Makroökonomische Konsequenzen strategischen Risikos

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Frank Heinemann, TU Berlin

Macroeconomic Consequences of Strategic Uncertainty

Sources of uncertainty:

- Exogenous uncertainty (macroeconomic shocks)
- Endogenous (strategic) uncertainty

    uncertainty about behaviour of other players

  Equilibrium theory assumes deductive reasoning

  (1) rational expectations: strategies are common knowledge (no strategic uncertainty)

  (2) rationalizability / iterative elimination of dominated strategies: infinite number of levels of reasoning, in general: large set of remaining strategies.

Macroeconomic Consequences of Strategic Uncertainty

Examples:

(1) speculative attacks, financial crises

If sufficiently many traders attack (sell) a currency, the central bank runs out of reserves and must devalue.
Attacking traders make a profit.
Equilibrium if all traders attack.

○ If almost no trader attacks, central bank can keep the peg (a single trader does not have sufficient capital).
Not-attacking is another equilibrium.

○ (2) price setting firms in monopolistic competition

The higher the prices of others, the higher the best response => strategic complementarity.

with costs of price adjustment: multiple equilibria

Macroeconomic Consequences of Strategic Uncertainty

Theory of Global Games

(Carlsson/van Damme 1993, Morris/Shin 1998, 2000)

embeds a model in a stochastic framework with private information about suitable parameters of the payoff function.

- One-shot game, strategic complementarity, existence of dominance regions
  => unique equilibrium if private information is sufficiently precise.
- Comparative statics follows intuition.

Speculative-attack game

- Simplest version, 2 players
- For R > t, the game has 2 pure strategy equilibria (both attack and both do not attack)
- Suppose, R is uncertain

  Let $R \sim N(\mu,\tau^2)$
- Players get private signals

  $x^i = R + \varepsilon^i, \quad \varepsilon^i \sim N(0,\sigma^2)$

  ε^1 and ε^2 are independent
- If σ / τ is sufficiently small, there is a unique equilibrium (for given μ) with a threshold signal x*, s.t. agent i attacks if $x^i > x^*$ and does not attack, if $x^i < x^*$.

	attack	no attack
attack	R – t R – t	0 – t
no attack	– t 0	0 0

Equilibrium condition:

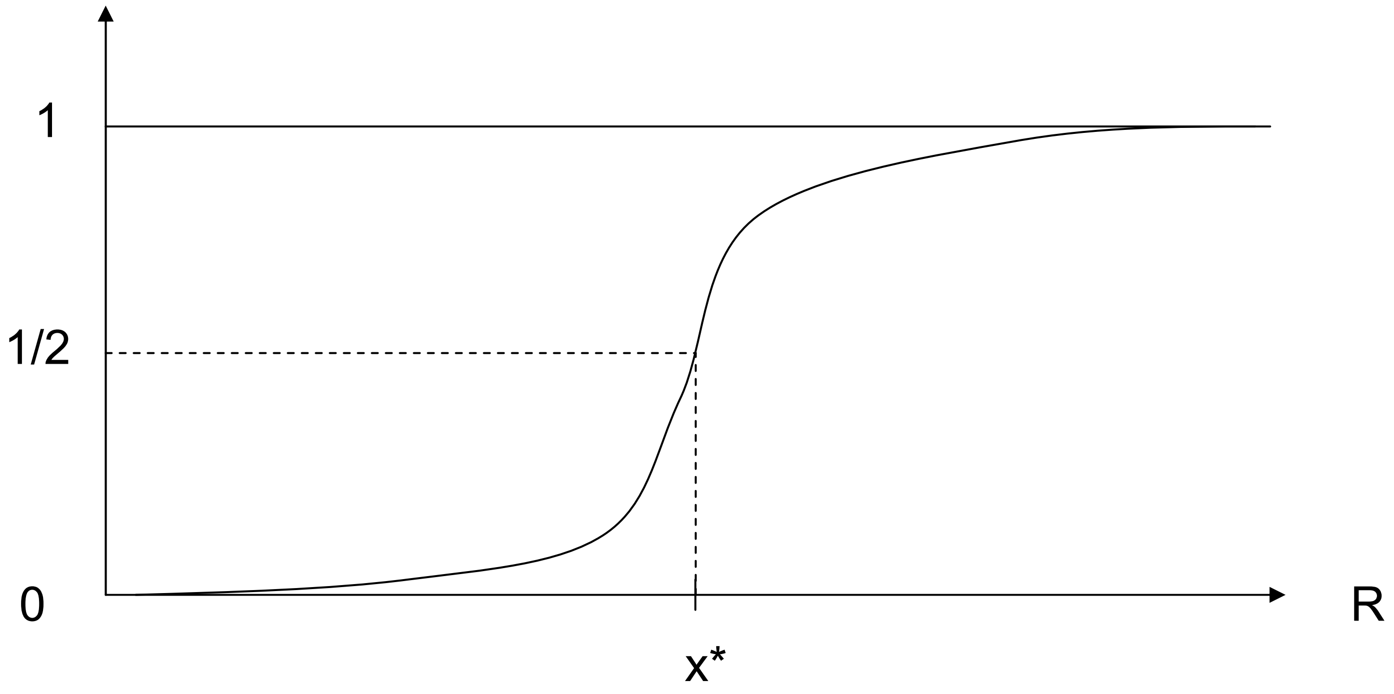
$$E\left(R\left[1-\Phi\left(\frac{x^*-R}{\sigma}\right)\right] \middle| x^i = x^* \right) = t$$

