Incomplete Information in Macroeconomics

or

Revisiting Coordination and Aggregate Demand

George-Marios Angeletos

MIT

Chicago: April 24, 2015
The mysterious, seductive notions of...

coordination failure

aggregate demand

But what do they stand for?

- buzz words?
- formal meaning?
- measurement?
State of the art (at least as of the previous handbook)

coordination failure = multiple equilibria

aggregate demand = gaps from flex-price allocations
State of the art (at least as of the previous handbook)

coordination failure \(=\) multiple equilibria

aggregate demand \(=\) gaps from flex-price allocations

This chapter (and recent developments)

\[
\begin{align*}
\text{coordination failure} \; \quad \text{and} \quad \text{aggregate demand} \; \quad \rightarrow \; \quad \text{strategic uncertainty}
\end{align*}
\]
Roadmap

- some clarifications and a unified perspective
- global games
- beauty contests
- revisiting aggregate demand
- macroeconomic policy
Informational Frictions and Strategic Uncertainty

- decision-theoretic uncertainty
  - beliefs of exogenous payoff fundamentals (preferences, technology, etc)

- strategic uncertainty (SU)
  - beliefs of the actions of others (consumer spending, labor demand, etc)

- my focus: SU
  - attacks the core of GE/macro mechanisms
  - formalizes friction in coordination
  - relaxes RE solution concept
  - delivers distinct testable implications
Is this about Crises, or about Business Cycles?

- standard practice:
  - macroeconomists prefer to interpret the business-cycle data and to guide policy on the basis of unique-equil models
  - coordination failure has thus found limited application to the modern study of business cycles, despite its central position in traditional Keynesian thinking

- the alternative:
  - \( SU = \text{unified method for studying coordination in business cycles and crises} \)
Revisiting Coordination Failure

- before: sharp distinction between unique- and multiple-equilib models
- now: distinction becomes blurry, perhaps even irrelevant
  - SU selects a unique equilibrium in models with multiple equilibria
  - SU rationalizes “animal spirits” in models with unique equilibrium

recalibrating the “right” question:
  - the observables of a model (volatility, co-movement, etc)
  - not the determinacy of its solutions
Global Games

- incomplete info in games of “regime change”
  - coordination games that admit multiple equilibrium under complete info
  - natural context: crises
Global Games

- Morris and Shin $\rightarrow$ unique equilibrium
  - disturbing discontinuity: tiny noise can drastically alter predictions!
  - important: what matters is SU, not information about fundamentals

Weinstein-Yildiz
- generic uniqueness but "anything goes"

Angeletos
- Inco Info, Coordination, and AD
Global Games

- Morris and Shin $\rightarrow$ unique equilibrium
  - disturbing discontinuity: tiny noise can drastically alter predictions!
  - important: what matters is SU, not information about fundamentals

- numerous applications.... [to be reviewed in the chapter]
Global Games

- Morris and Shin → unique equilibrium
  - disturbing discontinuity: tiny noise can drastically alter predictions!
  - important: what matters is SU, not information about fundamentals

- numerous applications.... [to be reviewed in the chapter]

- my prior work (with Hellwig, Pavan, Werning) → multiplicity hits back!
  - endogenous signals can “tame” SU and facilitate coordination
Global Games

- Morris and Shin $\rightarrow$ unique equilibrium
  - disturbing discontinuity: tiny noise can drastically alter predictions!
  - important: what matters is SU, not information about fundamentals

- numerous applications.... [to be reviewed in the chapter]

- my prior work (with Hellwig, Pavan, Werning) $\rightarrow$ multiplicity hits back!
  - endogenous signals can “tame” SU and facilitate coordination

- Weinstein-Yildiz $\rightarrow$ generic uniqueness but “anything goes”
Global games: take-home lessons

- forget about multiplicity vs uniqueness!

- the robust prediction of the theory is “excess sensitivity”
  - discontinuities
  - sharp reaction to noisy public signals
  - sunspots recast as higher-order beliefs (HOB)

- but also: details of information/communication matter a lot
  - knowledge vs common knowledge
    - e.g., stress tests, CDS markets
Global games: take-home lessons

- forget about multiplicity vs uniqueness!

