# emojicoin dot fun

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#### Econia Labs

## 1 Overview

emojicoin dot fun bootstraps liquidity for "fair" (public allocation only, no presale) emojicoin [1] markets using a two-state mechanism popularized by pump dot fun [2]. The first state, known as a bonding curve, uses an abridged Concentrated Liquidity Automated Market Maker (CLAMM) with a single price range [3] as described in section 3.

Once the APT-denominated [4] market capitalization for an emojicoin reaches a predefined value, a State Transition (ST) occurs whereby APT deposits are removed from the bonding curve and locked into a Constant Product Automated Market Maker (CPAMM) [5] together with a remainder of emojicoin supply, as described in section 4.

## 2 Economic variables

Price p is defined per table 1 and equation 1.

Term	Notation	Asset
Base asset	b	emojicoin
Quote asset	q	APT

Table 1: Base and quote asset definitions

$$p = \frac{q}{b} \tag{1}$$

The economic variables in table 2 fully specify the set of numerical values required for the implementation, as derived in sections 3 through 6.

Term	Notation
APT-denominated market capitalization	$m_a$
Circulating emojicoin supply	$c_e$
APT-denominated spot price	$p_s$

Table 2: Economic variables at time of ST

As derived in section 6.4, the alternative set of economic variables in table 3 can also be used to fully specify numerical values.

# 3 Bonding curve state

The bonding curve is represented by a CLAMM, which functions as a CPAMM within the price range  $[p_l, p_h]$  as defined by table 4, equation 2, and figure 1.

Term	Notation
$p_s^{-1} \approx \text{emojicoins per 1 APT at ST}$	A
Ratio of $p$ at ST to $p$ at start of bonding curve	R
Total APT deposited before ST	T

Table 3: Alternative economic variables

Term	Notation
Real base reserves	$b_r$
Real quote reserves	$q_r$
Virtual base reserves	$b_v$
Virtual quote reserves	$q_v$
Liquidity	L
Low price range endpoint	$p_l$
High price range endpoint	$p_h$
Real base reserves ceiling	$b_{r,c}$
Real quote reserves ceiling	$q_{r,c}$
Virtual base reserves ceiling	$b_{v,c}$
Virtual quote reserves ceiling	$q_{v,c}$
Virtual base reserves floor	$b_{v,f}$
Virtual quote reserves floor	$q_{v,f}$

Table 4: Terms, CLAMM as a fixed-range CPAMM

$$(b_r + b_{v,f})(q_r + q_{v,f}) = L^2 = b_v q_v$$
 (2)

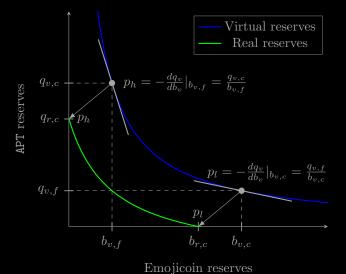


Figure 1: CLAMM as a fixed-range CPAMM

The bonding curve initializes with real emojicoin reserves  $c_e$ , which represent only a portion of total supply  $s_e$ . The remainder of emojicoin reserves  $r_e$  is set aside for the ST which occurs when  $q_{r,c}$  of APT has been deposited into the bonding curve, per equation 3 as derived in section 6.1.

$$r_e = \frac{m_a - c_e \cdot p_s}{p_s}, s_e = \frac{m_a}{p_s}, q_{r,c} = m_a - c_e \cdot p_s$$
 (3)

Virtual reserves initialize per equation 4 as derived in section 6.2.

$$b_{v,c} = \frac{c_e^2 \cdot p_s}{2 \cdot c_e \cdot p_s - m_a}, q_{v,f} = \frac{(m_a - c_e \cdot p_s)^2}{2 \cdot c_e \cdot p_s - m_a}$$
(4)

The bonding curve price initializes to  $p_l$  per equation 5, also derived in section 6.2.

$$p_l = \frac{(m_a - c_e \cdot p_s)^2}{c_s^2 \cdot p_s} \tag{5}$$

During the bonding curve phase, virtual reserve amounts in the CLAMM follow a simple constant product curve invariant for swaps per table 5 and equation 6 as derived in section 6.3.

