Coordination and allocation on land markets under increasing scale economies and heterogeneous actors – an experimental study

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Alfons Balmann*, Konrad Kellermann*, Karin Larsén*, Serena Sandri**
and Christian Schade**

*Leibniz Institute of Agricultural Development in Eastern and Central Europe, Germany (IAMO)
**Institute for Enterpreneurial Studies and Innovation Management, School of Business and Economics, Humboldt-Universität of Berlin, Germany
Introduction

• Economies of scale often not exploited in Western agriculture
  – dominance and persistence of small family farms (Balmann 1994, 1995)

• „Too little“ participation in collaborative arrangements that allow small firms to exploit economies of size

• Possible explanations for unexploited increasing returns
  – transaction costs limit
  – coordination failures among heterogeneous actors
Introduction

- This study focuses on the last explanation, i.e. coordination failures among heterogeneous actors
  - Balmann (1994, 1995)
    - establishing large arable farms in small farm agriculture can require price differentiation on land market
  - Aurbacher, Lippert, Dabbert (2007)
    - establishing machinery cooperations can require price differentiation
Objective

• Research question
  – Can price differentiation be achieved among heterogeneous actors?

• Approach
  – Laboratory experiments with students
  – An agent-based model with computationally intelligent agents using genetic algorithms provides a normative benchmark prediction
Outline

• Description of the land market example
• Experimental setting
• Benchmark prediction
• Experiment results
• Conclusions and further research
A land market example

Imagine the following situation

- A profit maximizing entrepreneur characterized by increasing returns wants to „take over“ a certain number of neighboring small farms
- The small farmers are assumed to
  - be equally large in terms of land
  - have land with identical physical properties
  - have heterogeneous reservation prices (opportunity costs) for their land
  - have private information on their reservation prices (but know the distribution of the others´ reservation prices.)
A land market example

- marginal economic rent, entrepreneur
- average economic rent, entrepreneur
- opportunity cost, farmers
- average opportunity cost, farmers
A land market example

Potential welfare gain = A – B

- marginal economic rent, entrepreneur
- average economic rent, entrepreneur
- opportunity cost, farmers
- average opportunity cost, farmers
Experimental setting

- Four scenarios (treatments):
  - two different levels of potential welfare gain: „tight“ and „generous“ room for negotiation.
  - two group sizes: „small“ (7 players) and „large“ (14 players)

<table>
<thead>
<tr>
<th>Potential welfare gain</th>
<th>Group size</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>“Tight” (A-B=352)</td>
<td>„Small“ (7 players)</td>
<td>“Large” (14 players)</td>
<td></td>
</tr>
<tr>
<td>Treatment 1</td>
<td>Treatment 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Generous” (A-B=704)</td>
<td>Treatment 2</td>
<td>Treatment 4</td>
<td></td>
</tr>
</tbody>
</table>

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### Experimental setting

**Example of parameters (treatment 1: 7 players, tight room for negotiations)**

<table>
<thead>
<tr>
<th>Player</th>
<th>Sum of land units</th>
<th>Opportunity cost of land unit*</th>
<th>Average opportunity cost</th>
<th>Total value of production*</th>
<th>Marginal value of production</th>
<th>Average value of production*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>80</td>
<td>80</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>160</td>
<td>120</td>
<td>52</td>
<td>40</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>240</td>
<td>160</td>
<td>232</td>
<td>180</td>
<td>77.3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>320</td>
<td>200</td>
<td>732</td>
<td>500</td>
<td>183</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>400</td>
<td>240</td>
<td>1382</td>
<td>650</td>
<td>276.4</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>480</td>
<td>280</td>
<td>2022</td>
<td>640</td>
<td>337</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>560</td>
<td>320</td>
<td>2592</td>
<td>570</td>
<td>370.3</td>
</tr>
</tbody>
</table>

* Information presented to the players

** Total potential welfare gain

= Total value of production (at 7 players) - sum of players opportunity costs

= 2592 – 2240 = 352
Experimental setting

• 40 repetitions/rounds
• Entrepreneur is computerized and profit-maximising
• Opportunity costs randomly assigned to the participants in each round
• Each player has information about
  – His/her own opportunity costs
  – The distribution of the other players’ opportunity costs
  – The entrepreneur’s production function (and average production)
➢ Players are well informed!
Experimental setting

• In each round, every player makes a bid (an ask)
• After every round, each player receives feedback on
  – the number of transactions occurred
  – acceptance or decline of the player’s own ask
  – the own payoff in the round
• The players are not informed about the other players’ asks and payoffs
Experimental setting

- The subject pool consisted of 98 participants (28 in treatments 2, 3 and 4; 14 in treatment 1)
- Monetary incentives were given that are proportional to the players performance in the game
What should we expect?

