

Experimentally Grounded Social Simulation

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GECS Research Group on Experimental and Computational Sociology

The Research Group on Experimental and Computational Sociology (GECS), based in the Department of Social Sciences at the University of Brescia, is a group of social scientists who believe that computational and experimental capacity to understand social and economic phenomena. It is informally operating since 2002, and formally established in 2007. GECS aims at promoting innovative analytical approaches and methods in the social sciences in Italy. The group firmly believes in the added value of modelling, formalisation, computer simulations and laboratory experiments for the advance of the scientific progress in sociology. GECS operates through personal participation in research projects, organisation of scientific events, as well as training and education initiatives for PhD. students and young scholars.

Members

Riccardo Boero (Computational and Experimental Economics)
[Giangiacomo Bravo](#) (Experimental Sociology and Social Simulation)
[Marco Castellani](#) (Cognitive Sociology)
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Socrate Laboratory Experiments 2007



- Improving the realism of ABMs
- Cross-fertilizing experimental and social simulation methods
- Examples: on partner selection and trust in social networks (Boero, Bravo and Squazzoni 2010) and reputation on markets (Boero et al. 2010)
- Drawing insights on:
 - ✓ **ABMs that support/extend Lab; Lab that tests ABMs; ABMs that guide/inform Lab**
- Emphasizing pros and cons
 - Boero et al. (2010) Why Bother with What Others Tell You? An Experimental Data Driven Agent-Based Model. JASSS, 13(3), 6: <http://jasss.soc.surrey.ac.uk/13/3/6.html>.
 - Boero , Bravo and Squazzoni (2010b) Trust and Partner Selection in Social Networks: An Experimentally Grounded Model, arXiv:1008.4705v1 [physics.soc-ph]: <http://arxiv.org/abs/1008.4705>

- ❑ ABM advantage is to offer a more realistic picture of human behaviour and interaction, against game theory, rational choice models and traditional social network models
- ❑ However, most social simulation models now differ from conventional models in that they theoretically speculate in other directions
- ❑ No integration with empirical research: the promise of making social simulation the 'real' experimental branch of social sciences
- ❑ This created a gap between theory and empirical research which mimics the roads taken by analytic traditions

- ❑ Empirical methods in the social sciences do not always guarantee clean and/or suitable data to look at social interaction
- ❑ Both the lab and ABMs explicitly model agent interaction
- ❑ Experiments focus on the same kind of interaction situation which is modelled with ABMs, whereas this is impossible in the social reality
- ❑ The lab can be easily used as a data generator mechanism for ABMs or as a test bed for simulation findings (Duffy 2006)
- ❑ Duffy (2006) Agent-Based Models and Human Subject Experiments, *Handbook of Computational Economics*, in: Leigh Tesfatsion & Kenneth L. Judd , Vol. 2 (Amsterdam: Elsevier, 2006), pp. 949-1011.



- ❑ Boero, Bravo and Squazzoni (2010): Trust and Partner Selection in Social Networks: An Experimentally Grounded Model, arXiv:1008.4705v1 [physics.soc-ph]: <http://arxiv.org/abs/1008.4705>
- ✓ ABM was used to extend lab findings
- ✓ ABM helped to draw implications about social networks for cooperation
- ✓ Simulation findings revealed social mechanisms to be tested in the lab
- ❑ Boero et al. (2010) Why Bother with What Others Tell You? An Experimental Data Driven Agent-Based Model. JASSS, 13(3), 6: <http://jasss.soc.surrey.ac.uk/13/3/6.html>.
- ✓ Lab was used as controlled observation to build ABM
- ✓ ABM was used to understand implications from observation

- ❑ Cooperation has to do with the selective intelligence of agents when they give rise to networks based on people who like each other: good preferential choices and incentives to reliability to avoid isolation (Ashlock 1996; Joyce 2006)
- ❑ Two sides: uncertainty makes long-term interaction partners look more attractive (Kollock 1994; Podolny 2001, Berkman 2004); trustworthiness and reliability signals (Molm 2000)
- ❑ It is not the “continuity” of interaction that explains cooperation (Axelrod 2002; Cohen 2001), but the capability of agents of selecting their partners and changing network shapes
- ❑ Ashlock et al. (1996) Preferential Partner Selection in an Evolutionary Study of Prisoner’s Dilemma. *BioSystems*, 37, 99-125. Joyce et al. (2006) My Way or the Highway: A More Naturalistic Model of Altruism Tested in an Iterative Prisoner’s Dilemma, *JASSS* 9(4).
- ❑ Beckman et al. (2004) Friends or Strangers? Firm-Specific Uncertainty, Market Uncertainty, and Network Partner Selection, *Organization Science*, 15(3), 259-275. Kollock (1994) The Emergence of Exchange Structures: An Experimental Study of Uncertainty, Commitment, and Trust, *AJS*, 100(2), 313-345. Molm et al. (2000) Risk and Trust in Social Exchange: An Experimental Test of a Classical Proposition. *AJS*, 105(5), 1396-1427. Podolny (2001) Networks as the Pipes and Prisms of the Market. *AJS*, 107, 33-60.
- ❑ Axelrod, Riolo and Cohen (2002) Beyond Geography: Cooperation with Persistent Links in the Absence of Clustered Neighborhood, *Personality and Social Psychology Review*, 6(4), 341-346. Cohen, Riolo and Axelrod (2001), The Role of Social Structure in the Maintenance of Cooperative Regimes, *Rationality & Society*, 13, 5-32.

