Confidence and the Propagation of Demand Shocks

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Outline

1. Introduction

2. Element 1: Variable Utilization ⇒ AS Responds to AD

3. Element 2: Rational Confusion ⇒ Confidence Multiplier

4. Extensions
Popular Narrative

- Household deleveraging or other AD shocks
  - Consumers spend less
  - Firms produce and hire less
  - Consumers lose confidence and spend even less
  - Firms produce and hire even less
  - ...
  - The Great Recession!
Does It Make Sense?

In RBC: no

- In GE, interest rates adjust, offsetting AD shock (Barro & King)

In NK: perhaps

- Only when MP does not replicate flexible price outcomes
- Effects of AD shock = monetary contraction
- Inflation and output co-move

BUT

- ZLB constraint not relevant in earlier recessions
- Philips curve elusive in the data (Mavroeidis et al., 14)
- Non-inflationary demand shocks prevalent
  - Beaudry & Portier (13); Angeletos, Collard, Dellas (20)
This Paper

- A theory of demand driven fluctuations with flexible prices

Element 1:
- **Variable utilization** + adjustment cost of capital
  - $\Rightarrow$ intertemporal substitution in production
  - $\Rightarrow$ **AS responds to AD**

Element 2:
- **Rational confusion** between idiosyncratic & agg. income fluctuations
  - $\Rightarrow$ **Confidence multiplier**
    - feedback loop between output, consumer & investor expectations
- A broader bounded rationality interpretation
Key Predictions

Key prediction:

- **Comovement** among $u$, $y$, $h$, $c$, $i$
- No comovement with TFP
- No comovement with $\pi$ & monetary policy

Consistent with main business cycle shock (Angeletos, Collard, Dellas, 20)
Literature Review

Sentiments and confidence:
- Coordination failure with *multiple eq.* (e.g., Benhabib & Farmer)
  - here: *unique eq.*
- Confidence as *extrinsic shocks to beliefs* (e.g., Angeletos & La’O)
  - here: confidence *varies endogenously with intrinsic AD shocks*
- Complementary: Bordalo, Gennaioli, Shleifer & Terry (20);

Variable utilizations and business cycles:
- Existing literature: GHH (88); King & Rebelo (99); CEE (05)
  - *static utilization choices* & reduces technology convexity
- Here: together with adjustment cost
  - *dynamic utilization choices*, intertemporal substitution in production
Roadmap

Representative agent, complete info, version model
  • Element 1: variable utilization $\Rightarrow$ **AS responds to AD**

Introduce information frictions
  • Element 2: rational confusion $\Rightarrow$ **confidence multiplier**

Comovement
  • Comovement of savers and borrowers
  • Comovement of consumption, output, and investment

Implications
  • Fiscal policy (front-loading vs back-loading)
  • TFP Shock
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Preferences and AD Curve

- Preference (representative agent & complete info)

\[ \mathcal{U}(c_t, n_t) + \beta_t \mathcal{U}(c_{t+1}, n_{t+1}) + \beta_t \beta_{t+1} \mathcal{U}(c_{t+2}, n_{t+2}) + \cdots, \]

where

\[ \mathcal{U}(c, n) = \frac{c^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} - \frac{n^{1+\frac{1}{v}}}{1+\frac{1}{v}} \]

\[ \log \beta_t = (1 - \rho_{\beta}) \log \beta + \rho_{\beta} \log \beta_{t-1} - \log \eta_t \]

- A positive \( \eta_t \) shock = urge to consume = positive AD shock

- AD curve (log-linearized, complete info)

\[ y_t = -\sigma (R_t + \beta_t) + \mathbb{E}_t [y_{t+1}] \]
Technology and AS Curve

- Technology

\[ y_t = (l_t)^\alpha (u_t k_t)^{1-\alpha} \]

\[ k_{t+1} = (1 - \delta (u_t) + \Psi (i_t)) k_t, \]

- Tentatively: shut down \( \Psi (i_t) \) (infinite adjustment cost)
Technology and AS Curve

- **Technology**
  \[ y_t = (l_t)^{\alpha} (u_t k_t)^{1-\alpha} \]
  \[ k_{t+1} = (1 - \delta(u_t) + \psi(t_t)) k_t, \]

