Monetary Policy and Sentiment-Driven Fluctuations

Jenny Chan
Bank of England

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This paper on one slide

Motivation: NK model as a workhorse for monetary policy analysis:

- Strong inflation targeting is optimal and nominal flexibilities are desirable.
- Optimal policy through lens of allocative efficiency.
- Taylor principle rules out indeterminacy.

Question: Are these results robust to information frictions?

- Let firms to make decisions before shocks are known, conditioning on an endogenous signal of demand.

Key result: Alternate channel for monetary policy

- Through its effect on aggregate variables, policy affects the precision of endogenous signals.

What I do

A model with two key features (NK model is a special case)

1. Information frictions: signals about demand that are correlated across firms
2. Complementarity/substitutability in firms' decisions

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Obtain two equilibria

1. Fundamental (fluctuations driven by fundamental shocks only)
2. Sentiment (fluctuations driven by both fundamental and non-fundamental shocks)

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Comparative static exercise

- How does monetary policy affect the sentiment equilibrium?
- Which equilibrium is better?
- What is the optimal stance of policy?

Several predictions of the New Keynesian model no longer hold

Assuming nominal rigidities and information frictions,

- Policy can be a source of non-fundamental shocks
- Both a strong response to inflation and nominal flexibilities increase the variance of non-fundamental shocks, which are shown to be suboptimal
  - non-fundamental shocks introduce a new tradeoff between stabilizing output and inflation
- Taylor principle no longer sufficient to rule out indeterminacy (from expectations of aggregate demand)

Overview

Stylized Model

Model

Effects of monetary policy

Optimal monetary policy

Fundamental shocks

Stylized Model

Beauty contest: motivation

$$y_j = \mathbb{E}[\alpha\varepsilon_j + \beta y | I_j]$$

2 features

- information frictions: decision-making before outcomes are known, condition on a dispersed signal
- interdependent action: $\beta \begin{cases} < 0 & \text{strategic substitutability} \\ > 0 & \text{strategic complementarity} \end{cases}$

New Keynesian model is a special case

- monopolistically competitive firms face strategic substitutability through the real wage in marginal cost

Beauty contest: unique equilibrium with complete information

$$y_j = \alpha\varepsilon_j + \beta y$$

Assuming LLN,

$$y = \int_0^1 (\alpha\varepsilon_j + \beta y)\,\mathrm{d}j = \beta y$$

$\rightarrow$ If $\beta \neq 1$, only the fundamental equilibrium exists ($y = 0$).

Beauty contest: multiple equilibria with incomplete information

$$y_j = \mathbb{E}[\alpha\varepsilon_j + \beta y | I_j]$$

Let $I_j = s_j$, a signal about an endogenous outcome (λ known)

$$s_j = \lambda\varepsilon_j + (1-\lambda)\int_0^1 y_j \, \mathrm{d}j$$

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$\rightarrow$ Then there are two equilibria

1. One with fluctuations driven by both fundamental and non-fundamental
2. Another with fluctuations driven only by fundamental shocks

Multiple equilibria with incomplete information

$$y_j = \mathbb{E}[\alpha \varepsilon_j + \beta y | s_j]$$
$$s_j = \lambda \varepsilon_j + (1 - \lambda) y$$

1. Suppose y is stochastic ($\sigma_y^2 > 0$)
   - Assume $\varepsilon_j \sim N(0, \sigma_\varepsilon^2)$, $y \sim N(0, \sigma_y^2)$ and that volatilities are known. Agents use Bayesian updating:

$$y_j = \frac{\text{cov}(\alpha \varepsilon_j + \beta y, s_j)}{\text{var}(s_j)} s_j$$

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   - Rational expectations equilibrium (REE) if
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$\rightarrow$ There exists an equilibrium in which y is stochastic, its distribution is determined by parameters. y can be driven by both non-fundamental and fundamental shocks.

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   $\rightarrow$ There exists an equilibrium in which y is stochastic, its distribution is determined by parameters. y can be driven by both non-fundamental and fundamental shocks.

2. Suppose y is non-stochastic ($\sigma_y^2 = 0$). Verify that there still exists an equilibrium with only fundamental shocks ($\sigma_y^2 = 0$ and $y = 0$).