- ❑ Experimental studies took into account only stylized and highly unrealistic interaction structures, e.g., random coupled subjects (Berg 1995; Boero et al. 2009)
- ❑ Simulation studies and formal models are not seriously based on experimentally verified assumptions (Cohen 2001; Pujol 2005)
- ❑ Removing these mutual limitations by combining the two methods
 - ❑ Berg et al. (1995) Trust, Reciprocity and Social History. *Games and Economic Behavior*, 10, 122-142.
 - ❑ Boero et al. (2009) Reputational Cues in Repeated Trust Games, *Journal of Socio-Economics*, 38(6), 871-877
 - ❑ Cohen, Riolo and Axelrod (2001), The Role of Social Structure in the Maintenance of Cooperative Regimes, *Rationality & Society*, 13, 5-32. Pujol et al. (2005) How Can Social Networks Ever Become Complex? Modelling the Emergence of Complex Networks from Local Social Exchanges. *JASSS*, 8(4), 12.

- 108 participants, 6 groups of 18 subjects (Brescia and Cuneo), 10 rounds, about 15 Euros

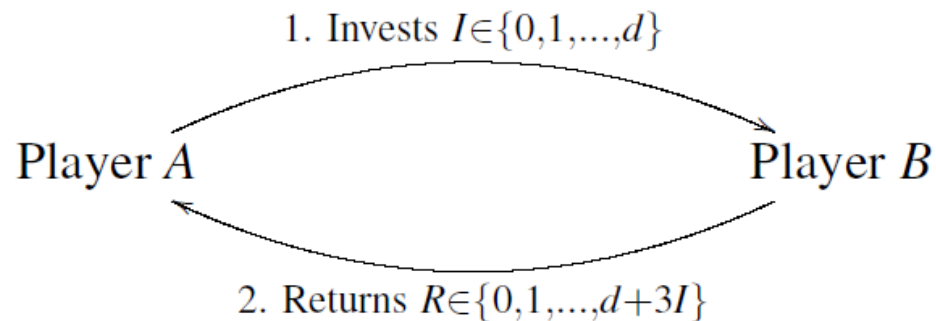


Figure 1: The investment game: player A profit = $d - I + R$; player B profit = $d + 3I - R$.

We used these experimental data to calibrate an ABM that reproduced the behavior of the subjects. With regards to *A* players, we estimated a coefficient β_i that indicated how much the player modified his/her investment in each period as a function of the difference between the amount invested and the amount received by *B* players in the previous period.

For any player *i* and period *t*, we computed the difference $X_{it} = R_i - I_i$, where I_i and R_i were the amounts that *i* invested and received as return from his/her investment in the previous period respectively. We subsequently fitted the model

$$Y_{it} = \alpha_i + \beta_i X_{it} + \varepsilon \quad (1)$$

where Y_{it} was the amount invested by player *i* in period *t*, in order to obtain two parameters α_i and β_i for each subject that defined his/her behavior as *A* player. The equation (1) took into account that *A* players could have had an individual constant propensity to trust represented by the individual intercept α_i , but also the capability of reacting upon past experiences, which was captured in the β_i coefficient.

On the other hand, *B* players were supposed to react mainly against what they received from *A* players. In order to capture their behavior, we estimated a third coefficient γ_i defined as the average amount returned by each subject as proportion of the amount received in each period plus the fixed endowment. Therefore, the parameter γ_i represented an estimate of the player's trustworthiness.

We were able to successfully estimate the parameter for 105 out of the 108 subjects that participated in the experiment. Figure 2 presents the distribution of the estimated coefficients. It is worth noting that, while β_i did not significantly correlate with the other parameters, the correlation between α_i and γ_i was significant and positive ($r = 0.44$, $p < 0.001$). In other terms, trustful subjects tended to be trustworthy as well: a result consistent with the hypothesis that agents who have a general propension toward cooperation tend to behave similarly also when the situation differs.

