Lecture 11

Confidence, sentiments, and animal spirits

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Outline

1. Overview and the Barro-King Conundrum
2. News Shocks
3. Noise Shocks
4. Beliefs about Aggregate Demand Orthogonal to Beliefs about TFPs
5. Fully Behavioral Approaches

Confidence, Sentiments, and Animal Spirits

- Iconic notion from **Keynes (1936)**
- Folk wisdom is that it plays an important role in driving AD and business cycles
- Exact meanings in economic theory and data are "elusive"
- Goal of this lecture: an overview of different notions, empirical evidence, and modeling approaches
- "Search for the golden fleece"

Keynes (1936)

- Even apart from the instability due to speculation, there is the instability due to the characteristic of human nature that **a large proportion of our positive activities depend on spontaneous optimism rather than mathematical expectations**, whether moral or hedonistic or economic.

- Most, probably, of our decisions to do something positive, the full consequences of which will be drawn out over many days to come, can only be taken as the result of animal spirits—**a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities**

- "Collective animal spirits" $\Longrightarrow$ "business cycles"?

- "Neo-Keynesian:" Keynes without animal spirits?

Pigou (1927)'s Theory of Cycles

- Recessions and booms arise due to **difficulties encountered by agents in properly forecasting the economy's future needs in terms of capital.**
- When agents are optimistic about the future, they decide to **build up capital in expectation of future demand.**
- In the case where their expectations are not met, there will be **a period of retrenched investment which is likely to cause a recession.**

Classical Multiple Equilibria Model in Macroeconomics

- Classical models of coordination failures in macroeconomics
  - features "strong complementarities"
  - admits **multiple equilibria**
- "Animal spirits" as **belief shifts across equilibria**
  - holding fundamentals and beliefs about them constant
- Extremely influential in 80s, but die out now (e.g., Diamond 82; Benhabib-Farmer, 94)
  - Hard to do policy and welfare analysis
  - Hard to find the exact empirical counterparts for "sunspots" and "equilibrium switching"
  - Strong complementarity requires non-standard assumptions

Coordination Games with Strong Complementarity

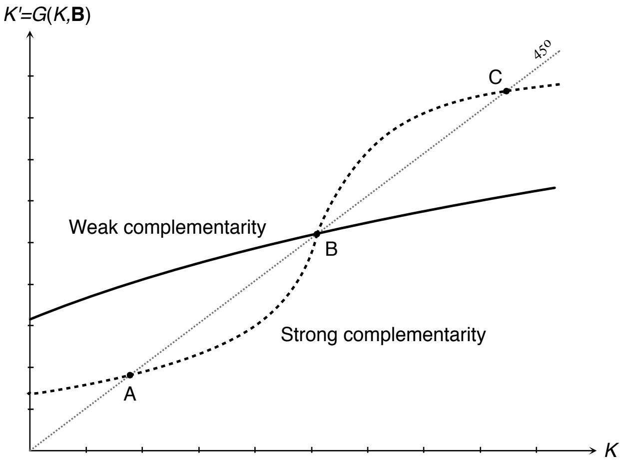
Optimal behavior for each agent i:

$$k_i = G\left(K, \theta_i\right),$$

where $K = \int k_i di$.

- Weak complementarity: $\frac{\partial G}{\partial K} \in (0, 1)\ \forall K$
  - unique rationalization outcome (linear beauty contest in previous lectures)
- Strong complementarity: $\frac{\partial G}{\partial K} > 1$ for some K
  - models for currency crisis, debt crisis, etc. (Obstfeld, 96 & Calvo, 98)

Coordination Games with Strong Complementarity



Multiple Equilibria in Dynamic Models with Rational Expectations

- Multiple "sunspot equilibria" in dynamic models with rational expectations
  - see Blanchard & Kahn (80) for the general case

- Here: the simple univariate case as an example

$$c_t = \delta E_t [c_{t+1}]$$

- If $\delta > 1$, multiple bounded sunspot equilibria

- As an example, focusing on responses to $t = 0$ sunspot "s_0"

$$c_t = \delta^{-t} s_0$$

Multiple Equilibria in Dynamic Models with Rational Expectations

- Each period can have a new "sunspot"

$$c_t = \sum_{k=0}^{t} \delta^{-k} s_{t-k},$$

  where $\{s_t\}$ is an i.i.d. sunspot.

- Benhabib-Farmer (94) & Farmer-Guo (94)
  - increasing returns in dynamic RBC models
  - sunspots as animal spirits

- NK models when the "Taylor" rule is not responsive enough
  - one rationale of the "Taylor" principle is to rule out sunspot equilibria

Issues of Multiple Equilibria Models

- Hard to do policy and welfare analysis
- Hard to find the exact empirical counterparts for "sunspots" and "equilibrium switching"
- Strong complementarity requires non-standard assumptions
- The existence of multiple equilria is not "robust"
  - requires perfect coordination
  - "Global Games:" introducing imperfect coordination leads to equilibrium uniqueness

Payoff and Best Responses

Strong strategic complementarity.