- **Tentatively: shut down \( \psi(t_t) \) (infinite adjustment cost)**

- **AS curve (log-linearized):**
  \[ y_t = (1 - \tilde{\alpha})(u_t + k_t), \]
  \[ u_t = \frac{\beta}{\tilde{\alpha} + \beta \phi} R_t + \beta E_t[u_{t+1}], \]
  \[ k_{t+1} = k_t - \kappa u_t, \]

where \( \tilde{\alpha} \equiv 1 - \frac{(1-\alpha)(1+\frac{1}{\nu})}{1+\frac{1}{\nu} - \alpha + \frac{\alpha}{\sigma}} \) and \( \phi \equiv \frac{\delta''(u^*)u^*}{\delta'(u^*)} \).
Equilibrium without Info Frictions

- **$R$ not $P$:** Intertemporal “Econ 101”
- **RBC/flexible price core of NK:** Vertical AS.
Equilibrium without Info Frictions

Prop. Demand-driven business cycle without nominal rigidity

\[
\frac{\partial y_t}{\partial \eta_t} = \gamma \quad \text{and} \quad \frac{\partial R_t}{\partial \eta_t} = \frac{\sigma}{\sigma + \varsigma},
\]

where

\[
\gamma \equiv \frac{\varsigma \sigma \beta}{\sigma + \varsigma} \frac{1}{1 - \rho \beta \beta} \quad \text{and} \quad \varsigma \equiv \frac{1 - \tilde{\alpha}}{\tilde{\alpha} + \beta \phi}.
\]

- \(\gamma\) increases with variability of \(u\) (decreases with \(\phi \equiv \frac{\delta''(u^*)u^*}{\delta'(u^*)}\))

- Baseline NK: natural rate of output fixed (\(\gamma = 0\) because \(\phi = \infty\))

- Here: natural rate of output responsive to AD
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Full Model with Information Frictions

Supply side
- Complete info, same as above

Demand side
- Islands & idiosyncratic shocks
- Know own discount rate, own income & own interest rates
- **Incomplete info** about, or inattention to, aggregate conditions
- **Rational confusion** of idiosyncratic & agg. income fluctuations
Demand Side

On each island $i \in [0, 1]$,

- Representative household $h = i$
- Monopolistically competitive firms $(i, j)$, for $j \in [0, 1]$

Household $h$'s preference

$$\mathcal{U}(c_t, n_t) + \beta_t \mathcal{U}(c_{t+1}, n_{t+1}) + \beta_t \beta_{t+1} \mathcal{U}(c_{t+2}, n_{t+2}) + \cdots$$

where $\mathcal{U}(c, n) = \frac{c^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} - \frac{n^{1+\frac{1}{\upsilon}}}{1+\frac{1}{\upsilon}}$ as before and

$$c^h_t = F\left(\{c^h_{i,t}, \xi_{i,t}\}_{i \in [0,1]}\right) \quad \text{and} \quad c^h_{i,t} = H\left(\{c^h_{i,j,t}\}_{j \in [0,1]}\right)$$

- $\xi_{i,t}$ island specific demand shock ($\Rightarrow$ local income shocks)
Demand Side

- Household’s discount factor

\[ \log \beta_t^h = (1 - \rho_\beta) \log \beta + \rho_\beta \log \beta_{t-1}^h - \log \eta_t + \log \epsilon_t^{\beta,h}, \]

AD shock

- Budget constraints

\[ \int_{i \in [0,1]} \int_{j \in [0,1]} p_{i,j,t} c_{i,j,t}^h dj di + R_{h,t}^{-1} b_{t+1}^h = w_{h,t} n_t^h + e_{h,t} + b_t^h, \]

where \( R_{h,t} = R_t \epsilon_{h,t}^R \) and \( \epsilon_{h,t}^R \) captures random intermediation cost.

