A Macroeconomics View of the Pocket Network

A first iteration by POKTscan

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Disclaimer

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Changelog

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1 Introduction

The Pocket Network strives to become the backbone of the Web3 ecosystem by providing unstoppable and high-quality access to any blockchain. As such, it must itself be a sovereign crypto network. A fundamental piece of a sovereign ecosystem is understanding the economic variables that influence it. While the crypto world is full of coins that have no intrinsic use apart from speculation or storing value (such as Bitcoin), the $POKT token, Pocket Network's native cryptocurrency, represents a different kind of token.

Designed as a utility coin, the $POKT token grants its holder access to the Pocket Network, and consequently, unrestricted access to the blockchain data provided by it. It is not the only utility token out there. Ethereum can be seen as another, providing the holder access to operate smart contracts on its network. However, it's essential not to conflate Ethereum and Pocket, given their differing use cases and economic processes, which we will elucidate later.

The purpose of this document is to outline the economic processes taking place within the Pocket Network. Drawing from the macroeconomic framework of a sovereign state, we describe how production, exchange rates, and interest within the Pocket Network economy are interconnected. The product of this analysis is an abstract economic model applicable to the current state of the network and adaptable to future changes.

We believe that establishing the macroeconomic foundations of the Pocket Network is crucial to:

- Standardize the language used in economic discussions, e.g., network profit, network cost, etc.
- Establish a robust foundation for creating more detailed microeconomic models, such as those for service providers, validators, and portal ROI.
- Define appropriate interaction and compensation mechanisms for new network actors, such as the "fishermen" in V1.
- Create a practical, standard model to weigh and propose changes to economic variables, such as relay cost and network cost.
- Introduce the concept of interest rate into the ecosystem.
- Equip the Decentralized Autonomous Organization (DAO) with tools to observe and manage the economy of the Pocket Network.

This document is structured as follows: In Section 2, we revisit fundamental macroeconomic theory concepts that drive any sovereign economy, demonstrate their operation, and present the limitations of any economic model, the “impossible trinity”. In Section 3, we frame the Pocket Network’s economy using macroeconomic concepts, defining production and consumption and modeling each element of the macroeconomic equations. Section 4 delves deeper into the Pocket economy, defining how we can gather the required data to complete the model. We share our estimations and beliefs in this section, acknowledging that much of the needed information does not currently exist. In Section 5, we present some results from our model, detailing where we stand today, what can be expected in the short term, and potential future trajectories (with a fair share of “ifs”). We conclude the document in Section 6, drawing some conclusions and opening the discussion to the community

2 The Macroeconomic Theory

The present work attempts to extrapolate basic concepts of classical fiat currency macroeconomics to the macroeconomics of our ecosystem in order to make rational decisions about its parameters. This introduction is based on the IS-LM model for an open economy. The reader is referred to [1] for a more detailed introduction to the subject. Here the notions applied to the developed model will be presented, assuming a basic knowledge of macroeconomic theory.

2.1 Goods and Services Market

From a macroeconomic point of view [1, Chap. 3], production (Y) can be measured in two ways: what the system supply (Y_s)and what the system demands Y_d. Being in equilibrium, the production of the system must be exactly equal to what the system spends:

$$Y_s = \sum relays \times RelaysToTokensMultiplier \tag{1}$$

$$Y_d = C(Y,T) + I(r,\varepsilon) + G(\varepsilon) + XN(Y,\varepsilon) \tag{2}$$

where Y_s is the aggregate supply, Y_d is the aggregate demand, C is the consumer expenditure of the system, I is the investment in the system, G is the government spending, and XN is the net exports (exports minus imports). As can be observed variables C is in function of Y and taxes T, I depends of interest rate (r) and exchange rate (ε), G depends of ε, and finally XN depends of Y and ε.

2.2 Money Market

While the supply of money is fixed at a given time t, the demand for money depends on the interest rate r in a decreasing way. That is, the lower the cost of money, the more industry will be predisposed to borrow to produce, and the more the population will be predisposed to consume. More in detail, the real quantity of money is defined as $\frac{M}{P}$, where M is the *nominal*[1] quantity of money and P is the price index. On the other hand, the demand for this real money will depend on Y and r such as the higher the level of activity Y, the more willing the industry will be to borrow at higher rates, since a high level of production is a symptom of a high level of return that allows paying high interest rates.

[1] Real" money differs from "nominal" money in that the former measures what can actually be purchased with the amount of money.

