Confidence and the Propagation of Demand Shocks

George-Marios Angeletos\textsuperscript{1}  Chen Lian\textsuperscript{2}
\textsuperscript{1}MIT and NBER  \textsuperscript{2}UC Berkeley

CREI, September 28, 2020
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

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 is elusive in the data (Mavroeidis et al., 2014)
- Non-inflationary demand shocks prevalent
The Main Business Cycle Shock in the Data (Angeletos, Collard, Dellas, 2020)

- Run a VAR on 10 key macro variables, 1950-2017
- Identify max-share shock for $U$ (or $Y$, $I$, $C$, $h$) over business cycle frequencies
- Inspect IRFs and variance contributions

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>10</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>$u$</td>
<td>73.71</td>
<td>58.51</td>
<td>47.72</td>
</tr>
<tr>
<td>$Y$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$h$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I$</td>
<td>20.38</td>
<td>5.86</td>
<td>23.91</td>
</tr>
<tr>
<td>$C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TFP</td>
<td>27.02</td>
<td>6.96</td>
<td>22.27</td>
</tr>
<tr>
<td>$Y/h$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wh/Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

⇒ looks like a non-inflationary AD shock, triggering a contractionary MP
Element 1: **variable utilization** + adjustment cost for $K$

$\Rightarrow$ intertemporal substitution in production

$\Rightarrow$ **AS responds to AD**

Element 2: **confusion** between idiosyncratic & agg. income fluctuations

$\Rightarrow$ **confidence multiplier**

(feedback loop between output, consumer & investor expectations)

1+2 $\Rightarrow$:

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

Variable utilization and business cycles:

- GHH (88); Burnside, Eichenbaum & Rebelo (1995); King & Rebelo (99); CEE (05)
  - static utilization choice, reduces technology convexity

- Here: together with adjustment cost
  - forward-looking utilization choice, intertemporal substitution in production
1. Start with FIRE (full-info, rational expectations) and no investment margin variable utilization ⇒ AS responds to AD

2. Add info friction (or bounded rationality) ⇒ confidence multiplier

3. Comovement and other implications
   - Gov spending (crowding in, front-loading vs back-loading)
   - Comovement between savers and borrowers
   - Comovement between consumption and investment
   - TFP/AS shocks vs AD shocks
Preferences and AD Curve

- Preferences (representative agent & complete info)

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

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

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

- 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

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

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

- Tentatively: shut down \( \iota_t \) margin (infinite adjustment cost: \( \Psi(0) = 0 \) and \( \Psi'(0) \to \infty \))
Technology and AS Curve

- Technology

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

- Tentatively: shut down \( \iota_t \) margin (infinite adjustment cost: \( \Psi(0) = 0 \) and \( \Psi'(0) \to \infty \))

- AS curve (log-linearized):

\[ y_t = (1 - \tilde{\alpha})(u_t + k_t), \]
\[ u_t = \frac{\beta}{\tilde{\alpha} + \beta \phi} R_t + \beta \mathbb{E}_t [u_{t+1}], \]
\[ k_{t+1} = k_t - \kappa u_t, \]

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

- Resembles NK, but: $R$ not $P$ in vertical axis, and $y^{\text{natural}}$ not $y^{\text{gap}}$ on horizontal axis
- Flexible-price core of NK: vertical AS, $y^{\text{natural}}$ invariant to AD
- Here: Intertemporal “Econ 101”
**Equilibrium without Info Frictions**

**Prop. Demand-driven fluctuations without nominal rigidity**

\[
\frac{\partial y_t}{\partial \eta_t} = \gamma \equiv \frac{\varsigma \sigma \beta}{\sigma + \varsigma \frac{1}{1 - \rho \beta}} > 0
\]

where \( \sigma \) and \( \varsigma \equiv \frac{1 - \tilde{\alpha}}{\tilde{\alpha} + \beta \phi} \) parameterize the elasticities of AD and AS, respectively.

- \( \varsigma \) and hence \( \gamma \) increase with flexibility of \( u \) (decrease with \( \phi \equiv \frac{\delta''(u^*)u^*}{\delta'(u^*)} \))
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
Prop. The AD Curve

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

- \( B_t \) captures avg misperception of **permanent income**

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

where \( y_{h,t} = y_t + \xi_{h,t} \) is local/idiosyncratic income at \( t \).

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

\[
G_t \equiv -\sigma \sum_{k=1}^{+\infty} \beta^k \int (E^h_t [R_{t+k}] - \mathbb{E}_t [R_{t+k}]) \, dh
\]
To understand $B_t$, let's study first the true aggregate permanent income.