An equilibrium with fundamental and non-fundamental fluctuations: key properties

$$y_j = \mathbb{E}[\alpha\varepsilon_j + \beta y | s_j]$$
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Abstract from fundamental shocks for now. In this equilibrium:

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- Equilibrium is pinned down by a distribution (σ_y^2), and is not knife-edge
  If $\lambda, \alpha, \beta, \sigma_\epsilon^2$ change, then equilibrium σ_y^2 changes. Any $y \sim N(0, \sigma_y^2)$ is a REE solution.

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  - Beliefs = outcomes determined endogenously
  - Information externality: the use of information by agent j, aggregated across all agents, will affect the precision of the signal it will receive (σ_y^2)
  - To sustain this equilibrium, ($\sigma_y^2 = \frac{\lambda}{1-\lambda}\left(\frac{\alpha - \frac{\lambda}{1-\lambda}}{1-\beta}\right)\sigma_\varepsilon^2 > 0$)
    $\rightarrow$ Agents want to respond differently to ε_j and y, but it is sufficiently difficult to distinguish between them (λ)

Model

New Keynesian model with information frictions

- Standard NK + nominal wage rigidity + CB targets wage inflation
- Important thing to note is the timing

New Keynesian model with information frictions

$$y_j = \mathbb{E}[\alpha\varepsilon_j + \beta y | s_j]$$
$$s_j = \lambda\varepsilon_j + (1-\lambda)z$$

1. **Households** form schedules: labor supply (Calvo wage rigidity) and consumption

Timing

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1. **Households** form schedules: labor supply (Calvo wage rigidity) and consumption
2. Shocks are drawn

   ε_j: idiosyncratic demand for good j

   z: belief about aggregate consumption

Timing

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3. Monopolistically competitive **firms** commit to production ($y_j(s_j)$), conditional on a private signal that confounds idiosyncratic and aggregate demand

   $\rightarrow$ strategic substitutability through real wage in marginal cost

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   - Timing: make production decisions before demand is known

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3. Monopolistically competitive **firms** commit to production ($y_j(s_j)$), conditional on a private signal that confounds idiosyncratic and aggregate demand
   - Timing: make production decisions before demand is known
   - Inference problem: base production decision on an endogenous signal that confounds idiosyncratic preference (ε_j) and aggregate demand (z).

Timing

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Monetary policy follows a Taylor rule that targets wage inflation and output

$$\beta = f(\phi_\pi^w, \phi_y, ...)$$

Through its effect on aggregate variables, the stance of monetary policy affects how firms respond to aggregate demand.

Timing

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An equilibrium with non-fundamental shocks: beliefs about aggregate demand are self-fulfilling ($z = y$) and $y \sim N(0, \sigma_y^2)$ is stochastic, equilibrium pinned down by

$$\sigma_y^2 = \sigma_z^2 = \frac{\lambda}{1-\lambda}\left(\frac{\alpha - \frac{\lambda}{1-\lambda}}{1-\beta}\right)\sigma_\varepsilon^2$$

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Stance of policy $\beta = f(\phi_\pi^w, \phi_y, \ldots)$ affects the precision of the endogenous signal that firms receive

Timing

Firms

Monopolistically competitive intermediate goods producers indexed by $j \in [0, 1]$: set production before shocks to demand are known,

$$\max_{Y_{j,t}} \mathbb{E}_t \left[P_{j,t} Y_{j,t} - W_t N_{j,t} | S_{j,t} \right]$$

subject to

$$S_{j,t} = \epsilon_{j,t}^{\lambda} Z_t^{1-\lambda}$$
$$Y_{j,t} = N_{j,t}$$
$$Y_{j,t} = \left(\frac{P_t}{P_{j,t}} \right)^{\theta} \epsilon_{j,t} Y_t$$

Best response of firm j:

$$Y_{j,t} = \left[\left(1 - \frac{1}{\theta} \right) \mathbb{E}_t \left((\epsilon_{j,t} Y_t)^{\frac{1}{\theta}} \frac{P_t}{W_t} | S_{j,t} \right) \right]^{\theta}$$

Equilibrium conditions

As in the abstract model,

$$
\begin{aligned}
y_{j,t} &= \mathbb{E}_t[\varepsilon_{j,t} + y_t - \theta w_t^r | s_{j,t}] \\
s_{j,t} &= \lambda \varepsilon_{j,t} + (1-\lambda) z_t \\
z_t &= y_t
\end{aligned}
$$

where $y_t = \int_0^1 y_{j,t}\,\mathrm{d}j$.

