes**

$$T(x_i, p) = t_p p x_i$$

Then, no matter whether info is exogenous or endogenous, optimal $t_p = 0$.

- Ad-valorem taxes have no effect on
  - acquisition of private information
  - sensitivity of eq. limit orders to private info

- They manipulate
  - sensitivity of eq. limit orders to price, $\hat{c}$
  - ex-ante volume of trade, $\hat{b}$
  - however, $\hat{c}$ and $\hat{b}$ are efficient under laissez-fare (given y and a^*)

Conclusions

Conclusions

- Historical decline in cost of information:

  - over-investment in information

  - over-sensitivity of financial trades to private information

- Efficiency in trading does not guarantee efficiency in acquisition

- Efficiency in **both acquisition and trading**

  - taxes on trades + subsidies on info purchases

    - verifiable acquisition

  - conditioning tax rates on **aggregate volume of trade**

Conclusions

- Other market-design interventions may also help

  - regulation of trade frequency

  - public info disclosures

  - orders conditional on aggregate volume

THANK YOU!