- Role of idiosyncratic shocks: not “reveal” the AD shock
  ▶ alternative: rational inattention
Supply Side

Production of firm $j$ on island $i$

$$q_{i,j,t} = (l_{i,j,t})^\alpha (u_{i,j,t}k_{i,j,t})^{1-\alpha}$$

Law of motion of land/capital

$$k_{i,j,t+1} = (1 - \delta(u_{i,j,t})) k_{i,j,t}$$

- No investment $\Psi(t_t)$ (for now)
- Effectively “infinite” adjustment
Information and Equilibrium

- No info friction among the firms

- Household $h$’s information

\[ \mathcal{I}_t^h = \mathcal{I}_{t-1}^h \cup \{ \beta_t^h \} \cup \{ w_{h,t}, e_{h,t}, R_{h,t}, (p_{i,l,t})_{i \in [0,1], l \in [0,1]} \} \cup \{ \eta_{t-1} \} \]

  - know own discount rate, current local income & interest rates
  - **incomplete info about the current AD shock $\eta_t$**

- Solution concept: (Noisy) Rational Expectations Equilibrium

- From now on: log-linearization around the steady state
AS: Same as the Representative Agent Economy

Aggregate production:

\[ y_t = (1 - \tilde{\alpha})(u_t + k_t) \]

Optimal Utilization:

\[ u_t = \frac{\beta}{\check{\alpha} + \beta \phi} R_t + \beta E_t [u_{t+1}] \]

Evolution of land/capital:

\[ k_{t+1} = k_t - \kappa u_t \]
AD: Two Belief Wedges

Household $h$’s optimal consumption function

$$c_h^t = (1 - \beta) b_h^t - \beta \sigma \sum_{k=0}^{+\infty} \beta^k E_t^h \left[ R_{h,t+k} + \beta_{h,t+k}^t \right] + (1 - \beta) \sum_{k=0}^{+\infty} \beta^k E_t^h [y_{h,t+k}] ,$$

where $y_{h,t+k} = y_{t+k} + \xi_{h,t+k}$ and $R_{h,t+k} = R_{t+k} + \epsilon_{h,t+k}^R$

Aggregate subjective beliefs ⇒ rational expectations + errors

$$c_t = -\beta \sigma \sum_{k=0}^{+\infty} \beta^k E_t [R_{t+k} + \beta_{t+k}] + (1 - \beta) \sum_{k=0}^{+\infty} \beta^k E_t [y_{t+k}] + \beta (B_t + G_t) ,$$

where $B_t(G_t)$ captures misperception of permanent income (interest rates).
AD Curve

Prop. The AD Curve

\[ y_t = -\sigma \{ R_t + \beta_t \} + \mathbb{E}_t [y_{t+1}] + (B_t + G_t). \]

- \( B_t \) captures misperception of permanent income

\[
B_t \equiv \frac{1-\beta}{\beta} \sum_{k=0}^{+\infty} \beta^k \int \left( E_t^h [y_{t+k}] - \mathbb{E}_t [y_{t+k}] \right) dh
\]

- \( G_t \) captures misperception of future interest rates

\[
G_t \equiv -\sigma \sum_{k=1}^{+\infty} \beta^k \int \left( E_t^h [R_{t+k}] - \mathbb{E}_t [R_{t+k}] \right) dh
\]
Our Hulten’s Theorem

To understand $B_t$, first study the true aggregate permanent income

Prop. Our Hulten’s Theorem

Aggregate permanent income

\[
\sum_{k=0}^{+\infty} \beta^k \int y_{t+1} = \frac{1-\tilde{\alpha}}{1-\beta} k_t
\]

invariant to the AD shock $\eta_t$.

- Efficient production decisions across times
- Original: static; here: dynamic
- But current agg output/income \textit{does} move
  - intertemporal substitution without altering its present discounted value
\( \mathcal{B}_t \): Misperception of Permanent Income

**Prop. Pro-cyclical perceived permanent income**

\[
\mathcal{B}_t = \frac{1 - \beta}{\beta(1 - \beta \rho \xi)} (1 - \lambda) \frac{\partial y_t}{\partial \eta_t} \eta_t
\]

- \( \rho \xi \) is the persistence of the idiosyncratic income shock \( \xi_{h,t} \)
- \( 1 - \lambda \): degree of confusion between idiosyncratic & agg.

