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Strategic Evolution in a Dual-Game Framework: An Agent-Based Model of Inequality and Cooperation

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Research Questions: How do different learning mechanisms influence strategic behaviours and outcomes in interconnected UG–PGG setting? What are the long-term effects of imitation-based learning on cooperation and inequality, and how robust are experimentally observed behavioural patterns when structural incentives are systematically varied?

INTRODUCTION & AIMS

• Starting from von Neumann & Morgenstern (1944), **classical Game Theory** predicts self-interested equilibria, yet experiments show consistent patterns of fairness and cooperation that deviate from the standard game-theoretic approach (e.g., Güth et al., 1982; Fehr & Gächter, 2000).

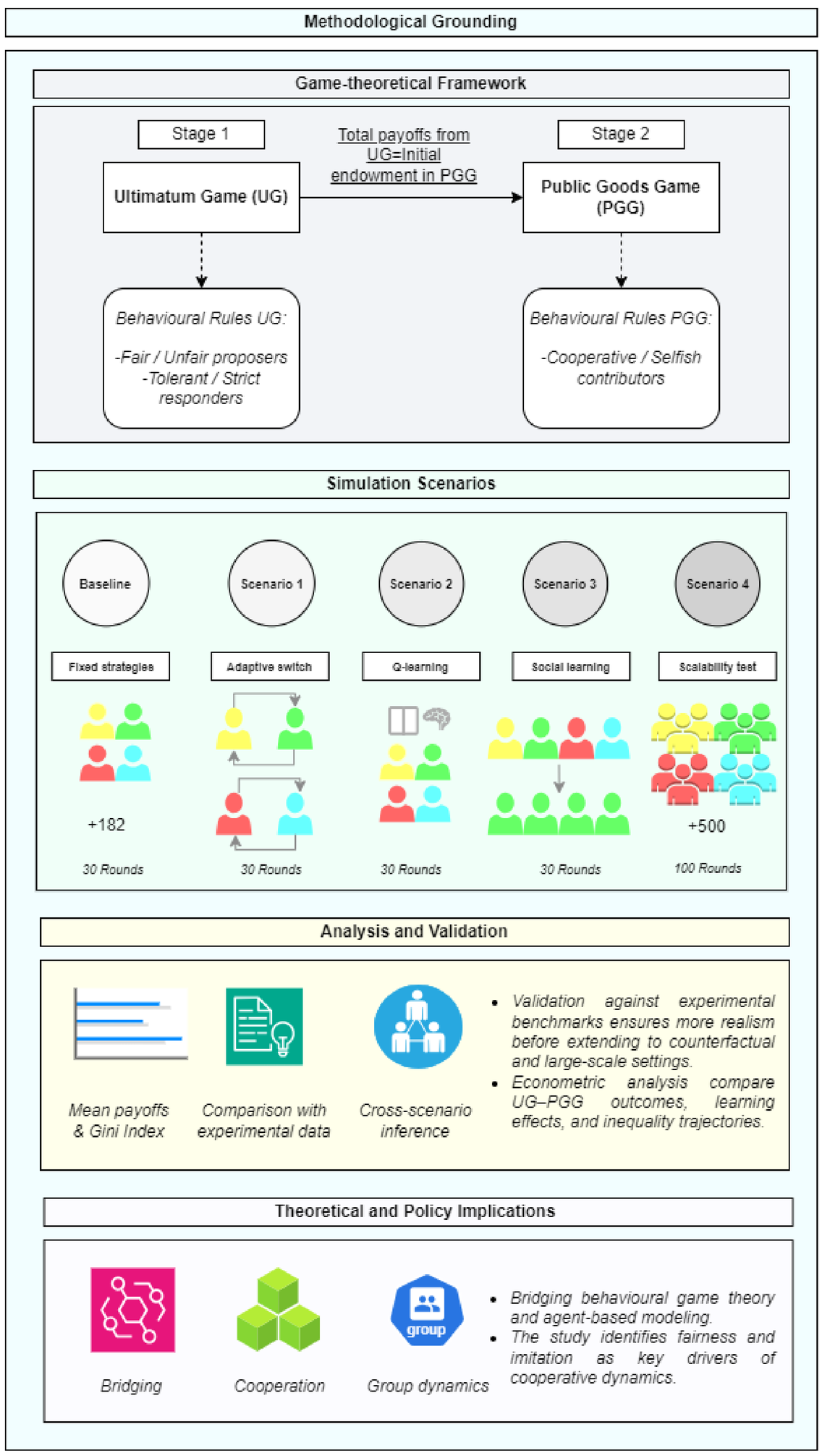
• **Agent-based models (ABM)** allow simulation of heterogeneity, bounded rationality, and adaptive learning in social dilemmas and the related (e.g., Axelrod, 1997).