- the robust prediction of the theory is “excess sensitivity”
  - discontinuities
  - sharp reaction to noisy public signals
  - sunspots recast as higher-order beliefs (HOB)

- but also: details of information/communication matter a lot
  - knowledge vs common knowledge
  - e.g., stress tests, CDS markets
Beauty Contests

- incomplete info in games with linear best responses
  - settings that admit a unique equilibrium no matter the info structure
  - natural context: business cycles and asset markets in “normal times”
Beauty Contests: Theory and Applications

- Morris-Shin, Angeletos-Pavan, Bergemann-Morris
  \[ a_i = E_i[(1 - \alpha)\theta + \alpha A] \]

- Woodford, Mankiw-Reis, Mackowiak-Wiederholt, Nimark, Hellwig-Venkateswaran, Gaballo, Melosi, etc
  \[ p_{it} = E_{it}[(1 - \alpha)\theta_t + \alpha P_t] \]

- Angeletos-La’O, Benhabib-Wang-Wen, Angeletos-Lian
  \[ y_{it} = E_{it}[(1 - \alpha)\theta_t + \alpha Y_t] \quad c_{it} = E_{it}[(1 - \alpha)\theta_t + \alpha C_t] \]

- Allen-Morris-Shin, Rondina-Walker, etc
  \[ p_t = \bar{E}_{it}[\theta_t + \beta p_{t+1}] \]

- related topics:
  - info aggregation (Grossman-Stiglitz, Hassan-Mertens, etc)
  - news/noise (Lorenzoni etc)
  - heterogeneous beliefs (Scheinkman-Xiong, Simsek, etc)
Beauty Contests: take-home lessons

- inertia of HOB to innovations in fundamentals $\rightarrow$ macro-level rigidity
  - e.g., nominal rigidity in response to monetary shocks, or real rigidity in response to technology shocks

- “noise” in HOB $\rightarrow$ sunspot-like volatility
  - dual role of public signals

- contagion, propagation, waves of optimism and pessimism
Revisiting Aggregate Demand

- is “aggregate demand” a monetary or a real phenomenon?

- where does nominal rigidity come from?
AD and the NKPC

- aggregate demand = gaps from flex-price allocations

- discomforting facts:
  - disconnect between unemployment and inflation
  - the Great Recession and the “missing disinflation” puzzle
  - Bachmann et al: inflation expectations reduce consumer spending
  - a simple test of the NKPC (ongoing work)
    - in the theory: positive inflation innovations predict positive output gaps
    - in the data: the opposite is true!

- maybe time to move past the NK formalization of AD???
VAR on \((u, \pi)\), Cholesky decomposition

**innovation in unemployment**

Unemployment

Inflation

**innovation in inflation**

Unemployment

Inflation

<table>
<thead>
<tr>
<th>Unemployment</th>
<th>Inflation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \varepsilon^u_t )</td>
<td>( \varepsilon^\pi_t )</td>
</tr>
<tr>
<td>1</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td>[100.00,100.00]</td>
</tr>
<tr>
<td>4</td>
<td>95.15</td>
</tr>
<tr>
<td></td>
<td>[92.44,97.16]</td>
</tr>
<tr>
<td>8</td>
<td>79.72</td>
</tr>
<tr>
<td></td>
<td>[71.28,86.78]</td>
</tr>
<tr>
<td>20</td>
<td>47.60</td>
</tr>
<tr>
<td></td>
<td>[34.48,60.84]</td>
</tr>
</tbody>
</table>

Note: 68% HPDI into brackets
Beliefs and Nominal Rigidity

- Woodford, Mankiw-Reis, Mackowiak-Wiederholt, etc

- Key mechanism: inertia of beliefs about endogenous outcomes (inflation)

- Coibion-Gorodnichenko:
  - Evidence of this kind of belief inertia
  - But disconnect from theory

- Ongoing work: use forecast data to quantify the theory
Coibion and Gorodnichenko (2011)

Fig. 3.—Response of forecast errors of consumers, firms, and FOMC members to shocks. The figure reports impulse responses to a unit shock computed from estimated (34). Each row shows responses to a given structural shock. Standard errors for impulse responses are computed using a parametric bootstrap. The left column is based on the forecasts reported in the Michigan Survey of Consumers. The middle column is based on firms’ forecasts reported in the Livingston Survey. The right column is based on the forecasts of FOMC members.
An Anatomy of the Data

- VAR on
  \[ \{ Y, U, H, I, C, W, \pi, R, G, TFP, SP, VIX, \ldots \} \]