The above is usually defined as [1, Chap. 4]:

$$L(Y,r) = \frac{M}{P} \tag{3}$$

Where the surface $L(Y,r)$ is a specific function of each economy analyzed.

2.3 Balance of Payments

The balance of payments (BOP) relates the flows of money coming into and going out of the economy under analysis, such as imports, exports, foreign investments, etc. It is the sum of flows made and payments received for/by agents outside the system and it is composed of two accounts: current account (CA) and capital and financial account (CFA). Since money is neither created nor destroyed by interaction with the external sector (it only changes hands) BOP is zero [1, Chap. 19]:

$$BOP = CA + CFA = 0 \rightarrow CA = -CFA \tag{4}$$

The CA includes exports and imports of goods and services of our system (e.g. hardware rental or insurance payments) and depends negatively on the level of production, thus, $CA(Y)$: the higher the production, the more inputs are needed. The CFA refers to the flow of financial assets and depends positively on the r [CK(r)] because the higher the r, the more capital will flow into our ecosystem. As an example, having anegative CA it is compensated by a positive CFA (i.e. to have a trade deficit compensated by an inflow of foreign capital).

CA is defined as the difference between exports X and imports IM:

$$CA \approx XN = X - IM \rightarrow X(Y) - IM(Y) \tag{5}$$

On the other hand, the CFA is defined as F, a function of r and foreign interest rate (r^*):

$$CFA = F(r, r^*) \tag{6}$$

A major factor in the balance of payments is the ε. The ε is the relative price of the currencies of two systems; it is the amount of foreign money needed to acquire one unit of one's own currency. Tuhs, Eq. 4 is defined as follows:

$$XN(Y,\varepsilon) + F(r, r^*) = 0 \tag{7}$$

2.4 The Impossible Trilemma

The Impossible Trilemma (a.k.a. Mundellian Trilemma)[11] is a concept is a concept of international economics and international political economy that states that it is impossible to have the following three things at the same time:

1. A fixed exchange rate ε
2. The free mobility of capital, i.e. the entry and exit of capital into and out of the system without restrictions as to time of permanence or taxation.
3. Autonomous monetary policy, which refers to the free determination by the monetary authority the amount of money in circulation.

It is only possible to have at most two of the three conditions, but not all three. For example: Let us think of a country with free mobility of capital and a fixed exchange rate, if this country enters into recession, it will want to lower the interest rate through an expansive monetary policy, this will generate that capital will seek better interest rates outside the country, this makes local currency is sold and foreign currency is bought to take it abroad, to maintain the fixed exchange rate, the local money supply must be reduced, and this is contradictory to the idea of reducing the interest rate, losing the autonomy of monetary policy. In our case, it is impossible to even think of an attempt to control the exchange rate, since the price of the Pokt measured in dollars is governed by the laws of supply and demand in all the exchanges in which it is traded. The mobility of capital is not completely free, since it requires the well-known 21 days for unstaking, which gives us a good margin to develop an autonomous monetary policy.

2.5 Some assumptions about the system

Under the following assumptions:

- The real exchange rate is equal to the nominal exchange rate: As a consequence, the local price level is equal to the global price level, i.e. we cannot charge more for a relay than what is charged in other systems and we do not want to charge less.
- Price of the relay is expected to be constant: If we define inflation as follows:

$$1 + f = \frac{p_1}{p_0} \tag{8}$$

  Our assumption is not that inflation exists, nor is it expected, in the future.

- Capital mobility: in our system this is quite true, as the 21 days needed to perform an unstakig does not seem too deep a constraint. The exchange rate adjusts instantaneously to maintain equilibrium in the exchange market, this seems a cruelly self-evident truth, given that the price of the Pokt varies freely on each exchange.
- Inability of the local interest rate to influence the global interest rate: very easy to think of as verified.
- Free mobility of capital inflows and outflows: it's is more difficult to verify. Despite the minimum staking time is a mere 21 days, we cannot think that this is exactly the same as the free mobility of capital.

and from Eqs. 2, 3, and 4, it can be established the following system of equations [16, Chap. 8.6]:

$$Y - C(Y, T) - I(r, \varepsilon) - G(\varepsilon) + XN(Y, \varepsilon) = 0 \tag{9}$$

$$L(Y, r) - \frac{M}{P} = 0 \tag{10}$$

$$XN(Y, \varepsilon) + F(r, r^*, \varepsilon) = 0 \tag{11}$$

3 The Macroeconomy of the Pocket Network

The macro economy of any sovereign ecosystem is observed using three features:

- The total production production (Y)
- The exchange rate ε
- The interest rate r

