# An AMM minimizing user-level extractable value and loss-versus-rebalancing

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# Motivation

DEX protocol liquidity and order inclusion are typically controlled *exclusively* by the block producer.

This monopoly is particularly profitable when:

1. The liquidity is stale, not updating to current information: **loss-versus-rebalancing (LVR)** (Millionis et al., 2022).
2. The orders are unencrypted: **front-/back-running, sandwiching.**

We provide **V0LVER**, an AMM protocol addressing both of these sources.

# V0LVER

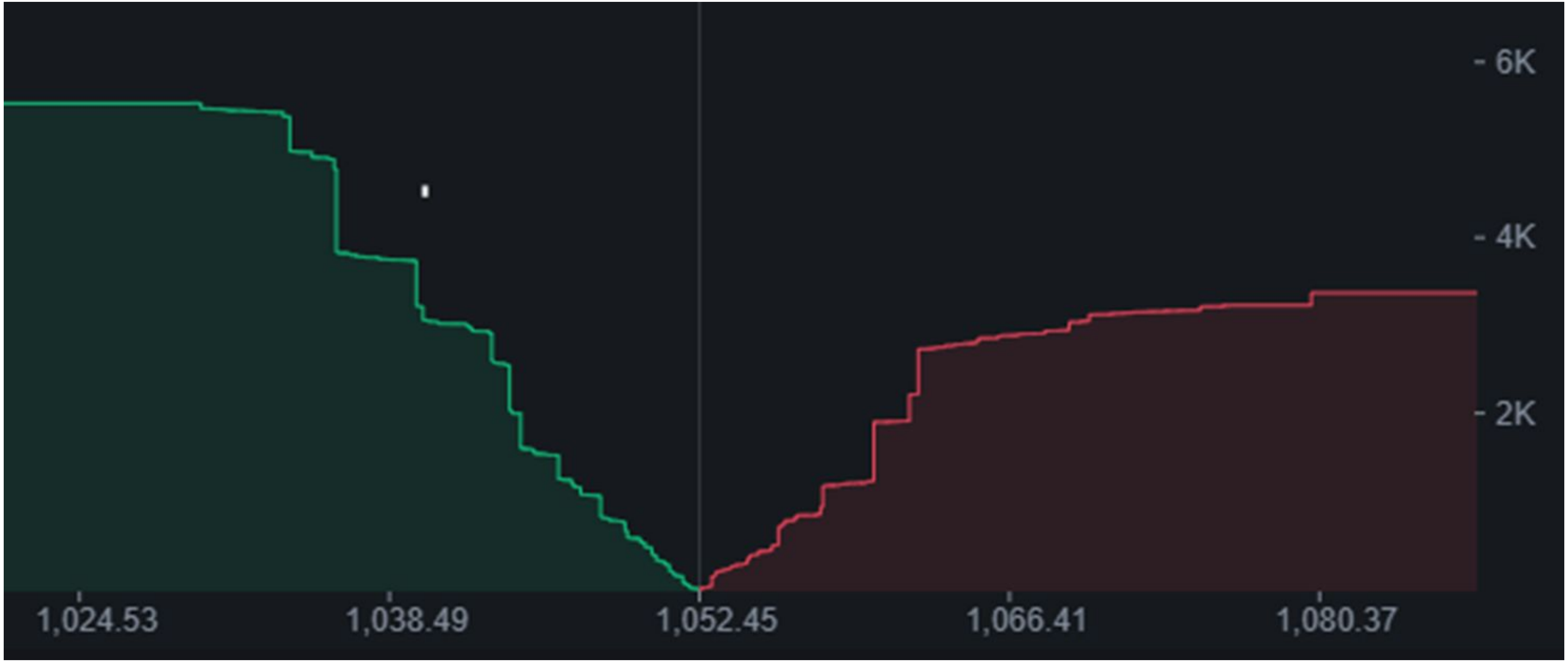
Techniques:

- Encrypt orders.
  - V0LVER orders are allocated while encrypted.
  - No information revealed pre-allocation.
- Update liquidity.
  - Single execution price.
  - Producer must provide some $\beta \in [0,1]$ of liquidity to allocated orders.
  - Incentivized to allocate liquidity at external market price.