Now, in addition:

$$
\begin{aligned}
\pi_t^w &= \beta \mathbb{E}_t \pi_{t+1}^w - \lambda_w (w_t^r - y_t) \\
y_t &= \mathbb{E}_t y_{t+1} - \frac{1}{\gamma}(i_t - \mathbb{E}_t \pi_{t+1}) \\
i_t &= \phi_\pi \pi_t^w + \phi_y y_t \\
w_t^r &= w_{t-1}^r + \pi_t^w - \pi_t
\end{aligned}
$$

Effects of monetary policy

Overview of this section

Comparative statics exercise: consider a positive *iid* shock to sentiment. The stance of policy (ϕ_π^w):

- affects how firms respond to aggregate demand, $\beta(\phi_\pi^w)$
- thereby determining the equilibrium volatility of non-fundamental shocks, σ_z^2
- and introducing a new tradeoff between stabilizing output and inflation

An increase in wage flexibility (λ_w) will also have this effect.

Consider a positive *iid* shock to sentiment

$$\underset{\Uparrow}{y_t} = \mathbb{E}_t y_{t+1} - \frac{1}{\gamma}(\underset{\Downarrow}{i_t} - \mathbb{E}_t \underset{\Uparrow}{\pi_{t+1}})$$

For the nominal interest rate to decrease, wage inflation must fall

$$\underset{\Downarrow}{i_t} = \phi_\pi^w \underset{\Downarrow}{\pi_t^w} + \phi_y y_t$$

For wage inflation to fall when aggregate demand rises, the real wage must increase

$$\underset{\Downarrow}{\pi_t^w} = \beta \mathbb{E}_t \pi_{t+1}^w - \lambda_w(\underset{\Uparrow}{w_t^r} - \underset{\Uparrow}{y_t})$$

$\rightarrow$ Real wage increases

$\rightarrow$ z_t is conceptually a demand shock, looks like a mark-up shock. A sentiment shock introduces a trade-off between stabilizing output and inflation

$\rightarrow$ Both high ϕ_π^w and λ_w limit the amount that the real wage increases in equilibrium, but this will make output more volatile

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Stance of policy affects how firms respond to aggregate demand

Firm j's optimal production decision

$$y_{j,t} = \mathbb{E}_t(\varepsilon_{j,t} + y_t - \theta w_t^r | s_{j,t})$$

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Incorporating the relationship between the real wage and sentiment

$$y_{j,t} = \mathbb{E}_t \left[\varepsilon_{j,t} + \left(1 - \theta \underbrace{\left[\frac{\phi_\pi^w \lambda_w + (\gamma + \phi_y)}{1 + \phi_\pi^w \lambda_w} \right]}_{D} \right) z_t | s_{j,t} \right] \tag{1}$$

$$\tag{2}$$

where $D \equiv \frac{\partial w_t^r}{\partial z_t}$

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where $D \equiv \frac{\partial w_t^r}{\partial z_t}$

$\rightarrow$ Through its effect on the equilibrium real wage, the stance of policy affects how firms respond to aggregate demand

$$\beta = f(\phi_\pi, \lambda_w, \phi_y, \gamma)$$

Stance of policy pins down equilibrium outcomes

Firm j's optimal production decision

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Details

Stance of policy pins down equilibrium outcomes

Firm j's optimal production decision

$$y_{j,t} = \mathbb{E}_t(\varepsilon_{j,t} + y_t - \theta w^r_t | s_{j,t})$$

In an equilibrium with non-fundamental fluctuations

$$y_t = \underbrace{\frac{\lambda\sigma_\varepsilon^2 + (1-\lambda)(1-\theta D)\sigma_z^2}{\lambda^2\sigma_\varepsilon^2 + (1-\lambda)^2\sigma_z^2}(1-\lambda)}_{=1} z_t$$

$$\iff \qquad \sigma_z^2 = \left[\frac{1+\phi_\pi^w\lambda_w}{\phi_\pi^w\lambda_w + (\gamma+\phi_y)}\right]\frac{\lambda}{1-\lambda}\frac{1-\frac{\lambda}{1-\lambda}}{\theta}\sigma_\varepsilon^2$$

Details

Stance of policy pins down equilibrium outcomes

Firm j's optimal production decision

$$y_{j,t} = \mathbb{E}_t(\varepsilon_{j,t} + y_t - \theta w_t^r | s_{j,t})$$

In an equilibrium with non-fundamental fluctuations

$$y_t = \underbrace{\frac{\lambda\sigma_\varepsilon^2 + (1-\lambda)(1-\theta D)\sigma_z^2}{\lambda^2\sigma_\varepsilon^2 + (1-\lambda)^2\sigma_z^2}(1-\lambda)}_{=1} z_t$$

$$\iff \quad \sigma_z^2 = \left[\frac{1+\phi_\pi^w\lambda_w}{\phi_\pi^w\lambda_w + (\gamma+\phi_y)}\right]\frac{\lambda}{1-\lambda}\frac{1-\frac{\lambda}{1-\lambda}}{\theta}\sigma_\varepsilon^2$$