- “X shock” = shock that maximizes volatility of X at BC frequencies
  - method builds on Uhlig, Barsky-Sims, and others

- inspect IRFs and variance contributions → anatomy of co-movement
An Anatomy of the Data

- $U$ shock $\approx Y$ shock $\approx (I, H)$ shock

- but very different from
  - $\pi$ shock
  - $TFP$ and $P_I/P_C$ shocks
  - $SP$, $VIX$

- evidence at odds with technology/news/noise/uncertainty shocks

- an “invisible” $TFP$ shock? a mysterious “demand shock”?
The “Business-Cycle Shock”
Revisiting AD in the Theory

- Angeletos and La’O (2013), Angeletos, Collard, Dellas (2014)
  - AD = coordination failure = gaps from complete-info outcomes
  - AD = confidence about short-run outlook

Confronting the data: Angeletos, Collard and Dellas (2014)

- Textbook RBC/NK model augmented with “confidence shocks” does wonders
- Mechanism outperforms alternatives (I-shocks, C-shocks, news shocks, etc)
  - Parsimonious calibration / pony races
  - Medium-scale DSGE / structural estimations
- “Confidence shock” in the model mirrors
  - “Mysterious demand shock” in the data
  - Empirical measures of consumer confidence
  - Gennaioli-Ma-Shleifer evidence on CEO beliefs
### Pony Race: Confidence vs NK

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Our RBC</th>
<th>NK with TFP plus...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$I$ shock</td>
</tr>
<tr>
<td>$\text{stddev}(y)$</td>
<td>1.42</td>
<td>1.42</td>
<td>1.24</td>
</tr>
<tr>
<td>$\text{stddev}(h)$</td>
<td>1.56</td>
<td>1.52</td>
<td>1.18</td>
</tr>
<tr>
<td>$\text{stddev}(c)$</td>
<td>0.76</td>
<td>0.76</td>
<td>0.86</td>
</tr>
<tr>
<td>$\text{stddev}(i)$</td>
<td>5.43</td>
<td>5.66</td>
<td>7.03</td>
</tr>
<tr>
<td>$\text{corr}(c, y)$</td>
<td>0.85</td>
<td>0.77</td>
<td>0.42</td>
</tr>
<tr>
<td>$\text{corr}(i, y)$</td>
<td>0.94</td>
<td>0.92</td>
<td>0.82</td>
</tr>
<tr>
<td>$\text{corr}(h, y)$</td>
<td>0.88</td>
<td>0.85</td>
<td>0.80</td>
</tr>
<tr>
<td>$\text{corr}(c, h)$</td>
<td>0.84</td>
<td>0.34</td>
<td>-0.19</td>
</tr>
<tr>
<td>$\text{corr}(i, h)$</td>
<td>0.82</td>
<td>0.99</td>
<td>1.00</td>
</tr>
<tr>
<td>$\text{corr}(c, i)$</td>
<td>0.74</td>
<td>0.47</td>
<td>-0.17</td>
</tr>
<tr>
<td>$\text{corr}(y, y/h)$</td>
<td>0.08</td>
<td>0.15</td>
<td>0.37</td>
</tr>
<tr>
<td>$\text{corr}(h, y/h)$</td>
<td>-0.41</td>
<td>-0.37</td>
<td>-0.24</td>
</tr>
<tr>
<td>$\text{corr}(y, sr)$</td>
<td>0.82</td>
<td>0.85</td>
<td>0.92</td>
</tr>
<tr>
<td>$\text{corr}(h, sr)$</td>
<td>0.47</td>
<td>0.47</td>
<td>0.52</td>
</tr>
</tbody>
</table>
Confidence shock (model) vs business-cycle shock (data)
VAR on models vs VAR on data

Output

Consumption

Investment

Hours Worked

Labor Productivity

Inflation Rate

Quarters

Quarters

Quarters

Quarters

Quarters

5 10 15 20

5 10 15 20

5 10 15 20

5 10 15 20

5 10 15 20

5 10 15 20
Conclusion

- strategic uncertainty = a method for studying, and quantifying, the role of
  - coordination failure
  - “mistakes” in expectations, “market psychology”
  - belief inertia, macro rigidity
  - “aggregate demand” beyond sticky prices

- implications for macroeconomic policy
  - optimality of price stability
  - Ricardian equivalence, fiscal multipliers
  - stress tests
  - macro-prudential insurance