Term	Swap input	Swap output
Base	$b_{in}$	$b_{out}$
Quote	$q_{in}$	$q_{out}$

Table 5: Swap input and output definitions

$$b_{out} = \frac{b_0 \cdot q_{in}}{q_0 + q_{in}}, q_{out} = \frac{b_{in} \cdot q_0}{b_0 + b_{in}}$$
 (6)

The ST occurs when virtual reserves reach the values from equation 7, derived in section 6.2.

$$b_{v,f} = \frac{c_e \cdot (m_a - c_e \cdot p_s)}{2 \cdot c_e \cdot p_s - m_a}, q_{v,c} = \frac{c_e \cdot p_s \cdot (m_a - c_e \cdot p_s)}{2 \cdot c_e \cdot p_s - m_a}$$
(7)

Notably, this results in a percent dilution at the time of ST,  $d_{\%}$ , defined in equation 8 as derived in section 6.2.

$$d\% = \frac{c_e \cdot p_s}{m_a} \cdot 100\% \tag{8}$$

### 4 CPAMM state

At the ST,  $q_{r,c}$  is withdrawn from the bonding curve and locked into a CPAMM together with  $r_e$ , thus maintaining a constant spot price throughout the ST. This results in the minting of  $L_i$  initial Liquidity Provider (LP) tokens, with  $L_i$  taken as the geometric mean of the two contributions per equation 9 as derived in section 6.5.

$$L_i = \frac{m_a - c_e \cdot p_s}{\sqrt{p_s}} \tag{9}$$

The initial LP token mint is then held by the protocol, similar in effect to burning LP tokens, thus constituting protocolowned liquidity.

A pool fee rate  $f_p$  denominated in basis points is assessed on the output of a swap to incentivize additional LPs. By assessing the fee on the output amount and reinvesting it in the pool, spot price slippage decreases and liquidity increases for each swap.

For example figure 2 denotes a swap sell, where  $f_p \cdot q_{out}$  is deducted from quote proceeds and reinvested in the pool, thus increasing available liquidity.

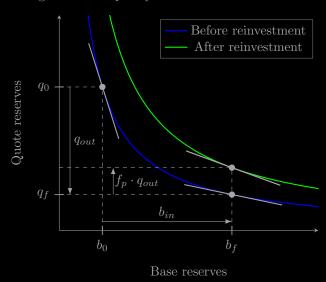


Figure 2: CPAMM swap sell with fee

# 5 Actual implementation values

Nominal implementation values are given in table 6.

Term	Amount
A	10,000
R	12.25
$T = q_{r,c}$	1,000
$m_a$	4,500
$c_e = b_{r,c}$	35,000,000
$r_e$	10,000,000
$s_e$	45,000,000
$d_{\%}$	$77.\bar{7}$
$p_s = p_h$	0.0001
$p_l$	0.000008163
$L_i$	100,000
$f_p$	25
$b_{v,f}$	14,000,000
$q_{v,f}$	400
$b_{v,c}$	49,000,000
$q_{v,c}$	1,400

Table 6: Nominal implementation values

This value set meets the restriction from equation 10, derived in section 6.2.

$$c_e \cdot p_s < m_a < 2 \cdot c_e \cdot p_s \tag{10}$$

Notably, for a given  $c_e$  and  $p_s$ , larger values of  $m_a$  correspond to larger R and larger  $d_{\%}$ . Hence the alternative economic variable approach described in section 1, which enables direct specification of R.

 $m_a$  scales to octa-denominated [4] market capitalization  $m_o$  as shown in equation 11.

$$m_o = 10^8 m_a$$
 (11)

For simplicity emojicoins are taken to have 8 decimals, the same as APT. Hence  $c_e$  scales to integer emojicoin subunits  $c_s$  as shown in equation 12.

$$c_s = 10^8 c_e$$
 (12)

Applying the same scale factor across variables produces the integer values in table 7.