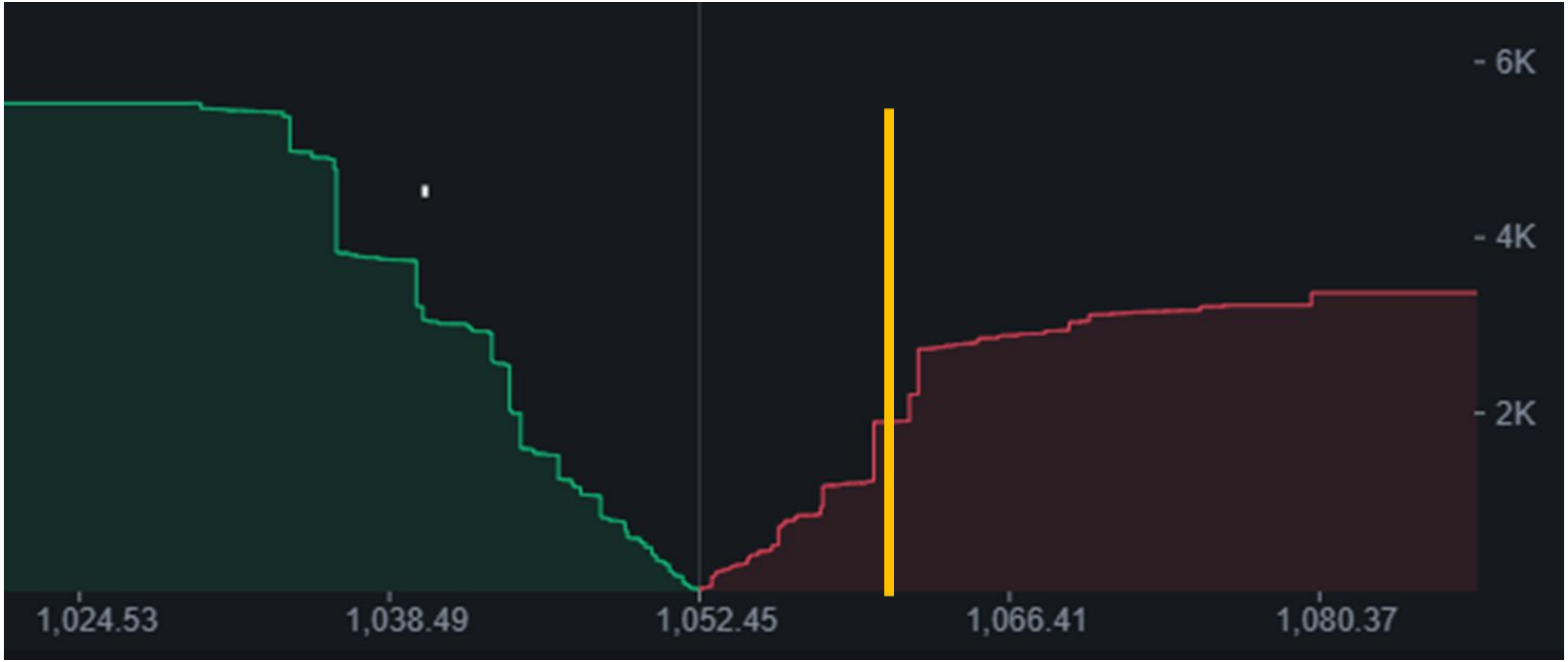
# Decentralized Exchange Losses

$687M

# LVR



# LVR



# LVR Protection in V0LVER

Orders cannot be executed until block producer updates the implied pool price.

These updates are typical buy/sell orders, with 2 caveats:

1. Some percentage $\beta \in [0,1]$ of an update order is not executed.
    a. Pool price reflects the implied move of the original update order (before $\beta$ is applied).
    b. Excess pool tokens are added to a *vault*.
2. The producer must **attest** to this pool price.

**Attesting to a pool price**: If *n* orders are allocated after an update tx, the producer must provide $\beta$ of the liquidity for those orders.

# Excess Pool Tokens

Consider Uniswap V2, where for reserves $R_x$, $R_y$ the implied price is $R_x/R_y$, and reserves updated according to $R_x.R_y=K$, the pool constant.