- An individual wants to attack if and only if the status quo collapses
- The status quo collapses if and only if a sufficiently large fraction of the agents attacks.

To see this more clearly, rewrite the payoff of agent i as $(b > c > 0)$

$$u_i = U(a_i, A, \theta) = \begin{cases} a_i(b-c) & \text{if } A \geq \theta \\ -a_i c & \text{if } A < \theta \end{cases}$$

Assuming θ is known, the best response is

$$g(A, \theta) = \arg\max_{a \in \{0,1\}} U(a_i, A, \theta) = \begin{cases} 1 & \text{if } A \geq \theta \\ 0 & \text{if } A < \theta \end{cases}$$

Perfect Coordination Benchmark

- Fundamentals θ were commonly known by all agents.
- For $\theta \leq \underline{\theta} \equiv 0$, the regime is doomed with certainty
  - the unique equilibrium is every agent attacking
- For $\theta > \overline{\theta} \equiv 1$, the regime can survive an attack of any size
  - the unique equilibrium is every agent not attacking
- For $\theta \in (\underline{\theta}, \overline{\theta}]$, multiple equilibria sustained by self-fulfilling beliefs
  - individuals expect everyone else to attack, find it individually optimal to attack, and the status quo is abandoned.
  - individuals expect no one else to attack, find it individually optimal not to attack, the status quo is spared.
- Multiple equilibria arises because of perfect coordination
  - attack when I exactly know that all others attack

Imperfect Strategic Interactions and Equilibrium Uniqueness

- **Imperfect coordination** through noisy private signals

$$x_i = \theta + \varepsilon_i,$$

  where $\varepsilon_i \overset{i.i.d.}{\sim} \mathcal{N}(0, \sigma_\varepsilon^2)$ and θ has an "uninformed prior"

- Translate into "strategic uncertainty" in eq:
  - Uncertainty about whether other agents "attack" or "not attack"
  - Imperfect coordination

- In fact, for any $\sigma_\varepsilon > 0$, no matter how small, there is a unique equilibrium!

- There exist unique rationalizable eq with thresholds x^* and θ^*
  - An agent attacks if and only if $x < x^*$
  - The regime collapses if and only if $\theta < \theta^*$

Proof: Iterative Elimination of Dominated Strategies

First find $\underline{x}_1$.

- If nobody else attacks, the agent finds it optimal to attack if and only if $x \leq \underline{x}_1$.
- By complementarity, if some people attack, the agent finds it optimal to attack *at least* for $x \leq \underline{x}_1$.
- That is, for $x \leq \underline{x}_1$, attacking is *dominant*.

Next, consider $\underline{x}_2$.

- When other agents attack if and only if $x \leq \underline{x}_1$, then it is optimal to attack if and only if $x \leq \underline{x}_2$.
- By complementarity, if other agents attack at least for $x \leq \underline{x}_1$, then it is optimal to attack *at least* for $x \leq \underline{x}_2$.
- That is, attacking becomes dominant for $x \leq \underline{x}_2$ after the second round of deletion of dominated strategies.

Similarly, for any k, we have that attacking becomes dominant $x \leq \underline{x}_k$ after the k round of deletion of dominated strategies.

Imperfect Coordination and Equilibrium Selection

- Hence, $\{\underline{x}_k\}_{k=0}^{\infty}$ represents iterated deletion of dominated strategies "from below".
- Similarly, $\{\overline{x}_k\}_{k=0}^{\infty}$ represents iterated deletion of dominated strategies "from above".
- But both $\underline{x}_k$ and $\overline{x}_k$ converge to x^* as $k \to \infty$.
- The only strategy that survives is the function a such that $a(x) = 1$ for $x \leq x^*$ and $a(x) = 0$ for $x > x^*$.