These three features balance each other following the equations 2, 3, and 4 presented in section 2, which we will repeat here for convenience:

$$\begin{aligned} Y - C(Y,T) - I(r,\varepsilon) - G(\varepsilon) + XN(Y,\varepsilon) &= 0 \\ L(Y,r) - \frac{M}{P} &= 0 \\ XN(Y,\varepsilon) + F(r,r^*,\varepsilon) &= 0 \end{aligned}$$

These three equations conform to a system which is balanced at any given time. How the balance is achieved depends on the functions:

- $C(Y,T)$: The consumption.
- $I(r,\varepsilon)$: The investment.
- $G(\varepsilon)$: The DAO spending.
- $L(Y,r)$: The liquid money surface.
- $XN(Y,\varepsilon)$: The current account or balance of trade.
- $F(r,r^*,\varepsilon)$: The capital account.

In this section we will describe how these functions can be modeled for the Pocket Network, defining probable behaviors for each of them based on available data.

3.1 The Trilemma in the Pocket Network

We can phrase the economic trilemma in terms of the Pocket Network and achieve some general understanding of its macroeconomic implications. Currently:

- Capital mobility is high: The 21 days needed to unstake are not a significant barrier to capital mobility.

- Exchange rate ε is not fixed: By any ways can't be controlled right now.
- Monetary autonomy is high: the DAO is the one that imposes the amount of the circulating POKT, being able to make a restrictive or expansive monetary policy.

Given free mobility and monetary autonomy, then the price cannot be controlled. If it is desired that ε changes, for example, rising, it's needed to change:

- The monetary policy: modifying the monetary base through less emission, burning tokens and/or taking pokts through borrowing. This restricts the money supply. It can no longer (arbitrarily) be decided the amount of circulating pokt, but it must be adjusted to an equilibrium with ε.
- The mobility of capital: this would be to generate obstacles for the exit of capital from the ecosystem, for example by increasing the minimum unstaking time or that loans are not transferable (in case there is, in the future, something similar to a bond).

3.2 Consumption: C

The consumption (C) function represents all the value that is eliminated from the system, like eating a watermelon, the good ceases to exist along with the value that it had. The POKT token is consumed in several ways:

1. Slashing : An actor gets slashed due to misbehavior [6] [2].
2. Transaction Fees : A transaction is done, like sending POKT from an account to another or placing a `CLAIM` or `PROOF` transaction.
3. AppBurn : An application pays for the relays it consumed from the Pocket Network.

From these three, currently in Pocket Network v0, only the first one is real burning. As the number two is in fact collected and redistributed to the validators and DAO [6] [3] and the last one is not implemented. We assume that in Pocket Network v1 the application burning will be implemented and that transaction fees will not be collected and rather burnt [4]. From these three elements, only the first two are real consumption. The third one, the app burning relays are in fact exports of the Pocket Network, the product (the relay) is leaving the Pocket Network and is being paid for by a foreign actor [5]. We will account for application burning later in this section.

[2] https://github.com/pokt-network/pocket-network-protocol/tree/main/utility#327-stake-burning
[3] https://github.com/pokt-network/pocket-network-protocol/tree/main/utility#362-block-rewards
[4] See section 6.1 for more information
[5] This is true unless it is a relay for the Pocket Network blockchain, we will assume this error and move forward.

We have narrowed down the Pocket Network consumption to two elements, slashing and transaction fees, now we can model how these change as functions of the Y, the taxes (T) and the ε. We propose the following function family to describe the Pocket Network's consumption function:

$$C(Y,T) = c_0 + c_1(Y) + c_2(Y,T), \tag{12}$$

where c_0 represents the constant consumption of the network, these are all the transactions that take place regardless of the production rates of the network. This is expected to be really low. The function $c_1(Y)$ are all the transaction fees paid for working, this means all the `CLAIM`, `PROOF` and `SEND` that are direct consequences of the relay processing, without paying these fees the relay won't be processed. Finally the function $c_2(Y,T)$ are all the transaction fees originating from production gains. More tokens in the economy probably will produce more exchanging of tokens or more staking, this function models it. If T is too high, this function must reflect a negative effect on consumption.

3.3 DAO Spending: G

The DAO spending is what normally is called "Public" or "Governmental" spending. This represents all the tokens coming from the DAO accounts and distributed to the community to pay for services, salaries, developments, etc. The DAO has two types of spending, some denominated in POKT like grants, and some denominated in in USD, like DAO employees wages. The DAO spending can be easily modeled by:

$$G(\varepsilon) = d_0 + d_1\varepsilon, \tag{13}$$

Where d_0 is the spending in POKT and d_1 is the amount of USD spending.

