Coordinating Expectations:
Global Games with Strategic Complementarities

Stephen Morris
PSE conference on "Expectations and Coordination" in honor of Roger Guesnerie

June 2009
Eductive Justifications of the Rational Expectations Hypothesis: Guesnerie 92

- Does common certainty of market participants’ rationality and market clearing imply common and correct ("rational") expectations?
- If yes, "strong rational-expectations equilibrium" (sREE) and expectations are coordinated
- Possible to characterize economies that do (and do not) lead to sREE
  - e.g., Supply has lower slope (more price sensitivity) than demand
  - in Guesnerie 92 $\exists$ sREE $\iff$ supply is sufficiently price inelastic relative to demand.
Eductive Justifications of the Rational Expectations Hypothesis

Game Theory

- Existence of sREE = uniqueness of rationalizable outcomes in continuum player game (Guesnerie-Jara-Moroni 08)
- Difference between strategic complementarities (SC) and strategic substitutes (SS)
  - under SC, unique rationalizable outcome if and only if unique equilibrium outcome
  - under SS, GJM provide conditions for unique rationalizable outcome in continuum player, aggregative games
    - these results underlie results in Guesnerie 92 and later work
Global Games

- A complete information game with multiple equilibria has a unique equilibrium if complete information (=common certainty of payoffs) assumption is relaxed by adding noise to payoffs
  - in two player, two action, games (Carlsson and van Damme 93)
  - more generally if strategic complementarities (Morris and Shin 98, 00), Frankel, Morris and Pauzner 03)

- Powerful force coordinating expectations?

- But to understand connection, need to understand global games with strategic substitutes
This Paper

- Global Games with Strategic Substitutes
  - New results
  - Understanding Harrison 03: unique equilibrium in global games with strategic substitutes and ex ante asymmetries in payoffs
- Integrated treatment with static version of Guesnerie’s eductive market model
  - Interesting connections
Outline

1. Leading example
   - linear example from Guesnerie 92
   - slight variant is canonical ex ante symmetric global game with strategic substitutes (same qualitative insights)
   - adding ex ante asymmetries à la Harrison 03 gives unique equilibrium but multiple rationalizable outcomes

2. Review of Guesnerie-Jara-Moroni 08 with explanation of relation to global games

3. New results for ex ante symmetric global games with strategic substitutes with normal distributions
Outline

1. Leading example

2. Review of Guesnerie-Jara-Moroni 08 with explanation of relation to global games

3. New results for ex ante symmetric global games with strategic substitutes with normal distributions
   - tight characterization of sREE / unique rationalizable outcomes in terms of distribution of public and private information
   - re-parameterization in terms of correlation and heterogeneity
     - heterogeneity is good for uniqueness (cf, Guesnerie 05)
     - correlation is good for uniqueness with SC, bad for uniqueness with SS
Outline

1. Leading example
2. Review of Guesnerie-Jara-Moroni 08 with explanation of relation to global games
3. New results for ex ante symmetric global games with strategic substitutes with normal distributions
4. Conclusion and Discussion
Demand

inverse demand curve tomorrow

\[ p = D^{-1}(q) = 3 - 2q; \]
Case 1: Heterogeneous Farmer version of Guesnerie 92

Case 1 Supply

- continuum of farmers with mass one produce 0 or 1 unit
- heterogeneous farmer version of Guesnerie 92
- costs are uniformly distributed on $[\theta - \frac{1}{2}\sigma, \theta + \frac{1}{2}\sigma]$
  - $\theta$ is average cost
  - $\sigma$ is dispersion of costs
- Thus the inverse supply curve is

$$p = S^{-1}(q) = \theta + \sigma \left(q - \frac{1}{2}\right)$$
Case 1: Equilibrium

\[
q^* = \frac{3 - \theta + \frac{1}{2} \sigma}{2 + \sigma}
\]

\[
p^* = \theta + \frac{(2 - \theta) \sigma}{2 + \sigma}
\]
Case 1: Heterogeneous Farmer version of Guesnerie 92

\[ P \]
\[ 3 \]
\[ \theta - \frac{1}{2} \sigma \]

\((q^*, p^*)\)

\(S\)