In Uniswap V2 (and V0LVER), optimal producer update is move implied price to external market price. (check!)

If only $\beta$ of order is executed, we need to remove pool tokens to ensure implied price equals external market price.

# Attest to Price, Provide $\beta$ of Liquidity

The *n* orders are batch executed, equiv. to one meta order.

Meta order executed according to the pool invariant function ($R_x.R_y=K$ for Uni V2) at the attested price/reserve ratio.

$\beta$ of the sent/received tokens are received/sent by the block producer.

As *n* and max order size are known when submitting update order, the max necessary liquidity is allocated from pool: block producer in a ratio of (1-$\beta$): $\beta$.

# Non-LVR MEV

As mentioned, liquidity is allocated to orders.

Allocated orders in V0LVER are encrypted, must be decrypted to be executed.

Depending on the encryption used (threshold/committee controlled vs. user controlled), decryption may occur in the next block, or later.

Decryption must be incentivized (not decrypting punished).

Similarly, we must hide user-/order-information until order is allocated.

ZK commitment schemes allow for this.

# Putting it all together

Under producer competition, block producers compete to allocate orders and submit update transactions.

In V0LVER, this keeps $\beta$ high, which:

**Effectively eliminates LVR (update tx extracts $\beta$ of LVR).**

Even under producer monopoly, as long as orders are encrypted when allocated:

**Users trade at external market price, in expectancy, minus impact and fees.**

# Questions?

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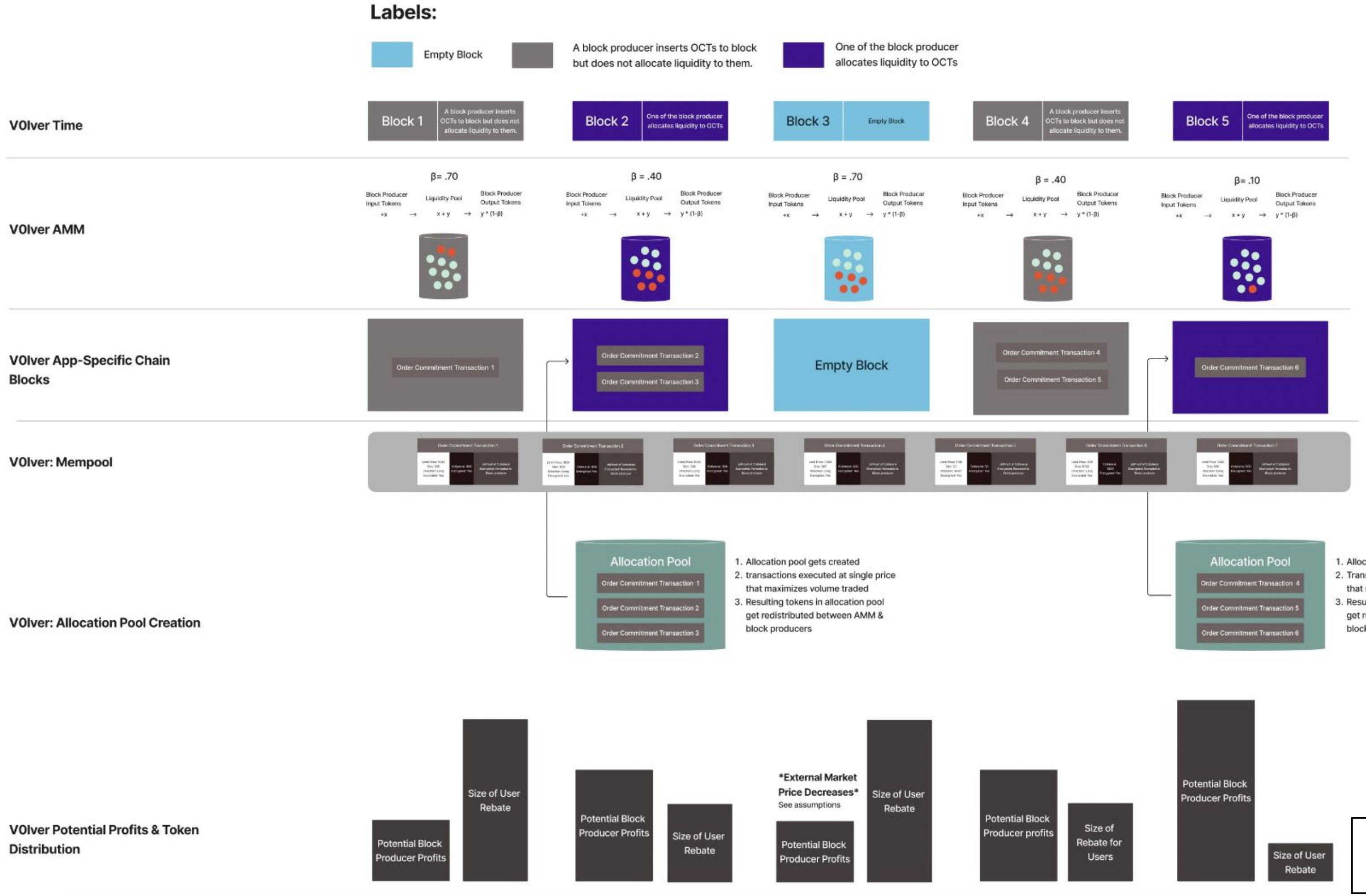
Arxiv version: https://arxiv.org/abs/2301.13599