**Mechanism:** current aggregate income \( y_t \) drops

\( \implies \) local income \( y_{h,t} = y_t + \xi_{h,t} \) drops

\( \implies \) rationally confused as drop in idiosyncratic income \( \xi_{h,t} \)

\( \implies \) drop in perceived permanent income

\( \mathcal{B}_t \) does not depend on the persistence of the AD shock \( \rho \beta \) (Hulten)
Confidence Multiplier

![Diagram showing the relationship between R and y, with old and new AD and AS curves]
Confidence Multiplier

Focus on the impact of $B_t$ (as if $G_t = 0$)

Prop. Equilibrium Impact of Confidence Multiplier

\[
\frac{\partial y_t}{\partial \eta_t} = \gamma \cdot m^{\text{conf}} (\lambda, \rho_\xi),
\]

where the confidence multiplier

\[
m^{\text{conf}} (\lambda, \rho_\xi) \equiv \frac{\zeta + \sigma}{\zeta + \sigma - \zeta \frac{1-\beta}{1-\beta \rho_\xi} (1 - \lambda)} > 1
\]

- Increases with the persistence of idiosyncratic income $\rho_\xi$
- Increases with the confusion $1 - \lambda$
$G_t$: Discounting GE Interest Rate Adjustment

Prop. Misperception of Future Interest Rate Adjustment

\[
G_t \equiv -\sigma \sum_{k=1}^{+\infty} \beta^k \int \left( E_t^h [R_{t+k}] - \mathbb{E}_t [R_{t+k}] \right) dh \\
= (1 - \lambda) \frac{\sigma^2}{\sigma + \varsigma} \frac{\beta \rho_\beta}{1 - \beta \rho_\beta} \eta_t
\]

Persistent negative AD shock

- Neoclassical GE: future interest rate $R_{t+k}$ drops
  - goes against the impact of the AD shock

- Here: cannot fully perceive $R_{t+k}$ drop
  - $G_t$ negative
  - Further amplifies the impact of the AD shock
Connection to GE dampening in forward guidance

- Angeletos & Lian (18); Gabaix (20); Farhi & Werning (19)

Two key differences:

- **Form of strategic interaction:**
  - Literature: strategic complementarity (Keynesian income multiplier)
  - Here: strategic substitutability (Interest rate adjustment)

- **Objects:**
  - Literature: output gap
  - Here: natural rate of output
The equilibrium response of aggregate output is given by

\[ \frac{\partial y_t}{\partial \eta_t} = \gamma \cdot m_{\text{conf}}(\lambda, \rho_\xi) \cdot m_{\text{GE}}(\lambda, \rho_\beta), \]

where

\[ m_{\text{GE}}(\lambda, \rho_\beta) \equiv 1 + \beta \rho_\beta \frac{\sigma}{\sigma + \zeta} (1 - \lambda) \geq 1 \]

- Increases with the persistence of AD shock \( \rho_\beta \)
- Increases with the confusion \( 1 - \lambda \)
Taking Stock

Element 1: variable utilization ⇒ \textit{AS responds to AD}

Element 2: rational confusion ⇒ \textit{confidence multiplier}

In the paper: endogeneity/uniqueness of info friction ($\lambda$)

Next

- Bounded rationality interpretations
- Comovement (savers & borrowers; investment & consumption)
- Other shocks (fiscal, TFP)
Bounded Rationality

So far: rational confusion

Broader interpretation of confidence multiplier $B_t$
  - Key: the response of $c_{h,t}$ to $y_{h,t}$ independent from idio. vs agg.
  - Rule of thumb (Kahneman, 11)
  - Extrapolation (Barberis, Greenwood, Jin, Shleifer, 14)
  - One-factor representation (Molavi, 19)

Broader interpretation of GE discounting $G_t$
  - Lack of common knowledge (Angeletos & Lian, 18)
  - Level-k thinking (Farhi & Werning, 19; Garcia-Schmidt & Woodford, 19)
  - Cognitive discounting (Gabaix, 20)
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Comovement: Borrowers and Savers