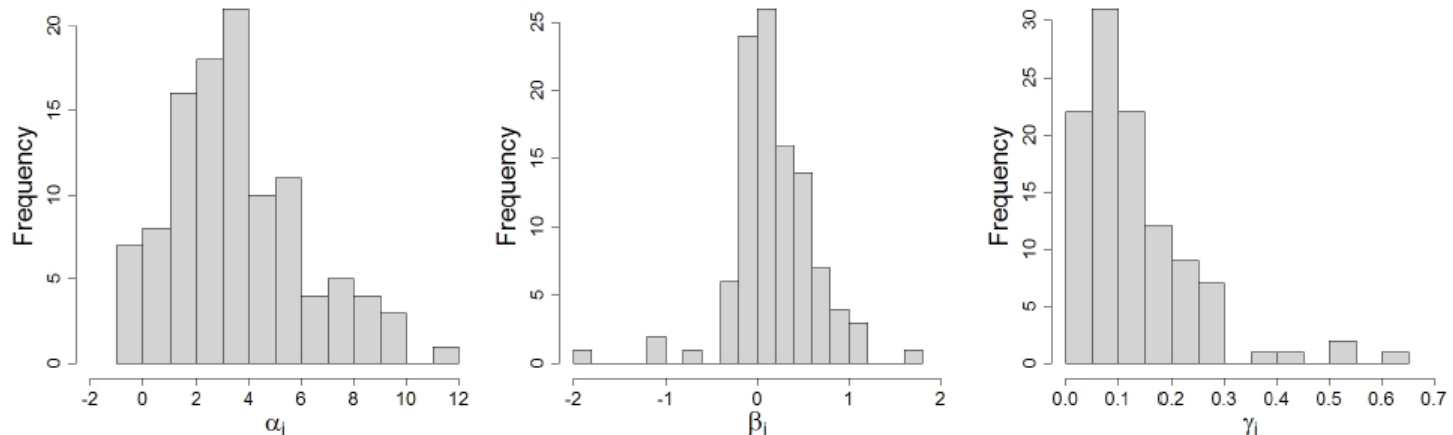


Figure 2: Distribution of the estimated coefficients

Model name	Main characteristics
<i>experimentLike</i>	<ul style="list-style-type: none"> • random coupling in each period • one way interaction
<i>twoWays</i>	<ul style="list-style-type: none"> • random coupling in each period • two way interaction
<i>fixedCouples</i>	<ul style="list-style-type: none"> • fixed couples • two way interaction
<i>denseNetwork</i>	<ul style="list-style-type: none"> • fixed fully connected network • two way interaction
<i>smallWorld</i>	<ul style="list-style-type: none"> • fixed small-world network • two way interaction
<i>scaleFree</i>	<ul style="list-style-type: none"> • fixed scale-free network • two way interaction
<i>dynamic1Couples</i>	<ul style="list-style-type: none"> • dynamic network • broken links are replaced only for isolated agents • two way interaction • start from random coupling
<i>dynamic1Dense</i>	<ul style="list-style-type: none"> • dynamic network • broken links are replaced only for isolated agents • two way interaction • start from dense network
<i>dynamic2Couples</i>	<ul style="list-style-type: none"> • dynamic network • broken links are replaced only by one of the two formerly linked agents • two way interaction • start from random coupling
<i>dynamic2k10</i>	<ul style="list-style-type: none"> • dynamic network • broken links are replaced only by one of the two formerly linked agents • two way interaction • start from from a regular network of degree 10

Threshold happiness function

From fully connected to random networks

Table 1: The simulation scenarios

Model name	Period 1–10		Period 11–20		Period 21–30	
	<i>A</i> invest.	<i>B</i> returns	<i>A</i> invest.	<i>B</i> returns	<i>A</i> invest.	<i>B</i> returns
<i>dynamic1Couples</i>	3.65 (2.58)	2.92 (2.96)	3.67 (2.60)	2.95 (2.90)	3.68 (2.62)	2.96 (2.93)
<i>dynamic1Dense</i>	3.79 (2.67)	3.32 (3.20)	3.66 (2.60)	2.96 (2.96)	3.68 (2.62)	2.97 (2.94)
<i>dynamic2Couples</i>	3.82 (2.68)	3.37 (3.42)	4.48 (3.01)	5.02 (4.50)	4.63 (3.11)	5.58 (5.12)
<i>dynamic2k10</i>	4.11 (2.82)	4.00 (3.59)	4.43 (3.01)	4.85 (4.30)	4.49 (3.04)	5.02 (4.50)
Experiment	3.48 (2.69)	2.79 (3.58)	–	–	–	–

Table 4: Average investments and returns in the original experiment and in the dynamic network models. Standard deviations are in parenthesis. Averages significantly different (at the 10% level) from the experimental ones are marked in bold.



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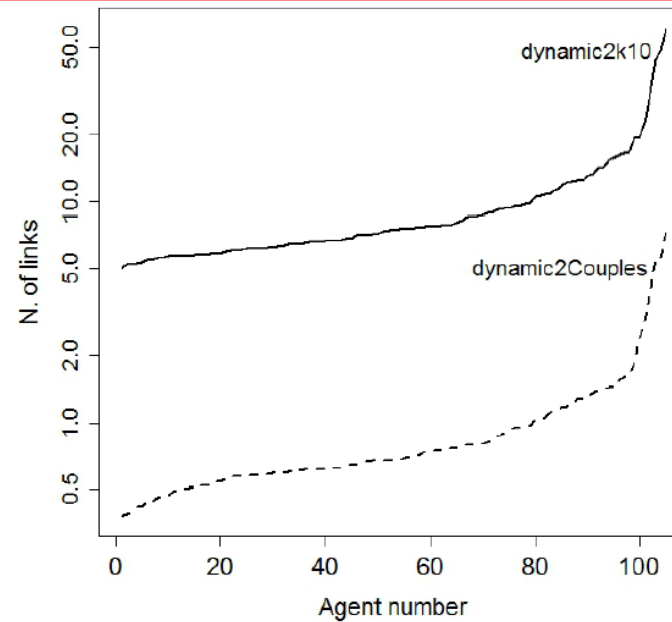


Figure 5: Average number of links per agent in the *dynamic2Couples* and *dynamic2k10* models.