For $\sigma^2 \to 0$, the equilibrium converges to $x^* = 2\,t$

“Global-game solution“

Speculative-attack game

Prob(player i attacks) = Prob($x^i > x^*$)



Experimental evidence

Heinemann, Nagel, Ockenfels (2006)

- Groups of N subjects simultaneously decide between two options A or B.

  Option A pays X Euro,

  Option B pays 15 € if at least K of the other N-1 group members opt for B and zero otherwise.

- X varies from 1.50 to 15 €. Other parameters see table.
- *k* = (K-1)/(N-1) = 1/3, 2/3, or 1

  k = proportion of *other* players needed for success with B

Group size	*k* = 1/3	*k* = 2/3	*k* = 1
N=4	K=2	K=3	K=4
N=7	K=3	K=5	K=7
N=10	K=4	K=7	K=10

- Each group plays 30 coordination games without feedback (plus ten lottery choices). In the end one game is selected randomly for payoffs.

Experimental evidence

Example: group size N = 7, k =2/3 => K=5

Situation number	Payoff if you decide for A	Your decision		Payoff if you decide for B
		A	B	
11	1.50	○	○	in situations 11 – 20: 0 Euro, if less than **K = 5** members of your group decide for B. 15 Euro, if at least **K = 5** members of your group (including yourself) decide for B
12	3.00	○	○	
13	4.50	○	○	
14	6.00	○	○	
15	7.50	○	○	
16	9.00	○	○	
17	10.50	○	○	
18	12.00	○	○	
19	13.50	○	○	
20	15.00	○	○	
				OK