Constant	Amount
MARKET_CAP	450_000_000_000
EMOJICOIN_REMAINDER	1_000_000_000_000_000
EMOJICOIN_SUPPLY	4_500_000_000_000_000
LP_TOKENS_INITIAL	10_000_000_000_000
BASE_REAL_FLOOR	0
QUOTE_REAL_FLOOR	0
BASE_REAL_CEILING	3_500_000_000_000_000
QUOTE_REAL_CEILING	100_000_000_000
BASE_VIRTUAL_FLOOR	1_400_000_000_000_000
QUOTE_VIRTUAL_FLOOR	40_000_000_000
BASE_VIRTUAL_CEILING	4_900_000_000_000_000
QUOTE_VIRTUAL_CEILING	140_000_000_000
POOL_FEE_RATE_BPS	25

Table 7: Integer implementation values

# 6 Derivations

### 6.1 Supply amounts

To ensure a constant price during the ST, a portion of emojicoin reserves must be set aside from the initial bonding curve. At the ST this emojicoin remainder  $r_e$  is locked into the CPAMM together with all of the APT from the bonding curve, yielding:

$$p_{s} = \frac{q_{r,c}}{r_{e}}$$

$$p_{s} \cdot r_{e} = q_{r,c}$$

$$r_{e} = \frac{q_{r,c}}{p_{s}}$$
(13)

Define  $p_s = f(m_a, c_e, r_e)$ :

$$p_s = \frac{m_a}{c_c + r_c} \tag{14}$$

Substitute (13) into (14):

$$p_s = \frac{m_a}{c_e + \frac{q_{r,c}}{p_s}}$$

$$p_s \cdot \left(c_e + \frac{q_{r,c}}{p_s}\right) = m_a$$

$$c_e + \frac{q_{r,c}}{p_s} = \frac{m_a}{p_s}$$

$$\frac{q_{r,c}}{p_s} = \frac{m_a}{p_s} - c_e$$

$$q_{r,c} = m_a - c_e \cdot p_s$$

$$(15)$$

Note  $q_{r,c}$  is only positive for:

$$m_a - c_e \cdot p_s > 0$$

$$m_a > c_e \cdot p_s \tag{16}$$

Substitute (15) into (13):

$$r_e = \frac{m_a - c_e \cdot p_s}{p_s} \tag{17}$$

Hence total supply  $s_e$  evaluates to:

$$s_e = c_e + r_e$$

$$s_e = c_e + \frac{m_a - c_e \cdot p_s}{p_s}$$

$$s_e = \frac{c_e \cdot p_s}{p_s} + \frac{m_a - c_e \cdot p_s}{p_s}$$

$$s_e = \frac{c_e \cdot p_s + m_a - c_e \cdot p_s}{p_s}$$

$$s_e = \frac{m_a}{p_s}$$

$$(18)$$

### 6.2 Bonding curve amounts

Evaluated at  $p_l$ , (2) reduces to:

$$(b_{r,c} + b_{v,f}) \cdot q_{v,f} = L^2 \tag{19}$$

Likewise, (2) evaluated at  $p_h$  reduces to:

$$b_{v,f} \cdot (q_{r,c} + q_{v,f}) = L^2 \tag{20}$$

For  $b_{r,c} = c_e$ , combining (15), (19), and (20) yields:

$$(b_{r,c} + b_{v,f}) \cdot q_{v,f} = b_{v,f} \cdot (q_{r,c} + q_{v,f})$$

$$b_{r,c} \cdot q_{v,f} + b_{v,f} \cdot q_{v,f} = b_{v,f} \cdot q_{r,c} + b_{v,f} \cdot q_{v,f}$$

$$b_{r,c} \cdot q_{v,f} = b_{v,f} \cdot q_{r,c}$$

$$q_{v,f} = \frac{b_{v,f} \cdot q_{r,c}}{b_{r,c}}$$

$$q_{v,f} = \frac{b_{v,f} \cdot (m_a - c_e \cdot p_s)}{c_e}$$
(21)