Imperfect Coordination and Equilibrium Selection

- With imperfect coordination and strategic uncertainty
  - cannot frictionless coordinate on an "attack" or "not attack" equilibrium
  - "smooth out" beliefs about the distribution of others actions
    - someone (with high signals) will attack
    - someone (with low signals) will not attack
  - leads to unique equilibrium
- Question "multiple equilibria" as a model for "animal spirits"
- "Global game" is still a model of sudden "regime switching"
  - the unique equilibrium outcome is very sensitive to fundamentals around the threshold
  - can conduct policy and welfare analysis

Pause for Questions

Modern Approaches within the Standard Unique Equilibrium Framework

- News shocks (about future TFPs)
  - e.g., Beaudry and Portier (06); Jaimovich and Rebelo (09); Schmitt-Grohe and Uribe (12)
- Noise shocks (about future TFPs)
  - e.g., Lorenzoni (09); Blanchard, Huillier & Lorenzoni (13)
  - shocks to **belief about future TFPs** that orthogonal to **actual** TFPs process
- Beliefs about aggregate demand **independent of beliefs about TFPs**
  - Angeletos & La'O (13); Angeletos, Collard & Dellas (18, 20)
- Fully behavioral approaches (e.g., diagnostic expectations)
  - Bordalo, Gennaioli, Shleifer (18); Bordalo, Gennaioli, Shleifer, Terry (20)

The Barro-King Conundrum

- No matter whatever type of AD shock, face a conundrum on the AS side (Barro-King, 84)
  - AD shocks means shocks impact current AD but not current AS
  - include news and noise shocks (about future TFPs)

- First, without capital
  - Time separable preferences:

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

  - Production function:

$$y_t=f\left(A_t, n_t\right)$$

A "Vertical" AS Curve

- Optimal labor supply and labor demand

$$\underbrace{\frac{\mathscr{U}_n(c_t, n_t)}{\mathscr{U}_c(c_t, n_t)}}_{\text{MRS between } c \text{ and } n} = \underbrace{w_t}_{\text{wage}} = \underbrace{f_n(A_t, n_t)}_{\text{MPL}}$$

- Together with market cleaning, **total output is supply determined**

$$c_t = y_t = g(A_t)$$

- **AD shock is fully absorbed by interest rate**

$$\underbrace{\mathscr{U}_c(c_t, n_t)}_{\text{AS}-\text{determined}} = \underbrace{R_t}_{\text{absorb AD shocks}} \underbrace{E_t[\beta_t \mathscr{U}_c(c_{t+1}, n_{t+1})]}_{\text{AD shocks}}$$

  - e.g., positive AD shocks fully offset by higher rates

Adding Investment

- Still true: positive AD shocks $\Longrightarrow$ higher rates

- Higher rates $\Longrightarrow$ lower investment

$$R_t = E_t \left[f_k \left(A_{t+1}, n_{t+1}, k_{t+1} \right) \right]$$

- Moreover, with time separable preferences, positive AD shocks also means **positive demand shocks for leisure**

- In equilibrium, after positive AD shocks
  - consumption may increase
  - output, labor supply, and investment all decrease
  - no comovement

The First Way Out

First: NK/sticky-price

- **Labor demand no-longer optimal**

$$\underbrace{\frac{\mathscr{U}_n(c_t, n_t)}{\mathscr{U}_c(c_t, n_t)}}_{\text{MRS between } c \text{ and } n} = \underbrace{w_t}_{\text{wage}} \neq \underbrace{f_n(A_t, n_t)}_{\text{MPL}}$$

- If sticky-wage, labor supply is instead not optimal

- Allow the possibility for AS to accommodate AD, but
  - **Only when MP does not replicate flexible price outcomes**
    - ⋆ Effects of AD shock = monetary expansion/contraction
  - Along the Philips curve, inflation and output co-move
    - ⋆ demand-driven business cycles need to be inflationary/deflationary

The Second Way Out

Second: **Variable utilization** + adjustment cost of capital

$\Longrightarrow$ forward looking utilization decisions

$\Longrightarrow$ intertemporal substitution in production

$\Longrightarrow$ **AS responds to AD**

- E.g., Jaimovich and Rebelo (09); Angeletos & Lian (22)

Now we turn different approaches to operationalize confidence, sentiments, and animal spirits

Pause for Questions

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Confidence as News Shocks (about Future TFPs)

- Goal: finding the best "proxy" of confidence/animal spirits in modern macro models featuring equilibrium uniqueness?
- A first/popular attempt: **news shocks about future TFPs?**
  - Do not impact current aggregate supply in the baseline RBC
  - Impact current aggregate demand because of "confidence" or "optimism" about future
- Close cousin: **noise shocks** (Lorenzoni, 09)
  - shocks to **belief about future TFPs** that orthogonal to **actual** TFPs process

Beaudry and Portier (2006)

- How to identify news shocks (about future TFPs)?
- Two alternative identification strategies based on S-VARs
- First, long-run restrictions ($\tilde{\varepsilon}_1$)
  - identify shock that captures all long-run movements in TFP
- Second, short-run restrictions (ε_2)
  - identify shock that does not have an instantaneous effect on TFP
  - but can have instantaneous effect on SP (stock price)
- Results similar for standard TFP measure (Solow residual) or utilization-adjusted TFP measure (Basu, Fernald, & Kimball, 06)