Experimental evidence

Typical behaviour: threshold strategy

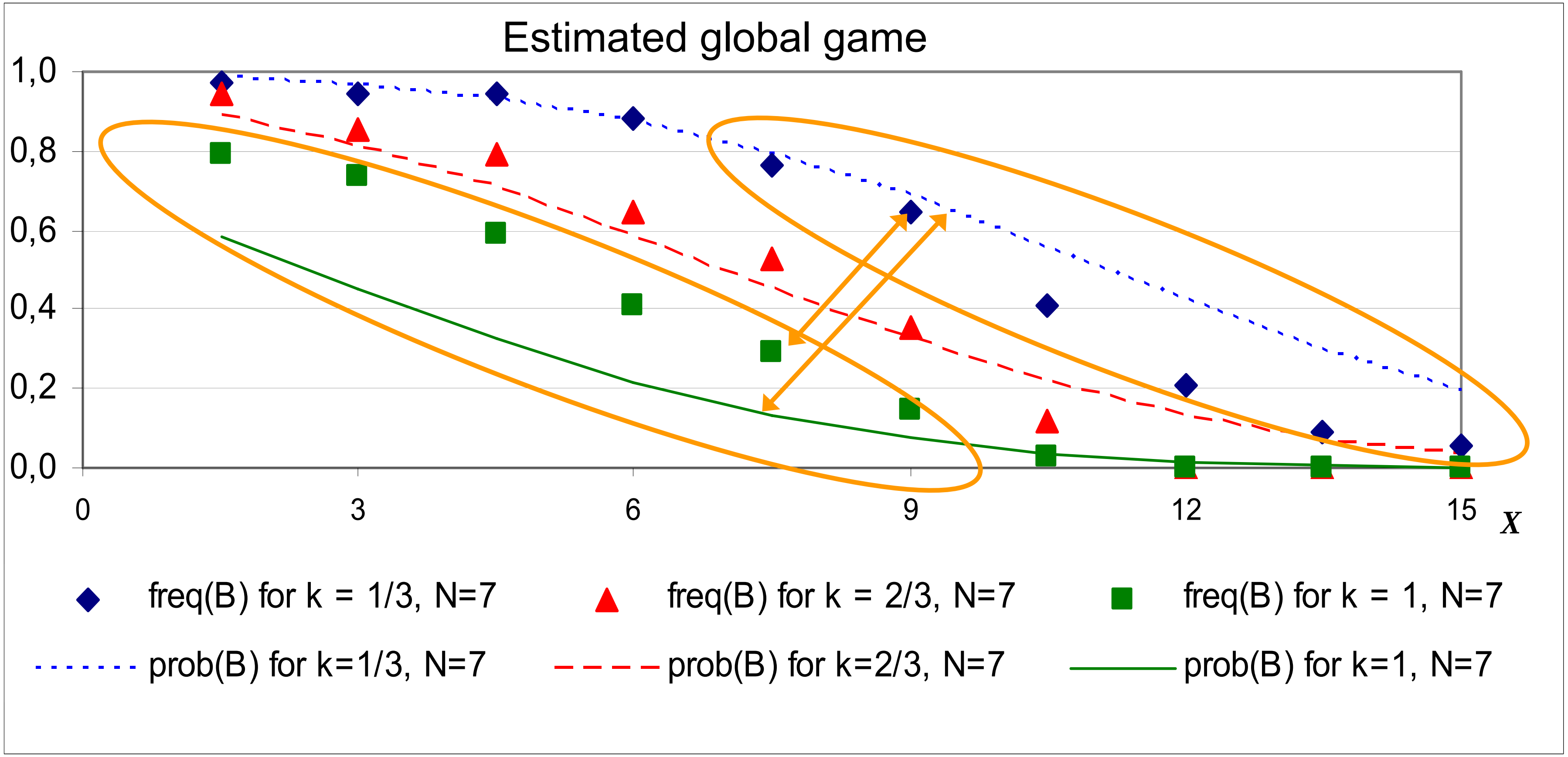
Situation number	Payoff if you decide for A	Your decision		Payoff if you decide for B
		A	B	
11	1.50	○	⊗	in situations 11 – 20: 0 Euro, if less than **K = 5** members of your group decide for B. 15 Euro, if at least **K = 5** members of your group (including yourself) decide for B
12	3.00	○	⊗	
13	4.50	○	⊗	
14	6.00	○	⊗	
15	7.50	○	⊗	
16	9.00	○	⊗	
17	10.50	⊗	○	
18	12.00	⊗	○	
19	13.50	⊗	○	
20	15.00	⊗	○	
				OK

Estimating the theory of global games

- assume that payoffs from option B are 15+y if at least *K* players decide for B and y otherwise, where y is a random variable. The true game (with y=0) is selected randomly from the class of all games with $y \in R$.
- Subjects behave as if they have private information on y.
- Prior distribution of y: uniform on the reals
- Private signals x_i: normal around y=0 with variance σ^2.

○

	Frankfurt	Barcelona	Köln	Bonn
σ	4.496	8.636	4.825	5.92
α	- 0.0086	- 0.0649	- 0.0678	- 0.054
Loglikelihood (LL)	- 1546.789	- 366.831	- 1080.934	- 499.035
Number of observations	3630	660	2460	1020
Average LL	- 0.426	- 0.556	- 0.439	- 0.489



Dots represent observed relative frequencies of B-choices. Curves indicate the probabilities of B-choices in the estimated global-game equilibrium for *N* = 7 in Frankfurt.

