Pegnet Conversions
Formulas for Conversion Amount and Rates
November 19, 2019

1 Definitions

Market Rate

The market rate is the rate of a given pAsset reported by the miners denoted in pXXX/pUSD.

Average Rate

The average rate is the weighted moving average of a given pAsset. The weighted average includes past block rates, meaning the average rate will always trail any volatility in the market.

Rate

A rate is a tuple of {Market Rate, Average Rate}. When given the rate, the choice of which rate to use in the tuple depends on the situation.

2 Equations

2.1 Average Rate

The average rate is computed as a moving average of the market rate. The current $BlockWeight$ is 7.

$$Avg = \frac{(PreviousAverage * (BlockWeight - 1)) + CurrentMarketPrice}{BlockWeight}$$

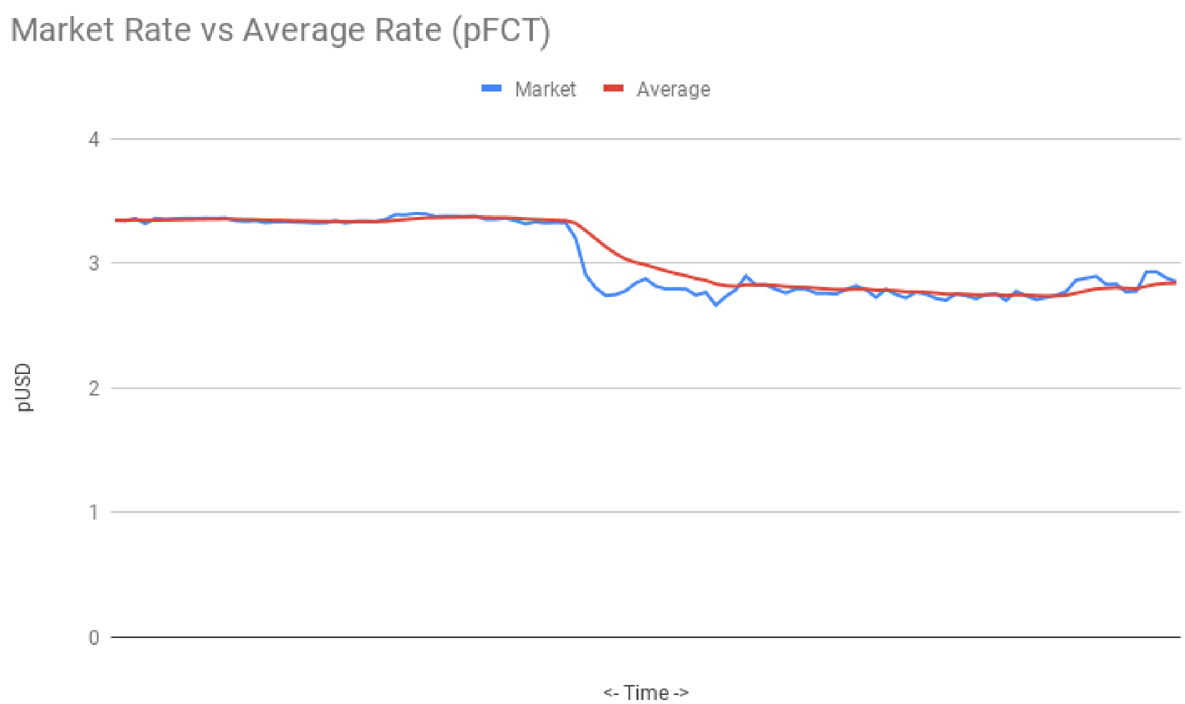

Figure 1: You can see how the average price is less affected by swings in the market price.

2.2 Conversions

Conversions are how Pegnet handles converting 1 pAsset to another.

2.2.1 Simple Calculation

The simple calculation uses the latest **market rate**. When doing a conversion, there is always a **Source-Asset** and a **Destination-Asset**. For a conversion of a pFCT $\rightarrow$ pUSD, pFCT is the source, and pUSD is the destination. The formula computes the destination amount in the destination units. All rates in the formula are **market rates**.

$$DestAmount = SourceAmount * \frac{SourceMktRate}{DestMktRate}$$

2.2.2 Spread

Pegnet simulates market spread by using a combination of the market and average rate. To do this, we use the same formula as above, but change which rates are used. All rates in the formula are **rate tuples** of market and average rate.

$$DestAmount = SourceAmount * \frac{min(SourceRate)}{max(DestRate)}$$

The spread from the market rate can be computed like so:

$$Spread = \frac{SourceMktRate}{DestMktRate} - \frac{min(SourceRate)}{max(DestRate)}$$

The spread is the amount lost in the conversion. Notice the numerator is always min, and the denominator is always max. This means the spread always works against you, it will never benefit a trader. Highly volatile assets will be hit with higher spread.

Examples, with MktRatio being the ratio you'd receive without spread, and PegnetRatio being the amount you'd receive with spread per source asset. So 1 source asset * ratio = destination amount. To get the spread percent, the spread is divided by the MktRatio.