- ❑ Dynamic networks made the difference: it is not the structure that matters but the isolation of free riders which promotes cooperation
- ❑ Relevance of clusters between cooperators who have more links/interactions and achieve higher payoffs
- ❑ This confirms Eguiluz' findings (2005): agents in central positions have more links and play an essential role in sustaining cooperation in the system
- ❑ Eguiluz et al. (2005) Cooperation and the Emergence of Role Differentiation in the Dynamics of Social Networks. *AJS*, 110(4), 977-108

- ❑ How does reputation affect, at the micro level, the economic performance of agents in uncertain environments and, at the macro level, the exploration capability of the system?
- ❑ Comparing social systems where agents are atomized entities that rely only on their individual capabilities/experience and systems where agents can rely on reputation mechanisms

- ❑ 64 subjects, 38 females / 26 males, two days, October-November 2007
- ❑ The FTB Game: exploring an uncertain solution space (e.g., financial market)
- ❑ 17 rounds (end unknown)
- ❑ Initial endowment
- ❑ Final payoff



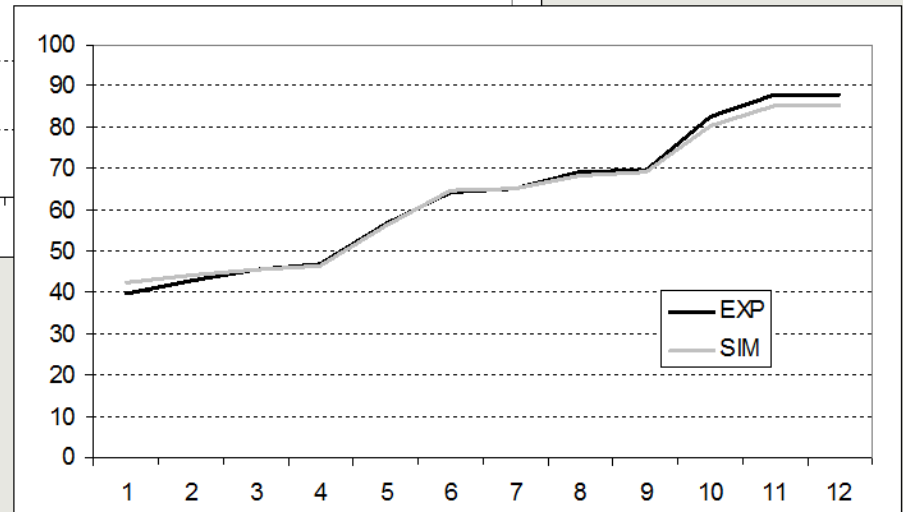
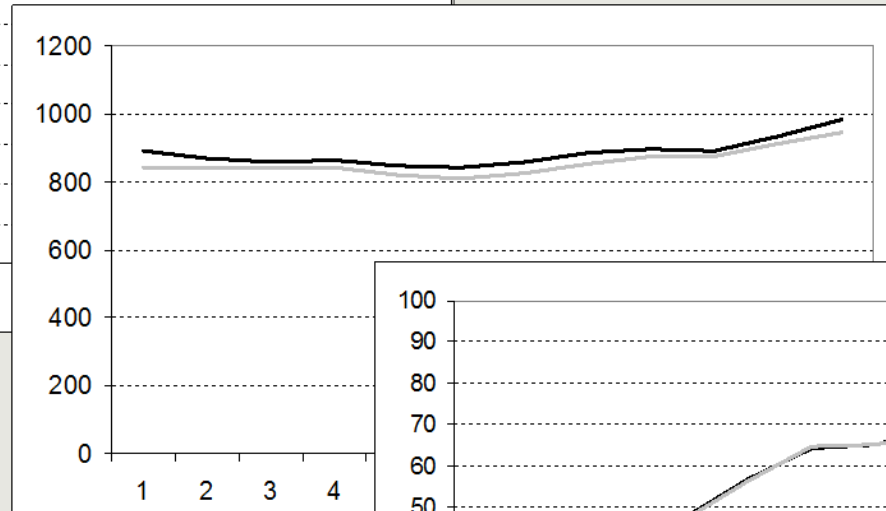
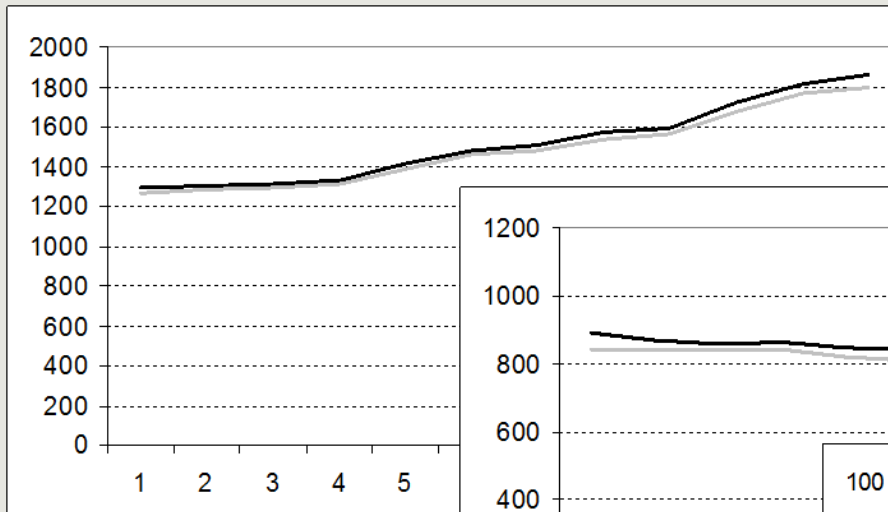
- Decision
 - ✓ Exploration via random search
 - ✓ Exploitation
 - ✓ Follow others' hints

- Communication
 - ✓ True yield (first best security)
 - ✓ True yield (second best security)
 - ✓ Lower yields
 - ✓ Higher yields



- If you trust, you explore, don't lie or reciprocate!
- Players who lie are those who don't trust and exploit!