- General patterns: for *k* = 1 the theory underpredicts the actual frequency of B.
- For *k* = 1/3 and *X* > 9, the theory predicts a higher proportion of B-choices.
- Changes in *k* (and *N)* have smaller effects on observed choices than predicted by the theory.

Theory of Global Games

Applications:

- currency crises (Morris/Shin 1998, 1999, Corsetti et al. 2004)
- banking crises (Rochet/Vives 2004, Goldstein/Pauzner 2005)
- twin crises (Goldstein 2004)

Model without pure strategic complementarity

- contagion (Keister 2006)
- network externalities (Fukao 2003, Angeletos/Pavan 2004)
- increasing returns to scale (Karp 2000)
- refinancing firms in distress (Hubert/Schäfer 2002)
- competition between stock exchanges (Dönges and Heinemann 2001)

Impact of information precision on equilibrium (Heinemann/Illing 2002, Hellwig 2002a, Metz 2002, Bannier/Heinemann 2005)

-> distinction between public and private information!

Theory of Global Games

Equilibrium for vanishing variance of private signals (Heinemann 2000, Frankel/Morris/Pauzner 2003)

Alternative modelling approach: uncertainty about risk aversion (Hellwig 2002b)

Empirical tests of hypotheses about effects of information precision (Bannier 2006, Prati/Sbracia 2002)

Experimental evidence (Cabrales/Nagel/Armenter 2003, Heinemann/Nagel/Ockenfels 2004, 2006, Schmidt et al. 2003, Cornand 2006)

○ **Distinction between public and private information**

- effects on financial markets / overreactions (Shin and co.)
- New Keynesian models (Angeletos/Pavan 2004, …)
- Welfare effects of public information (Morris/Shin 2002, Cornand/Heinemann forthcoming in *EJ*)

Welfare Effects of Public Information

Morris and Shin (2002): agents $i \in [0,1]$

Simultaneously decide on activities a_i

Payoff function

$$u_i(a,\theta) \equiv -(1-r)(a_i-\theta)^2 - r\left(L_i - \overline{L}\right)$$

$$L_i \equiv \int_0^1 (a_j - a_i)^2 \, dj \qquad \overline{L} \equiv \int_0^1 L_j \, dj$$

a_i = activity of agent i. θ = fundamental state

L_i = individual loss from uncoordinated activities

$\overline{L}$ = for an individual: exogenous

Each agent has an incentive to choose an action close to average action of others

Welfare Effects of Public Information

Welfare function

$$W(a,\theta) \equiv \int_0^1 u_i(a,\theta)di = -(1-r)\int_0^1 (a_i-\theta)^2 di$$

Coordination per se is not welfare improving (beauty contest).

- ○ Information: agents receive two kinds of signals

  private signal $x_i = \theta + \varepsilon_i$, public signal $y = \theta + \eta$.

  Error terms are mutually independent.

  $$\varepsilon_i \sim N(0,1/\beta) \qquad \eta \sim N(0,1/\alpha)$$

  α and β are the precisions of public and private information.

- ○ **Morris and Shin (2002) show:**
  if precision of public information is limited $\alpha \leq \alpha^{\max}$,
  it may be better not to disclose public information at all.

Welfare Effects of Public Information

Assume that the public signal is given to each agent with some probability P.

$\Rightarrow$ A fraction P of all agents has two signals x_i and y.

$\Rightarrow$ A fraction $1-P$ of all agents has only the private signal x_i.

Signal is common knowledge among those who get it. It is common P-belief among all agents.