• **Previous ABM studies** explored, among others, reinforcement learning in public goods and fairness in ultimatum games, but often treated these contexts separately.

• **This work develops** an experimentally grounded ABM that bridges the Ultimatum Game (UG) and the Public Goods Game (PGG), where UG payoffs determine PGG endowments, integrating distributive fairness and collective cooperation.

• **Research aims:** to compare fixed, adaptive, reinforcement, and imitation learning; to test how structural incentives (e.g., MPCR) shape cooperation and inequality; and to validate model dynamics against experimental benchmarks (Bucciarelli & Ascatigno, 2025).

METHODOLOGY



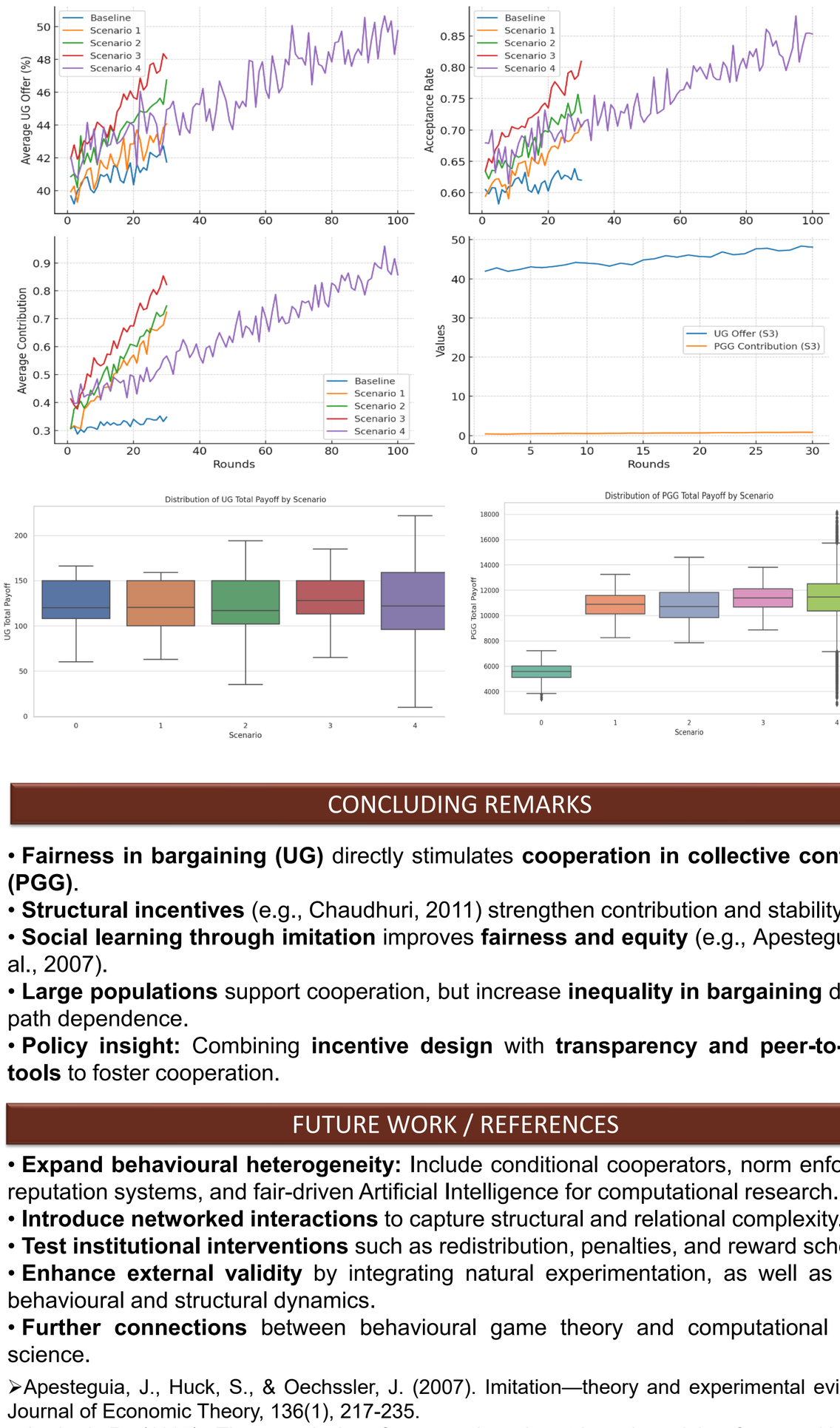
RESULTS & DISCUSSION

• **Baseline model** reproduces experimental benchmarks (UG mean ≈ 122, UG Gini ≈ 0,127**;** PGG mean ≈ 5,542, PGG Gini ≈ 0,108).

• **Higher MPCR and adaptive/reinforcement learning** (Scenarios 1–2) tend to boost cooperation and reduce inequality.

• **Imitation dynamics** (Scenario 3) seek to maximise both efficiency and equity (UG mean = 130,6, PGG mean = 11,362**;** Gini ↓ to 0,075), supporting the stabilising role of **social learning.**

• **The large-scale extension** (Scenario 4) supports high cooperation (mean ≈ 11,430) but shows increasing UG inequality (Gini ≈ 0,175) due to **path dependence** and **strategy lock-in**.



CONCLUDING REMARKS

• **Fairness in bargaining (UG)** directly stimulates **cooperation in collective contexts (PGG)**.

• **Structural incentives** (e.g., Chaudhuri, 2011) strengthen contribution and stability.

