

# Peer Review

**Reviewer:** Ji Wu, Ai Zhou, and Yihan Chen

**Peer:** Boyan Zhang

**Date:** September 17

**Project Title:** Deployment of a Budgeted Second-Price Auction

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## Acknowledgment of Contribution

The economist section demonstrates a creative and thoughtful extension of the classic Vickrey auction by introducing dynamic budget constraints. The analysis is rigorous: SPNE is correctly identified as the solution concept, threshold strategies are clearly motivated, and the discussion links directly to efficiency and fairness outcomes. Highlighting both envy-freeness and inequity via the Gini coefficient shows strong awareness of welfare trade-offs.

The project as a whole tackles a sophisticated extension of the second-price auction by incorporating budget constraints. Boyan's Computational Scientist section demonstrates real effort: the simplified normal form is well specified, the payoff matrix example is clear, and the dynamic simulation is conceptually described. I especially liked the discussion of threshold strategies and how they connect to budgets — this shows strong understanding of the economics–computation interface.

The Behavioral Scientist section presents a clear and well-structured comparison between theoretical predictions, human behavior, and LLM performance in a dynamic budget-constrained auction. The design is rigorous, and the findings are insightful.

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## Major Revision Suggestions

### Replicability

The text mentions recursive threshold strategies but does not show intermediate derivations or examples in the economist section. Including one numerical example or reference to the exact GitHub function would make replication easier.

The biggest issue is that the report was not submitted as a standalone PDF in Canvas. Instead, the GitHub repo contains the report, but it is hard to locate if one only has the link. According to the PS1 requirements, students must submit one PDF report directly plus the GitHub repo. Without a direct PDF, replicability and review are hindered.

In Part 2, several figures are marked as “placeholders” (e.g., threshold plot, equilibrium heatmap). This means the code outputs were not finalized in time for submission, so it is not possible to verify the results.

**Suggestion:** Please resubmit with a finalized PDF report and ensure all figures are generated and included.

## Coherence

The economist analysis connects well to the computational and behavioral parts, but the refinement discussion (SPNE thresholds vs. observed deviations) could be tied more directly to human/LLM results. For example, explaining how regret minimization (noted in the behavioral section) relates to the threshold model would improve alignment.

The numerical analysis is consistent with the theoretical section, but the write-up would benefit from explicitly linking the simulation threshold strategy (Figure 1) to the SPNE logic in Part 1. Right now, the connection is implied but not spelled out.

**Suggestion:** Add 1–2 sentences highlighting how the computational results reproduce the recursive thresholds derived in the theoretical analysis.

**Suggestion:** Explicitly link the threshold strategy derived in Section 2 (Economist) to the behavioral deviations observed in humans and the normative behavior of the LLM.

**Reason:** This would strengthen the narrative by showing how theory explains both ideal and suboptimal behaviors.

## Resourcefulness

Citations to “SpirakisAuctionsSlides” are helpful but incomplete; referencing standard auction theory sources (e.g., Vickrey 1961, Krishna 2009) would strengthen the scholarly grounding. Expanding the existence proof with a fixed-point argument would also show stronger theoretical rigor.

The section references Spirakis’s slides for dominance arguments but would be stronger with a citation to a standard text (e.g., Osborne & Rubinstein, *A Course in Game Theory*) for second-price equilibria.

Since placeholders are used for some figures, the report does not yet demonstrate full resourcefulness in turning code outputs into polished evidence. Ensuring finalized plots would address this.

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## Minor Revision Suggestion

- Add a simple illustrative figure of the threshold function  $\omega(B)$  (even a stylized sketch) within the economist section. This would make the analysis more intuitive and accessible before the computational part.
- Label the axes and legends clearly in the generated figures once they are ready. For example, the threshold function plot should clearly mark valuation ranges and budget units.

- Clarify whether Participant 2's overbid of 110 was allowed by the interface or resulted from a misunderstanding of the rules.

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## Comments on Organization and Flow

The structure follows the required order (specification → equilibrium → solution → efficiency/fairness → refinements) very well. Transitions are clear, but the fairness subsection could flow more smoothly into the refinements by first summarizing the welfare losses due to budgets.

The Computational Scientist section is well structured: normal form → dynamic simulation → extensive form. However, the placeholders disrupt the flow. Final figures and captions would make it much smoother.

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## Ethical and Practical Implications

The economist analysis acknowledges inequity and efficiency loss under budget constraints. A stronger reflection could highlight practical implications for real-world online ad auctions, where budget caps often disadvantage smaller bidders, raising fairness and market design concerns.

One practical issue is transparency: when figures are missing or repos are hard to navigate, replication becomes difficult. Highlighting this and ensuring accessibility would align better with the course's emphasis on replicability and reproducibility.

Finally, briefly discuss the implications of using LLMs as substitutes for human bidders in experimental economics or mechanism design.

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## Courtesy and Encouragement

This section is impressive in both creativity and rigor. The introduction of budget dynamics shows real originality, and the equilibrium analysis is carefully reasoned. With a few refinements in replicability, citations, and fairness discussion, this economist section could easily reach a publishable standard.

This is an ambitious and thoughtful project. The extension from static Vickrey auctions to dynamic budgeted versions is impressive and original. Once the figures are finalized and the submission format clarified, this will be a strong and valuable contribution. Great work pushing the analysis beyond the basics!

Part 3 provides a compelling empirical complement to the theoretical and computational analyses. The human-LLM comparison is particularly valuable. With minor additions to

methodological transparency and interpretive depth, this section could serve as a model for behavioral auction research.