Senswap Protocol

Thanh-Phuong Nguyen - Tu Phan - Nguyen Anh Tuan
{phuongnguyen, tuphan, tuannguyen}@descartes.network

Senswap

1 Constant Ellipse/Circle Function

Cost function has a form of an ellipse

$$C(q) = \sum_{i=1}^{n} (q_i - a)^2 + b \sum_{i \neq j} q_i q_j = k,$$

where $q \in \mathbb{R}_+^n$, a and b are coefficients of the ellipse.

Marginal price - the relative price between two assets

$$p_{ij} = \frac{P_i(q)}{P_j(q)} = \frac{2(q_i - a) + b \sum_{k \neq i} q_k}{2(q_j - a) + b \sum_{k \neq j} q_k},$$

where $P_i(q)$ is the derivative of $C(q)$ with respect to q_i

2 Swapping process

$$q_1 = (x_1, y_1) \longrightarrow q_2 = (x - \Delta x, y + \Delta y) = (x_2, y_2)$$

$$C(q_1) = C(q_2)$$
$$(x_1 - a)^2 + (y_1 - a)^2 + bx_1y_1 = (x_2 - a)^2 + (y_2 - a)^2 + bx_2y_2$$

$$y_2 = \frac{(2a - bx_2) - \sqrt{(2a - bx_2)^2 - 4(a^2 - k + (x_2 - a)^2)}}{2}$$

3 Liquidity provision

When a liquidity provider deposit an arbitrary amount of each token, the relative price stays the same. We wish to find new a after depositing, assume b is fixed

$$\frac{P_i(q_1)}{P_j(q_1)} = \frac{P_i(q_2)}{P_j(q_2)}$$
$$\frac{2(x_1 - a_1) + b_1y_1}{2(y_1 - a_1) + b_1x_1} = \frac{2(x_2 - a_2) + b_2y_2}{2(y_2 - a_2) + b_2x_2}$$
$$a_2 = \frac{(2c_1 - b_2d_1)y_2 + (b_2c_1 - 2d_1)x_2}{2(c_1 - d_1)}$$

Another way to calculate a with fixed b such that it can remain high price interval.

$$(x - a)^2 + (y - a)^2 + bxy = a^2 + f$$
$$a = x + y + \sqrt{(2 - b)xy + f}$$

Both ways employ the assumption that b is fixed.