**Prop. Our Hulten’s Theorem**

Aggregate permanent income is **invariant to the AD shock $\eta_t$**. Instead, it is pinned down by technology/capital alone:

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

- Standard Hulten’s thm: static. Here: dynamic
- Key assumption: efficient production (both within and across periods)
- Note: current agg output/income does move
  - intertemporal substitution without altering present discounted value
Our Hulten’s theorem implies that $B_t$ is procyclical

Mechanism: current aggregate income $y_t$ drops

⇒ local income $y_{h,t} = y_t + \xi_{h,t}$ drops

⇒ rationally confused as drop in idiosyncratic income $\xi_{h,t}$

⇒ drop in perceived permanent income

Prop. Pro-cyclical misperception of permanent income

$$\frac{\partial B_t}{\partial \eta_t} = \frac{1-\beta}{\beta(1-\beta\rho_\xi)} (1 - \lambda) \frac{\partial y_t}{\partial \eta_t} > 0$$

where $1 - \lambda$ measures degree of confusion of idiosyncratic & agg income fluctuations
Confidence Multiplier

\( AD \) drops \( \Rightarrow y \) drops \( \Rightarrow \) perceived permanent income drops even though actual doesn’t \( \Rightarrow AD \) drops further \( \Rightarrow y \) drops further \( \Rightarrow \ldots \)
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” is given by

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

increases with the degree of confusion, $1 - \lambda$; increases with the persistence of idiosyncratic income, $\rho \xi$; is invariant to the persistence of AD shock $\rho \beta$; and increases with the MPC.
Consider now the role of \( G_t \)

**Prop. Discounting GE**

\[
\frac{\partial G_t}{\partial \eta_t} = (1 - \lambda) \frac{\sigma^2}{\sigma + \varsigma} \frac{\beta \rho \beta}{1 - \beta \rho \beta} > 0
\]

- Neoclassical GE: interest rates \( R_{t+k} \) drop
  - discourages consumption
  - goes against the direct impact of the AD shock
- Here: cannot fully perceive \( R_{t+k} \) drop
  - arrests the Neoclassical GE effect
  - i.e., amplifies the impact of the AD shock
- **Bottom line**: this mechanism reinforces confidence multiplier
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

\[ m^{\text{GE}}(\lambda, \rho \beta) \equiv 1 + \beta \rho \beta \frac{\sigma}{\sigma + \varsigma} (1 - \lambda) \geq 1 \]

increases with degree of confusion, $1 - \lambda$, and with persistence of AD shock, $\rho \beta$. 

**Prop. Two Multipliers**
Element 1: variable utilization ⇒ \textbf{AS responds to AD}

Element 2: info friction ⇒ \textbf{amplification}

In the paper: signal extraction, endogeneity/uniqueness of $\lambda$

Next:

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

So far: agents are imperfectly informed but super rational

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, 2011)
- Extrapolation (Barberis, Greenwood, Jin, Shleifer, 2014)
- One-factor representation (Molavi, 2019)

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)
- There: GE discounting of future output gaps = attenuation of current gaps
- Here: GE discounting of future natural $R =$ amplification of current natural $y$
Government Spending

- Same AS as above
- Only shut down wealth effect of $G$ on labor supply (for simplicity)
- No confusion about tax burden (Ricardian equiv still holds)
- AD with $G$ shocks:

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

**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
Credit crunch:

\[ c^b_t = -\sigma R_t + \mathbb{E}_t [c^b_{t+1}] + B_t + G_t - \sigma \beta_t \]
\[ c^s_t = -\sigma R_t + \mathbb{E}_t [c^s_{t+1}] + B_t + G_t \]

With FIRE, as \( R_t \) adjusts, \( c^s_t \) moves in the opposite direction than \( c^b_t \)

**Prop. Borrowers and Savers**

With enough noise/bounded rationality, \((c^s_t, c^b_t, y_t)\) **positively co-move.**
Allow for investment, with positive but non-infinite adjustment cost

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

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
Prop. Investment-consumption comovement

There exist $\bar{\lambda}, \bar{\phi}, \nu, \psi > 0$. If $\lambda < \bar{\lambda}$, $\phi < \bar{\phi}$, $\nu > \bar{\nu}$ and $\psi > \bar{\psi}$,

$(c_t, i_t, y_t, n_t, u_t)$ positively co-move.

- Large confidence multiplier (small $\lambda$)
- Elastic utilization (small $\phi$ and large $\psi$)
- Elastic labor supply (large $\nu$)
AS Shocks

- Replace $\beta$ shock with **aggregate TFP shock**
- Confidence multiplier: basically **absent**
  - Actual permanent income moves with aggregate TFP
  - Confusion of idio and agg shocks $\Rightarrow$ ambiguous $B_t$
  - Useful benchmark $B_t \approx 0$ ($\rho_\xi \approx \rho_A$)
- GE discounting: **reversed**
  - With FIRE: positive TFP Shock $\Rightarrow$ reduces $R$ $\Rightarrow$ encourages AD
  - Without: $R$ adjustment is discounted $\Rightarrow$ AD moves less $\Rightarrow$ $y$ also moves less

**Prop. AS vs AD Shock**

Friction **dampens AS shocks** at the same time it **amplifies AD shocks**
Circling Back to Motivating Facts

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

Not only: \( u, y, h, c, i \) comove without TFP & \( \pi \)

But also: some vidence of intertemporal substitution in production

Plus: Utilization accounts for pro-cyclicality in labor prod

And: non-accommodative MP and procyclical real \( R \)
Adding Sticky Prices

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

Contribution:

- A theory of demand-driven fluctuations without sticky prices
- A theory of amplification for AD shocks (but not AS shocks)
- A theory of comovement among components of AD (without inflation comovement)

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

- Help with evidence on elusive/inverted/flat Philips curve
- Disentangle question of whether AD drives bulk of business cycles from role of MP