**Standard:** borrowers “credit crunch”

\[
\begin{align*}
    c^b_t &= -\sigma R_t + \mathbb{E}_t \left[ c^b_{t+1} \right] - \sigma \beta_t \\
    c^s_t &= -\sigma R_t + \mathbb{E}_t \left[ c^s_{t+1} \right],
\end{align*}
\]

- Borrower & saver *negatively co-move* \((R_t \text{ adjusts})\)

**Here:**

\[
\begin{align*}
    c^b_t &= -\sigma R_t + \mathbb{E}_t \left[ c^b_{t+1} \right] + B_t + G_t - \sigma \beta_t \\
    c^s_t &= -\sigma R_t + \mathbb{E}_t \left[ c^s_{t+1} \right] + B_t + G_t
\end{align*}
\]

**Prop. Borrowers and Savers**

With strong enough info friction, \((c^s_t, c^b_t, y_t) \text{ positively co-move.}\)

Difference from NK: no need for ZLB/constrained monetary policy
Comovement: Investment

\[ k_{t+1} = [1 - \delta(u_t) + \psi(i_t)] k_t. \]

Complete info (with small wealth effect on labor supply)

- Positive comovement between \( c \) and \( y \)
  - non-vertical AS thanks to the forward-looking \( u \)

- **Negative comovement between \( i \) and \( c \)**
  - negative AD shock, \( c \downarrow, R \downarrow, i \uparrow \)

Our resolution:

- **Investment** subject to **confidence multiplier** too

- Feedback between \( y_t \) & investor expectations of returns
Comovement: Investment

There exist \( \hat{\lambda}, \hat{\phi}, \nu, \psi > 0 \). If \( \lambda < \hat{\lambda}, \phi < \hat{\phi}, \nu > \nu \) and \( \psi > \psi \), \((c_t, i_t, y_t, n_t, u_t)\) positively co-move.

- Large confidence multiplier (small \( \lambda \))
- Elastic utilization (small \( \phi \) and large \( \psi \))
- Elastic labor supply (large \( \nu \))
Government Spending

Q: How does confidence multiplier impact fiscal policy?

Here, for simplicity, shut down wealth effect of G on labor supply

- Same AS as above

AD:

\[ y_t = -\sigma R_t + G_t - E_t [G_{t+1}] + E_t [y_{t+1}] + (B_t + G_t) \]

**Front-loading** \( G_t \) \( \implies \) positive AD shock \( \implies \) confidence multiplier

Prop. Front-loading government spending

With strong enough info friction, \( G_t \) can **crowd in** \( c_t \)

**Back-loading** \( G_t \) \( \implies \) negative AD shock \( \implies \) negative multiplier
AD Shocks vs AS Shocks

- Replace the AD shock with an aggregate TFP shock
- Maintain same info assumptions
- **No confidence multiplier**
  - Actual permanent income moves with aggregate TFP
  - Rational confusion $\implies$ Ambiguous $B_t$
  - Useful benchmark $B_t \approx 0$ ($\rho_\xi \approx \rho_A$)
- GE discounting has **reverse effect**
  - Negative TFP Shock $\implies$ positive $R_t$ $\implies$ **Positive** $G_t$

**Prop. TFP Shock**

Info friction dampens the relative impact of AS vs AD shock

- Consistent with the importance of non-inflationary AD shock
Circling Back to Motivating Facts

- **Main Business Cycle Shock** (Angeletos, Collard, Dellas, 20)

- $u, y, h, c, i$ comove without TFP & $\pi$

- Evidence of intertemporal substitution in production

- Utilization accounts for pro-cyclicality in labor prod

- Non-accommodative MP and procyclical real $R$
Sticky Prices

- Main insights go through sticky prices
- A theory why & how the **natural output responds to the AD shock**
- Additional mechanism: misperception of output gaps (MP)
  - existing literature on forward guidance etc.
Conclusion

Contributions:

- A theory of demand-driven fluctuations without sticky prices
- A theory of amplifications for AD shock (but not AS shocks)
- A theory of comovement among business cycle variables
  - but not with $TFP$ or inflation

Not to replace NK, but to **strengthen its “flexible-price” core**

- Help with evidence on exceedingly flat Philips curve