For  $p_h = p_s$ , substituting (15) and (21) yields:

$$p_{h} = \frac{q_{v,c}}{b_{v,f}}$$

$$p_{s} = \frac{q_{r,c} + q_{v,f}}{b_{v,f}}$$

$$b_{v,f} \cdot p_{s} = q_{r,c} + q_{v,f}$$

$$b_{v,f} \cdot p_{s} - q_{v,f} = q_{r,c}$$

$$b_{v,f} \cdot p_{s} - \frac{b_{v,f} \cdot (m_{a} - c_{e} \cdot p_{s})}{c_{e}} = m_{a} - c_{e} \cdot p_{s}$$

$$\frac{b_{v,f} \cdot c_{e} \cdot p_{s}}{c_{e}} + \frac{b_{v,f} \cdot (c_{e} \cdot p_{s} - m_{a})}{c_{e}} = m_{a} - c_{e} \cdot p_{s}$$

$$\frac{b_{v,f} \cdot (2 \cdot c_{e} \cdot p_{s} - m_{a})}{c_{e}} = m_{a} - c_{e} \cdot p_{s}$$

$$b_{v,f} \cdot (2 \cdot c_{e} \cdot p_{s} - m_{a}) = c_{e} \cdot (m_{a} - c_{e} \cdot p_{s})$$

$$b_{v,f} = \frac{c_{e} \cdot (m_{a} - c_{e} \cdot p_{s})}{2 \cdot c_{e} \cdot p_{s} - m_{a}} \quad (22)$$

Since  $m_a > c_e \cdot p_s$ , the numerator is always positive for positive  $c_e$ . However the denominator is only positive if:

$$\begin{aligned} 2 \cdot c_e \cdot p_s - m_a &> 0 \\ 2 \cdot c_e \cdot p_s &> m_a \\ m_a &< 2 \cdot c_e \cdot p_s \end{aligned} \tag{23}$$

Combining (23) and (16) yields:

$$c_e \cdot p_s < m_a < 2 \cdot c_e \cdot p_s \tag{24}$$

Substituting (22) into (21) yields:

$$q_{v,f} = \frac{\frac{c_e \cdot (m_a - c_e \cdot p_s)}{2 \cdot c_e \cdot p_s - m_a} \cdot (m_a - c_e \cdot p_s)}{c_e}$$

$$q_{v,f} = \frac{(m_a - c_e \cdot p_s)^2}{2 \cdot c_e \cdot p_s - m_a}$$
(25)

For  $b_{r,c} = c_e$  and  $b_{v,f}$  per (22),  $b_{v,c}$  resolves to:

$$b_{v,c} = b_{r,c} + b_{v,f}$$

$$b_{v,c} = c_e + \frac{c_e \cdot (m_a - c_e \cdot p_s)}{2 \cdot c_e \cdot p_s - m_a}$$

$$b_{v,c} = \frac{c_e \cdot (2 \cdot c_e \cdot p_s - m_a)}{2 \cdot c_e \cdot p_s - m_a} + \frac{c_e \cdot (m_a - c_e \cdot p_s)}{2 \cdot c_e \cdot p_s - m_a}$$

$$b_{v,c} = \frac{c_e \cdot (c_e \cdot p_s)}{2 \cdot c_e \cdot p_s - m_a}$$

$$b_{v,c} = \frac{c_e^2 \cdot p_s}{2 \cdot c_e \cdot p_s - m_a}$$
(26)

For  $q_{r,c}$  per (15) and  $q_{v,f}$  per (25),  $q_{v,c}$  resolves to:

$$q_{v,c} = q_{r,c} + q_{v,f}$$

$$q_{v,c} = m_a - c_e \cdot p_s + \frac{(m_a - c_e \cdot p_s)^2}{2 \cdot c_e \cdot p_s - m_a}$$

$$q_{v,c} = \frac{(2 \cdot c_e \cdot p_s - m_a) \cdot (m_a - c_e \cdot p_s)}{2 \cdot c_e \cdot p_s - m_a} + \frac{(m_a - c_e \cdot p_s)^2}{2 \cdot c_e \cdot p_s - m_a}$$

$$q_{v,c} = \frac{(m_a - c_e \cdot p_s) \cdot (2 \cdot c_e \cdot p_s - m_a + m_a - c_e \cdot p_s)}{2 \cdot c_e \cdot p_s - m_a}$$