Two Identified Shocks are Essentially the Same

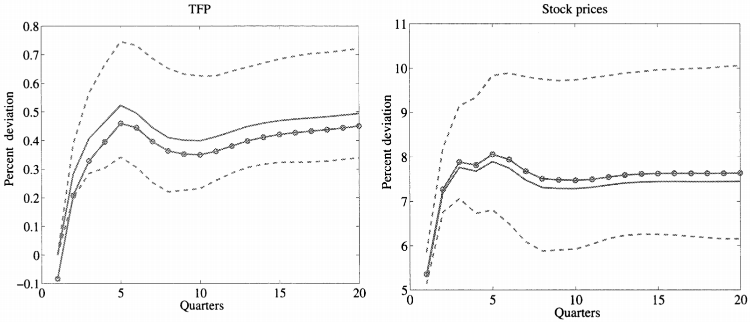


FIGURE 1. IMPULSE RESPONSES TO SHOCKS ε_2 AND $\tilde{\varepsilon}_1$ IN THE (*TFP*, *SP*) VECM

Notes: In both panels of this figure, the bold line represents the point estimate of the responses to a unit ε_2 shock (the shock that does not have instantaneous impact of *TFP* in the short-run identification). The line with circles represents the point estimate of the responses to a unit $\tilde{\varepsilon}_1$ shock (the shock that has a permanent impact on TFP in the long-run identification). Both identifications are done in the baseline bivariate specification (five lags and one cointegrating relation). The unit of the vertical axis is percentage deviation from the situation without shock. Dotted lines represent the 10-percent and 90-percent quantiles of the distribution of the impulse response functions (IRFs) in the case of the short-run identification, this distribution being the Bayesian simulated distribution obtained by Monte-Carlo integration with 2,500 replications, using the approach for just-identified systems discussed in Thomas J. Doan (1992).

News Shocks Drive Business Cycle Comovement

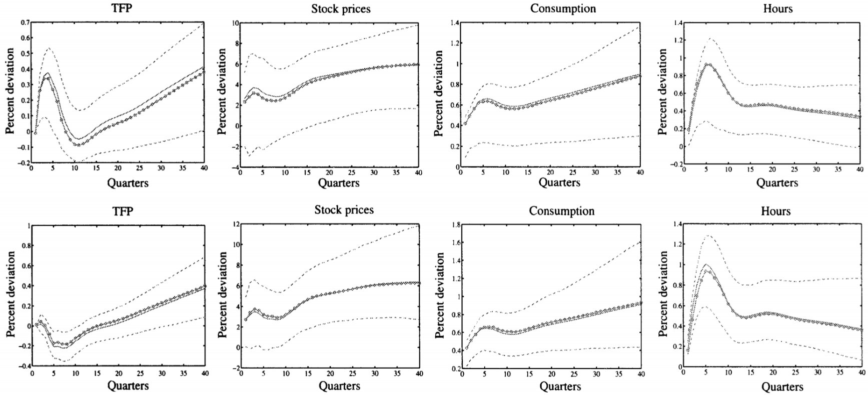


FIGURE 9. IMPULSE RESPONSES TO ε_2 AND $\tilde{\varepsilon}_1$ IN THE (*TFP*, *SP*, *C*, *H*) VECM, WITHOUT (UPPER PANELS) OR WITH (LOWER PANELS) ADJUSTING TFP FOR CAPACITY UTILIZATION

Notes: In each panel of this figure, the bold line represents the point estimate of the responses to a unit ε_2 shock (the shock that does not have instantaneous impact on *TFP* in the short-run identification). The line with circles represents the point estimate of the responses to a unit $\tilde{\varepsilon}_1$ shock (the shock that has a permanent impact on TFP in the long-run identification). In this system with hours, both identifications are done in a specification with five lags and three cointegrating relations, i.e., a VAR in levels. The unit of the vertical axis is percentage deviation from the situation without shock. Dotted lines represent the 10-percent and 90-percent quantiles of the distribution of the IRF in the case of the short-run identification, this

Jaimovich and Rebelo (2009)

- **Element 1:** variable capital utilization

$$Y_t = A_t (u_t K_t)^{1-\alpha} N_t^{\alpha}$$

- **Element 2:** adjustment costs of *investment*

$$K_{t+1} = I_t \left[1 - \varphi\left(\frac{I_t}{I_{t-1}}\right)\right] + [1-\delta(u_t)] K_t$$