# Graphical Representations of V0LVER




## Definitions:

**Order Commitment Transactions/OCTs**
Encrypted orders known to be collateralized by either max: x or max: y tokens

**External Market Price**
Price at which OCTs could be executed off-chain

**Potential Block producer profits**
Function of spread between V0lver price & external market price on other exchanges

**β:** This represents the LVR rebate parameter
**x, y:** Token reserves in V0lver Pools

## Assumptions:

1. Multiple block producers competing for profits.
2. Simplified external market price movements:
   a. Constant external market price between Block 1 - 2
   b. External market price decreases at Block 3
   c. Constant external market price between Block 3 - 5

Credit: Benjamin Funk

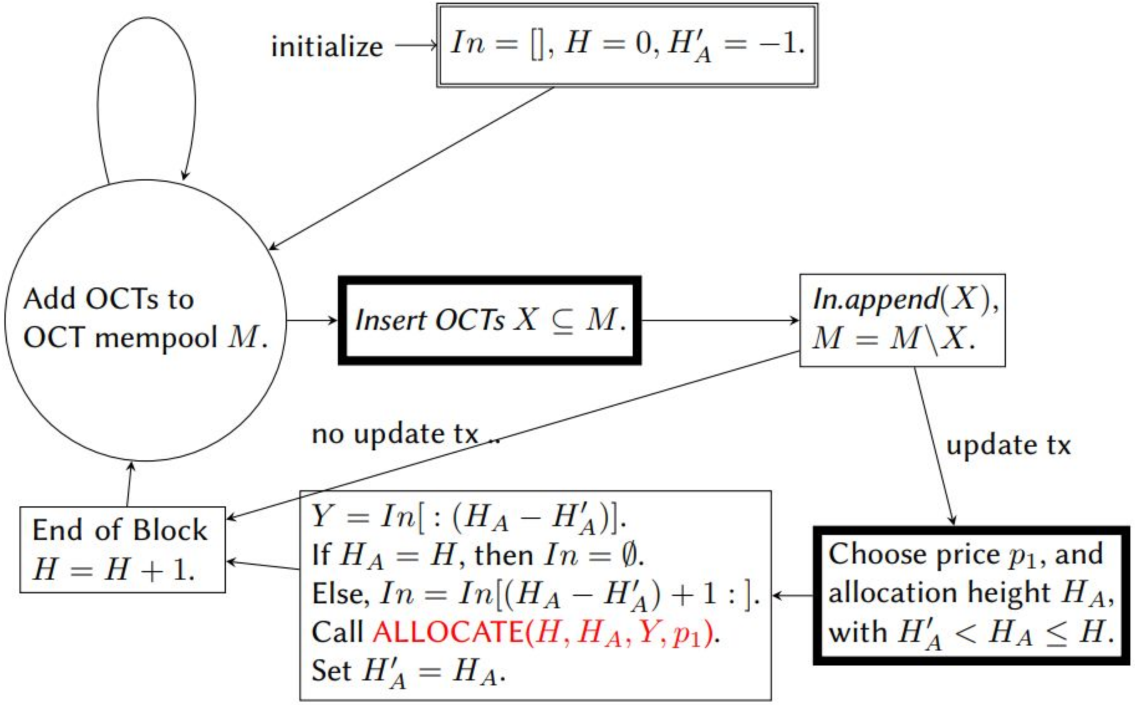



**Figure 2:** Flow of V0LVER protocol, excluding the allocation protocol (see Figure 3 for the allocation protocol). The double-border rectangle is the initialization