3.4 Liquid Money: L

The liquid money surface relates the monetary base M and the relay price p to a given curve that determines the expected production Y given a certain interest rate r. This will describe how the amount of available tokens and the price of the relays in POKT relates to Y. Currently we don't know much about this curve because the Pocket Network has no finite r, but we have some boundary conditions that can help us shape it:

- The higher the r, the lower is the Y (tokens will be used to lend not to produce).
- Today we are at infinite r and hence at max Y given the monetary base (a large amount of tokens are staked on serviser nodes)

- The LM surface is defined by the historical Y of the network ($\frac{M}{p}$)

Without any more information we propose to model this behavior as simple as possible:

$$L(Y, r) = l_b Y^{l_{kb}} - l_a r^{l}_{ka}, \tag{14}$$

Where the parameters l_b, l_{kb}, l_a, l_{ka} define a linear relationship between Y and r for a given L value. These variables play in such a way that an increase of r result in a decrease of Y.

3.5 Current Account - Balance of Trade: XN

The balance of trade or current account is the difference between the imports and exports of the Pocket ecosystem. The Pocket Network has a single export, which is the relay, and several imports, which are hardware and services. The exports of the network are easily observable as they are composed of all the tokens that are burnt from relay processing. The cost of burning these tokens must be paid by the recipients of the relay service, so we count this burning as exports. On the other hand the imports of the network are not easily observed, they are composed of all the tokens that the Pocket Network participants (such as servicers, validators, fishermen, etc) require to function, including hardware, services and human resources. These costs can vary wildly depending on the current development of the Pocket Network client, international costs of hardware and wages, etc. We can only estimate the amount of imports and how we estimate this is a subject by itself that we do not pretend to solve here, we will accept that there is a cost and somehow we can achieve a number that represents it. With this in mind the balance of trade can be simply defined as:

$$XN(Y, \varepsilon) = X(Y) - NC(Y)\varepsilon \tag{15}$$

Where X is a function that represents the burning associated to a production volume Y, this in fact could be a linear function like $X(Y) = Yx_a + x_b$ that accounts for how much production comes directly from relays that incur into burning and how much comes from other sources. The second term of the equation, $NC(Y)$ is a function that relates production levels to costs in USD, we believe that this function is a step function, meaning that at certain levels of production a change in the cost is applied and that value holds for a given range. This means that we argue that the network cost is not elastic with production levels, it adjusts in discrete changes.

3.6 Capital and Financial Account

The capital and financial account CFA represents the flow of capital in the ecosystem for reasons that are not related to production. This account represents the capitals entering the system to invest or leaving the system to take profit or invest elsewhere. At least two factors affect this account: r and r^*. When r in the ecosystem, adjusted by ε, is higher that the r^* (like ETH staking returns), the capitals will enter if they perceive an acceptable risk, on the other hand, if r is lower than the reference, the capitals will leave the ecosystem creating a negative balance. There is also part of the capitals that will enter or leave regardless of r and tied only to the r^*, so part of this balance cannot be controlled by the ecosystem. The Pocket Network has another factor to bake in, which is the amount of capital that will enter the ecosystem regardless of r and looking only at the ε. This represents the majority of the current capital inflow, they are high risk inversions that are willing to buy as long as the price is low enough, expecting a later increase in the price to make profit. All these factors can be represented as:

$$F(r, r^*, \varepsilon) = f_a(r, r^*) + f_b(r^*) + f_c\left(\frac{\partial \varepsilon}{\partial t}\right) \tag{16}$$

With:

$$f_a(r, r^*) = f_h\left(1 - \frac{1}{f_k^{\,r-r^*}}\right) + f_{h0} \tag{17}$$

Where f_h determines the maximum expected inflow of capital due to the high-risk infinite interest rate scenario (the current scenario). Then:

$$f_b(r^*) = -f_{bk}r^* + f_{ba} \tag{18}$$

Where f_{bk} and f_{ba} represent a linear function that relates capital inflow as a function of the external interest rate. We have no information on the behavior of this function, we assume it is linear. And finally,

$$f_c\left(\frac{\partial \varepsilon}{\partial t}\right) = f_{ck}\frac{\partial \varepsilon}{\partial t} \tag{19}$$

Where f_{ck} is a linear constant that relates how many tokes the market is willing to buy at a given price increase or decrease velocity. This function is linear here but it is important to analyze its behavior further in future works.