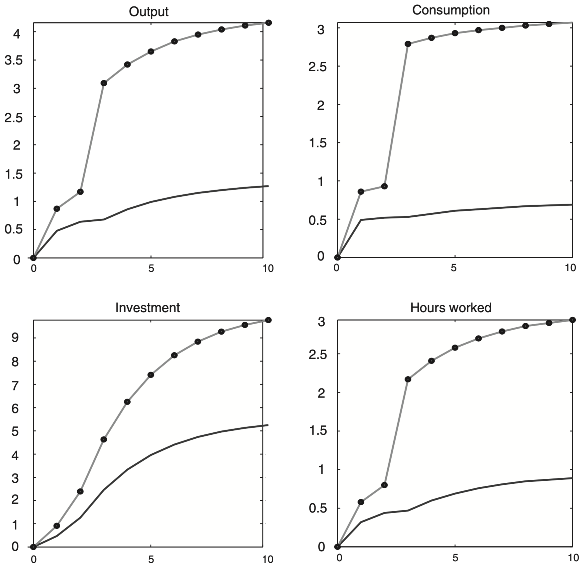
  - future investment increase $\Longrightarrow$ current investment increase

- **Element 3:** small wealth effect on the labor supply (+ consumption habit formation)

$$U = E_0 \sum_{t=0}^{+\infty} \beta^t \frac{\left(C_t - \psi N_t^{\theta} X_t\right)^{1-\sigma} - 1}{1-\sigma} \quad \text{with} \quad X_t = C_t^{\gamma} X_{t-1}^{1-\gamma}.$$

  - $\gamma = 1$: KPR, standard balance growth preference
  - $\gamma = 0$: no wealth effect of labor supply + habit formation
    - habit formation: future consumption increase $\Longrightarrow$ current consumption increase

Responses to News about Future TFP (Dotted Line)



Extensions

- In the paper, similar elements can also generate comovement in response to
  - contemporary and news about investment-specific technical change
  - contemporary and news about sectoral TFP shocks
- Schmitt-Grohe and Uribe (2012): a medium-scale DSGE estimation

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Noise Shocks (Lorenzoni, 2009)

- Close cousin: **noise shocks** (Lorenzoni, 09)
  - shocks to belief about future TFPs that orthogonal to **actual** current and future **TFPs**
  - driven noisy public signals about future TFPs
- These noises
  - raise expectations about expected future TFPs & aggregate demand
  - **orthogonal to the actual TFP process**
  - perhaps a better proxy for Keynes' animal spirits?
- Lorenzoni (2009) as an example
  - NK aggregate supply side
  - noise shocks about the persistent component of the TFPs
  - noise shocks increase output, employment, and inflation in the short run and have no effects in the long run

Lorenzoni (2009)

- To illustrate, consider a representative agent version of the model without disperse information

- TFP process

$$a_t = \underbrace{x_t}_{\text{permanent}} + \underbrace{\eta_t}_{\text{temporary}} \quad \text{and} \quad x_t = x_{t-1} + \varepsilon_t,$$

  where $\eta_t \sim \mathcal{N}\left(0, \sigma_\eta^2\right)$ and $\varepsilon_t \sim \mathcal{N}\left(0, \sigma_\varepsilon^2\right)$.

- Public signal about the permanent component x_t

$$s_t = x_t + e_t,$$

  where $e_t \sim \mathcal{N}\left(0, \sigma_e^2\right)$ is the **noise shock**.

- Information: (a_t, s_t) as noisy signals about x_t.

Lorenzoni (2009)

- AD: standard Euler (log utility)

$$y_t = E_t[y_{t+1}] - i_t + E_t[\pi_{t+1}],$$

where $E_t[\cdot]$ captures expectation given (a_t, s_t).

- NKPC:

$$\pi_t = \kappa(y_t - a_t) + \beta E_t[\pi_{t+1}]$$

- Monetary policy

$$i_t = i^* + \varphi \pi_t,$$

  - i_t does not move directly with natural rate of interest rate
  - cannot replicate flexible price outcome

Lorenzoni (2009)

- Equilibrium

$$y_t = \frac{1}{1+\varphi\kappa} E_t[x_t] + \frac{\varphi\kappa}{1+\varphi\kappa} a_t,$$
$$\pi_t = \frac{\kappa}{1+\varphi\kappa} \left(E_t[x_t] - a_t\right)$$

- Learning

$$E_t[x_t] = \rho \underbrace{E_{t-1}[x_{t-1}]}_{\text{prior}} + (1-\rho) \underbrace{\left(\delta s_t + (1-\delta) a_t\right)}_{\text{signal}},$$

where $\rho, \delta \in [0,1]$.