state, thin single-border rectangles are state updates on-chain, while thick-bordered rectangles are block producer decisions/computations off-chain. The circle state is controlled by the network. Note that $In$, the array of inserted but unallocated OCTs, is an ordered array of sets of OCTs. For $1 < a \leq len(In)$, $In[: a]$ returns an ordered sub-array of $In$ elements at indices $[1, ..., a]$, while $In[a :]$ returns an ordered sub-array of $In$ elements at indices $[a, ..., len(In)]$.

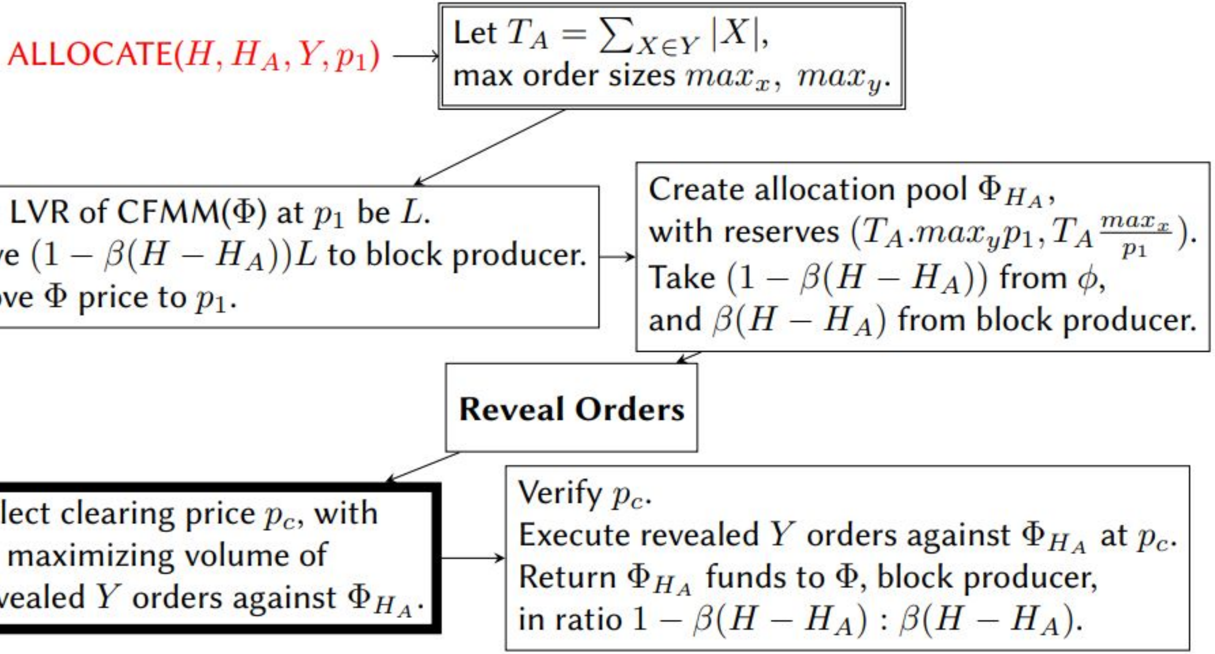



**Figure 3:** Flow of allocation protocol for V0LVER pool $\phi$, initialized every time the ALLOCATE() function is called in Figure 2. The Reveal Orders state happens by some block after height $H$. As in the previous figure, the double-border rectangle is the initialization state, thin single-border rectangles are state updates on-chain, while thick-bordered rectangles are block producer decisions/computations off-chain.