Reducing Slippage in dAMMs (WIP)

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Abstract

Drift Protocol currently experiences relatively high slippage on market orders. Here, we aim to define the slippage as a continuous function of base and quote asset, leading to an optimization problem with a tractable optimal solution. By doing so, the dAMM can hopefully adjust and fine-tune its virtual reserves so that it fully adapts to trading demand in real-time.

1 How does slippage occur?

Slippage is the difference between the expected and actual trade execution price, and in the AMM context is defined as the gap between the pool price before a trade and the effective price obtained for the trade. Essentially, as long as a token price changes during the trade, we can expect slippage to occur. Moreover, slippage tends to increase dramatically when large trades happen compared to the pool size (resulting in lower trading profits).

2 Problem formulation

Consider a liquidity pool with base asset amount x (related to token X), and quote asset amount y (related to token Y). The dAMM uses a constant product curve to facilitate the exchange of one token for another, as follows:

$$x \cdot y = k \iff y = \frac{k}{x}$$

Wlog, suppose that a trader wishes to buy $\Delta x > 0$ units of token X when the LP is at state (x_0, y_0). Then suppose that after the trade, the new point on the curve will be $(x_n, y_n) := (x_0 - \Delta x, y_n)$. Relative to the initial state, the amount of quote asset that the trader would need to put into the LP would be $\Delta y := y_n - y_0$ i.e. the new point can be defined as $(x_n, y_n) := (x_0 - \Delta x, y_0 + \Delta y)$. Assume that the pool price at the initial state is $p_0 := p_{x_0}(y_0)$.

- When the trader wishes to buy Δx amount of token X, the buyer would have to pay $\Delta y_0 := p_0 \Delta x$. The slippage is defined as $S(x_0, y_0, \Delta x) = \Delta y - \Delta y_0 = (y_n - y_0) - p_0 \Delta x$.
- When the trader wishes to sell Δx amount of token X, the slippage is defined as $S(x_0, y_0, -\Delta x) := \Delta y_0 - \Delta y = p_0 \Delta x - (y_0 - y_n)$.

Now suppose that $\mathbf{x}, \mathbf{y} \in \mathbb{R}^n$, and $k, \Delta x \in \mathbb{R}$ are fixed scalars. Using the definition of slippage above, we can obtain the following optimization problem with solution vector $\mathbf{y}$ (as we assume that the main aim is for Drift to effectively manage its reserves of quote asset Y):

$$\begin{aligned} \text{minimize } & y_n - y_0 - p_0 \Delta x \\ \text{subject to } & \mathbf{x}^\top \mathbf{y} = k \\ & \Delta x \cdot \mathbf{e} \leq \mathbf{x} \\ & \mathbf{y} \in \mathbb{R}^n \end{aligned}$$

Since this gives a linear optimization problem within a polytope constraint space, we should expect to solve it fairly easily using well-known techniques e.g. Dantzig's simplex algorithm.

3 References

1. Drift Protocol dAMM Deep Dive: https://www.notion.so/Drift-dAMM-deep-dive-ff154003aedb4efa83d6e7f4440

2. Dynamic Curves for Decentralized Autonomous Cryptocurrency Exchanges: https://arxiv.org/pdf/2101.02778.pdf