\(D\)
Case 1: Rationalizability

- If everyone expected the price to be \( p \), supply would be

\[
q = S(p) = \frac{1}{2} + \frac{p - \theta}{\sigma}
\]

and the resulting price would be

\[
\beta(p) = D^{-1}(S(p)) = 2 - \frac{2}{\sigma}(p - \theta) = 2 + \frac{2\theta}{\sigma} - \frac{2}{\sigma}p.
\]

- \( k \)th level certainty of rationality and market clearing implies

\[
p \in \left[ p_k, \bar{p}_k \right]
\]

where

- \( p_0 = 1 \) and \( \bar{p}_0 = 3 \)
- \( p_{k+1} = \beta(\bar{p}_k) \) and \( \bar{p}_{k+1} = \beta(p_k) \)

- Unique rationalizable outcome if and only if \( \frac{2}{\sigma} < 1 \), i.e., \( \sigma > 2 \)
Case 1: Rationalizability

- Unique rationalizable outcome if and only if $\frac{2}{\sigma} < 1$, i.e., $\sigma > 2$
- Generalized in many directions e.g., in "Eductive Stability in Economics" volume
Case 2: Supply

- as before, costs $\sim U \left[ \theta - \frac{1}{2} \sigma, \theta + \frac{1}{2} \sigma \right]$
- $\theta$ drawn from uniform prior....
Case 2: Equilibrium

- If $\sigma \geq 2$, there is a unique threshold equilibrium with entry if and only if cost is less than 2 and realized price

  $$\tilde{p}(\theta) = \begin{cases} 
  1, & \text{if } \theta \leq 2 - \frac{1}{2} \sigma \\
  2 - \frac{2}{\sigma} (\theta - 2), & \text{if } 2 - \frac{1}{2} \sigma \leq \theta \leq 2 + \frac{1}{2} \sigma \\
  3, & \text{if } 2 + \frac{1}{2} \sigma \leq \theta 
  \end{cases}$$

- For small $\sigma$, no symmetric pure equilibrium, thus inefficient equilibria
Case 2: Rationalizability

- For large $\sigma$ (sufficient heterogeneity), there is a unique rationalizable strategy with entry if and only if cost is less than 2
- For small $\sigma$, any decision is rationalizable for costs in $[1, 3]$ and any price in the interval $[1, 3]$ is rationalizable for $\theta \in \left[1 + \frac{1}{2}\sigma, 3 - \frac{1}{2}\sigma\right]$
- Qualitatively similar to case 1
Case 2: Ex Ante Symmetric Private Values Global Game with Strategic Substitutes

Coordinating Expectations
Case 2: Ex Ante Symmetric Private Values Global Game with Strategic Substitutes
Case 2: Ex Ante Symmetric Private Values Global Game with Strategic Substitutes

Terminology

- "global games": each farmer observes noisy version of underlying parameter (Carlsson and van Damme 93)
- "private values": each farmer’s payoff depends on the noisy version of parameter (Morris and Shin 05, Argenziano 08) unlike in more usual "common value" case
- "strategic substitutes": each farmer’s payoff to entry is decreasing in the proportion of other farmers who enter
- "ex ante symmetric": private noise is only heterogeneity
  - We will be studying ex ante symmetric global games with strategic substitutes in more detail
  - But Harrison 03 showed that with strategic substitutes, ex ante asymmetry matters a lot
Case 3: Supply

- total cost $c = x + y$
- "public cost" $y \sim U \left[ \theta_y - \frac{1}{2}\sigma_y, \theta_y + \frac{1}{2}\sigma_y \right]$, with common certainty of $\theta_y = 2$.
- "private cost" $x \sim U \left[ \theta_x - \frac{1}{2}\sigma_x, \theta_x + \frac{1}{2}\sigma_x \right]$, with $\theta_x$ uniformly distributed
- focus on small $\sigma_y$ but much smaller $\sigma_x$ case
Case 3: Equilibrium

Fix $\sigma_y > 0$. For sufficiently small $\sigma_x$, there is a unique equilibrium. As $\sigma_x \to 0$, we get efficient outcome: farmers enter

1. if $x \leq -1 + \frac{1}{2} \sigma_y$ (so it is dominant strategy for even lowest public cost farmer to enter); and