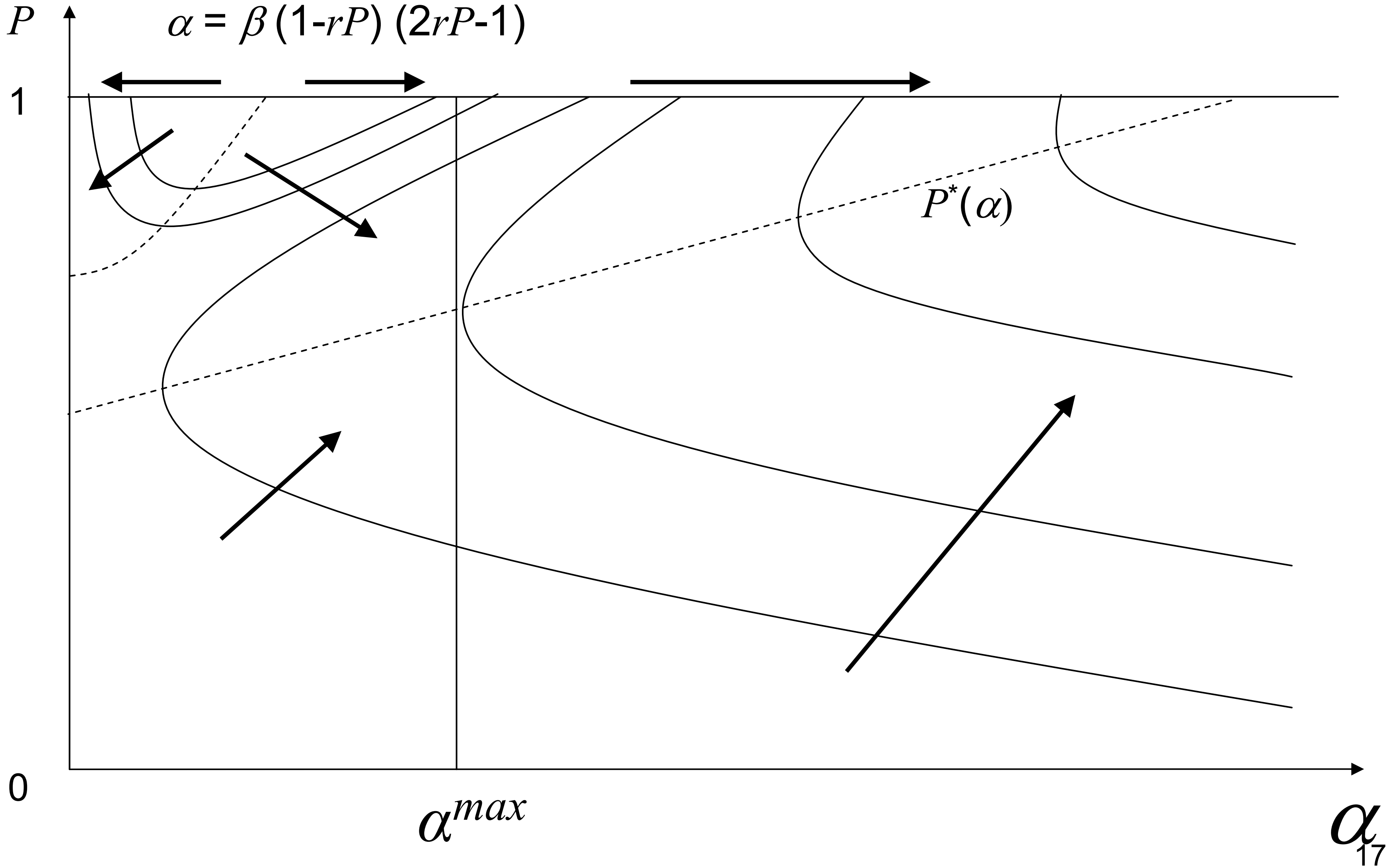
Call P the degree of publicity.

Cornand/Heinemann (forthcoming) show:
optimal policy requires providing public information with maximum precision but eventually not to all agents.