• **Social learning through imitation** improves **fairness and equity** (e.g., Apesteguia et al., 2007).

• **Large populations** support cooperation, but increase **inequality in bargaining** due to path dependence.

• **Policy insight:** Combining **incentive design** with **transparency and peer-to-peer tools** to foster cooperation.

FUTURE WORK / REFERENCES

• **Expand behavioural heterogeneity:** Include conditional cooperators, norm enforcers, reputation systems, and fair-driven Artificial Intelligence for computational research.

• **Introduce networked interactions** to capture structural and relational complexity.

• **Test institutional interventions** such as redistribution, penalties, and reward schemes.

• **Enhance external validity** by integrating natural experimentation, as well as richer behavioural and structural dynamics.

• **Further connections** between behavioural game theory and computational social science.

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➢Bucciarelli, E., & Ascatigno, A. (2025). Assessing bargaining and cooperation through longitudinal clustering analysis: Evidence from a lab-in-the-field experiment. Socio Economic Planning Sciences, 100(102239), 1-28.

➢Chaudhuri, A. (2011). Sustaining cooperation in laboratory public goods experiments: a selective survey of the literature. Experimental economics, 14(1), 47-83.

➢Fehr, E., & Gächter, S. (2000). Fairness and retaliation: The economics of reciprocity. Journal of Economic Perspectives, 14(3), 159-181.

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