$$q_{v,c} = \frac{(m_a - c_e \cdot p_s) \cdot (c_e \cdot p_s)}{2 \cdot c_e \cdot p_s - m_a}$$

$$q_{v,c} = \frac{c_e \cdot p_s \cdot (m_a - c_e \cdot p_s)}{2 \cdot c_e \cdot p_s - m_a}$$

$$(27)$$

Hence for  $q_{v,f}$  per (25) and  $b_{v,c}$  per (26),  $p_l$  resolves to:

$$p_{l} = \frac{q_{v,f}}{b_{v,c}}$$

$$p_{l} = \frac{\frac{(m_{a} - c_{e} \cdot p_{s})^{2}}{2 \cdot c_{e} \cdot p_{s} - m_{a}}}{\frac{c_{e}^{2} \cdot p_{s}}{2 \cdot c_{e} \cdot p_{s} - m_{a}}}$$

$$p_{l} = \frac{(m_{a} - c_{e} \cdot p_{s})^{2}}{c_{e}^{2} \cdot p_{s}}$$

$$(28)$$

Define dilution percentage at the time of ST,  $d_{\%}$  substituting (18):

$$d_{\%} = \frac{c_e}{s_e} \cdot 100\%$$

$$d_{\%} = \frac{c_e}{\frac{m_a}{p_s}} \cdot 100\%$$

$$d_{\%} = \frac{c_e \cdot p_s}{m_a} \cdot 100\%$$
(29)

### 6.3 Base in and out for CPAMM swap

Let  $b_0$  and  $q_0$  represent base and quote reserves before a swap, and  $b_f$  and  $q_f$  represent reserves after a swap. For a feeless swap buy:

$$b_{0} \cdot q_{0} = b_{f} \cdot q_{f}$$

$$b_{0} \cdot q_{0} = (b_{0} - b_{out}) \cdot (q_{0} + q_{in})$$

$$b_{0} \cdot q_{0} = b_{0} \cdot q_{0} + b_{0} \cdot q_{in} - b_{out} \cdot q_{0} - b_{out} \cdot q_{in}$$

$$b_{0} \cdot q_{0} = b_{0} \cdot q_{0} + b_{0} \cdot q_{in} - b_{out} \cdot (q_{0} + q_{in})$$

$$b_{out} \cdot (q_{0} + q_{in}) = b_{0} \cdot q_{in}$$

$$b_{out} = \frac{b_{0} \cdot q_{in}}{q_{0} + q_{in}}$$
(30)

For a feeless swap sell:

$$b_{0} \cdot q_{0} = b_{f}q_{f}$$

$$b_{0} \cdot q_{0} = (b_{0} + b_{in}) \cdot (q_{0} - q_{out})$$

$$b_{0} \cdot q_{0} = b_{0} \cdot q_{0} - b_{0} \cdot q_{out} + b_{in} \cdot q_{0} - b_{in} \cdot q_{out}$$

$$b_{0} \cdot q_{0} = b_{0} \cdot q_{0} + b_{in} \cdot q_{0} - q_{out} \cdot (b_{0} + b_{in})$$

$$q_{out} \cdot (b_{0} + b_{in}) = b_{in} \cdot q_{0}$$

$$q_{out} = \frac{b_{in} \cdot q_{0}}{b_{0} + b_{in}}$$
(31)

# 6.4 Alternative economic variable selection

Define the inverse of spot price, roughly interpreted as the number of emojicoins that 1 APT will buy at the ST, A:

$$A = \frac{1}{p_s} \tag{32}$$

Define the ratio of bonding curve price endpoints, R:

$$R = \frac{p_s}{p_l} \tag{33}$$

Define the total amount of APT required to initiate the ST, T:

$$T = q_{r,c} \tag{34}$$

Combine (33), (28), and (15):

$$R = \frac{p_s}{p_l}$$

$$R = \frac{p_s}{\frac{(m_a - c_e \cdot p_s)^2}{c_e^2 \cdot p_s}}$$

$$R = \frac{c_e^2 \cdot p_s^2}{(m_a - c_e \cdot p_s)^2}$$

$$R = \frac{c_e^2 \cdot (\frac{1}{A})^2}{T^2}$$

$$R = \frac{c_e^2}{A^2 \cdot T^2}$$

$$A^2 \cdot R \cdot T^2 = c_e^2$$

$$c_e^2 = A^2 \cdot R \cdot T^2$$

$$c_e = A \cdot T \cdot \sqrt{R}$$
(35)

Refactor (32):

$$A = \frac{1}{p_s}$$

$$A \cdot p_s = \frac{1}{p_s}$$

$$p_s = \frac{1}{4}$$
(36)

Combine (34), (15), (35), and (36):

$$T = m_a - c_e \cdot p_s$$

$$T = m_a - A \cdot T \cdot \sqrt{R} \cdot \frac{1}{A}$$

$$T = m_a - T \cdot \sqrt{R}$$

$$T + T \cdot \sqrt{R} = m_a$$

$$m_a = T + T \cdot \sqrt{R}$$

$$m_a = T \cdot (1 + \sqrt{R})$$
(37)

Combine (16), (35), (36), (37), demonstrating a condition that is always met:

$$T \cdot (1 + \sqrt{R}) > A \cdot T \cdot \sqrt{R} \cdot \frac{1}{A}$$

$$1 + \sqrt{R} > \sqrt{R}$$

$$1 > 0 \tag{38}$$

Combine (23), (35), (36), (37), demonstrating another condition that is always met:

$$m_a < 2 \cdot c_e \cdot p_s$$

$$T \cdot (1 + \sqrt{R}) < 2 \cdot A \cdot T \cdot \sqrt{R} \cdot \frac{1}{A}$$

$$1 + \sqrt{R} < 2 \cdot \sqrt{R}$$

$$1 < \sqrt{R}$$

$$\sqrt{R} > 1$$

$$R > 1$$
(39)

To avoid numerical issues during calculations in a script or similar, substitute (34) and (36) into (13):

$$r_e = \frac{q_{r,c}}{p_s}$$

$$r_e = \frac{T}{\frac{1}{A}}$$

$$r_e = A \cdot T \tag{40}$$

Similarly, substitute (35), (36), and (37) into (26):

$$b_{v,c} = \frac{c_e^2 \cdot p_s}{2 \cdot c_e \cdot p_s - m_a}$$

$$b_{v,c} = \frac{(A \cdot T \cdot \sqrt{R})^2 \cdot \frac{1}{A}}{2 \cdot (A \cdot T \cdot \sqrt{R}) \cdot \frac{1}{A} - T \cdot (1 + \sqrt{R})}$$

$$b_{v,c} = \frac{A^2 \cdot T^2 \cdot R \cdot \frac{1}{A}}{2 \cdot T \cdot \sqrt{R} - T \cdot (1 + \sqrt{R})}$$

$$b_{v,c} = \frac{A \cdot T^2 \cdot R}{T \cdot (2 \cdot \sqrt{R} - (1 + \sqrt{R}))}$$

$$b_{v,c} = \frac{A \cdot T \cdot R}{2 \cdot \sqrt{R} - (1 + \sqrt{R})}$$

$$b_{v,c} = \frac{A \cdot T \cdot R}{\sqrt{R} - 1}$$

$$(41)$$

### 6.5 Initial LP tokens

Define  $L_i$  as the geometric mean of  $q_{r,c}$  and  $r_e$ , substituting (15) and (17):

$$L_{i} = \sqrt{q_{r,c} \cdot r_{e}}$$

$$L_{i} = \sqrt{(m_{a} - c_{e} \cdot p_{s}) \cdot \frac{m_{a} - c_{e} \cdot p_{s}}{p_{s}}}$$

$$L_{i} = \sqrt{\frac{(m_{a} - c_{e} \cdot p_{s})^{2}}{p_{s}}}$$

$$L_{i} = \frac{m_{a} - c_{e} \cdot p_{s}}{\sqrt{p_{s}}}$$

$$(42)$$

# References

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