Policy with Dispersed Information

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Motivation
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- Economies with **dispersed** information about **common** fundamentals
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- Economies with **dispersed** information about **common** fundamentals
  - investment in new technologies/sectors
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- Economies with dispersed information about common fundamentals
  
  - investment in new technologies/sectors
  
  - pricing in large market games
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- Economies with **dispersed** information about **common** fundamentals
  - investment in new technologies/sectors
  - pricing in large market games
  - consumption + production decisions over business cycle
Motivation

- Inefficiency can emerge in
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  - way agents use available information (payoff externalities)
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  - way equilibrium reacts to noise (volatility and dispersion)
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  - way information is endogenously aggregated (info externalities)
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- **Policy question:** can government increase welfare even *without* communicating information to the agents?
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• Inefficiency can emerge in
  • way agents use available information (payoff externalities)
  • way equilibrium reacts to noise (volatility and dispersion)
  • way information is endogenously aggregated (info externalities)

• **Policy question:** can government increase welfare
  even *without* communicating information to the agents?

• **Answer:** yes, through contingency of taxes on aggregate activity
Motivation

- Traditional policy analysis
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  - complete, or common, information
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  - complete, or common, information
  - correct market distortions (Pigou)
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  - smooth tax distortions (Ramsey)
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  - private information on *private* values (e.g., one’s own productivity or tastes)
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  - social insurance (redistribution) subject to incentive constraints
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- costless communication between the agents and a “center” (the planner)
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- **This paper**
  - *dispersed* information on *common* values
  - policies that boost welfare *without communication* through the government
Roadmap
Roadmap

1. Baseline model (simple static game)
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2. Equilibrium use of information
Roadmap

1. Baseline model (simple static game)
2. Equilibrium use of information
3. (Decentralized) efficient use of Information
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4. Implementation $\rightarrow$ optimal policy
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4. Implementation → optimal policy
5. Dynamic economies
6. Informational externalities
Baseline Model
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- Static game with large number of players and continuous actions
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- Static game with large number of players and continuous actions

- Reduced-form payoffs with external and strategic effects
 Baseline Model

- Static game with large number of players and continuous actions
- Reduced-form payoffs with external and strategic effects
- Unique and well-behaved equilibrium and first-best allocations
Baseline Model

- Static game with large number of players and continuous actions
- Reduced-form payoffs with external and strategic effects
- Unique and well-behaved equilibrium and first-best allocations
- Incomplete information on common values
Actions and Payoffs


\[ u_i = U(k_i, \{k_j\}_{j \neq i}, \theta) - \tau_i \]
Actions and Payoffs

\[ u_i = U(k_i, K, \sigma, \theta) - \tau_i \]

\[ \theta \in \Theta: \text{exogenous fundamental} \]

\[ K \text{ and } \sigma: \text{mean and dispersion of activity} \]

\[ \tau_i: \text{tax paid to the government} \]
Actions and Payoffs

\[ u_i = U(k_i, K, \sigma, \theta) - \tau_i \]

\( \theta \in \Theta \): exogenous fundamental

\( K \) and \( \sigma \): mean and dispersion of activity

\( \tau_i \): tax paid to the government

**Assumptions:**

- \( U(\cdot) \) quadratic in \( (k, K, \theta) \) and linear in \( \sigma^2 \)
- concavity restrictions s.t. equilibrium and FB are unique and bounded
- \( \tau_i = T(k_i, K, \sigma, \theta, ...) \)
Stage 1: government announces policy rule $T(\cdot)$
Timing

**Stage 1**: government announces policy rule $T(\cdot)$

**Stage 2**: agents receive information $\omega_i$ and choose $k_i(\omega_i)$
Stage 1: government announces policy rule $T(\cdot)$

Stage 2: agents receive information $\omega_i$ and choose $k_i(\omega_i)$

Stage 3: taxes $\tau_i = T(k_i, K, \sigma, \theta)$ paid
Information

- General information structure
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  - Agent $i$'s information: $\omega_i \in \Omega$
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- First nature draws $(\theta, \phi) \in \Theta \times \Phi$ from some distribution $\mathcal{F}$

  $\Phi$ is a family of distributions over $\Omega$

  $\mathcal{F}$ is the common prior
Information

- General information structure

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  - Then each agent $i$ is assigned a type $\omega_i \in \Omega$ from distribution $\phi$
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- Then each agent $i$ is assigned a type $\omega_i \in \Omega$ from distribution $\phi$

