AE Report for OPRE-2023-01-026

The paper studies one type of loot box in video games in which items sold are replaceable and vertically differentiated. The paper optimizes the uniform purchase price and drop rate of each item and focuses on investigating polynomial-time approximation algorithms with provable guarantees for the NP-hard problem.

I invited three experts to evaluate the paper. R1 recommends a major revision. R2 and R3 label "rejection" in the manuscript center. In private comments, R3 is torn between a major revision and rejection and is willing to review a resubmission if the authors are able to overcome their modeling assumptions.

Major Comments:

1. Because the paper takes an algorithmic approach to the problem, the paper is light on managerial insights. Though I understand game developers may not want to directly sell virtual goods for various reasons, as listed in the introduction, and the focus of the journal is more technical, I feel it is still worth investigating the questions of whether and when the loot box is possibly more profitable than direct selling, which is to answer the "why" question before getting into the technical details of answering the "how" question. (Note that this suggestion is different from what is suggested by R2 in her/his major comment 5.) R1's major concerns are along the same line, and s/he suggests a set of under-explored aspects. R2 shares a similar sentiment, as s/he puts it, "The managerial insights provided in this paper are somewhat limited." R3 also is not convinced by the arguments put forward in the introduction on why the firm prefers loot boxes over direct selling, as s/he feels that "it would seem that many of the issues pointed out in the introduction also apply to loot boxes." R3 also suggests that "the authors could significantly boost the paper's value by providing some insights on how loot boxes can be designed in practice."

2. Though the paper extracts a parsimonious model from the loot box context (i.e., probabilistic selling with a uniform price and different drop rates for vertically differentiated items), the model may not capture the loot box setting well. R2 raises the concern that in video games, the customer valuation of an item should depend on the drop rates, while the paper assumes it is exogenously given. R3 echos this point by saying, "my understanding is that [this model] is not the dominant case." R3 suggests "relaxing the unit-demand model to consider other sub-additive demand functions."

3. Both R2 and R3 point out that the paper makes strong assumptions (see R2's major comment 2 and R3's comment 2 for Modeling and Assumptions), which limit the applicability of the results.

4. Both R1 and R3 question the applicability of the algorithms in practice, particularly how the firm would know the customer valuations and how sensitive the optimal price and drop rates are to such knowledge of customer valuations. I also feel it is not practical to assume the firm optimizes up to a discrete number of customers. It is more

natural to assume there are multiple segments of customers, each representing a fraction of the customer population (see also R1's minor comment 3), or generally, a continuous distribution of customer valuations. I am not sure how your algorithm complexity results with respect to n would extend to, say, a discrete customer valuation distribution.

Overall Assessment: **Risky** Major Revision

The paper studies an interesting problem, is well-written, and obtains promising results. But the paper also suffers some critical issues, as listed above, which may not be resolved, and hence, a successful path leading to publication is unclear at this point. Nevertheless, I recommend a major revision as the referees' expectations are clear. Finally, I want to emphasize the risky nature of the revision and hope the authors can convince the review team through an overhaul of thorough revisions with new results.

Typos/Style:

L6, much -> must

L9, Under "two" different restrictions

L142, "as discussed in the introduction." I am not sure where.

L382, prices \boldface{p}. Up to this point, only loot box uniform price P is introduced. I was puzzled why there are multiple prices reading up to this point. (I understand later this will be useful for direct selling.)

L392, "Another set of conditions …" as a new paragraph?

End of page 15. Add more discussion on Proposition 3. It is striking to see a continuum of c is equivalent.

L519, the constraints -> the constraint … represents

L665, "no worse off". What do you compare with?

L743, ca -> can