- Benchmark case
  - game theoretic equilibrium for bidding behavior
  - agent-based simulation with genetic algorithm learning
- In the ABM, the entrepreneur and small farmers are modeled as agents
  - entrepreneur and small farmers interact repeatedly on market
  - small farmers “learn” optimal individual bids for given opportunity costs by applying individually a genetic algorithm (GA) (Dawid, 1999)
  - the model converges towards a game theoretic equilibrium
Benchmark case – simulations with agent-based model

Outcome of GA: treatment 1
Benchmark case – simulations with agent-based model

Outcome of GA: treatment 2
Benchmark case – simulations with agent-based model

The results from the genetic algorithms, i.e. the game theoretic equilibrium, suggest that:

• The farmers/players extract all welfare gain/rent
• The rent is distributed equally among the players with the exception that no player can receive a price higher than the „market price“
Experiment results

- Experiments were carried out in September and October 2009 with students

- Players not always playing rationally
  - Some exceptionally low asks
    - some asks lower than the opportunity cost of player (the share in each session varies between 0.4% and 8.9%)
    - behavioral explanation: analogy of winner’s curse (Thaler, 1988): people want to “win” the deal even if they lose money
  - Some exceptionally high asks
    - Asking for too much – no risk to loose
  - Possibly also typing errors
Experiment results

Distributions of number of accepted asks per round

Tight room for negotiation

Treatment 1

Treatment 2

Generous room for negotiation

Treatment 3

Treatment 4
## Experiment results

### Average share of accepted asks by treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 players, tight room (N=80)</td>
<td>7 players, generous room (N=160)</td>
<td>14 players, tight room (N=80)</td>
<td>14 players, generous room (N=80)</td>
</tr>
<tr>
<td>Average share accepted asks (standard deviation)</td>
<td>0.39 (0.44)</td>
<td>0.52 (0.44)</td>
<td>0.26 (0.41)</td>
<td>0.51 (0.44)</td>
</tr>
<tr>
<td>P-value, Mann-Whitney U-test*</td>
<td>0.054</td>
<td></td>
<td>0.0024</td>
<td></td>
</tr>
</tbody>
</table>

* Tests whether the data comes from two different populations (the null hypothesis is that the two samples are drawn from identical populations)
### Experiment results

Average share of accepted asks by treatment

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<th>Average share accepted asks (standard deviation)</th>
<th>P-value, Mann-Whitney U-test*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 7 players, tight room (N=80)</td>
<td>0.39 (0.44)</td>
<td>0.74</td>
</tr>
<tr>
<td>3 14 players, tight room (N=80)</td>
<td>0.26 (0.41)</td>
<td></td>
</tr>
<tr>
<td>2 7 players, generous room (N=160)</td>
<td>0.52 (0.44)</td>
<td>0.96</td>
</tr>
<tr>
<td>4 14 players, generous room (N=80)</td>
<td>0.51 (0.44)</td>
<td></td>
</tr>
</tbody>
</table>

* Tests whether the data comes from two different populations (the null hypothesis is that the two samples are drawn from identical populations)
Experiment results

• Findings (I)
  – In general the share of accepted asks is surprisingly low
    • < 50 % in treatments with tight room for negotiation
    • ~ 50 % in treatments with high room for negotiation
      ➢ highly inefficient outcome
  – Smaller groups are (slightly) more successful (although not statistically significant)
  – Rate of acceptance does not increase over time
    • players do not learn to coordinate (even after 40 rounds)
Experiment results

Comparison with benchmark case – Treatment 2

- In average too high asks for low and very high opportunity costs
- Bidding more efficient as too high asks are more costly
Experiment results

Comparison with benchmark case – Treatment 4

- In average too high asks for lower and high opportunity costs (not just outliers)
## Experiment results

### Regression results, FE-model

<table>
<thead>
<tr>
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<th>7 players</th>
<th>14 players</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tight room</td>
<td>Generous room</td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>153000***</td>
<td>166000***</td>
</tr>
<tr>
<td></td>
<td>(22100)</td>
<td>(14800)</td>
</tr>
<tr>
<td><strong>Opportunity cost</strong></td>
<td>0.74***</td>
<td>0.83***</td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(0.041)</td>
</tr>
</tbody>
</table>

Dependent variable: *Ask*
Experiment results

• Findings (II)
  – Individuals consider their opportunity costs
    • „Anchoring and adjustment“ (Tversky and Kahneman, 1974).
  – Problem: mark-ups too high among low and high opportunity cost players

  ➢ “Too high” mark-ups of low and high opportunity cost players could be related to some form of inequity aversion (Fehr and Schmidt, 1999), but with emphasis on different dimensions:
    • Low opportunity cost players: expect equal price
    • High opportunity cost players: expect to receive the same mark-up.
    • The dimensions - price and mark-up - are likely to be considered as „scarse“ or „prominent“ by the respective individual players.
Conclusions

• The experimental results suggest that
  – Players do not reveal information although this is costly
  – Players with low and high opportunity costs generally ask for „too much“
  – When potential gain is larger, the number of accepted asks is higher, i.e., when too high asks are more costly

• Experiments provide evidence for market failures and cooperation deficits as reasons for unexploited increasing returns
Further research

• Conduct the experiments with
  – individualized opportunity costs
  – with farmers instead of students
  – with other auction schemes (e.g. spectrum auctions)

• Identify which market mechanisms that are needed in order to support coordination so that reallocation to more efficient outcomes can be achieved.
Thank you for your attention!