	A1	A2	A3	Total
I1	12.50%	1.56%	12.50%	26.56%
I2	17.19%	4.69%	28.13%	50.00%
I3	1.56%	7.81%	14.06%	23.44%
Total	31.25%	14.06%	54.69%	100.00%



- ❑ The model consists of 100 agents, direct interaction between randomly paired agents, variability of yields, scarcity of resources
- ❑ Simulation runs were repeated 1000 times and results averaged

Simulation Parameters	Values
Agents	100
Securities	1 million
Standard deviation of yields' distribution	500
Initial Endowment	1000 ECU
Exploration cost	8000 ECU
Number of interactions	495

Base settings

- | | | |
|---|----------------|---|
| 1 | "exploit_only" | Pure exploitation: agents can only exploit securities randomly distributed at the beginning of the simulation |
| 2 | "explore_only" | Pure exploration: agents can only explore via a random search, when they have enough resources to do so |

No trustworthiness evaluation

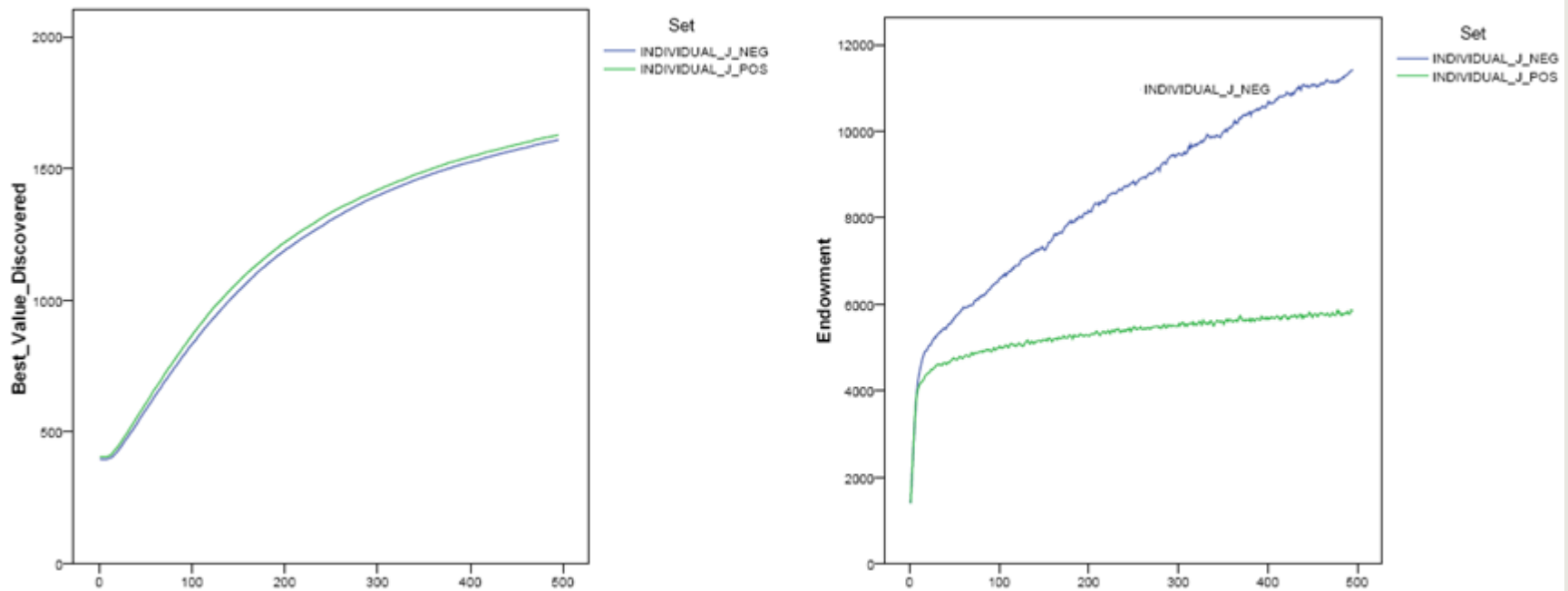
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|---|-----------------|---|
| 3 | "listen_always" | No trustworthiness evaluation: agents communicate information as observed in the experiment and trust everybody |
|---|-----------------|---|