3.7 Inversement: I

The investment function collects all tokens that are committed to a given purpose on the Pocket Network. A POKT token can be used for other purposes besides obtaining relays, it can be staked in several actors (Apps, Servisers, Fishermen, etc), holded with speculative purposes or lend to expect some return. All these uses conform to a way of investment which is governed by different kinds of variables. We model the investment on the Pocket Network by means of the following terms:

$$I(r,\varepsilon) = \frac{r_a}{r^{r_k}} + r_0 + r_h(\frac{\partial \varepsilon}{\partial t}), \tag{20}$$

where r_0 is investment done regardless of the other variables, this models the constant investment seen for servicer and validator nodes in v0, which is done regardless of the high interest rate. It can also be thought of as a function of the investment return but we are not analyzing staking economics in this document.

The parameter r_a is the sensitivity of the Pocket Network to changes in the interest rate. For higher interest rates we would expect to have lower investments, as it would be more difficult to recover the investment due to higher payments required. The final function $r_h(\frac{\partial \varepsilon}{\partial t})$ represents the capital that is being held with speculative purposes, this depends on many things, but it can be argued that it depend on the derivative of the token exchange rate over time, if the token has an upward trend, the community will hold more and the other way around.

4 Constructing the Macroeconomic Model

In this section we will build upon the previous sections' definitions. Here we define the required data to complete the model and show where this information can be obtained. Many parameters cannot be fully defined without making assumptions about the capital interactions in the Pocket Network. These assumptions only represent our beliefs and therefore we do not claim that they are correct.

For simplicity and reliability we will assume all values to be expressed in a period of a single day, this means that a production of X POKT is actually a production of X POKT/Day. The analyzed period is for all data the same, we sampled 120 days, or 11136 blocks from 2022-12-21 18:35:52 (height 80138) to 2023-04-20 18:32:21 (height 92287). The exchange rate at the beginning of the analyzed period was 0.07267 USD/POKT and at the end of the period was 0.04118 USD/POKT, according to Coinmarketcap [5]. The produced POKT per day at the beginning of the period is 872×10^3POKT and at the end 523×10^3POKT. According to [4] the current annual network costs are 15×10^6 USD.

4.1 Consumption: C

Recalling Eq. 12, C is expressed following the equation:

$$C(Y, T) = c_0 + c_1(Y) + c_2(Y, T)$$

The data required to give entity to the equation parameters comes mostly from the number and type of transactions in the Pocket Network. Taking a sample of transactions fees in the given period [6] it is obtained the distribution of fees in the network as shown in Fig. 1

[6] Removing outlier transactions: E057A461C645562C90A0E7EB005E0F1685CEFC112AE46089961E4F17C7D4CDE0 and 55AFB3703C92BFCE3B1DA610383705410F4FD7034CD31D514825485404DFCA85

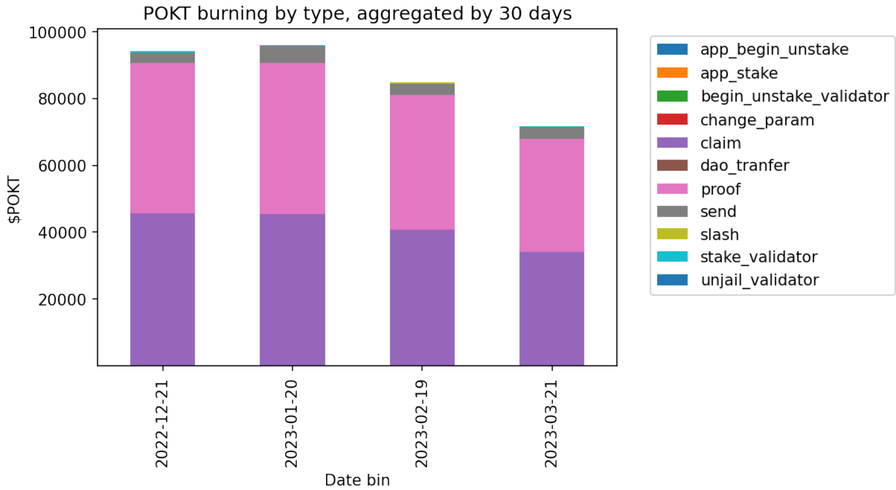


Figure 1: Distribution of fees in the Pocket Network

It can be seen that the dominating fees are the ones of type `PROOF` and `CLAIM`. These transfers are directly related to the number of processed relays and hence to production Y. The fees related to relay processing make up for 95.23% of the total. Due to this fact we model simplify consumption with:

- $c_0 = 0 \rightarrow$ no marginal consumption.
- $c_2(Y, T) = 0 \rightarrow$ No profit related consumption.

