IdeaMarkets Docs

Bonding Curve Price Calculations

The IdeaMarkets contracts use a bonding curve mechanism to exchange tokens in turn for Dai.

1 Constants

There are several constants required for price calculation which are set in the smart contract:

B Base cost: The initial cost in Dai per IdeaToken in the first interval

R Rise: The price rise in Dai per IdeaToken per completed interval

T Tokens per interval: The amount of IdeaTokens in each interval

2 Price calculation by IdeaToken amount

To calculate the price Y in Dai to buy X amount of IdeaTokens we calculate the difference between the price of the existing supply S and the supply $S+X$ after the tokens have been bought:

$$Y = P(S + X) - P(S)$$

with P being a function which calculates the price for a given amount of IdeaTokens from 0 supply. $P(X)$ consists of the sum of two parts: the price for the completed intervals and the price for the IdeaTokens in the remaining interval:

$$P(X) = C(X) + M(X)$$

To calculate $C(X)$ we sum up the cost of the completed intervals with N being the amount of completed intervals:

$$N = \left\lfloor \frac{X}{T} \right\rfloor$$

$$C(X) = \sum_{n=1}^{N}(B + R \cdot (n - 1)) \cdot T$$

$$= NT \cdot (B - R) + RT \cdot \frac{N \cdot (N+1)}{2}$$

To calculate the $M(X)$ we multiply the amount of remaining IdeaTokens with the price of the last interval:

$$M(X) = (X - NT) \cdot (B + NR)$$

This leaves us with the final formula for $P(X)$:

$$P(X) = NT \cdot (B - R) + RT \cdot \frac{N \cdot (N+1)}{2} + (X - NT) \cdot (B + NR)$$

3 Price calculation by Dai amount

To calculate the amount Y of IdeaTokens which can be purchased by X amount of Dai we calculate the difference between the existing supply S and the supply after additional IdeaTokens have been bought for X Dai:

$$Y = D(P(S) + X) - S$$

with D being a function which calculates the amount of IdeaTokens purchasable for a given amount of Dai from 0 supply. To calculate the formula for D we first need to find the amount of completed intervals for a given amount of X Dai. This can be done by solving $C(X)$ for N:

$$N(X) = \frac{\sqrt{T \cdot (4B^2 T - 4BRT + R^2 T + 8RX)} - 2BT + RT}{2RT}$$

To calculate the amount of IdeaTokens which can be bought by the remaining Dai in the final interval:

$$\frac{X - C(N(X))}{B + N(X) \cdot R}$$

This leaves us with the final formula for $D(X)$:

$$D(X) = N(X) \cdot T + \frac{X - C(N(X))}{B + N(X) \cdot R}$$