Experimental Economics
basic concepts and applications to NRM

Stefano Farolfi
Plan of the presentation

• Experiments in social sciences and in economics
• Methodology of experimental economics and open questions
• Case study
• Practical work: an economic experiment, debriefing
Experiment

- Procedure carried out to verify, refute, or establish the validity of a hypothesis.
- Experiments provide insight into cause and effect by demonstrating what outcome occurs when a particular factor is manipulated. => treatment
- Experiments always rely on repeatable procedure and logical analysis of the results.
- Experiments typically include controls, which are designed to minimize the effects of variables other than the single independent variable (x) on the dependent one (y). Internal validity of an experiment is the extent to which a causal conclusion based on a study is warranted.
Experimental journals in social sciences

• (Psychology)

• Sociology and Social psychology
  – Advances in Experimental Social Psychology (1964)
  – Journal of Experimental Social Psychology (1965)
  – Experimental articles in sociology journals (AJS), multidisciplinary and cognitive sciences journals, such as JASSS (1998)

• Economics
  – EE (1998)
  – Journal of Behavioural Economics (1972), then Journal of Socio Economics (until 2014), and Journal of Behavioural and Experimental Economics
  – Strategic Behaviour and the Environment (2010)

• Criminology

• Political sciences
  – Journal of Experimental Political Sciences (2014)
Experiments in economics scientific articles

• V. Smith (1962) ‘An experimental study of competitive market behaviour’, The journal of political economy, 70(2) 111-137

• Fewer than 10 experimental papers per year were published before 1965, which grew to about 30 per year by 1975.

• Starting from this low level, experimentation in economics greatly increased in the mid-1980s.

• Fraction of laboratory experimental papers in relation to all published papers (In the American Economic Review, Econometrica, and Quarterly Journal of Economics) :
  – From 0.84% to 1.58% in the 1980s,
  – From 3.06% to 3.32% in the 1990s,
  – From 3.8% to 4.15% between 2000 and 2008.
Experimental Economics$^2$

- Laboratory testing as a means of determining the validity of various economic theories
- Using cash motivated students
- Control
- Repetability
The purposes of experiments (Roth, 1995)

• Searching for facts
  – Isolating the cause of observed regularities
  – As a complement of other exploratory work

• Speaking to scientists
  – Testing theories

• Whispering to the ears of princes
  – Reproducing in lab/field real situations to test policies
Looking beyond Homo oeconomicus
Behavioural analysis
Looking beyond Homo oeconomicus

Experimental economics to model human behaviour

• Rationality (egoïsm, maximization of individual utility, self regarding agents)

• Game theory: Nash equilibrium

• Prisoner dilemma

• Iterated prisoner dilemmas
  – Public good games
  – CPR games

• Nash => cooperative equilibrium
Prisoner dilemma

<table>
<thead>
<tr>
<th></th>
<th>Silence</th>
<th>Confess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silence</td>
<td>2,2</td>
<td>0,3</td>
</tr>
<tr>
<td>Confess</td>
<td>3,0</td>
<td>1,1</td>
</tr>
</tbody>
</table>

Robbery = 3 years
Receiving stolen goods = 1 year

• In the laboratory
  – Nash when no communication, cooperative when communication
  – Possibility to cheap talk
  – Possibility to punish
  – => Reputation, reciprocation, TRUST
Experimental Economics: what is it?

**Objective**: reproduce an stylized economic situation in the laboratory

**Interest**:
1. To test theoretical models’ predictions.
2. To study the effect of certain variables whose impact is difficult to measure.
3. To explore ‘regularities’.
4. To formulate recommendations for decisionmakers.

**Where**: Laboratory (here the LEEM)
   Subjects (students, farmers...) and real remuneration

**Data analysis**: Statistics, econometrics
Two types of experiments

**Laboratory experiments:**
- Standard subjects, randomly selected, non experimented
- In a controlled environment: interactions through a computer network
- Main goal: experimental control to test theories
- Decontextualized protocols

**Field experiments:**
- Decontextualized experiments but with experimented subjects
- Contextualized experiments
- Natural ‘experiments’ *(subjects do not know they are taking part into an experiment)*
Internal validity, external validity

- Capacity to explain the causality between variables of a model
- Generalization of the results

Trade-off?

Low

- Natural data (field study)
  - Internal: low
  - External: high

Control

High

- Randomized Field Experiments
- Or Lab in the Field Experiments
  - Internal: high
  - External: low

Laboratory exp

Willinger (2005)
Experimental design

• Randomization (dividing line between experimental and non experimental research in social science: rule to explain why some subjects receive a treatment).
  – A research design is randomized when individuals (or schools or other units of investigations) are put into an ‘experimental group’ (which receives the intervention) or a ‘control group’ (which does not) on the basis of a random process like the toss of a coin. The power of this random assignment is that, on average, the two groups that result are initially the same, differing only in terms of the intervention.

• Between subjects
• Within subjects (order)
• Partner/stranger procedures
• Sample size (power analysis)
• Remunerating subjects
• Deception
A full experimental protocol

- Preliminary survey → Research Question(s)
- Hypotheses
- Protocol design
  - Model/Game
  - Treatments
  - Instructions
  - Sample
  - Remuneration/Budget
  - Electronic program for the Lab (Z-tree, Python, etc.)
- Experience in the Lab
  - Recruitment (random) of the subjects
  - Session(s)
  - Payment of subjects
  - Data collection
- Data processing (experimetrics)
  - Descriptive statistics
  - Tests of hypotheses (parametric, non-parametric)
  - Regressions (ex. panel data, when repeated games)
- Report/scientific paper
‘Experimetrics’

• Test of Hypotheses
  – Parametric (assumptions on the distribution of data)
  – Non Parametric (ex. Mann-Withney)
    • Null hypothesis (no effect)
    • p-value (probability of rejection of the null hypothesis)
    • p<0.1 = mild evidence; p<0.05 = evidence; p<0.01 = strong evidence; p<0.001 = overwhelming evidence

• Regression
  – Panel regression: \( y_{it} = \alpha + \beta'x_{it} + \gamma'z_i + u_i + e_{it} \)
    • Fixed effects
    • Random effects
Open questions (Falk-Heckman, 2009)

- Lab or field?
- Remuneration and stakes
- Sample size
- Students as participants
- Demand/Hawthorne effect
- Self-Selection bias
- => combining lab and field
- => complementarity with surveys/econometrics
Experimental economics and water management issues

• How to design and implement social experiments with stakeholders in order to understand and help to manage socio-hydrological dynamics in an interdisciplinary way

• We focus on the 2nd and 3rd objectives identified by Roth (1995)
Information provision and willingness to pay irrigation water in Tunisian local associations for agricultural development

S Farolfi, D Dubois, S Morardet, I Nouichi, S Marlet
Rationale

• Irrigated agriculture in Tunisia: importance in terms of food security and development
• Devolution, decentralisation, creation of local groups of farmers (GDA) WUAs
• Lack of recognition of the role of WUAs, lack of legitimacy as a real development tool for farmers
• Reticence to pay water fees by farmers
• IBs’ managers do not provide institutional information about IBs’ role and functioning to farmers.
Development question

A better information within WUAs and a systematic communication of the technical and financial results of the irrigation systems to the farmers would improve the commitment of farmers towards the institution and their WTP for the public good represented by the water provision services.
The four studied GDA

Silyena

Sousse (Sahel)
Results of the survey in the four associations

**Received information**

**Services provided**
Research question

« Institutional » information
« Social » information

Which relation of causality between « institutional » and « social » information provision and farmers’ WTP for water in a Tunisian IB?
Model underpinning the game

\[ \pi_i(g_i, G) = 10 - g_i + \varphi_i(r_i) \]

\[ r_i = \left( \frac{g_i}{G} \right) \times R(G) \]

Farolfi et al., 2018, adapted from: Janssen et al. (2011)
Treatments

We introduce progressively information into a baseline treatment where the only information is about individual items

- **T0** (info on individual resources and earnings) = Players have only information about the relation abstraction/individual payoff.

- **T1** (info on the relation between collective contribution and common resource) = Players have ALSO information about the group contribution (c), AND the available resource as a result of the contribution.

- **T2** (info on the contribution of the other members of the group = Social information) = In addition to the information provided in T0, Players know ALSO what the other players do (individual contributions).

- **T3 = T1+T2**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Institutional Information</th>
<th>Social Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>II</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
<td>IS</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>IC</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
Hypotheses

• *H 1*: Information has a positive impact on the group’s contribution to resource production

• *H 2*: « institutional » information increases the quantity of resource produced by the group

• *H 3*: « social » information reduces individual contributions’ variance within a group
Experimental Conditions

- Eight experimental sessions (two per treatment).
- 150 subjects, students from various faculties at UM (51% females).
- Experiments consisted of a repeated game (20 periods).
- Groups of 5 members remained unchanged during a full session (partner procedure).
- Each subject took part only in a treatment in order to ensure independence of results (between subjects procedure).
- Subjects were isolated within closed booths equipped with a computer screen.
- Subjects received a payment at the end of each session in function of their performance. Exchange rate €0.04 for 1 ecu. Show-up payment was €2 for UM students and €6 for other students.
Results

Average contribution per period and per group
Results

Variance of individual contributions and of payoffs within a group
# Results

Panel regression on the treatment effect

**Table 2. Estimated effect of treatments based on individual contributions.**

<table>
<thead>
<tr>
<th></th>
<th>Coefficient estimé</th>
<th>Coefficient estimé</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>5.7525***</td>
<td>5.78587***</td>
</tr>
<tr>
<td>II</td>
<td>0.68464</td>
<td>Information institutionnelle</td>
</tr>
<tr>
<td>IS</td>
<td>0.87875*</td>
<td>Information sociale</td>
</tr>
<tr>
<td>IC</td>
<td>1.42036***</td>
<td></td>
</tr>
</tbody>
</table>

F-statistic: 4.4286 on 3 and 146 DF, p-value: 0.0051884

F-statistic: 6.65265 on 2 and 147 DF, p-value: 0.0017146

Niveau de significativité : 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘’ 1.

n: nombre de joueurs, T: nombre de périodes, N: nombre total d’observations.
## Results

Panel regression on individual contributions

*Table 3. Estimation of variables influencing the individual contributions in the various treatments.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>SI</th>
<th>II</th>
<th>IS</th>
<th>IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ressource obtenue en t-1</td>
<td>0.141371***</td>
<td>0.120804***</td>
<td>0.097831***</td>
<td>0.1327494***</td>
</tr>
<tr>
<td>Gain de la période t-1</td>
<td>-0.053033*</td>
<td>-0.08005**</td>
<td>-0.15185***</td>
<td>-0.1782777***</td>
</tr>
<tr>
<td>Contribution du groupe t-1</td>
<td>0.012904</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution minimale des autres en t-1</td>
<td></td>
<td>0.058969</td>
<td></td>
<td>0.0981694</td>
</tr>
<tr>
<td>Contribution maximale des autres en t-1</td>
<td></td>
<td>0.202948***</td>
<td></td>
<td>0.1055145</td>
</tr>
</tbody>
</table>

Observations
- **n**: 40
- **T**: 19
- **N**: 760

F-statistic:
- **41,163**
- **17,3992**
- **27,047**
- **28,7586**

p-value
- **< 2,22e-16**
- **7,5267e-11**
- **< 2,22e-16**
- **< 2,22e-16**

Niveau de significativité : 0 ‘***’ 0.001 ‘***’ 0.01 ‘**’ 0.05 ‘.’ 0.1 ‘ ’ 1.

*n*: nombre de joueurs, **T**: nombre de périodes, **N**: nombre total d'observations.
Conclusions of lab experiment

• Contributions close to optimal strategy. And this also in T0
• Reduction of contributions overtime, typical of a public good
• The protocol is representative of a ‘regulated’ situation (proportional share of the common resource)
• Confidence on the other players because the demanded effort is not so high (shape of the model’s functions)
• Information provision, “institutional” and “social”, pushes subjects to higher contribution (H1)
• Social information seems to determine conditional cooperation (imitate the max. contributor)
• “Institutional” information increases resource production (H2)
• “Social” information reduces variance of contributions within a group (H3)
Steps of the research

- Rationale and research questions
- **Field survey** => stakeholders (farmers/GDA)
- Refinement of research questions
- Experimental protocol
- **Laboratory experiment**
- Discussion of preliminary results => stakeholders (Decisionmakers)
- **Field experiments** (with IBs) => stakeholders (farmers/GDA)
- Final results => stakeholders (farmers/GDA + decisionmakers)
Perspectives

• Back to laboratory with a water production function that needs more collective contribution in order to start producing resource (effect ‘game structure’)

• Field experiments with the GDAs in Tunisia
  • Comparison with lab results
  • Correlation with GDA characteristics