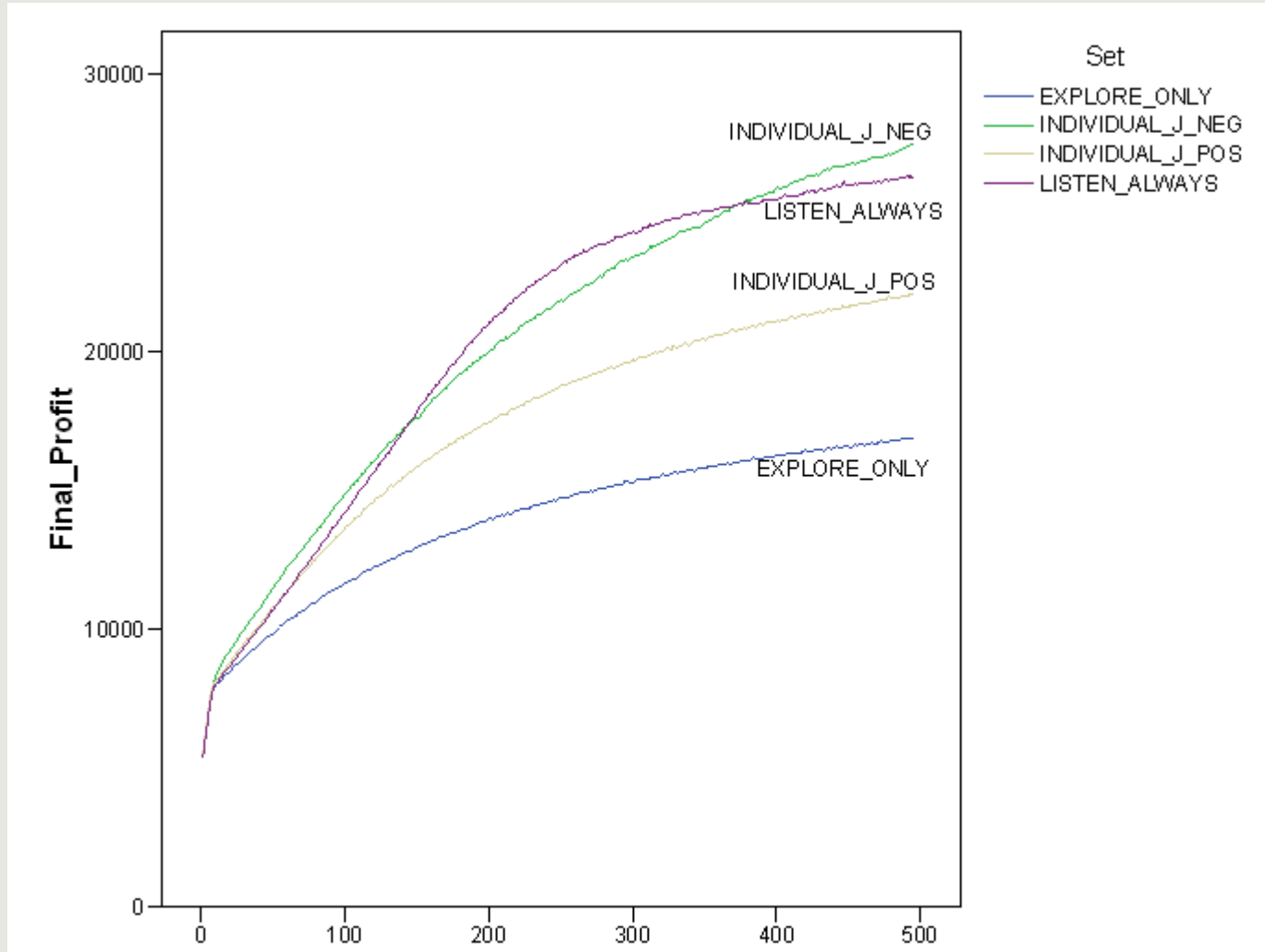
Trustworthiness evaluation at the individual level