Lorenzoni (2009)

- Effects of a permanent technology shock:

$$\frac{dy_{t+\tau}}{d\varepsilon_t} = 1 - \frac{\rho^{\tau+1}}{1+\varphi\kappa} \quad , \quad \frac{dn_{t+\tau}}{d\varepsilon_t} = -\frac{\rho^{\tau+1}}{1+\varphi\kappa} \quad , \quad \frac{d\pi_{t+\tau}}{d\varepsilon_t} = -\kappa\frac{\rho^{\tau+1}}{1+\varphi\kappa}$$

  - gradual adjustment in output to its new long-run level
  - a temporary fall in employment and inflation

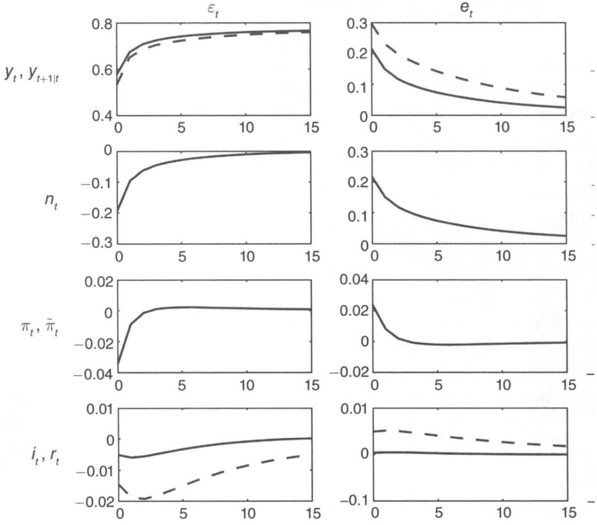
- Effects of a noise shock:

$$\frac{dy_{t+\tau}}{de_t} = \rho^{\tau}\frac{(1-\rho)\delta}{1+\varphi\kappa} \quad , \quad \frac{dn_{t+\tau}}{de_t} = \rho^{\tau}\frac{(1-\rho)\delta}{1+\varphi\kappa} \quad , \quad \frac{d\pi_{t+\tau}}{de_t} = \rho^{\tau}\frac{\kappa(1-\rho)\delta}{1+\varphi\kappa}$$

  - a temporary, **belief-driven**, increase in output, employment, and inflation
  - no long run effect

Lorenzoni (2009)

- With disperse information
  - perfect knowledge about the local TFPs, $a_{l,t} = x_t + \eta_{l,t}$
  - imperfect knowledge about the aggregate x_t
- Idiosyncratic shocks can be very large, slow aggregate learning
- Noise shocks can have sizable and persistent effects in the short run



ε_t
e_t
$y_t, y_{t+1|t}$
n_t
$\pi_t, \tilde{\pi}_t$
i_t, r_t

Noise Shocks: Caveat

- Agents cannot differentiate between true news about future TFPs and noises
  - news & noise shocks both work through expectations about expected future TFPs
  - in this sense, at least **for initial responses, news & noise shocks are essentially the same**
- Similarly, impossible for structural VARs to identify news/noise shocks separately
  - if agents are unable to separate news from noise
  - the econometrician, faced with either the same data as the agents or a subset of these data, cannot differentiate them either
- Can try to identify news/noise shocks separately with structural assumptions/estimation
  - Barsky & Sims (2012): news shocks matter for business cycles, noise shocks do not
  - Blanchard, Huillier & Lorenzoni (2013): noise shocks matter a lot

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Sentiments Orthogonal to Beliefs about TFPs

- True to Keynes' notion, "animal spirits"/"confidence"
  - **orthogonal to beliefs about current and future TFPs**
  - e.g., **beliefs about aggregate demand?**

- Consistent with beliefs in traditional multiple-equilibria models

- Theory within the unique eq. (Angeletos and La'O, 13; Angeletos, Collard & Dellas, 18)

$$\int E_{i,t}\left[y_t\right] di = y_t + \xi_t \qquad \text{but} \qquad \int E_{i,t}\left[A_t\right] di = A_t$$

  - possible with decentralized trading

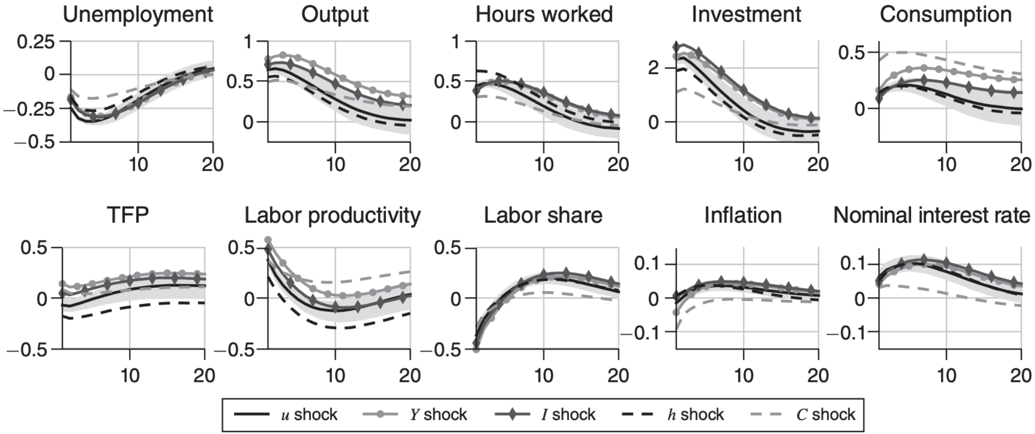
Angeletos, Collard & Dellas (2020). Business Cycle Anatomy.