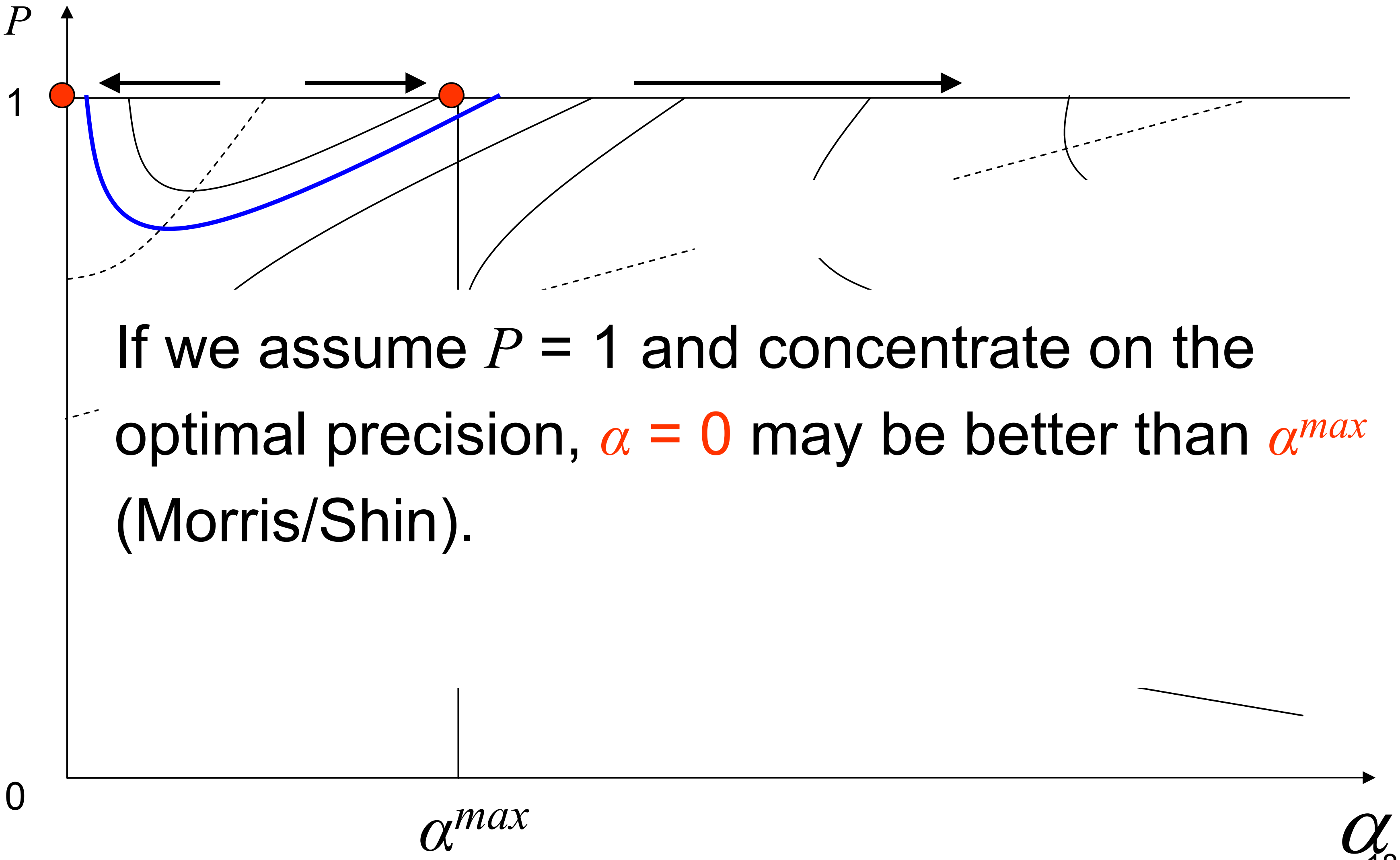
Maximizing expected welfare w.r.t. $0 \leq P \leq 1$ and $\alpha \leq \alpha^{\max}$ yields

$$\alpha^* = \alpha^{\max} \qquad P^* = \min\left\{1, \frac{\alpha^{\max}+\beta}{3r\beta}\right\}$$