We impute all consumption to Y which we think behaves linearly:

$$c_1(Y) = c_k Y, \tag{21}$$

Where c_k is a constant defined by the amount of daily fees that we observe today:

$$c_k = \frac{\text{Relays Fees by Day}}{\text{POKT minted by Day}} \tag{22}$$

Replacing with the current observed values:

$$c_k = \frac{347006\text{POKT}}{110} \frac{1}{523 \times 10^3\text{POKT}} = 0.005526 \tag{23}$$

This creates a behavior of network consumption, near the current equilibrium, as illustrated in Fig. 2.

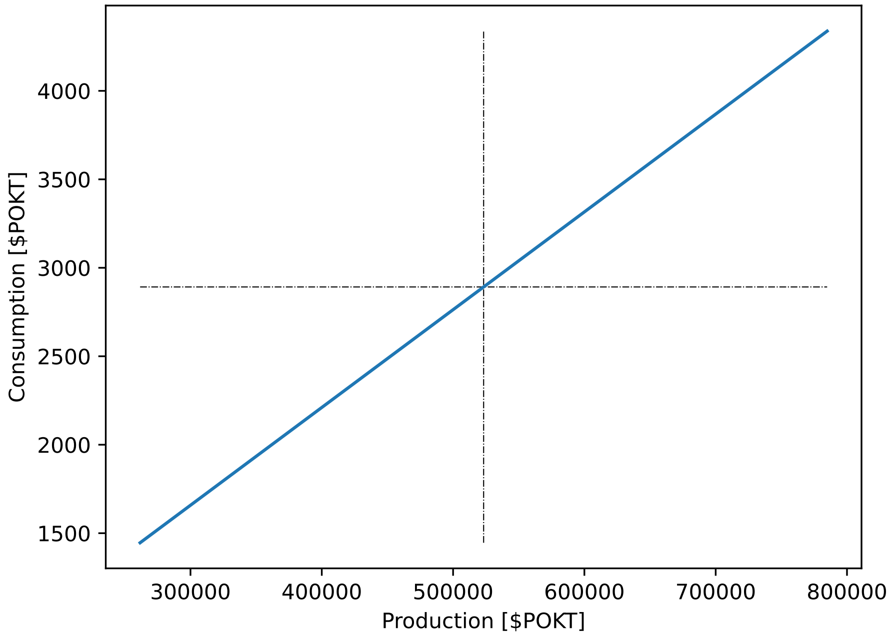


Figure 2: Pocket Network consumption $C(Y,T)$**.**

4.2 DAO Spending: G

Recalling Eq. 13 DAO spending is defined as:

$$G(\varepsilon) = d_0 + d_1\varepsilon, \tag{24}$$

We are able to track all the expenses from the DAO in the observed period, they all add up to 436647.205POKT, meaning that the DAO spend 3638.72POKT per day on average. Given that most expenditures are due to reimbursements, the majority of the DAO spending is denominated in USD, then we model the current spending with $d_0 = 0$ and:

$$d_1 = \frac{\text{Current spending}}{\varepsilon} = 3638.72 \text{ POKT } 0.04118 \frac{\text{USD}}{\text{POKT}} = 149.84 \text{ USD} \tag{25}$$

4.3 Liquidity: L

Recalling Eq. 14, liquid money surface is defined as:

$$L(Y,r) = L(Y,r) = l_b Y^{l_{kb}} - l_a r^l_{ka}$$

Without an active interest rate r, the only information that the Pocket Network can provide regarding r is an upper threshold, which should be around the production rewards. This means that if you make r_s return in a year being a servicer node and taking the risk of running the hardware and so on, the r "risk free" return of lending money to finance business in the ecosystem should be below the production return, hence $r_s > r$. Nevertheless there is no lending mechanism in the Pocket ecosystem, so we can think that $r_s \sim r$ which translates in no lending occuring. With this in mind we can calculate the value of r_s by tracking the profit of the nodes during the observed period:

$$\text{income 15k block} = \sum_{b=1}^{B} \frac{\frac{\text{node rewards}_b}{\text{number of nodes}_b} \times \text{SSWM}_b}{B} \tag{26}$$

Where B is the number of blocks in the observed period and SSWM is the *Servicer Stake Weight Multiplier* [7], then in the period of analysis (4 months) the average POKT income per 15×10^3 POKT staked is:

$$\text{income 15k (4 months)} = \text{income 15k block} \times 4 \times 30 \times 4 \times 24 \tag{27}$$

Then, to get the devaluation corrected value of the yearly return we proceed to:

$$r_s = \frac{\text{income 15k (4 months)}}{15 \times 10^3 \text{ POKT}} \frac{12}{4} \frac{0.04118}{0.07267} = 0.26480 \tag{28}$$

Then, by using the reference of the current return of stake POKT of 26% we argue that the current interest rate is approximately at $r = 0.26$. Which would explain that no lending occurs, but if someone is willing to take a high risk (and counter intuitive business) it's possible to obtain a loan.