- Very hard to directly measures beliefs about aggregate demand that are orthogonal to beliefs about TFPs
- An alternative approach
  - Recover a shock that has **max contribution to volatility of macro variables over BC frequencies**
- This shock
  - Instrumental in explaining business cycle comovements
  - Disconnected from TFP/inflation at all horizons
  - An non-inflationary "animal spirits" shock?

Empirical Implementation

- A structural vector autoregression (SVAR)-based shock that accounts for the maximal volatility of a particular variable over a particular frequency band
  - "Principle component analysis" in the frequency domain
- Five shocks obtained by targeting the main macroeconomic quantities, namely unemployment, output, hours worked, consumption, and investment
- Interchangeable in the sense of giving rise to nearly the same impulse response functions (IRFs) for all the variables, as well as being highly correlated with one another
- Business cycle comovement but orthogonal to inflation/TFPs

Results


Unemployment
Output
Hours worked
Investment
Consumption
TFP
Labor productivity
Labor share
Inflation
Nominal interest rate
u shock
Y shock
I shock
h shock
C shock

Results

Table 2—The Various Facets of the MBC Shock, Variance Contributions

Targeted variable:	u	Y	h	I	C
Unemployment	73.7	57.8	46.9	61.1	20.0
	[66.7, 79.8]	[50.5, 65.1]	[39.6, 53.9]	[54.7, 67.9]	[13.7,27.0]
Output	55.6	79.8	44.0	66.5	32.6
	[49.6, 61.7]	[72.9, 86.2]	[36.7,51.3]	[61.0, 72.6]	[26.0,39.2]
Hours worked	49.0	46.5	70.0	46.7	21.7
	[41.8, 56.3]	[38.0, 55.3]	[63.0, 76.7]	[37.3, 55.6]	[15.6,28.5]
Investment	58.2	66.2	44.4	80.1	18.8
	[52.3, 64.0]	[60.2, 72.3]	[36.8, 51.9]	[73.5, 86.6]	[12.5,26.3]
Consumption	18.3	30.9	19.5	16.2	67.8
	[12.2, 25.8]	[22.5, 39.3]	[13.4, 26.1]	[10.2, 24.1]	[60.7, 75.3]

Sentiment as Belief Over-reaction to Other AD Shocks

Angeletos & Lian (2022). Confidence and the Propagation of Demand Shocks.

Sentiment as belief over-reaction to other AD Shocks

- Orthogonal to beliefs about TFPs
- Consistent with empirical evidence above
- No longer “exotic”

Confidence multiplier

- Feedback loop between output, consumer & investor expectations

Confidence and the Propagation of Demand Shocks

Supply side

- Complete info, same as "the second way out" of the lecture

Demand side

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

  $\Longrightarrow$ movements in each consumer's income/firm's demand

  $\Longrightarrow$ rationally confused as idiosyncratic incomes/demands

  $\Longrightarrow$ aggregate movements in beliefs about idiosyncratic incomes/demands
- "Broader" behavioral interpretation, e.g., extrapolation
  - Consistent with evidence on expectation formation

Preferences

Household h's preference

$$\mathscr{U}\left(c_t, n_t\right) + \beta_t^h \mathscr{U}\left(c_{t+1}, n_{t+1}\right) + \beta_t^h \beta_{t+1}^h \mathscr{U}\left(c_{t+2}, n_{t+2}\right) + \cdots$$

where $\mathscr{U}\left(c, n\right) = \frac{c^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} - \frac{n^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}}$ as before and

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

- $\xi_{i,t}$ island specific demand shock ($\Rightarrow$ local income shocks)
- Household's discount factor

$$\log \beta_t^h = (1-\rho_\beta)\log\beta + \rho_\beta \log \beta_{t-1}^h - \underbrace{\log \eta_t}_{\text{AD shock}} + \log \varepsilon_t^{\beta,h},$$

  - role of idiosyncratic shocks: not "reveal" the AD shock

AD Curve

Prop. The AD Curve

$$y_t = -\sigma\{R_t + \beta_t\} + \mathbb{E}_t[y_{t+1}] + (\mathscr{B}_t + \mathscr{G}_t).$$

- $\mathscr{B}_t$ captures misperception of *own* permanent income

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

where $y_{h,t} = y_t + \xi_{h,t}$ is the local income at t.