Expected Welfare

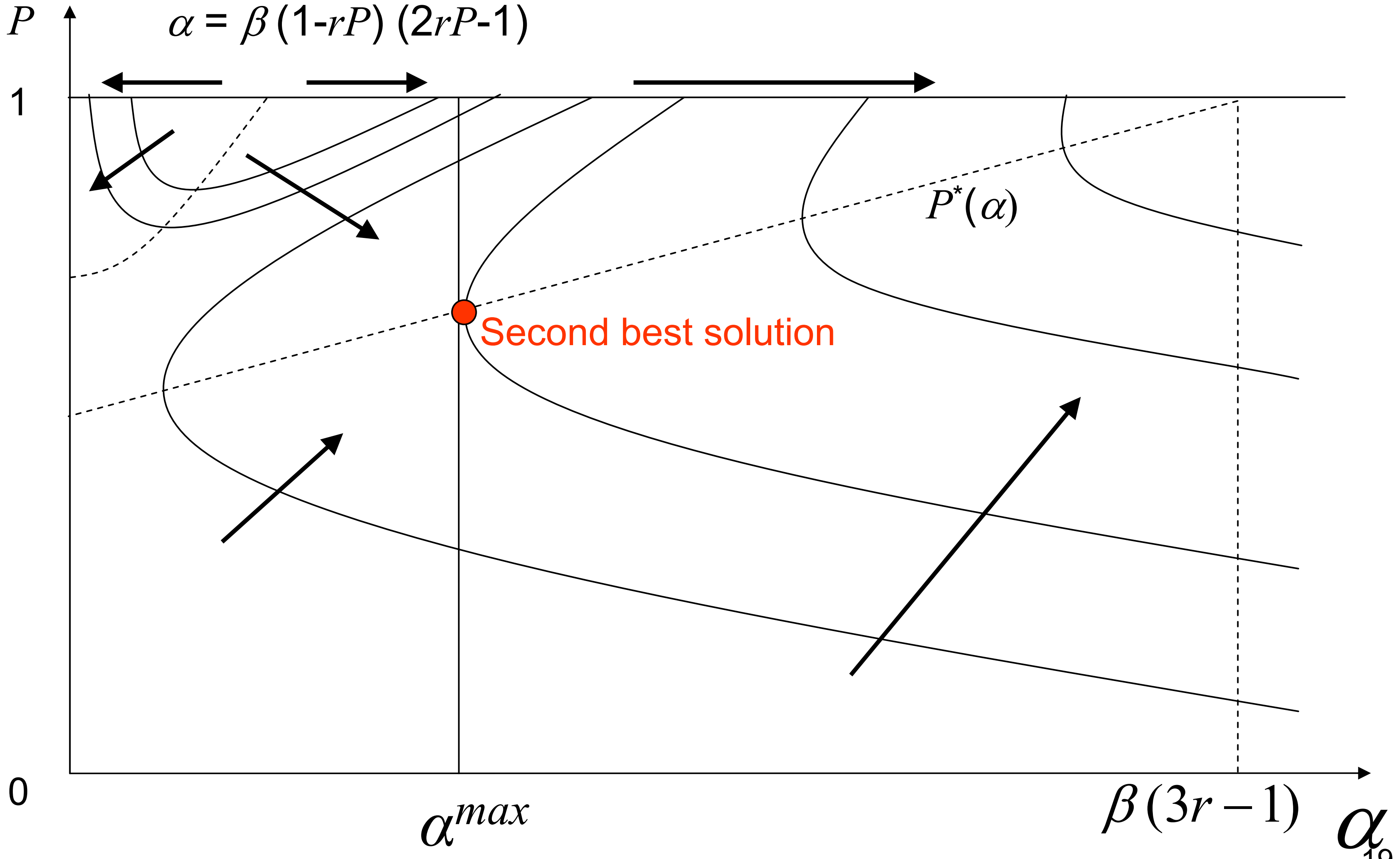


Expected Welfare



If we assume P = 1 and concentrate on the optimal precision, $\alpha = 0$ may be better than α^{max} (Morris/Shin).

Expected Welfare



Macroeconomic Consequences of Strategic Uncertainty

Research questions:

- Calculating the global-game solution

  Binary-choice games: in the limit, as variance of private signals approaches zero, each player behaves as if the proportion of other players taking either action has a uniform distribution

How can this rationale be extended to games with more than two possible actions?

(In search of an easy and intuitive way of calculating equilibria)

Macroeconomic Consequences of Strategic Uncertainty

Research questions:

- Theory of global games competes with other concepts of modelling strategic uncertainty (risk dominance, uncertainty about risk aversion, quantal response equilibria, non-additive subjective probabilities).

Is uncertainty (plus private information) about others players‘ payoffs/beliefs/information sufficient for uniqueness?

Which testable hypotheses distinguish these theories?

What do they imply for the outbreak of currency crises?