- $\omega_i$ encodes a belief about both $\theta$ and $\phi$


- **Common prior:**

\[ \theta \sim N(\mu_\theta, \sigma^2_\theta) \]
Information
Gaussian example

- Common prior:
  \[ \theta \sim N(\mu_\theta, \sigma_\theta^2) \]

- Private signals:
  \[ x_i = \theta + \sigma_x \xi_i \]
  \[ \xi_i \sim N(0, 1) \]
Information
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- Public signals:
  \[ y = \theta + \sigma_y \epsilon \]
  \[ \epsilon \sim N(0, 1) \]
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- Common prior:
  \[ \theta \sim N(\mu_\theta, \sigma_\theta^2) \]

- Private signals:
  \[ x_i = \theta + \sigma_x \xi_i \quad \xi_i \sim N(0, 1) \]

- Public signals:
  \[ y = \theta + \sigma_y \varepsilon \quad \varepsilon \sim N(0, 1) \]

- Type: \( \omega_i = (x_i, y) \in \Omega = \mathbb{R}^2 \)
Examples and Applications
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- **Investment spillovers** (Angeletos & Pavan, 2004)

  \[ u_i = (\theta + aK) k_i - \frac{1}{2} k_i^2 \]
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  \[ u_i = (\theta + aK)k_i - \frac{1}{2}k_i^2 \]

  \[ u_i = -(1-r)(k_i - \theta)^2 - (1-r)\int (k' - k_i)^2 d\Psi(k') + r\int \int (k' - k)^2 d\Psi(k')d\Psi(k) \]
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  \[ u_i = (a_0 + a_1 \theta - bK) k - c k^2 \quad \text{(Cournot)} \]
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  \[ u_i = (a_0 + a_1 \theta - bK) k - ck^2 \quad \text{(Cournot)} \]


  \[ u_i = \pi^* - (k_i - k^*)^2, \text{ with } k^* = (1 - \alpha) \theta + \alpha K \]
Complete-information benchmarks
Complete-information benchmarks

- Equilibrium:

\[ k_i = \kappa(\theta) \text{ with } U_k(\kappa, \kappa, 0, \theta) = 0 \]
Complete-information benchmarks

- Equilibrium:

  \[ k_i = \kappa(\theta) \text{ with } U_k(\kappa, \kappa, 0, \theta) = 0 \]

- First best:

  \[ k_i = \kappa^*(\theta) \text{ with } W_K(\kappa^*, 0, \theta) = 0 \]

  \[ W(K, \sigma, \theta) \equiv U(K, K, \sigma, \theta) + \frac{1}{2} U_{kk} \sigma^2. \]
Complete-information benchmarks

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- Quadratic payoffs: \( \kappa(\theta) = \kappa_0 + \kappa_1 \theta \) and \( \kappa^*(\theta) = \kappa_0^* + \kappa_1^* \theta \)
Complete-information benchmarks

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- Quadratic payoffs: \( \kappa(\theta) = \kappa_0 + \kappa_1 \theta \) and \( \kappa^*(\theta) = \kappa_0^* + \kappa_1^* \theta \)

- Incomplete, but common information (\( \omega_i = \omega \forall i \))

\[ k_i(\omega) = \mathbb{E}[\kappa(\theta) | \omega] \text{ and } k_i^*(\omega) = \mathbb{E}[\kappa^*(\theta) | \omega] \]
Complete-information benchmarks

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- Incomplete, but common information (\( \omega_i = \omega \forall i \))

\[ k_i(\omega) = \mathbb{E}[\kappa(\theta) | \omega] \text{ and } k_i^*(\omega) = \mathbb{E}[\kappa^*(\theta) | \omega] \]

- Benchmark economies: \( \kappa(\cdot) = \kappa^*(\cdot) \)
Roadmap

1. Baseline model
2. **Equilibrium** use of information
3. Efficient use of information
4. Implementation → optimal policies
5. Dynamic economies
6. Informational externalities
Equilibrium (without policy)
Definition

Equilibrium is (measurable) strategy \( k : \Omega \rightarrow \mathbb{R} \) s.t.

\[
k(\omega) \in \arg \max_{k' \in \mathbb{R}} \mathbb{E} \left[ U \left( k', K(\phi), \sigma(\phi), \theta \right) \mid \omega \right] \quad \forall \ \omega
\]

where \( K(\phi) = \int k(\omega) d\phi(\omega) \) and \( \sigma^2(\phi) = \int [k(\omega) - K(\phi)]^2 d\phi(\omega) \quad \forall \ \phi. \)
Equilibrium (without policy)

Proposition

Equilibrium exists, is unique, and satisfies

\[ k(\omega) = \mathbb{E}[\kappa(\theta) + \alpha \cdot [K(\phi) - \kappa(\theta)] | \omega] \quad \forall \omega \]

- \( \kappa(\theta) \rightarrow \) complete-info equilibrium action
- \( K(\phi) \rightarrow \) average action under incomplete info
- \( \alpha \equiv \frac{U_{kK}}{-U_{kk}} \rightarrow \) private value of aligning choices (complementarity)
Equilibrium
Gaussian example
Equilibrium

Gaussian example

- **Complete information:** \( \kappa(\theta) = \kappa_0 + \kappa_1 \theta \)
Complete information: \( \kappa(\theta) = \kappa_0 + \kappa_1 \theta \)

Common information: \( k(y) = \kappa_0 + \kappa_1 [\lambda \mu \theta + \lambda y y] \)
Equilibrium

Gaussian example

- **Complete information:** $\kappa(\theta) = \kappa_0 + \kappa_1 \theta$

- **Common information:** $k(y) = \kappa_0 + \kappa_1 [\lambda \mu \mu \theta + \lambda y y]$

- **Dispersed Information:** $k(x,y) = \kappa_0 + \kappa_1 [\gamma \mu \mu \theta + \gamma y y + \gamma x x]$
Equilibrium

Gaussian example

- **Independence** \((\alpha = 0)\) \(\Rightarrow\) \(\gamma_{\mu} = \lambda_{\mu}\) \(\gamma_{y} = \lambda_{y}\) \(\gamma_{x} = \lambda_{x}\)
Equilibrium

Gaussian example

- **Independence** \((\alpha = 0)\) \(\Rightarrow\) \(\gamma_{\mu} = \lambda_{\mu}\) \(\gamma_{y} = \lambda_{y}\) \(\gamma_{x} = \lambda_{x}\)

- **Complementarity** \((\alpha > 0)\) \(\Rightarrow\) \(\gamma_{\mu} > \lambda_{\mu}\) \(\gamma_{y} > \lambda_{y}\) \(\gamma_{x} < \lambda_{x}\)

(more inertia and volatility, less dispersion!)
Equilibrium
Gaussian example

- **Independence** \((\alpha = 0)\) \(\Rightarrow\) \(\gamma_\mu = \lambda_\mu\) \(\quad \gamma_y = \lambda_y\) \(\quad \gamma_x = \lambda_x\)

- **Complementarity** \((\alpha > 0)\) \(\Rightarrow\) \(\gamma_\mu > \lambda_\mu\) \(\quad \gamma_y > \lambda_y\) \(\quad \gamma_x < \lambda_x\)
  
  (more inertia and volatility, less dispersion!)

- **Substitutability** \((\alpha < 0)\) \(\Rightarrow\) \(\gamma_\mu < \lambda_\mu\) \(\quad \gamma_y < \lambda_y\) \(\quad \gamma_x > \lambda_x\)

  (less inertia and volatility, more dispersion!)
Summary of key positive properties
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• Impact of information:
Summary of key positive properties

- Impact of information:
  - common noise $\rightarrow$ non-fundamental volatility
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- Impact of information:
  - common noise $\rightarrow$ non-fundamental volatility
  - idiosyncratic noise $\rightarrow$ non-fundamental dispersion
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- Impact of complementarity:
Summary of key positive properties

- Impact of information:
  - common noise $\rightarrow$ non-fundamental volatility
  - idiosyncratic noise $\rightarrow$ non-fundamental dispersion

- Impact of complementarity:
  - higher $\alpha$ $\rightarrow$ more sensitivity to public information
    $\rightarrow$ heightened volatility (but also lower dispersion)
Roadmap

1. Baseline model
2. Equilibrium use of information
3. Efficient use of information
4. Implementation → optimal policy
5. Dynamic economies
6. Informational externalities
Efficient use of information
Efficient use of information

Definition

Efficient strategy is a mapping $k : \Omega \rightarrow \mathbb{R}$ that maximizes ex-ante utility

$$\mathbb{E}u = \int_{\Theta \times \Phi} \int_{\Omega} U (k(\omega), K(\phi), \sigma(\phi), \theta) d\phi(\omega) d\mathcal{F}(\theta, \phi),$$

with $K(\phi) = \int k(\omega) d\phi(\omega)$ and $\sigma^2(\phi) = \int [k(\omega) - K(\phi)]^2 d\phi(\omega) \forall \phi.$
Proposition

Efficient strategy exists, is unique, and satisfies

\[ k(\omega) = \mathbb{E}[\kappa^*(\theta) + \alpha^* \cdot (K(\phi) - \kappa^*(\theta)) \mid \omega] \]

for almost all \( \omega \), with \( K(\phi) = \int k(\omega) d\phi(\omega) \).

- \( \kappa^*(\theta) \rightarrow \) first-best action (complete info)
- \( K(\phi) \rightarrow \) average action (incomplete info)
- \( \alpha^* \rightarrow \) social value of aligning choices
Efficient use of information

- Utilitarian welfare function:

\[ W(K, \sigma, \theta) \equiv \int U(k, K, \sigma, \theta) d\Psi(k) \]
Efficient use of information

- Utilitarian welfare function:
  \[ W(K, \sigma, \theta) \equiv \int U(k, K, \sigma, \theta) d\Psi(k) \]

- For any given strategy \( k: \Omega \rightarrow \mathbb{R} \), let
  \[ \hat{K}(\theta) \equiv \mathbb{E}[k(\omega) | \theta] = \mathbb{E}[K(\phi) | \theta] \]
Efficient use of information

- Utilitarian welfare function:

\[ W(K, \sigma, \theta) \equiv \int U(k, K, \sigma, \theta) d\Psi(k) \]

- For any given strategy \( k : \Omega \rightarrow \mathbb{R} \), let

\[ \hat{K}(\theta) \equiv \mathbb{E}[k(\omega) | \theta] = \mathbb{E}[K(\phi) | \theta] \]

- Ex-ante utility:

\[ \mathbb{E}u = \mathbb{E}W(\hat{K}, 0, \theta) + \frac{W_{KK}}{2} \text{Var}(K - \hat{K}) + \frac{W_{\sigma\sigma}}{2} \text{Var}(k - K) \]
Efficient use of information

- Utilitarian welfare function:

\[ W(K, \sigma, \theta) \equiv \int U(k, K, \sigma, \theta) d\Psi(k) \]

- For any given strategy \( k : \Omega \rightarrow \mathbb{R} \), let

\[ \hat{K}(\theta) \equiv \mathbb{E}[k(\omega)|\theta] = \mathbb{E}[K(\phi)|\theta] \]

- Ex-ante utility:

\[ \mathbb{E}u = \mathbb{E}W(\hat{K}, 0, \theta) + \frac{W_{KK}}{2} \text{Var}(K - \hat{K}) + \frac{W_{\sigma\sigma}}{2} \text{Var}(k - K) \]

- Efficient use of info reflects social aversion to volatility/dispersion:

\[ \alpha^* = 1 - \frac{W_{KK}}{W_{\sigma\sigma}} = 1 - \frac{\text{weight to volatility}}{\text{weight to dispersion}} \]
Normative implications

**Corollary**

Consider economies that are efficient under common info ($\kappa = \kappa^*$)

- *Equilibrium is efficient under incomplete information iff $\alpha = \alpha^*$*
Normative implications

Corollary

Consider economies that are efficient under common info ($\kappa = \kappa^*$)

- Equilibrium is efficient under incomplete information iff $\alpha = \alpha^*$

- When $\alpha > \alpha^*$ equilibrium exhibits

  1. overreaction to public information
  2. excessive non-fundamental volatility

  3. excessive cross-sectional dispersion
Normative implications

Corollary

Consider economies that are efficient under common info ($\kappa = \kappa^*$)

- Equilibrium is efficient under incomplete information iff $\alpha = \alpha^*$

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  - overreaction to public information
Normative implications

Corollary

*Consider economies that are efficient under common info (κ = κ*)*

- Equilibrium is efficient under incomplete information iff \( \alpha = \alpha^* \)

- When \( \alpha > \alpha^* \) equilibrium exhibits
  - Overreaction to public information
  - Excessive non-fundamental volatility
Normative implications

Corollary

Consider economies that are efficient under common info \( (\kappa = \kappa^*) \)

- Equilibrium is efficient under incomplete information iff \( \alpha = \alpha^* \)

- When \( \alpha > \alpha^* \) equilibrium exhibits
  1. overreaction to public information
  2. excessive non-fundamental volatility

- When \( \alpha < \alpha^* \) equilibrium exhibits
Corollary

Consider economies that are efficient under common info \((\kappa = \kappa^*)\)

- Equilibrium is efficient under incomplete information iff \(\alpha = \alpha^*\)

- When \(\alpha > \alpha^*\) equilibrium exhibits
  1. overreaction to public information
  2. excessive non-fundamental volatility

- When \(\alpha < \alpha^*\) equilibrium exhibits
  1. overreaction to private information
Corollary

Consider economies that are efficient under common info \((\kappa = \kappa^*)\)

- *Equilibrium is efficient under incomplete information iff* \(\alpha = \alpha^*\)

- *When* \(\alpha > \alpha^*\) *equilibrium exhibits*
  1. overreaction to public information
  2. excessive non-fundamental volatility

- *When* \(\alpha < \alpha^*\) *equilibrium exhibits*
  1. overreaction to private information
  2. excessive cross-sectional dispersion
Roadmap

1. Baseline model
2. Equilibrium
3. Efficient use of information
4. Implementation → Optimal policies
5. Dynamic economies
6. Informational externalities
Implementation
Implementation

- Equilibrium with taxes
Implementation

- Equilibrium with taxes
- Optimal tax policy
Implementation
Equilibrium with taxes
Let \( \mathcal{T} \) denote set of policy rules

\[
\tau_i = T(k_i, K, \sigma, \theta)
\]

where \( T(\cdot) \) is quadratic and satisfies budget balance.
Implementation
Equilibrium with taxes

Let $\mathcal{T}$ denote set of policy rules

$$\tau_i = T(k_i, K, \sigma, \theta)$$

where $T(\cdot)$ is quadratic and satisfies budget balance

Given policy $T \in \mathcal{T}$, let

$$\tilde{U}(k,K,\sigma,\theta) \equiv U(k,K,\sigma,\theta) - T(k,K,\sigma,\theta)$$
Let $\mathcal{T}$ denote set of policy rules

$$\tau_i = T(k_i, K, \sigma, \theta)$$

where $T(\cdot)$ is quadratic and satisfies budget balance

- Given policy $T \in \mathcal{T}$, let

$$\tilde{U}(k, K, \sigma, \theta) \equiv U(k, K, \sigma, \theta) - T(k, K, \sigma, \theta)$$

**Proposition**

Given any $T \in \mathcal{T}$, equilibrium exists, is unique, and satisfies

$$k(\omega) = \mathbb{E}[\tilde{k}(\theta) + \tilde{\alpha} \cdot (K(\phi) - \tilde{k}(\theta)) \mid \omega]$$

for all $\omega \in \Omega$, with $K(\phi) = \int k(\omega) d\phi(\omega)$ for all $\phi \in \Phi$. 
Implementation
Optimal tax policies
Proposition

(i) $\exists$ multiple policies in $\mathcal{T}$ that implement efficient strategy.
Proposition

(i) $\exists$ multiple policies in $\mathcal{T}$ that implement efficient strategy.

(ii) Holding $T_{kk}$ constant, optimal $T_{kK}$ increases with $\alpha$ and decreases with $\alpha^*$. 
Implementation
Optimal tax policies

Two goals:
Implementation
Optimal tax policies

Two goals:

1. manipulate level of activity (overall sensitivity of $k$ to $\theta$)
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1. manipulate level of activity (overall sensitivity of $k$ to $\theta$)
2. manipulate volatility-dispersion trade-off (sensitivity to public/private info)
Implementation
Optimal tax policies

Two goals:

1. manipulate level of activity (overall sensitivity of $k$ to $\theta$)
2. manipulate volatility-dispersion trade-off (sensitivity to public/private info)

Three instruments:

1. sensitivity of marginal tax to fundamental ($T_{k\theta}$) → only #1
Implementation

Optimal tax policies

Two goals:

1. manipulate level of activity (overall sensitivity of $k$ to $\theta$)
2. manipulate volatility-dispersion trade-off (sensitivity to public/private info)

Three instruments:

1. sensitivity of marginal tax to fundamental ($T_{k\theta}$) $\rightarrow$ only #1
2. sensitivity of marginal tax to aggregate activity ($T_{kK}$) $\rightarrow$ both #1 and #2
Optimal tax policies

Two goals:

1. manipulate level of activity (overall sensitivity of $k$ to $\theta$)
2. manipulate volatility-dispersion trade-off (sensitivity to public/private info)

Three instruments:

1. sensitivity of marginal tax to fundamental ($T_{k\theta}$) $\rightarrow$ only #1
2. sensitivity of marginal tax to aggregate activity ($T_{kK}$) $\rightarrow$ both #1 and #2
3. progressivity or regressivity of the tax system ($T_{kk}$) $\rightarrow$ both #1 and #2
Implementations with “less information”
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- Government (as well as any other agent) observes only

\[ \tilde{k}_i = k_i + \eta + \nu_i \]

(\(\eta\) and \(\nu_i\) are measurement errors)
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\( \mathcal{T} \) denotes set of policies
\[ \tau_i = T(\tilde{k}_i, \tilde{K}, \tilde{\sigma}) \]
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**Proposition**

A policy in \( \tilde{T} \) that implements efficient strategy exists iff

\[ Cov(\kappa(\theta), \kappa^*(\theta)) \geq 0 \]
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Key policy result
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- Any inefficiency in use of information can be corrected with combination of contingency of marginal taxes on aggregate activity and progressivity/regressivity of taxes.
Key policy result

- Any inefficiency in use of information can be corrected with combination of:
  - Contingency of marginal taxes on aggregate activity
  - Progressivity/regressivity of taxes

- In economies in which inefficiency emerges only under dispersed info:
Key policy result

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- In economies in which inefficiency emerges only under dispersed info:
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  - when $\alpha < \alpha^*$, optimal tax is countercyclical and progressive: $T_{kK} < 0 < T_{kk}$
Roadmap

1. Baseline model
2. Equilibrium
3. Efficient use of information
4. Implementation → Optimal policies
5. Dynamic economies
6. Informational externalities
Embedding the simple game in a dynamic economy
Embedding the simple game in a dynamic economy

- Each period $t \in \{1, 2, \ldots, T\}$, agents choose
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  - delivers $F(k_{i,t},K_t,\sigma_t,A_{t+1})$ in period $t+1$, with $A_{t+1} \equiv \theta_t$
Embedding the simple game in a dynamic economy

- Budgets:

\[ c_{i,t} + G(k_{i,t}) + q_t b_{i,t} = F(k_{i,t-1}, K_{t-1}, \sigma_{t-1}, \theta_{t-1}) + b_{i,t-1} - \tau_{i,t} \]
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- **Preferences:**
  \[ \mathcal{U}_i = \sum_{t=1}^{T+1} \beta^{t-1} U(c_{i,t}, k_{i,t}) . \]
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Embedding the simple game in a dynamic economy

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- Exogenous information \( \omega_{i,t} \in \Omega_t \) cross-section distribution \( \phi_t \in \Phi_t \)
  - \( (\omega_{i,t-1}, \theta_{t-1}, \phi_{t-1}) \) belongs to \( \omega_{i,t} \rightarrow \) nothing to learn from past actions
Embedding the simple game in a dynamic economy

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- Agents’ problem reduces to

\[
\max \mathbb{E}_0\sum_{t=1}^{T}\beta^{t-1}V(k_{i,t}, K_t, \sigma_t, \theta_t)
\]

\[
V(k, K, \sigma, \theta) \equiv -[G(k) + h(k)] + \beta F(k, K, \sigma, \theta)
\]
Equilibrium, efficiency, and policy

Proposition

- Equilibrium strategy exists, is unique, and satisfies

\[
k_{i,t}(\omega_t) = \mathbb{E}_{i,t}[ \kappa_t(\theta_t) + \alpha \cdot [K_t(\phi_t) - \kappa_t(\theta_t)] ] \quad \forall \omega_t, \forall t
\]
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\]

- **Efficient strategy exists, is unique, and satisfies**

\[
k_{i,t}(\omega_t) = \mathbb{E}_{i,t}\left[ \kappa_t^*(\theta_t) + \alpha^* \cdot [K_t(\phi_t) - \kappa_t^*(\theta_t)] \right]
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- **Optimal policies \(\longrightarrow\) as in static benchmark**
Roadmap

1. Baseline model
2. Equilibrium
3. Efficient use of information
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6. Informational externalities
Informational externalities
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- Endogenous aggregation of information via
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  - indicators of past activity
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- Additional source of inefficiency:
Informational externalities

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  - indicators of past activity
  - market prices

- Additional source of inefficiency:
  - agents do not internalize how their decisions affect information of others
Informational externalities

\[ \theta_t = \theta \text{ for all } t \]
Informational externalities

- $\theta_t = \theta$ for all $t$
- public signal: $y_t = \theta + \varepsilon_t$
Informational externalities

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- $\theta, \varepsilon_t, \xi_{i,t}, \eta_t, \nu_t, a_t$ : Gaussian noises
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- $\theta, \varepsilon_t, \xi_{i,t}, \eta_t, \nu_t, a_t$ : Gaussian noises
- Period-$t$ budget

$$c_{i,t} + G(k_{i,t}) + q_t b_{i,t} = F(k_{i,t-1}, \tilde{K}_{t-1}, \tilde{\sigma}_{t-1}, \tilde{A}_t) + b_{i,t-1} - \tau_{i,t}$$
Suppose

\[
k_{t-1} = \kappa_0 + \kappa_1 [\gamma_{t-1} X_{i,t-1} + (1 - \gamma_{t-1}) Y_{t-1},]
\]
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Then
\[ K_{t-1} = \kappa_0 + \kappa_1[\gamma_{t-1} \theta + (1 - \gamma_{t-1}) Y_{t-1}] \]
Informational externalities

Key observation

- Suppose
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- Signal \( \tilde{K}_{t-1} = K_{t-1} + \eta_t \) is informational equivalent to
  \[ \tilde{\eta}_t = \theta + \frac{1}{\kappa_1 \gamma_{t-1}} \eta_t \]
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- Signal \( \hat{K}_{t-1} = K_{t-1} + \eta_t \) is informational equivalent to
  \[ \hat{y}_t = \theta + \frac{1}{\kappa_1 \gamma_{t-1}} \eta_t \]

- Precision of \( \hat{y}_t \) is increasing in sensitivity of \( k_{t-1} \) to private info
Informational externalities

Proposition

- *Equilibrium:* essentially same as with exogenous info
Informational externalities

Proposition

- **Equilibrium**: essentially same as with exogenous info

- **Efficient strategy**

\[
    k_{it}(\omega_t) = \mathbb{E}_{i,t} \left[ \kappa_i^*(\theta_t) + \alpha_t^{**} \cdot [K_t(\phi_t) - \kappa_t^*(\theta_t)] \right]
\]

\[
    \alpha_t^{**} < \alpha^* \left( \equiv 1 - \frac{\text{weight on volatility}}{\text{weight on dispersion}} \right)
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- Intuition:
Informational externalities

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  - only aggregation of private info, not public, induces learning
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  2. efficient use of info ensures that social value of info is positive
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  3. 1 and 2 \(\Rightarrow\) higher sensitivity to private info \( (\alpha_i^{**} < \alpha^*) \)
Proposition

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k_{it}(\omega_t) = E_{i,t}[\kappa_t^*(\theta_t) + \alpha_t^{**} \cdot (K_t(\phi_t) - \kappa_t^*(\theta_t))]
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  1. only aggregation of private info, not public, induces learning
  2. efficient use of info ensures that social value of info is positive
  3. 1 and 2 ⇒ higher sensitivity to private info (\(\alpha_t^{**} < \alpha^*\))

- **Policy implication**: info externalities contribute to higher \(T_{kK}\)
Social value of information

- Suppose now government can collect and disseminate information
Social value of information

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Corollary

In general, more precise information can reduce welfare. However, once optimal tax policy is in place, any type of information is welfare-enhancing!
Suppose now government can collect and disseminate information

**Corollary**

*In general, more precise information can reduce welfare. However, once optimal tax policy is in place, any type of information is welfare-enhancing!*

- Policies that correct inefficiencies in use of available information are complement to policies that collect / disseminate new information
Conclusions
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- Novel role for policy in economies with dispersed info on common values

Government can increase welfare even without communicating info

Key instrument: contingency of taxes on aggregate activity

Extensions:
- redistribution (and insurance)
- limits to information aggregation / dissemination
Conclusions

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