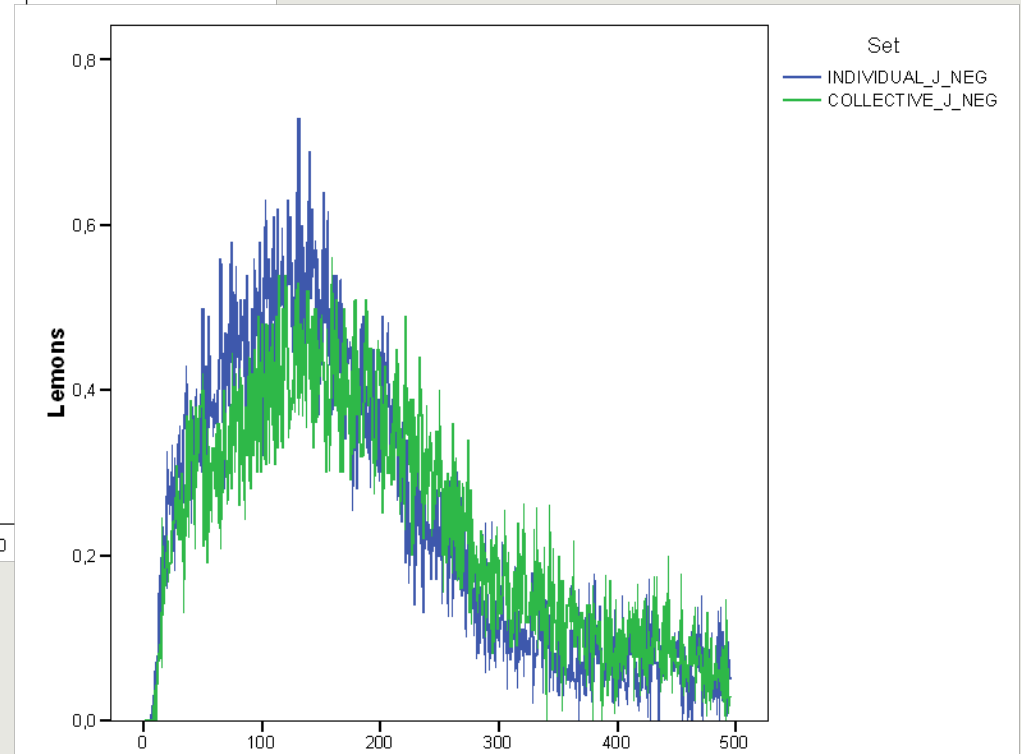
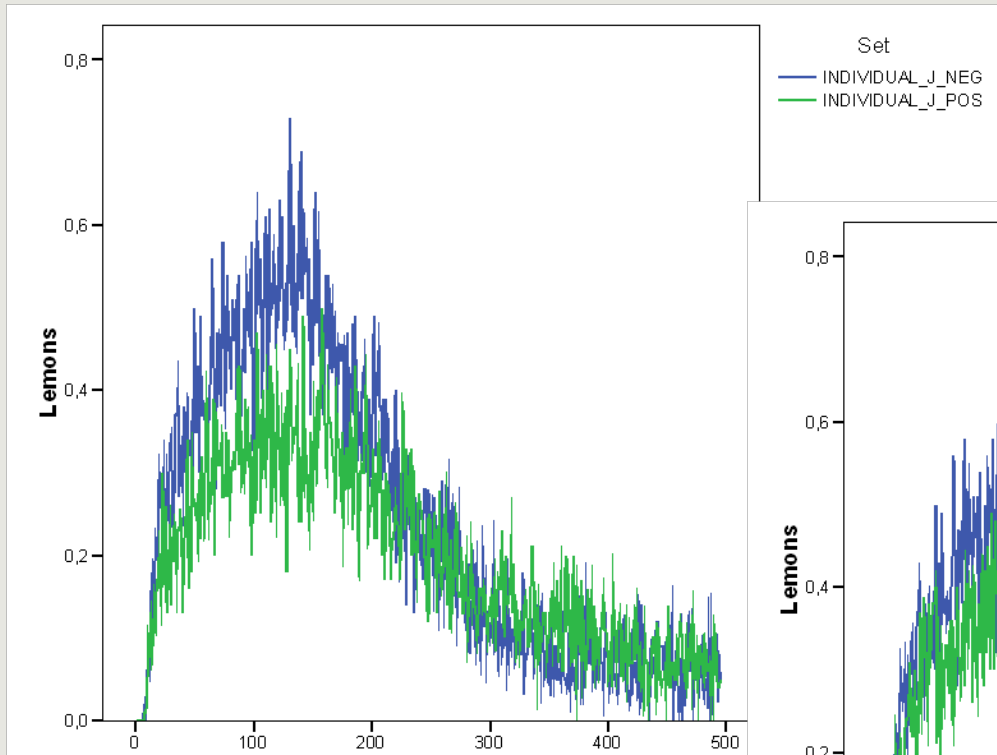
- | | | |
|---|--------------------|---|
| 4 | "individual_J_pos" | Agents explore partners' trustworthiness without sharing any personal experience with others and with a "positive attitude" towards unknown partners (presumption of partner trustworthiness) |
| 5 | "individual_J_neg" | Agents explore partners' trustworthiness without sharing any personal experience with others and with a "negative attitude" towards unknown partners (presumption of partner untrustworthiness) |