SrcRate (Mkt, Avg)	DstRate (Mkt, Avg)	MktRatio	PegnetRatio	Spread
($5.00, $4.95)	($1.00, $1.00)	5	4.95	1%
($2.4112, $19.5716)	($2.4151, $19.3165)	0.12319	0.12502	1.46%

2.2.3 Spread Tolerance

Spread is intended to mitigate attacks on the Pegnet in markets with low liquidity. Low liquidity being relative to the upside benefit of an attack. The downside of this mitigation, is that is hits all traders equally in normal operation. To attempt to reduce the impact of spread in most cases, a level of spread tolerance can be introduced. The spread tolerance has the goal of bringing the average rate closer to the market rate. This means the tolerance will never change the market price, it will only ever affect the average price.

To add price tolerance, we use the same price formulas as above, but we expand the *min* and *max* parts of the equation. The goal of the tolerance is to reduce the spread, but never give the conversion a discount (negative spread). The *tolerance* is some fixed percentage of the MktRate.

MinTolerance(rate) will never go above the MktRate, but it will bring the average up until the MktRate. So if the market is bullish, the trailing average will be less than the market, and the tolerance will bring the avg closer to the market rate, increasing the value that you are converting from.

$$MinTolerance = \begin{cases} MktRate & AvgRate \geq MktRate \\ min(MktRate, AvgRate + tolerance) & MktRate > AvgRate \end{cases}$$

MaxTolerance(rate) will never go below the MktRate, but it will bring the average rate down. So if the market is bearish, the trailing average will be greater than the market, and the tolerance will bring the avg closer to the market rate, decreasing the value that you are converting to (resulting in more tokens purchased).

$$MaxTolerance = \begin{cases} MktRate & AvgRate \leq MktRate \\ max(MktRate, AvgRate - tolerance) & MktRate < AvgRate \end{cases}$$

Calculating the tolerance is done by taking a fixed constant $VolatilityLimit$, and multiplying it by the market rate. If the $VolatilityLimit$ is 1%, then the tolerance formula is:

$$tolerance = 0.01 * MktRate$$

2.3 Pricing

All the spread calculations indicate how to run a conversion, however for users, often being able to display a price is must more helpful. When using a broker service like Coinbase, the buy/sell price of bitcoin is listed. The buy price is always larger than the sell price, as the broker will sell at a premium and buy at a discount. Pegnet is not much different, except pegnet will have smaller spreads most of the time.

The most simple way to find the buying and selling rate of any given asset pair, is to run a conversion of 1 token. By running the conversion of 1 token through both directions, you can then display the buy/sell price. An example using the data provided below. This data comes from height 206920 on the mainnet. It was specifically chosen to show an example of some extremely high spread. All prices are listed in pUSD unless otherwise specified.

Currency	Market Price	Moving Average Price	Volatility Limit	Tolerance
pFCT	3.7948	3.4960572	1%	0.037948
pXBT	10408.0785	10168.76596492	1%	0.01040807

Before we compute the buy/sell price of pFCT/pXBT, it is easier to show how to compute the buy/sell price of each asset individually. Recalling the conversion formula, and plugging in our numbers for pFCT: (pUSD rates are always (1,1)

$$SellPrice(pFCT) = 1 * \frac{MinTolerance(3.7948,\ 3.4960572)}{MaxTolerance(1{,}1)}$$
$$SellPrice(pFCT) = 1 * \frac{3.5340052}{1}$$
$$SellPrice(pFCT) = 3.5340052$$

If you want to keep the buy price in the same units of pFCT/pUSD, then rather than running the conversion in the reverse (which would get the units as pUSD/pFCT), we can change the conversion formula to use Max in the numerator and Min in the denominator.

$$BuyPrice(pFCT) = 1 * \frac{MaxTolerance(3.7948,\ 3.4960572)}{MinTolerance(1{,}1)}$$
$$BuyPrice(pFCT) = 1 * \frac{3.7948}{1}$$
$$BuyPrice(pFCT) = 3.7948$$

Doing this with pXBT yields:

$SellPrice(pXBT) = 10272.84674992$
$BuyPrice(pXBT) = 10408.0785$

All conversions between pairs use USD as the shared pair. So to find the buy/sell price of the pFCT/pXBT pair, we can use the buy and sell prices calculated above. It should be known that if you used the process above using the pFCT rates vs the pXBT rates, you would get the buy and sell price for the pair. By doing the process individually for each asset, it better shows the spread on both sides of the trading pair.

$SellPrice(pFCT/pXBT) = \frac{SellPrice(pFCT)}{BuyPrice(pXBT)}$
$SellPrice(pFCT/pXBT) = \frac{3.5340052}{10408.0785)}$
$SellPrice(pFCT/pXBT) = 0.00033954$

And for the BuyPrice
$BuyPrice(pFCT/pXBT) = \frac{BuyPrice(pFCT)}{SellPrice(pXBT)}$
$BuyPrice(pFCT/pXBT) = \frac{3.7948}{10272.84674992}$
$BuyPrice(pFCT/pXBT) = 0.0003694$