

Invariant Bonds

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1 Introduction

This paper is a short description focused to show how Invariant Bonds works. Bonds are a pricing mechanism that allows users to purchase tokens at a lower price. Bond is made up of various variables. The first, `floor_price`, defines the lowest price at which we may buy tokens. Each token purchase increases the price, which further falls linearly over time. The `up_bound` parameter controls how much the price can rise, while the `velocity` parameter determines how fast the price hits the `floor_price`.

When a user buys a part of a bond, he or she sets a new price and pays the arithmetic mean of the previous and new prices. Each time, bond specifications are given, and the user may see in real time what price he will pay if he purchases a certain quantity of bonds.

Pure mathematical formula for price:

$$\max\left(\text{previous_price} - \text{velocity} \cdot \text{up_bound} \cdot \text{floor_price} \cdot \frac{\text{current_time}}{\text{sale_time}}, \text{floor_price}\right) + \frac{1}{2} \cdot \frac{\text{buy_amount}}{\text{bond_amount}} \cdot \text{up_bound} \cdot \text{floor_price}$$

velocity

When velocity is set to 1, the price in `sale_time` will move from the maximum price to the `floor_price`. Because the price reduces even quicker over time, the higher the value, the more users are rewarded.

For example, if `floor_price = 25 TOKEN_A/TOKEN_B`, `up_bound = 300` percent, and the bond lasts one week, the price might drop by as much as 10.71 in a single day.

up_bound

Each purchase transaction raises the price by a certain percentage; the more we buy, the higher the price rises afterward. The price rises by the product of two factors, bond amount and supply ratio, in percentage terms (a percentage of how much we bought out of the entire bond).

The Bonds, are price mechanisms that tries to sell tokens at a predetermined rate over a specified period of time. Assume a Seller wishes to sell one token in exchange for a another one. `BondSale` is launched by the seller, who configures five variables:

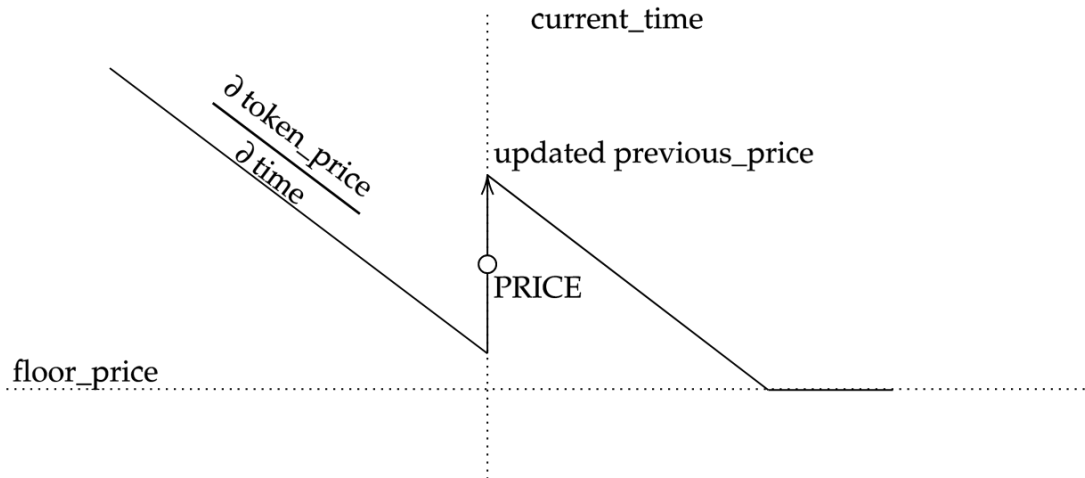
Variable	Description
<code>bond_amount</code>	The amount of tokens that the Seller wishes to sell. of token which Seller want to sale.
<code>floor_price</code>	Minimal (and starting) price of a selling token.
<code>sale_time</code>	BondSale exists at this time.
<code>up_bound</code>	Defines the percentage difference between ceil price and floor price.
<code>velocity</code>	Defines how quickly price fall over time.

Calculation

```
pub fn calculate_new_price(  
  bond_sale: &mut BondSale,  
  current_time: u64,  
  buy_amount: TokenAmount,  
) -> Decimal {  
  let delta_time = current_time - bond_sale.last_trade;  
  let sale_time = bond_sale.end_time - bond_sale.start_time;  
  let time_ratio = Decimal::from_integer(delta_time.try_into().unwrap())  
    / Decimal::from_integer(sale_time.try_into().unwrap());  
  
  let delta_price = bond_sale.velocity * bond_sale.up_bound * bond_sale.  
    floor_price * time_ratio;  
  let supply_ratio = buy_amount.percent(bond_sale.bond_amount);  
  
  let price = match { bond_sale.  
    previous_price } < { bond_sale.floor_price + delta_price } {  
    true => bond_sale.floor_price,  
    false => bond_sale.previous_price - delta_price,  
  };  
  let jump = supply_ratio * bond_sale.up_bound * bond_sale.floor_price;  
  
  bond_sale.previous_price = price + jump;  
  bond_sale.remaining_amount = bond_sale.remaining_amount - buy_amount;  
  bond_sale.last_trade = current_time;  
  
  price + Decimal::from_decimal(50, 2) * jump
```

where `current_time` measures how much time has passed since the start of the bonds and `buy_amount` is how much trader wants to buy.

Locally, in `trade_time`, the price chart looks like this:



$$\frac{\partial \text{token_price}}{\partial \text{time}} = - \text{velocity} \cdot \text{up_bound} \cdot \text{floor_price} \cdot \frac{1}{\text{sale_time}}$$

2 Example

Seller want to sale 1 m INVT for USDC with:

- `bond_amount` = 1 000 000,
- `floor_price` = 2 USDC,
- `sale_time` = 1week,
- `up_bound` = 300%,
- `velocity` = 1.

Consider following two scenarios:

Case 1

Someone instantly buy 1 000 000 INVT.

$$\text{PRICE} = 2 + \frac{1}{2} \cdot 300\% \cdot 2 \text{ USDC} = 5 \text{ USDC}$$

So buyer must paid 5 000 000 USDC.

Case 2

Only one person makes 28 proportionally equal trades every 6 hours, so he always has price equal to $2 \text{ USDC} + \frac{1}{2} \cdot \frac{1}{28} \cdot 300\% \cdot 2 \text{ USDC} \approx 2.107143 \text{ USDC}$ (due to `velocity` = 1). So buyer must paid 2 107 143 USDC.

Limit case

In general when person makes $n \rightarrow \infty$ proportionally equal trades, the price is equal to 2 USDC.

$$\text{ceil_price} = (1 + \text{up_bound}) \cdot \text{floor_price}$$

