Report on Bachelor Thesis

Institute of Economic Studies, Faculty of Social Sciences, Charles University

Student:	**Klára Grohmannová**
Advisor:	**Dr. Michal Červinka**
Title of the thesis:	**Learning in public goods game: alternative model performance**

OVERALL ASSESSMENT *(provided in English, Czech, or Slovak):*

Short summary

The thesis applies the evolutionary dynamics approach (called „learning“) to the analysis of the provision of public goods. In particular, it makes a twist to the simulation models covered in Cotla (2015) vis-a-vis experimental data from the past (collected also by Cotla 2015).

Contribution

The key objective is to test how different „heuristics“ that update the level of contribution (I prefer a „heuristic“ over a bit confusing term „learning“) match experimental data. The thesis finds that it is possible to change the established heuristics to improve a „fit“ with the experimental data.

This is definitely interesting, but it must be also seen that these experimental data for the simple public good provision game (see Figure 5.10 on p. 43) show a convergence to the unique Nash equilibrium of a static game (decay of contributions). From that perspective, we do not learn much from improvement in the dynamics of the provision; all eventually important information is already contained in the stable state, which, if I see it correctly, these experiments unequivocally find to be unique.

Methods

The thesis is definitely methodologically sound. It runs the simulations in R and calculates a degree of fit to the experimental data.

I only find it a bit unsatisfactory that the key paper (Cotla 2015) is only an unpublished working paper with only 2 citations.

Literature

The non-cooperative provision of public goods is a classic topic in economics, which has stimulated interest in many adjacent fields. The topic is covered in public economics, classic game theory, behavioral game theory, evolutionary game theory and experimental economics, and also is covered in applied mathematics and other fields that adopt formal modeling of competitive selection such as evolutionary biology. This breath makes it quite ambitious to map the state of the current knowledge.

At some points, it is therefore not surprising that certain statements are imprecise or even incorrect.

For instance, when analyzing the simplest version of a public good game, it is argued (p. 5) that "the social optimum, i.e., Pareto efficient (optimal) point, here is when each agent contributes fully." This is true only if the technology has sufficient returns to private contributions. In particular, if $r < 1/N$, it is socially optimal if all contributions are zero.

Also, the specification in (2.1) doesn't capture the standard issues that are analyzed in the private provision of public goods. This specification assumes (i) perfect substitution of contributions and (ii) public good benefits additively separable in money. This is quite restrictive. A general approach is to introduce well-behaved preferences over a private and public good with a certain degree of substitution. With the substitution and income effects of the opponents' contributions, the underlying economics gives fine-tuned predictions (sensitive to parameters) that can be studied experimentally and by simulations.

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Manuscript form

References are not updated. For instance, Nax et al. (2016) is actually published in JEBO.

There are small mistakes and shortcomings which a bit complicate understanding of the argument. For example, on p. 5, "r is the marginal rate of return" but there is no r in (2.1), only R. Also, "A is the initial endowment each agent" but there is no A in (2.1), only E_i serves at the endowment.

Also, the thesis contains several typos (Assymetric, inititialised).

Overall evaluation and suggested questions for the discussion during the defense

In my view, the thesis fulfills the requirements for a bachelor thesis at IES, Faculty of Social Sciences, Charles University. I truly appreciate the effort put into the thesis and the breadth of the references on the topic. The simulation methods that have been applied are relevant.

I recommend it for the defense and, given minor imperfections, suggest a **grade B**.

The results of the Turnitin analysis do not indicate significant text similarity with other available sources.

My main question for the thesis is as follows:

- *Can any of your algorithms/heuristics talk to existence conditions for the stable states with positive contributions?*

Let me motivate the question. While the experimental data in Figure 5.10 show that the experimental subjects in the simple public good provision game converge to the Nash equilibrium of a static game, there is definitely interest the in models of dynamics that involve multiple stable states, including stable states with substantially large amounts of contributions. For instance, see:

- Arigapudi, S., Heller, Y., & Milchtaich, I. (2021). Instability of defection in the prisoner's dilemma under best experienced payoff dynamics. *Journal of Economic Theory*, 197, 105174.

Therefore, from the perspective of the design of a mechanism to elicit contributions to public goods, there is interest in finding payoff dynamics that converge to positive levels and not only to those that match (old) experimental data (like those used in the meta-analysis in Cotla 2015).

This topic is highly interesting in the context of recent interest in algorithmic pricing. Some of the pricing algorithms (especially unsupervised learning) are found to be able to collude in price-setting, which is akin to cooperation in the prisoners' dilemma or provision of a public good. For instance, see:

- Asker, J., Fershtman, C., & Pakes, A. (2024). The impact of artificial intelligence design on pricing. *Journal of Economics & Management Strategy*, 33(2), 276-304.

Notice that all these games are strategically isomorphic since all individuals find that unilateral collusion (e.g., keeping a high price, staying silent, or providing a contribution) involves a private cost and an uncompensated benefit to the opponent. Therefore, the algorithms/heuristics you study have potential to speak to this highly topical issue of algorithmic collusion.

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SUMMARY OF POINTS AWARDED *(for details, see below):*

CATEGORY		**POINTS**
Contribution	*(max. 30 points)*	25
Methods	*(max. 30 points)*	28
Literature	*(max. 20 points)*	17
Manuscript Form	*(max. 20 points)*	17
TOTAL POINTS	*(max. 100 points)*	**87**
GRADE	**(A – B – C – D – E – F)**	**B**

NAME OF THE REFEREE: ***Martin Gregor***

DATE OF EVALUATION: ***May 13, 2024***

doc. PhDr. Martin Gregor, Ph.D.

Digitally signed by doc. PhDr. Martin Gregor, Ph.D.
Date: 2024.05.13 17:29:57 +02'00'

Referee Signature

EXPLANATION OF CATEGORIES AND SCALE:

CONTRIBUTION: *The author presents original ideas on the topic demonstrating critical thinking and ability to draw conclusions based on the knowledge of relevant theory and empirics. There is a distinct value added of the thesis.*

METHODS: *The tools used are relevant to the research question being investigated, and adequate to the author's level of studies. The thesis topic is comprehensively analyzed.*

LITERATURE REVIEW: *The thesis demonstrates author's full understanding and command of recent literature. The author quotes relevant literature in a proper way.*

MANUSCRIPT FORM: *The thesis is well structured. The student uses appropriate language and style, including academic format for graphs and tables. The text effectively refers to graphs and tables and disposes with a complete bibliography.*

Overall grading:

TOTAL	**GRADE**
91 – 100	**A**
81 - 90	**B**
71 - 80	**C**
61 – 70	**D**
51 – 60	**E**
0 – 50	**F**