- $\mathscr{G}_t$ captures misperception of future interest rates

$$\mathscr{G}_t \equiv -\sigma\sum_{k=1}^{+\infty}\beta^k \int \left(E_t^h[R_{t+k}] - \mathbb{E}_t[R_{t+k}]\right) dh$$

$\mathscr{B}_t$: Misperception of Permanent Income

Prop. Pro-cyclical perceived permanent income

$$\mathscr{B}_t = \frac{1-\beta}{\beta(1-\beta\rho_\xi)}(1-\lambda)\frac{\partial y_t}{\partial \eta_t}\eta_t$$

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

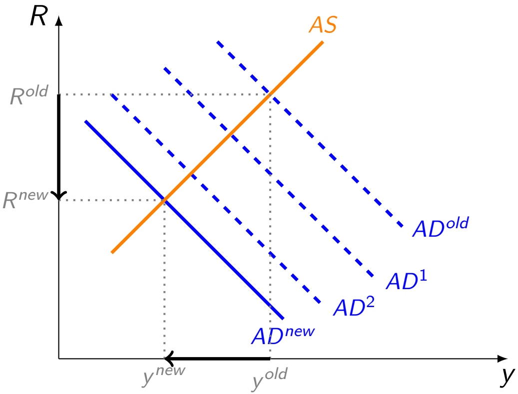
Mechanism: negative AD shocks $\Longrightarrow$ current aggregate income y_t drops

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

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

$\Longrightarrow$ drop in perceived permanent income

Confidence Multiplier



$\mathscr{G}_t$: Discounting GE Interest Rate Adjustment

Prop. Misperception of Future Interest Rate Adjustment

$$\mathscr{G}_t \equiv -\sigma \sum_{k=1}^{+\infty} \beta^k \int \left(E_t^h \left[R_{t+k} \right] - \mathbb{E}_t \left[R_{t+k} \right] \right) dh$$

$$= (1-\lambda) \frac{\sigma^2}{\sigma + \varsigma} \frac{\beta \rho_\beta}{1 - \beta \rho_\beta} \eta_t$$

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
  - Further **amplifies** the impact of the AD shock

Literature: **dampens** the impact of forward guidance

- Strategic substitutability (here) vs complementarity (NK)

Full Equilibrium

Prop. Two Multipliers

The equilibrium response of aggregate output is given by

$$\frac{\partial y_t}{\partial \eta_t} = \gamma \cdot m^{\text{conf}}\left(\lambda, \rho_\xi\right) \cdot m^{\text{GE}}\left(\lambda, \rho_\beta\right),$$

where $\gamma > 0$ is frictionless response and $m^{\text{conf}}\left(\lambda, \rho_\xi\right), m^{\text{GE}}\left(\lambda, \rho_\beta\right) > 1$.

- Both $m^{\text{conf}}\left(\lambda, \rho_\xi\right)$ and $m^{\text{GE}}\left(\lambda, \rho_\beta\right)$ increase with the confusion $1 - \lambda$
- $m^{\text{conf}}\left(\lambda, \rho_\xi\right)$ increases with the persistence of idiosyncratic shock ρ_ξ
- $m^{\text{GE}}\left(\lambda, \rho_\beta\right)$ increases with the persistence of AD shock ρ_β

Bounded rationality interpretations:

- $m^{\text{conf}}\left(\lambda, \rho_\xi\right)$: Extrapolation/one-state representation
- $m^{\text{GE}}\left(\lambda, \rho_\beta\right)$: Level-k thinking

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Pause for Questions

Outline

1. Overview and the Barro-King Conundrum
2. News Shocks
3. Noise Shocks
4. Beliefs about Aggregate Demand Orthogonal to Beliefs about TFPs
5. Fully Behavioral Approaches

Diagnostic Expectations

- Sentiments as belief overreaction to aggregate TFP shocks (e.g. diagnostic expectations)

$$E_t^{\theta}\left[A_{t+1}\right] = E_t\left[A_{t+1}\right] + \theta\left[E_t\left[A_{t+1}\right] - E_{t-1}\left[A_{t+1}\right]\right]$$

- Credit cycles: Bordalo, Gennaioli, Shleifer (18);
- Business cycles: Bordalo, Gennaioli, Shleifer, Terry (2020)
  - A RBC model with with heterogeneous firms and risky debt
  - Buoyant credit markets, measured by low credit spreads
  - Followed by a financial tightening, in which credit spreads rise, investment growth drops, and GDP growth declines

Pause for Questions