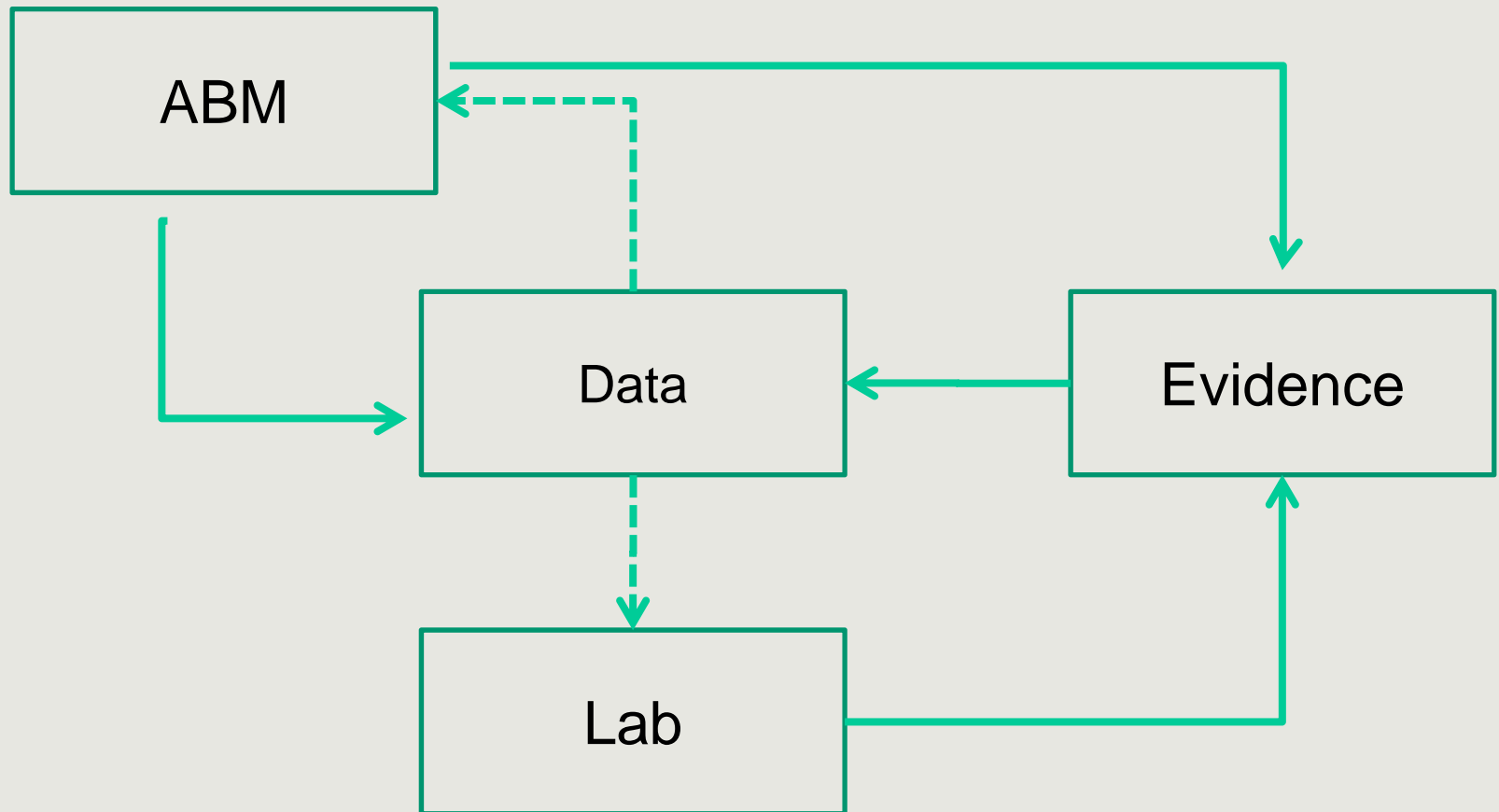
Trustworthiness evaluation is shared at the system level (reputation)

- | | | |
|---|--------------------|--|
| 6 | "collective_J_pos" | Agents know the partners' reputation (trustworthy/cheater) if any and follow a "positive attitude" towards unknown partners (presumption of partner trustworthiness) |
| 7 | "collective_J_neg" | Agents know the partners' reputation (trustworthy/cheater) if any and follow a "negative attitude" towards unknown partners (presumption of partner untrustworthiness) |



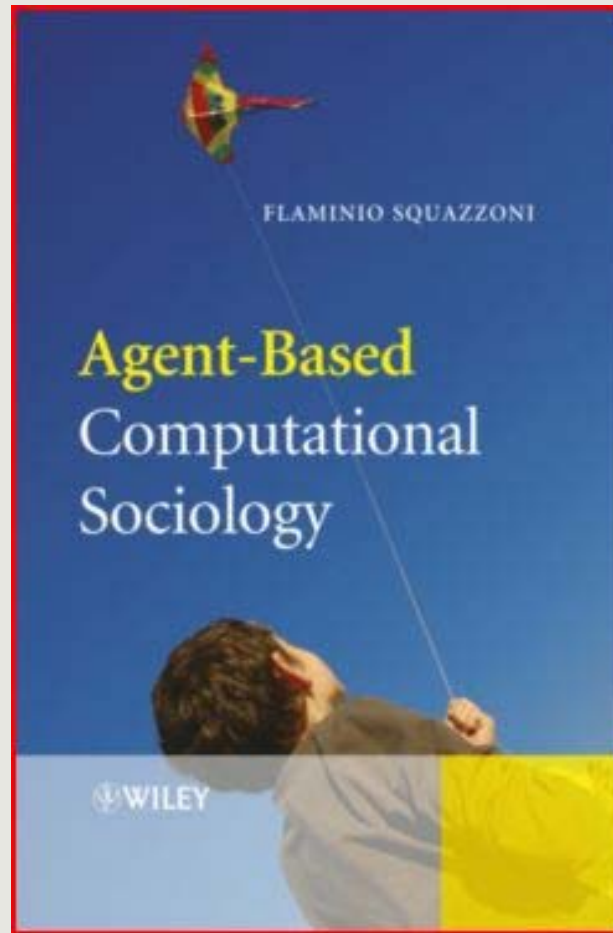






- Combining theory and empirical research: being guided by evidence rather than by speculation is crucial in social simulation
- Approaching micro-macro link issues in terms of scales helps to 'secularize' the debate
- Reducing the problem of external validity of experimental results, by helping to achieve finding generalisation between scales (as in all branches of experimental sciences)
- Making result falsification possible

- This type of research is time/money/labour consuming and is risky (need for lab facilities, humans escape any prediction, even in the lab!)
- The balkanization: the challenge of sharing lab data in the community is a big problem
- There are no standard which to rely on
- The challenge of external validity of experimental data



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Questions
are
guaranteed in
life;
Answers
aren't.