2. if $x \in [-1 + \frac{1}{2} \sigma_y, 1 - \frac{1}{2} \sigma_y]$ (so some farmer does not have a dominant strategy), enter only if $y \leq 3 - 2 \left( \frac{x-1+\frac{1}{2} \sigma_y}{2+\sigma_y} \right)$ (i.e., as if he expects exactly lower cost farmers to be entering); otherwise, they do not enter.
Case 3: Ex Ante Asymmetric Private Values Global Game with Strategic Substitutes
Case 3: Ex Ante Asymmetric Private Values Global Game with Strategic Substitutes
Case 3: Rationalizability

- If $\sigma_x \leq \sigma_y \leq 1$, then both entering or not entering are rationalizable if $|x| \in \left(\left(1 + \frac{1}{2}\sigma_y\right)\left(\frac{1-\sigma_y}{1+\sigma_y}\right), (1 + \frac{1}{2}\sigma_y)\right)$

- Similar result in Harrison 03 finite player case
Case 3: Ex Ante Asymmetric Private Values Global Game with Strategic Substitutes

Idea of Proof

- Idea of Proof: assume common certainty that all farmers....

1. enter if
   1.1 either $x \leq -1 - \frac{1}{2}\sigma_y$
   1.2 or $|x| \in \left( (1 + \frac{1}{2}\sigma_y) \left( \frac{1-\sigma_y}{1+\sigma_y} \right), (1 + \frac{1}{2}\sigma_y) \right)$ and $y \leq 2 - \frac{\sigma_y}{2+\sigma_y}x$

2. not enter if
   2.1 either $x > \frac{1}{2}\left( b + \sigma_y \right)$
   2.2 or $|x| \in \left( (1 + \frac{1}{2}\sigma_y) \left( \frac{1-\sigma_y}{1+\sigma_y} \right), (1 + \frac{1}{2}\sigma_y) \right)$ and $y > 2 - \frac{\sigma_y}{2+\sigma_y}x$
Case 3: Ex Ante Asymmetric Private Values Global Game with Strategic Substitutes

Coordinating Expectations
Case 3: Ex Ante Asymmetric Private Values Global Game with Strategic Substitutes

Idea of Proof

- consider farmer with private cost $x = \left(1 + \frac{1}{2}\sigma_y\right) \left(\frac{1-\sigma_y}{1+\sigma_y}\right)$
- assigns probability $\frac{1}{2}$ to any other farmer having a higher private cost and thus having its action determined by the above common certainty assumption
- conditional on the other farmer have a higher private cost, probability entering $\frac{\sigma_y}{1+\sigma_y}$
- expected proportion farmers entering is at least $\frac{\sigma_y}{2(1+\sigma_y)}$ and at most $\frac{1}{2} + \frac{\sigma_y}{2(1+\sigma_y)}$. 

Coordinating Expectations
Case 3: Ex Ante Asymmetric Private Values Global Game with Strategic Substitutes

Idea of Proof

- expected proportion farmers entering is at least \( \frac{\sigma_y}{2(1+\sigma_y)} \) and at most \( \frac{1}{2} + \frac{\sigma_y}{2(1+\sigma_y)} \).

- farmer expects to face a price of at most \( 3 - \frac{\sigma_y}{1+\sigma_y} \) and at least \( 2 - \frac{\sigma_y}{b+\sigma_y} \).

- best response for a maximum public cost farmer with private cost \( x \) to enter if

\[
3 - 2 \left( \frac{\sigma_y}{2 + 2\sigma_y} \right) \geq x + 2 + \frac{1}{2} \sigma_y
\]
Continuum Player Games

- Guesnerie-Jara-Moroni 08
- continuum of players, with mass 1.
- player of type $x \in X$ chooses action $a \in A \subseteq \mathbb{R}$,
  - $\{a, \bar{a}\} \subseteq A \subseteq [a, \bar{a}] \subseteq \mathbb{R}$
- unknown state $\theta \in \Theta$
- $\pi \in \Delta (X \times \Theta)$
- Writing $\hat{a}$ for average action, payoff of type $x$ player $u(a, \hat{a}, x)$
  - in market model $A = \{0, 1\}$ and $u(a, \hat{a}, x) = a(3 - 2\hat{a} - x)$
Strategies and Best Responses

- strategy profile $s : X \rightarrow A$
- $s$ generates average action $\hat{a}_s = \int_{x, \theta} s(x) \, d\pi$
- best response of type $x$ (assume unique):
  $$\beta(s, x) = \arg \max_{a \in A} u(a, \hat{a}_s, x)$$
- $\beta^*[s] : X \rightarrow A$ defined by
  $$\beta^*[s](x) = \beta(s, x)$$
  for each $x$. 
Solution Concepts

- $s^*$ is equilibrium if $s^* = \beta^* [s]$
- Define $R^k (x)$ - the $k$th level (point) rationalizable actions of type $x$ - iteratively by

$$R^0 (x) = A$$

$$R^{k+1} (x) = \bigcup \{ s | s(x') \in R^k (x') \text{ for all } x' \} \beta (s, x)$$

- Action $a$ is (point) rationalizable for type $x$ if

$$a \in R (x) = \bigcap_{k \geq 1} R^k (x)$$
Strategic Complementarities

- Strategic complementarities hold if
  \[ a > a' \Rightarrow u(a, \hat{a}, x) - u(a', \hat{a}, x) \text{ is weakly increasing in } \hat{a}. \]

**Theorem**

*Under strategic complementarities, there exist \( \bar{s} \) and \( s \) such that (i) \( \bar{s} \geq s \); (ii) \( R(x) = \{ a \mid s(x) \leq a \leq \bar{s}(x) \} \) and (iii) \( \bar{s} \) and \( s \) are equilibria.*

**Corollary**

*Under strategic complementarities, there is a unique rationalizable outcome if and only if there is a unique equilibrium (i.e., \( s = \bar{s} \)).*
Strategic Complementarities

Theorem

Under strategic complementarities, there exist $\bar{s}$ and $\underline{s}$ such that (i) $\bar{s} \geq \underline{s}$; (ii) $R(x) = \{a|\underline{s}(x) \leq a \leq \bar{s}(x)\}$ and (iii) $\bar{s}$ and $\underline{s}$ are equilibria.

Corollary

Under strategic complementarities, there is a unique rationalizable outcome if and only if there is a unique equilibrium (i.e., $\underline{s} = \bar{s}$).

- Well known, hold much more generally (Milgrom-Roberts 92).
- First step in strategic complementarities global game argument (Morris-Shin 03, Frankel-Morris-Pauzner 03)
Strategic substitutes hold if \( a > a' \Rightarrow u(a, \hat{a}, x) - u(a', \hat{a}, x) \) weakly decreasing in \( \hat{a} \).

**Theorem**

*Under strategic substitutes, there exist \( \bar{s} \) and \( \underline{s} \) such that (i) \( \bar{s} \geq \underline{s} \); (ii) \( R(x) = \{ a \mid \underline{s}(x) \leq a \leq \bar{s}(x) \} \); and (iii) \( \bar{s} = \beta^*(\bar{s}) \) and \( \underline{s} = \beta^*(\underline{s}) \).*

**Corollary**

*There is a unique rationalizable outcome if and only if \( [\beta^*]^2 \) has unique fixed point*
Strategic Substitutes

Theorem

Under strategic substitutes, there exist \( \bar{s} \) and \( s \) such that (i) \( \bar{s} \geq s \); (ii) \( R(x) = \{ a \mid s(x) \leq a \leq \bar{s}(x) \} \); and (iii) \( s = \beta^*(\bar{s}) \) and \( \bar{s} = \beta^*(s) \).

Corollary

There is a unique rationalizable outcome if and only if \( [\beta^*]^2 \) has unique fixed point

- Guesnerie and Jara-Moroni (2008)
- Hold only in special class of games with (i) continuum of players; (ii) linear aggregator of players’ actions
- But this covers global games with strategic substitutes results I will report.
Strategic Substitutes

- Define

\[ s^0(x) = a \text{ and } s^0(x) = \bar{a} \]

and

\[ s^k = \beta \left[ s^{k-1} \right] \text{ and } \bar{s}^k = \beta \left[ \bar{s}^{k-1} \right]. \]

- Now

\[ R^k(x) = \left\{ a \mid s^k(x) \leq a \leq \bar{s}^k(x) \right\}. \]

- \([\beta^*]^{2k} (s^0)\) decreasing and \([\beta^*]^{2k} (s^0)\) increasing

- So there exist \( s \) and \( \bar{s} \) such that \( s \leq \bar{s} \) with \([\beta^*]^{2k} (s^0) \rightarrow \bar{s}\) and \([\beta^*]^{2k} (\bar{s}^0) \rightarrow s\).
Normal Symmetric Global Games (Strategic Substitutes)

\[ A = \{0, 1\} \]

\[ u(a, \hat{a}, x) = a(3 - 2\hat{a} - x). \]
Private Costs with No Aggregate Uncertainty

- like case 1, common certainty of mean cost $\theta$
- unit cost $c \sim N(\theta, \frac{1}{\beta})$
- Unique rationalizable outcome of all $\theta$ if and only if

$$\beta \leq \frac{\pi}{2}$$
Private Costs with Aggregate Uncertainty

- one dimensional combination of cases 1 and 2
- unit cost $c \sim N(\theta, \frac{1}{\alpha})$, $\theta \sim N(y, \frac{1}{\beta})$
- Unique rationalizable outcome for all $y$ if and only if

$$
\beta \left(\frac{\alpha + 2\beta}{\alpha + \beta}\right) \leq \frac{\pi}{2}
$$

- As $\alpha \to \infty$, like case 1, $\beta \leq \frac{\pi}{2}$
- As $\alpha \to 0$, like case 2, $\beta \leq \frac{\pi}{4}$
Strategic Substitutes

Strategic substitutes with private costs

Multiplicity

Uniqueness

$\beta \frac{\alpha + 2\beta}{\alpha + \beta} < \frac{\pi}{2}$

Coordinating Expectations
Common Costs with Noise

- All farmers have identical cost $\theta$ observed with noise.
- Signal $x \sim N(\theta, \frac{1}{\alpha})$, $\theta \sim N(y, \frac{1}{\alpha})$.
- Unique rationalizable outcome for all $y$ if and only if
  \[
  \frac{(\alpha + \beta)(\alpha + 2\beta)}{\beta} \leq \frac{\pi}{2}
  \]
Strategic Substitutes

\[
\frac{(\alpha + \beta)(\alpha + 2\beta)}{\beta} \leq \frac{\pi}{2}
\]

\text{Uniqueness}

\text{Multiplicity}

Coordinating Expectations
Strategic Complementarities

Payoff function is

\[ u(a, \hat{a}, x) = a(3 + 2\hat{a} - x), \]

instead of

\[ u(a, \hat{a}, x) = a(3 - 2\hat{a} - x). \]

- continuum of farmers are decided whether to invest \((a = 1)\) or not invest \((a = 0)\).
- private cost \(x\) to invest
- common benefit \(3 + 2\hat{a}\) to investing
- same three cases as for strategic substitutes...
Private Costs with no Aggregate Uncertainty

- common certainty of mean cost $\theta$
- unit cost $c \sim N\left(\theta, \frac{1}{\beta}\right)$
- Unique rationalizable outcome of all $\theta$ if and only if
  \[ \beta \leq \frac{\pi}{2} \]
- independent heterogeneity gives unique in games with SC: Morris-Shin 05, McKelvey-Palfrey 95, Herrendorf-Valentinyi-Waldmann 00 and Baliga-Sjöstrom 04
Private Costs with Aggregate Uncertainty

- unit cost $c \sim N (\theta, \frac{1}{\alpha})$, $\theta \sim N \left( y, \frac{1}{\beta} \right)$
- Unique rationalizable outcome for all $y$ if and only if

$$\frac{\alpha^2 \beta}{(\alpha + \beta)(\alpha + 2\beta)} \leq \frac{\pi}{2}$$

- Note that as $\beta \to 0$ or $\beta \to \infty$, there is uniqueness (for any $\alpha$).
- But if $\alpha = \infty$ and $\beta \to \infty$, there is multiplicity but purification.
- This is a private value global games, as studied in Carlsson-van Damme 93 Appendix B, Morris-Shin 05 and Argenziano 08.
Strategic Complementarities

Uniqueness

\[ \frac{\alpha^2 \beta}{(\alpha + \beta)(\alpha + 2\beta)} < \frac{\pi}{2} \]

Multiplicity
Common Costs with Noise

- All farmers have identical costs, uncertainty about common cost $\theta$
- signal $x \sim N(\theta, \frac{1}{\alpha})$, $\theta \sim N(y, \frac{1}{\beta})$
- Unique rationalizable outcome for all $y$ if and only if

$$\frac{\alpha^2}{\beta} \left( \frac{\alpha + \beta}{\alpha + 2\beta} \right) \leq \frac{\pi}{2}$$

- This is a leading "linear" example in global games applications, e.g., Morris-Shin 00, 03.
Strategic Complementarities

Uniqueness

\[
\frac{\alpha^2(\alpha+\beta)}{\beta(\alpha+2\beta)} \leq \frac{\pi}{2}
\]

Multiplicity
### Interpreting the Results

<table>
<thead>
<tr>
<th></th>
<th>p.v.</th>
<th>p.v. with agg. unc</th>
<th>c.v. + noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>$\beta \leq \frac{\pi}{2}$</td>
<td>$\beta \left( \frac{\alpha+2\beta}{\alpha+\beta} \right) \leq \frac{\pi}{2}$</td>
<td>$\frac{(\alpha+\beta)(\alpha+2\beta)}{\beta} \leq \frac{\pi}{2}$</td>
</tr>
<tr>
<td>SC</td>
<td>$\beta \leq \frac{\pi}{2}$</td>
<td>$\frac{\alpha^2\beta}{(\alpha+\beta)(\alpha+2\beta)} \leq \frac{\pi}{2}$</td>
<td>$\frac{\alpha^2}{\beta} \left( \frac{\alpha+\beta}{\alpha+2\beta} \right) \leq \frac{\pi}{2}$</td>
</tr>
</tbody>
</table>
Re-Parameterize

- ex ante total variance of $x$ is $\sigma^2 = \frac{1}{\alpha} + \frac{1}{\beta}$
- correlation between $x_i$ and $x_j$ is $\rho = \frac{\beta}{\alpha + \beta}$
- following Ui 06, re-parameterize $\alpha = \frac{1}{\rho \sigma^2}$ and $\beta = \frac{1}{(1-\rho)\sigma^2}$.

<table>
<thead>
<tr>
<th></th>
<th>p.v.</th>
<th>p.v. with agg. unc</th>
<th>c.v. + noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>$\sigma^2 \geq \frac{2}{\pi}$</td>
<td>$\sigma^2 \geq \frac{2}{\pi} \left( \frac{1+\rho}{1-\rho} \right)$</td>
<td>$\sigma^2 \geq \frac{2}{\pi} \left( \frac{1+\rho}{1-\rho} \right) \left( \frac{1}{\rho^2} \right)$</td>
</tr>
<tr>
<td>SC</td>
<td>$\sigma^2 \geq \frac{2}{\pi}$</td>
<td>$\sigma^2 \geq \frac{2}{\pi} \left( \frac{1-\rho}{1+\rho} \right)$</td>
<td>$\sigma^2 \geq \frac{2}{\pi} \left( \frac{1-\rho}{1+\rho} \right) \left( \frac{1}{\rho^2} \right)$</td>
</tr>
</tbody>
</table>
Interpretation

- Heterogeneity always favors uniqueness (c.f., Guesnerie 05)
- Correlation favors uniqueness with SC, multiplicity with SS
Varying Degree of Strategic Substitutability / Complementarity

- Payoff functions
  \[ u(a, \hat{a}, x) = d(3 + b\hat{a} - x) \]
- For any \( \alpha, \beta \), always a unique equilibrium for sufficiently small \(|b|\)
- Morris and Shin 05, Mason and Valentinyi 07
Equilibrium Uniqueness

- Can also find analogous conditions for a unique "threshold" equilibrium
- For strategic complementarities, same conditions as for rationalizability
- For strategic substitutes, more permissive, but still fail for large $\beta$ (remember case 2)
Conclusion and Discussion

- "Global games with strategic substitutes": well posed question
- can characterize outcomes using similar techniques, substitute (more restrictive) Guesnerie-Jara-Moroni characterization of rationalizability
- conclusions qualitatively different from global games with strategic complementarities
- conclusions qualitatively similar to heterogeneous Guesnerie 92
- unique equilibrium result of Harrison 03 for ex ante asymmetric case does not apply to rationalizability
Uniqueness versus Multiplicity

- Models with uniqueness as a function of unobserved higher order beliefs may have very similar predictions to models with symmetric information multiple equilibrium/rationalizable outcomes.
- To the extent this is true, the contribution of "uniqueness" is "complete theory" (what determines which sunspot is played).
- But may also seek reduced form predictions to test and/or proxies/partial observation of higher order beliefs (e.g., information transmission mechanisms).