On Hedging Gas Usage

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September 2022

Abstract: In this paper we discuss various approaches to hedging gas usage for DApps, with their assumptions and limits - both from the client and provider perspectives. While we offer a practical solution to the problem, that we believe fits both the client and the provider, risks are really down to the actual smart contract implementation. The author sees this paper as an initial research that should lead to further discussions on the subject.

1 Introduction

Let's say a DApp knows they will need to use N amount of gas in the coming month and they want to hedge against gas price variations. That DApp may be paying gas on behalf of its users using relayers built on EIP-2771 (eg: Biconomy or Gelato). The DApp does not really know when its users will make transactions and when they will have to pay gas fees, but they have an idea of the overall amount of gas clients will use over the coming week/month. The DApp wants to lock-in a fixed cost on this gas by paying a fixed price to a counterparty that takes the risk of the gas spot price. How does the DApp effectively hedge its gas consumption? At what price? To what risks is the counterparty exposed?

For the sake of clarity: in this paper we refer indifferently to the DApp as the client and to the counterparty as the provider.

2 Why the classic pricing approach fails

We want to give the DApp an option to buy N amount of gas units that they may use in as many installments n_{t_i} at time t_i as they wish, between t and T for a fixed cost K.
i.e. we have:
$\forall i : t_i \in [t, T]$
$N = \sum n_{t_i}$
At each time t_i the provider will need to buy the amount n_{t_i} of gas units at the spot price S_{t_i} for the client to use.
What is the price of such an instrument?

We can assume that the client will want to exercise its right to buy whenever $S_{t_i} > K$ where K is the average price at which we sold him the instrument. This means the client's payoff is given by:

$$\mathbb{E}\left[\sum_i n_{t_i} \cdot (S_{t_i} - K)\right]$$

which yields:

$$K = \frac{1}{N}\,\mathbb{E}\left[\sum_i n_{t_i} \cdot S_{t_i}\right]$$

This is very much like pricing an American Call Option of which the exercise can be split in as many exercises as the client wishes as long as the sum of the exercises' notionals is equal to the initial notional of the option.

We need to estimate the random variables S_{t_i} and n_{t_i} which is impossible to do unless one has an extended historical dataset of the DApp's SC gas usage and a good gas price prediction model.

Also, a rational client would exercise 100% of N as soon as $S_{t_i} > K$ and the provider would always be at a loss, unless the spot price stays consistently under K which implies either luck with price regime change or bad pricing and the client would have been better off not paying for the service.

NB: It is worth noting that most of the target clients are DApps that mainly need to satisfy their gas consumption over time and they do not have much control over it, so the purchased gas may not always be used in the most optimal way.

3 A Safer Approach?

A safer approach for the provider, that still allows to provide the service to the client is to set K as the average price over a reference period (to be determined), and then to set a cap and a floor (note that the symmetry is to be fair to the client but only the cap is required to hedge the provider).

One could set the cap at p_{75} and the floor at p_{25} the 75-th and 25-th percentiles of the gas price over the reference period respectively.

The payoff for the client would effectively be:

$$\begin{aligned}
&\mathbb{1}\{q_{25} < S_{t_i} < q_{75}\} \cdot (S_{t_i} - K) + \\
&\mathbb{1}\{S_{t_i} > q_{75}\} \cdot (S_{t_i} - K - (S_{t_i} - q_{75})) + \\
&\mathbb{1}\{S_{t_i} < q_{25}\} \cdot (S_{t_i} - K + (q_{25} - S_{t_i}))
\end{aligned} \tag{1}$$

i.e. if we are within the bounds the client receives the difference between the price he paid K and the spot price. If we are outside the bounds he needs to finance the difference / we will pay him the difference *.

This way we can have a product that serves the hedging purpose of the client while avoiding the tails of gas prices spikes - and generously offering the client a discount if ever the price of gas drops considerably.

→ But in the end we still face the same as with the previous approach because as soon as the spot price goes above K the client is compelled to use 100% of N at once.

4 A matter of implementation

To really give a practical solution to this problem, we need to understand better how this will work in practice. Does the client pay gas and then shows the proof of its tx and the provider pays him back the gas? Is the provider filling a wallet that can only be used to pay the client's SC gas? If so it means the client will not be able to spend 100% of N at once and the provider is safe, the N is to be spent randomly as users of the DApp interacts with the client's SC. Could a malicious DApp could have a function they call only for the purpose of burning the gas the bought forward? Can we limit the forward gas usage to external functions only?

Another question is the following: each time a client makes a transaction, does he have a choice of paying the fee with its own money or with a part of the gas he bought forward? Or does he **have to** use the gas he bought forward until the N is exhausted? If the client has the choice between the two, he could use its own wallet whenever $S_{t_i} < K$ and use the gas bought forward only when $S_{t_i} > K$, which pauses a greater risk to the provider.

We believe that if the implementation is done carefully, the hedging approach proposed in section 3 (with or without a floor), is a practical solution to this hedging problem.

5 Receiving mining rewards

Another alternative is for the client to be long gas fees, i.e. to receive the mining rewards during a certain period of time. This is made possible by Alkimiya's Silicia swaps whereby the client would pay a fix amount to receive the mining rewards of a miner/node runner.

However, note that this would constitute an imperfect hedge as the client would receive the mining rewards over time while buying gas at discrete times, which may amount to an average gas cost that is higher/lower than the average mining reward received.

*A backtest needs to be conducted as for choosing the right lower and upper bounds as well as the reference period.