Gas Gambits — Game Theory Example of Incentivized Collaboration

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As an alternative to minimizing profit by competing with each other, KeeperDAO incentivizes keepers to pool their liquidity and share their profits. By pooling liquidity, keepers are able to tackle larger opportunities than would otherwise be possible. By incentivizing collaboration, KeeperDAO is able to avoid the wastefulness of gas wars, and maximize the profit for everyone involved. Users (liquidity providers) are also able to deposit liquidity, and share in the profits generated by keepers.

To this end, KeeperDAO changes and evolves autonomously in response to the behavior of its keepers, using its ability to extract extra profit to fund incentive programs. And for those that do not cooperate, its grim-triggering strategy is guaranteed to erase all profitability

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Priority Gas Auctions (PGAs)

One of the main functions

of the KeeperDAO liquidity pool(s) are to reduce competition in priority gas auctions

(PGAs). A PGA refers to the competition between keepers to get their transaction prioritized above others by continuously bumping up the gas price of their transactions. Consider two uncooperative keepers that are trying to capture the same on-chain opportunity. Profits are not shared, so the keepers will participate in a PGA that ultimately minimizes their profit. By pooling capital, profits are shared proportionally, and the keepers no longer have to engage in gas wars that will consume their profit.

When taking advantage of liquidation and/or arbitrage opportunities, keepers must decide on the gas price of the corresponding transactions. On one hand, keepers want to pay the minimum amount of gas possible, to maximize their profit. On the other hand, keepers want to make sure that their transactions are prioritized above those of other keepers, with whom they are competing.

There are many different strategies used by keepers: counter-bidding

(where keepers will bump the gas price of their transaction when they see a competitive transaction with a higher gas price than theirs), random incrementing

(where keepers will randomly increment the gas price of their transactions), and more.

PGAs cause keepers to engage in a “race to the bottom”, where the majority of potential profits end up being consumed by the ever increasing gas prices. PGAs are also bad for the network, causing congestion for other, unrelated, transactions.

Here we will analyze one possible strategy for the PGAs and see what the

payoffs are for a competitor when they compete versus when they join the keeper liquidity pool.

Assumptions

- There is one competitor for a liquidation opportunity.
- The liquidation opportunity has a maximum payoff of

M.

- If the competitor joins the pool, there will be

n

parties that a liquidation profit will be shared amongst.

- The pool can respond to external gas bids with delay

Δ

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The block time

D

is exponentially distributed with rate parameter

λ=0.1

(this corresponds to the average block time of Ethereum being 12.5 seconds).

Grim Trigger Strategy

The strategy that we will consider is a kind of optimistic strategy with agrim trigger fallback. Grim-triggering is an adversarial / punishing PGA strategy where keepers set a gas price for their transaction that consumes all of the profit from a liquidation/arbitrage opportunity, thereby eliminating all profitability from the auction. The pool will propose a transaction with the minimum gas price, and wait. If it detects another bid on the same liquidation, it will grim trigger by setting the gas price to the value such that the liquidation opportunity would no longer be profitable for anybody

.

Analysis

First, consider the case that the competitor competes with the pool. The only way that the competitor can make money is if they bid and the block is mined before the pool can react and grim trigger. Assume that if the pool reacts in time, the competitor does not lose any money, which in general would not be the case (since the competitor still pays the gas for their losing/reverted transaction).

The payoff for the competitor, which we will assume submitted a bid at time t

, in this instance would be M

times the probability that the block gets mined before time t+Δ. For an exponential distribution this probability is

where the second step follows from the memorylessness property of exponential distributions. Thus the expected payoff is

Now, if instead the competitor joined the pool, it would simply get an equal share of the maximum payoff, and hence the expected payoff is

We are interested in the case that this latter payoff is greater than the former; in this case it makes more sense to join the pool than to compete against it

. Solving this inequality for Δ gives:

Alternatively, we can solve for n

:

As an example, if Δ=100ms, then it is more profitable for the competitor to join the pool if there are not more than 100 parties in total sharing in the profits.

Summary

Any competitor to KeeperDAO faces the bleak reality of the grim trigger. We predict there are only 2 outcomes: either nobody makes a profit again, or everyone joins the system

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