The amount of *real* money in the ecosystem is also known, we have the total number of minted POKT at the end of the period $M = 1.5 \times 10^9$ POKT and the price index, which is the price of a relay. According to [12] a relay costs $P_{USD} = 0.000001 \frac{\text{USD}}{\text{relay}}$, then the real money is:

$$LM = \frac{M}{P} = \frac{1.5 \times 10^9 \text{ POKT} \times 0.04118 \frac{USD}{\text{POKT}}}{0.000001 \frac{\text{USD}}{\text{relay}}} = 4.88 \times 10^{15} \tag{29}$$

The current amount of liquid money is composed of two terms according to the formulation in Eq. 3, we ignore the real distribution of each term (we know nothing of this surface actually)

[7] Pocket Docs.

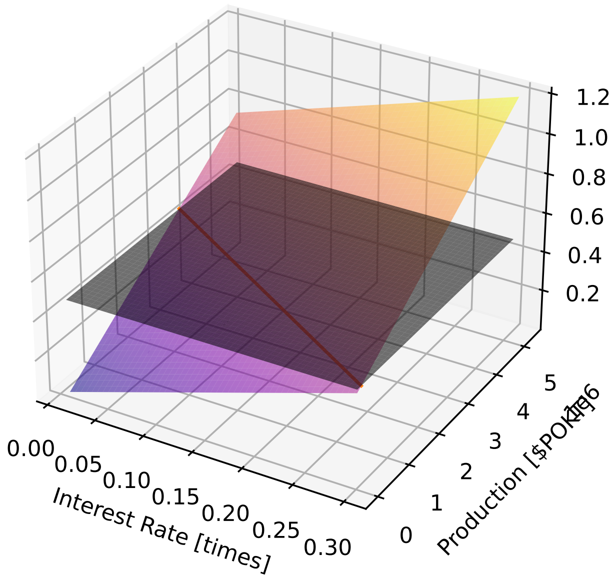


Figure 3: Liquidity surface

so we impose $l_{ka} = l_{kb} = 1$ and a $85/15$ split at current values:

$$L(Y,r) \times 0.85 = -l_a r, \tag{30}$$

And

$$L(Y,r) \times 0.15 = l_b Y, \tag{31}$$

Obtaining then:

$$l_a = -\frac{L(Y,r) \times 0.85}{r} = -\frac{4.88 \times 10^{15} \times 0.85}{0.26} = -1.5 \times 10^{16} \tag{32}$$

$$l_b = \frac{L(Y,r) \times 0.15}{Y} = \frac{4.88 \times 10^{15} \times 0.15}{523 \times 10^3 \text{POKT}} = 1.4 \times 10^9 \tag{33}$$

The resulting surface, along with the real money level plane and the current LM curve is shown in Fig. 3.

4.4 Current Account - Balance of Trade : XN

This is perhaps the most discussed subject in the Pocket network at this time. Recalling Eq. 15 the balance of trade accounts for all the imports and exports of the ecosystem:

$$XN(Y, \varepsilon) = X(Y) - NC(Y)\varepsilon \tag{34}$$

being the imports $NC(Y)$ the required infrastructure and human resources costs of running the network that are denominated in USD or other foreign currency and the exports $X(Y)$ the relays done for other blockchains. Obtaining the exact value of the latter is easy as all relays are written on the Pocket blockchain, the former on the other hand is more difficult to observe.

The current exports are zero, as the PNI buy-backs do not account for network revenue [12] and there is no active burning mechanism. Therefore the exports equation can be defined as:

$$X(Y) = Y \times x_a \tag{35}$$

With $x_a = \text{AppBurnRate} = 0.0$ The import term is not elastic, meaning that it won't move directly driven by production Y, it will move in discrete jumps depending on the node runners, gateways and other actors' investment. Since the model is only expected to remain informative in changes near the current equilibrium, we can consider the network costs to be fixed. Currently the yearly network costs are 15×10^6 USD, resulting in:

$$XN(Y) = NC_{level} = \frac{15 \times 10^6 \text{ USD}}{365} = 41.1 \times 10^3 \text{ USD}, \tag{36}$$

Finally:

$$XN(\varepsilon, Y) = Y \text{ AppBurnRate} - NC_{level}\varepsilon \tag{37}$$

Which we will leave parameterized for convenience of later implementations.