Which theory performs best in laboratory experiments?

Macroeconomic Consequences of Strategic Uncertainty

Research questions:

- Overlapping-generations economy

  Can we resolve multiplicity of equilibria?

  What is a rational bubble given private information about fundamental value?

- Optimal disclosure of information by the central bank

  Effects of public and private information, degree of publicity (common-p-beliefs)

  Price adjustment under monopolistic competition
  (New Keynesian Macroeconomics)

  Currency Crises

Macroeconomic Consequences of Strategic Uncertainty

- Simultaneous decisions (one-shot games)

- Sequential decisions
  - multiple equilibria even with private information
  - theory is less developed
  - explorative experiments and simulations

general observation: herding effects

Unresolved: when do attacks occur?

Macroeconomic Consequences of Strategic Uncertainty

Sequential decisions

players decide one after another

(i) in a preset order

(ii) each agent may decide anytime

a) entry games (investing in network goods)

b) switching games (currency crises, portfolio choice)

(ia) multiple continuation equilibria depending on signals of agents who decide first (Chamley 2003, Costain 2003)

region of multiple equilibria rises in the probability of observing predecessors

Macroeconomic Consequences of Strategic Uncertainty

Sequential decisions

(iia) Currency attack game (Heinemann/Ockenfels, work in progress). Players may enter anytime.

If the number of players meets a hurdle, devaluation occurs.

Motives to wait: gathering information from others‘ decisions, lower strategic risk if other players are „in“ already.

Motives to enter early: signalling to others,
preemptive game: once develuation occured, the game is over. Players may come too late!
(no pure strategic complementarity)

Payoffs vary over time (increasing or decreasing) to balance these effects.

Goal: assign monetary values to the above motives.

Macroeconomic Consequences of Strategic Uncertainty

Sequential decisions

(iib)

– the price of an asset rises for exogenous reasons and leaves behind the fundamental at some random point in time t_o. It is CK that the price collapses to the fundamental at t_o+t^*, where t^* is CK but t_o is not. An agent should sell just before a critical mass of sales is reached
(Abreu/Brunnermeier 2003, Brunnermeier/Morgan 2006)

Result: Agents wait a fixed amount of time after receiving their signal. This delay is the shorter the better their signal.

=> Occurence of bubbles and crashes related to information structure.

Macroeconomic Consequences of Strategic Uncertainty

Sequential decisions

(iib)

- deteriorating fundamentals (Cheung/Friedman 2006)

  more information and/or presence of a large trader lead to an earlier sale (attack)

- random evolution of fundamentals (Angeletos/Hellwig/Pavan 2006)

  fundamentals determine whether an attack occurs but not when (multiple equillibria)

  sudden outburst of attacks reveals private info. Equilibrium dynamics can alternate between phases of distress (attacks) and tranqil times without attacks.

Macroeconomic Consequences of Strategic Uncertainty

Research Questions:

Agents may observe predecessors

Observable decisions reveal private information

- signalling effect triggers herding behaviour

Equilibrium uniqueness requires uncertainty.

- Previous decisions reveal information and reduce uncertainty
- Shocks to payoff function create new uncertainty

How big must the variance of shocks be in order to prevent multiplicity of equilibria?

Does a faster flow of information raise the probability of entering a parameter region with multiple equilibria?

Optimal dissemination of information by central banks?

Macroeconomic Consequences of Strategic Uncertainty

Research Questions:

How do subjects react to decisions of others in the lab?

Is the relation between variances of private signals and shocks that is theoretically needed for uniqueness also needed in the lab?

Can limited levels of reasoning explain the difference (if any) between theoretical results and observed behaviour?

How are the incentives to wait for new information and to run early for signalling affected by the structure of payoffs and information?

Macroeconomic Consequences of Strategic Uncertainty

Research project:

2 focus areas: simultaneous games, sequential games

Applications to currency crises and
monetary policy in a New Keynesian framework

Methods: formal equilibrium analyses and experiments

Required funds:

2 research assistants (endowed with 1/2 BAT IIa)

2 student assistants (Hiwis) (each with 10 hours per week)

Hard- and software	~	8.000 €
Experiments	~	9.000 € p.a.