$\rightarrow$ Volatility of non-fundamental shocks depends on stance of monetary policy (ϕ_π^w, ϕ_y)

$\rightarrow$ Wage flexibility is also destabilizing: $\frac{\partial\sigma_z^2}{\partial\lambda_w} > 0$

Details

Optimal monetary policy

Constrained efficient allocation

Decentralized equilibrium:

- Dispersed and endogenous signal $\rightarrow$ room for non-fundamental component in aggregate output
- Policy affects the distribution of this component

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How would a social planner view these fluctuations? Is the use of information in the decentralized equilibrium socially optimal?

- Constrained efficient allocation (Angeletos and Pavan, 2007) with an endogenous signal.
  Keeping information decentralized (and non-transferrable), what is the mapping from signal to action that maximizes ex-ante utility?
- Assume a subsidy correcting for monopolistic competition in the labor market.

Inefficiency in the decentralized equilibrium

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Policy implications

- New channel for policy to influence outcomes: the use of information
- Simple interest rate rule weighting inflation less $\rightarrow$ mitigate non-fundamental shocks

Determinacy and Indeterminacy Regions - endogenous signal

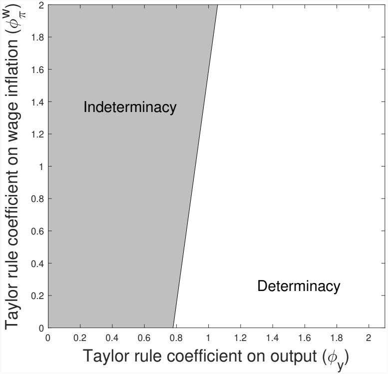

Figure 1: $\theta_w = \frac{1}{2}$, $\beta = 0.99$, $\gamma = 1$, $\lambda = 0.2$, $\epsilon_w = 8$

$\rightarrow$ Unlike Taylor principle, adjusting the nominal interest rate too strongly in response to inflation leads to real indeterminacy, from expectations of aggregate demand.

Fundamental shocks

Technology shock

Recap

- Sentiment driven fluctuations not efficient, but
- Policymaker can mitigate them by relaxing their response to inflation

Is this still true when fundamental shocks are present?

- As Y_t is driven by a fundamental source of fluctuations, it will be stochastic
- As long as firms receive endogenous signals, the sentiment component will always exist

Technology shock

Firm's optimal production, incorporating labor supply, demand for good j, and production $Y_{j,t} = A_t N_{j,t}$

$$Y_{j,t} = \left(\mathbb{E}\left[\frac{\theta - 1}{\theta} \frac{1}{\Psi} \epsilon_{j,t}^{\frac{1}{\theta}} Y_t^{\frac{1}{\theta} - \gamma} A_t | S_{j,t} \right] \right)^{\theta}$$
$$S_{j,t} = \epsilon_{j,t}^{\lambda} Z_t^{1-\lambda}$$

Conjecture and verify $Z_t = f(\zeta_t, A_t)$:

- Aggregate output is driven by both ζ_t and A_t
- Non-fundamental shocks (ζ_t) still introduce a trade-off between stabilizing output and inflation
- A policymaker unable to distinguish between fundamental and non-fundamental sources of fluctuations $\rightarrow$ cannot eliminate the output-inflation tradeoff

Conclusion

Takeaways

Minor deviation from complete information NK model

- Firms make decisions before shocks are known, conditioning on an endogenous signal

Results

- Non-fundamental shocks: conceptually (demand), tradeoff between stabilizing output and inflation (cost-push)
- Nominal flexibility and conventionally optimal monetary policy destabilizing
- Responding too much to inflation leads to indeterminacy from expectations of aggregate demand
- Optimal policy results derive from considering informational efficiency alongside allocative efficiency

Mechanism: alternate channel for policy to affect outcomes

- Stance of monetary policy affects the use of information by firms
- In the aggregate, firms' actions affect the precision of the endogenous signals that they receive

Broad implications: choice of policy affects informativeness of endogenous signals

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