Learning from Prices: Public Communication and Welfare

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Environment - Agents

There is a representative family consisting of:

- a continuum of workers who produce intermediate goods
- a shopper
- a final good producer

They maximize the following objective function:

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t \log C_t + \frac{1}{V} \log \frac{M_{t-1}^d}{P_t} - \frac{\delta}{1-\delta} \int_0^1 L_{it}^{1+\frac{1}{\delta}} di \right] \tag{1}$$

subject to

$$C_t + \frac{M_t^d}{P_t} = \int_0^1 \frac{P_{it}}{P_t} \Theta_i L_{it} di + \frac{M_{t-1}^d}{P_t} + \frac{\Pi_t}{P_t} \tag{2}$$

Production

Intermediate goods:

$$Y_{it} = \Theta_i L_{it} \tag{3}$$

Final good:

$$Y_t = \prod_{i \in [0,1]} Y_{it}^{A_i} \tag{4}$$

$$\int_0^1 A_i di = 1 \tag{5}$$

Shocks

There are 2 aggregate shocks and and 2 types of idiosyncratic shocks in period 0 (no shocks after period 0):

$$\log A_i = a_i - \frac{1}{2\psi_a} \tag{6}$$

$$a_i \sim N(0, 1/\psi_a) \tag{7}$$

$$\log \Theta_i = \theta_i = \theta + \varepsilon_i \tag{8}$$

$$\theta \sim N(0, 1/\Psi_\theta) \tag{9}$$

$$\varepsilon_i \sim N(0, 1/\psi_\theta) \tag{10}$$

$$\log V = \mu_v + v \tag{11}$$

$$v \sim N(0, 1/\Psi_v) \tag{12}$$

Information

- All agents observe all nominal prices in the economy
- the shopper observes v
- the final good producer observes all a_i's
- each worker i observes θ_i
- at the end of period 0 all agents share their information

Monetary Policy and Solution Strategy

$$M^s = M \; \forall t \tag{13}$$

Since all shocks are known after date 0 and M is constant, equilibrium for $t \geq 1$ is standard. The paper focuses on $t = 0$.

Equilibrium Conditions

shopper:

$$P_t Y_t = \frac{1-\beta}{\beta} MV \tag{14}$$

demand for intermediate goods:

$$P_t A_i \frac{Y_t}{Y_{it}} = P_{it} \tag{15}$$

worker:

$$Y_{it} = \Theta_i \left[\frac{\beta}{1-\beta} E_{it} \left(\frac{1}{MV} \right) \Theta_i P_{it} \right]^{\delta} \tag{16}$$

plus the production function for Y_t

Log-linear Equilibrium Conditions

$$y = v - p \tag{17}$$

$$y_i = y + a_i - \frac{1}{2\psi_a} + p - p_i \tag{18}$$

$$y = \int_0^1 y_i di + \int_0^1 y_i a_i di \tag{19}$$

$$y_i = (1 + \delta)\theta_i + \delta(p_i - E_i v + V_i(v)/2) \tag{20}$$

Symmetric Linear Equilibrium

A symmetric linear equilibrium is a final good price p, aggregate output y, and a distribution of intermediate goods prices p_i and intermediate good supplies y_i such that

- Log prices are linear functions of the states:

$$p = K_0 + K_v v + K_\theta \theta \tag{21}$$

$$p_i = k_0 + k_v v + k_\theta \theta + k_a a_i + k_\varepsilon \varepsilon_i \tag{22}$$

- Workers' expectations are rational: after incorporating all relevant information posterior beliefs are normally distributed with mean $E_i v$ and variance $V_i(v)$
- Agents' decisions are optimal and markets clear

The Relationship Between Aggregate and Intermediate Goods' Prices

$$p = \int_0^1 p_j dj + \frac{1}{2\psi_a} - \int_0^1 y_j a_j dj \qquad (23)$$

This implies $K_v = k_v$ and $K_\theta = k_\theta$, which means that prices only reveal a linear combination of aggregate shocks.

Equilibrium Characterization

Let $\Omega = -K_v/K_\theta$. The set of symmetric equilibria is non-empty and in any equilibrium Ω solves

$$\Omega = \frac{1}{1+\delta} + \frac{\delta}{1+\delta}\frac{\psi_a + \Omega^2\psi_\theta}{\Psi_v + \Omega^2\Psi_\theta + \psi_a + \Omega^2\psi_\theta} \tag{24}$$

All solutions of this equation lie in the interval $[1/(1+\delta), 1]$. Given Ω the authors show how to solve for all endogenous variables.

Information Aggregation

The workers' information set is equivalent to observing the following three signals about v:

1. $v + a_i$
2. $v - \frac{\theta}{\Omega}$ (aggregate signal)
3. $v + \frac{\varepsilon_i}{\Omega}$

Then we have

$$E_i v = \omega \text{ private forecast } + (1-\omega) \text{ public forecast} \tag{25}$$

where

$$\omega = \frac{\psi_a + \Omega^2 \psi_\theta}{\Psi_v + \Omega^2 \Psi_\theta + \psi_a + \Omega^2 \psi_\theta} \tag{26}$$

Information Aggregation II

The aggregate price as a function of forecasts:

$$p = \frac{1}{1+\delta}v + \frac{\delta}{1+\delta}(\omega \underbrace{\text{average private forecast}}_{=v} + (1-\omega)\text{ public forecast }) - \theta \tag{27}$$

Observing observing the aggregate price thus gives the workers the same information as observing $v - \theta/\Omega$ where $\Omega = \frac{1}{1+\delta} + \frac{\delta}{1+\delta}\omega$

Public Information and Welfare

- In a symmetric linear equilibrium, public information increases ex-ante utilitarian welfare if and only if it increases the posterior precision about v, $\Psi_v + \Omega^2\Psi_\theta + \psi_a + \Omega^2\psi_\theta = \frac{\delta}{1+\delta}\frac{\psi_a+\Omega^2\psi_\theta}{\Omega-1/(1-\delta)}$
- There are generally multiple equilibria, and the highest welfare equilibrium is associated with the largest value of Ω that solves the fixed point equation
- In the highest welfare equilibrium Ω is strictly decreasing in Ψ_θ and Ψ_v

Public Information and Welfare II

- The posterior precision of v is a U-shaped function of Ω, with the precision increasing if $\Omega > \frac{1}{1+\delta} + \sqrt{\frac{\psi_a}{\psi_\theta} + \frac{1}{(1+\delta)^2}}$ and decreasing for the opposite strict inequality
- Suppose the government has several independent signals about v and θ that would increase public precisions if revealed. Then, the optimal communication policy is to announce all or none.
- A sufficiently large release of public information about v or θ will always increase welfare.