4.5 Capital Account : F

The capital account, defined as

$$F(r, r^*, \varepsilon) = f_a(r, r^*) + f_b(r^*) + f_c(\frac{\partial \varepsilon}{\partial t}) \tag{38}$$

Is the responsible for achieving a balance in the current state of the ecosystem As seen in the previous subsection, the balance of trade is currently:

$$XN(\varepsilon, Y) = 0 - 41.1 \times 10^3 \text{ USD} \frac{1}{0.04118 \ \frac{\text{USD}}{\text{POKT}}} = -998 \times 10^3 \text{ POKT} \tag{39}$$

This large deficit must be compensated by inflow of capital into the system. This inflow is investment coming to the ecosystem and it is driven (at least) by three factors: interest rate r, exchange rate ε and expectative/marketing (which is not measurable). In today's ecosystem it is not realistic to think that capital is entering the ecosystem due to the interest rate or production profit. We calculated the nominal interest rate, adjusted by POKT inflation, to be capped at 26% due to production profit. As external low risk foreign interest rate we chose the ETH staking rate, $r^*_{\text{ETH}} = 5\%$ [2]. Now it's necessary to express $r^*_{\text{ETH}} = 5\%$ in terms of POKT. Given exchange prices of 5.97×10^{-5}ETH/POKT and 2.12×10^{-5}ETH/POKT at the beginning and end of the period, respectively, we calculate the ETH staking rate in terms of POKT as follow:

1. Compute 15k POKT as ETH:
   $\rightarrow$ 15K POKT $\times 5.97 \times 10^{-5}$ETH/POKT $= 0.8956$ ETH
2. Stake ETH along the period:
   $\rightarrow 0.8956$ ETH $(1 + r^*_{\text{ETH}} \frac{4}{12}) = 0.9103$ ETH
3. Compute Stake ETH plus rewards as POKT:
   $\rightarrow \frac{0.9103 \text{ ETH}}{2.12 \times 10^{-5} \text{ETH/POKT}} = 42907 POKT$
4. Compute the r^* rate as the ratio between the final and initial POKT proyected to a year:
   $\rightarrow r^* = \frac{42907 \text{ POKT} - 15K \text{ POKT}}{15K \text{ POKT}} \frac{12}{4} = 5.581$

We argue that the current imbalance is divided among the proposed terms as:

- An additional 20% of the total imbalance is added pressure from capital leaving the system due to high-risk low-revenue profile of the Pocket Network.
- An additional 20% of the total imbalance is added pressure from capital leaving the system due to high foreign interest rates.
- All the imbalance, 140% of the balance of trade imbalance is currently entering the system by means of POKT depreciation. This can be price action on exchanges or simply node runners having to absorb costs refusing to sell POKT at current prices.

Then, the first term can be expressed as:

$$f_a(r, r^*) = f_h \left(1 - \frac{1}{f_k^{r-r^*}}\right) + f_{h0} = -0.1\, XN(\varepsilon, Y), \tag{40}$$

But as it is seen, the equation is still indeterminate, as we have two unknowns, f_h and f_{h0}. Then we need to propose few additional points:

- Increasing the interest rate 10 times will only reduce production by half: $f_a(10, r^*) = 0.5 f_a(0.26, r^*)$
- With lower interest rate, capital will leave faster, then: $f_a(0.1, r^*) = 1.5 f_a(0.26, r^*)$

These are just arbitrary design choices that should be changed once we are able to define an interest rate and observe its effects. Given these three points, we can fit the proposed function using a modified powell method from the SciPy library [15], and obtain the values: $f_h = 1.03 \times 10^{-7}$, $f_k = 100$ and $f_{h0} = -4001$.

For the second term we chose a simplistic approach, since our knowledge is limited (if any). We propose that at current r^* we have:

$$f_b(r^*) = -f_{bk} r^* + f_{ba} = -0.2\, XN(\varepsilon, Y) \tag{41}$$

And also that at half of the interest rate this will invert:

$$f_b(0.5r^*) = -f_{bk} 0.5r^* + f_{ba} = 0.2\, XN(\varepsilon, