Optimal Monetary and Fiscal Policy with Investment Spillovers and Endogenous Private Information

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This Paper

- Economies with
  - investment spillovers
  - endogenous private information
  - real and nominal rigidities

- Optimal fiscal rule
  - usual subsidy/tax on revenues/employment correcting for market power
  - NOVEL subsidy to innovating firms
    - constant (exogenous information)
    - state-dependent (endogenous information)
    - co-moves with optimal monetary policy

- Optimal policies with exogenous information need not be optimal with endogenous information

- Optimal monetary policy
  - pro-cyclical
  - stabilizes prices within (endogenous) groups
  - must co-move with fiscal policy to create right incentives for information acquisition
**Policy with dispersed Information**
- Angeletos and Pavan (2009)
- Paciello and Wiederholt (2013)
- Angeletos and La’O (2019)
- La’O and Tahbaz-Salehi (2020)
- ..

**Inefficiency in information acquisition**
- Colombo, Femminis, Pavan (2014)
- Pavan (2017)
- Hebert and La’O (2020)
- ...
Plan

1. Introduction
2. Model
3. Efficient allocation
4. Real Rigidities
   1. exogenous information
   2. endogenous information
5. Nominal + Real Rigidities
6. Conclusions
Model
Model

- Economy populated by
  - representative household
  - (measure 1) continuum of agents
    - (measure 1) continuum of monopolistically-competitive firms producing differentiated intermediate goods
  - competitive retail sector producing final good
  - benevolent planner controlling monetary and fiscal policy
Model

- Each firm run by single entrepreneur
  - initially located on “island” with imperfect information about TFP $\Theta$
  - chooses whether to “upgrade” technology for intermediate good $i \in [0, 1]$

$$y_i = \begin{cases} 
\gamma \Theta (1 + \beta N)^\alpha l_i^\psi & \text{when } n_i = 1 \quad \text{(new)} \\
\Theta (1 + \beta N)^\alpha l_i^\psi & \text{when } n_i = 0 \quad \text{(old)}
\end{cases}$$

with $\gamma > 1$, $\beta \geq 0$, $\alpha \geq 0$, $\psi \leq 1$

- $N = \int n_i \, di$: aggregate investment in new technology
- $l_i$: undifferentiated labor (more below)

- Differential $y_i(n_i = 1) - y_i(n_i = 0)$ increasing in $\Theta$ and $N$

- dependence on $N$: spillover (within and across technologies)
  - human capital
  - physical capital

- Cost of new technology: $k > 0$ (effort)
Model

- Final good (produced by competitive retail sector):
  \[ Y = \left( \int y_i^{\frac{v-1}{v}} \, di \right)^{\frac{v}{v-1}} \]

- Profits of competitive retail sector \( \Pi = PY - \int p_i y_i \, di \)
  
  - \( P \): price of final good
  
  - \( p_i \) price of intermediate good of variety \( i \)
Entrepreneurs are members of representative household with utility

\[ U = \frac{C^{1-R}}{1-R} - k \int n_i di - \frac{l^{1+\varepsilon_l}}{1 + \varepsilon_l} - \int \mathcal{I}(\pi^x_i)di \]

- \( C \): consumption of final good
- \( \mathcal{I}(\pi^x) \): disutility of info of precision \( \pi^x \)
- \( \mathcal{I}' > 0, \mathcal{I}'' \geq 0, \mathcal{I}'(0) = 0. \)
Each entrepreneur maximizes her firm’s market valuation

\[ C^{-R} \left( \frac{p_i y_i - W l_i + T_i}{P} \right) - k n_i - I(\pi_i^x) \]

- \( W \): wage rate
- \( T_i \): fiscal transfer
Model

- Cash-in-advance' constraint:
  \[ PY \leq M \]

- \( M \): money provided by planner (returned at end of period)

- Benevolent planner maximizes ex-ante utility of representative household
  - monetary rule \( M(\theta) \)
  - fiscal rule \( T_n(r_i, \theta) \)
    - \( r_i = p_iy_i \): firm’s revenue

- Alternatively, \( T(P, p_i, l_i) \)
Model: Timing

1. Nature draws $\theta$ from $N(\theta_0, \pi_\theta^{-1})$

2. Each entrepreneur $i$ chooses $\pi_i^x$ and receives signal $x_i = \theta + \xi_i$, with $\xi_i$ drawn from $N(0, (\pi_i^x)^{-1})$, independent from $\theta$, independently across $i$

3. Each entrepreneur chooses
   1. whether or not to upgrade technology
   2. $p_i$ (nominal rigidities)

4. After $\theta$ revealed,
   1. government supplies $M = M(\theta)$
   2. each entrepreneur posts price $p_i$ (flexible prices)

5. Retail sector chooses demand $y_i$ of each intermediate good

6. Entrepreneur $i$ hires $l_i$ to meet demand

7. Representative consumer chooses $C$
1. Both retail sector and representative consumer take price $P$ as given.

2. Retail sector also takes prices of intermediate goods $p_i$ as given.

3. Labor $l_i$ acquired on competitive market.
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Efficient Allocation
Efficient Allocation

**Definition 1**
Efficient allocation is given by \( \pi^{x^*}, n^*(x), \text{ and } l^*(x, \theta) \) that jointly maximize \( E_0[U] \).
Proposition 1

Under appropriate parameters' restrictions, efficient upgrade policy given by
\[ \hat{n}(x) = I(x \geq \hat{x}). \]

Efficient employment policy given by \( \hat{l}_0(\theta) \) for firms retaining old technology and by \( \hat{l}_1(\theta) = \gamma^\varphi \hat{l}_0(\theta) \) for those innovating, where \( \varphi \equiv \frac{v-1}{v+\psi(1-v)}. \)

Efficient precision \( \hat{\pi}^x \) given by

\[
E \left[ \hat{C}(\theta)^{1-R} \left( \frac{\alpha \beta}{1 + \beta \hat{N}(\theta)} + \frac{v}{v-1} \frac{\gamma^\varphi - 1}{(\gamma^\varphi - 1) \hat{N}(\theta) + 1} \right) \frac{\partial \hat{N}(\theta)}{\partial \pi^x} \right]
\]

effect on \( C \)

\[
E \left[ \hat{l}_0(\theta)^{1+\varepsilon} \left( (\gamma^\varphi - 1) \hat{N}(\theta) + 1 \right)^\varepsilon (\gamma^\varphi - 1) \frac{\partial \hat{N}(\theta)}{\partial \pi^x} \right]
\]

effect on disutility of labor

\[-k E \left[ \frac{\partial \hat{N}(\theta)}{\partial \pi^x} \right] = \frac{dI(\hat{\pi}^x)}{d\pi^x} \]

where \( \hat{N}(\theta) = 1 - \Phi(\hat{x}|\theta) \).
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Real Rigidities
Proposition 2

Suppose information is exogenous and let \( r = p_y \). Any monetary and fiscal policy \( M \) and \( T \) satisfying following conditions are optimal

\[
T_1(\theta, r) = s(\theta) + \frac{1}{v-1} r
\]

\[
T_0(\theta, r) = \frac{1}{v-1} r
\]

\[
\mathbb{E} \left[ \hat{C}(\theta)^{-R} \frac{s(\theta)}{\hat{P}(\theta)} \mid \hat{x} \right] = \mathbb{E} \left[ \hat{C}(\theta)^{1-R} \frac{\alpha \beta}{1 + \beta \hat{N}(\theta)} \mid \hat{x} \right]
\]

with \( \hat{C}(\theta)^{-R} s(\theta) / \hat{P}(\theta) \) non-decreasing.
Exogenous Information

- No spillovers:
  - $s(\theta) = 0$
  - familiar subsidy $T = \frac{1}{v-1} r$

- Spillovers:
  - subsidy to innovating firms
    $$T_1 - T_0 = s(\theta)$$
  - corrects for externality in investment
    $$\mathbb{E} \left[ \hat{C}(\theta)^{1-R} \frac{\alpha \beta}{1 + \beta \hat{N}(\theta)} \right] = \mathbb{E} \left[ \hat{C}(\theta)^{-R} \frac{\partial \hat{C}(\theta)}{\partial N} \right]$$

- Single-crossing: $\hat{C}(\theta)^{-R} s(\theta)/\hat{P}(\theta)$ non-decreasing
  - guarantees efficient investment

- multiple combinations of mon and fiscal policy yielding efficiency
Proposition 3

In addition to previous conditions policy must satisfy

$$
\mathbb{E} \left[ C^* (\theta)^{-R} \frac{s(\theta)}{P^*(\theta)} \frac{\partial \hat{N}(\theta; \pi^{**})}{\partial \pi_i^x} \right] = \mathbb{E} \left[ C^* (\theta)^{1-R} \left( \frac{\alpha \beta}{1 + \beta N^*(\theta)} \right) \frac{\partial \hat{N}(\theta; \pi^{**})}{\partial \pi^x} \right]
$$
Endogenous Information

Corollary 1

*Policies that are optimal with exogenous info need not be optimal with endogenous info*

- However, policies exist correcting inefficiencies in **both usage and acquisition**
Nominal + Real Rigidities
Proposition 4

No matter whether information is exogenous or endogenous, optimal monetary policy given by

\[ \hat{M}(\theta)^{1-R} = m\hat{l}_0(\theta)^{1+\varepsilon} \left((\gamma^\varphi - 1)\hat{N}(\theta) + 1\right)^{(1+\varepsilon)(v-1)+R-1} \]

with \( m > 0 \).

- **Group-dependent price stability**: All entrepreneurs choosing same technology set same price.

- But then, necessarily \( s(\theta) \) state dependent with endogenous information

- Example:

\[ s(\theta) = \hat{P}(\theta)\hat{C}(\theta)\frac{\alpha\beta}{1 + \beta\hat{N}(\theta)} \]

- \( P^*(\theta) \) pinned down by mon. policy
Conclusions

- **Optimal fiscal policy**
  - standard subsidy correcting for market power
  - NOVEL subsidy to innovating firms
    - sensitivity of fiscal policy to fundamentals higher when information is endogenous

- **Optimal monetary policy**
  - pro-cyclical
  - stabilizes prices within groups
  - supports efficient investment and information acquisition
THANKS!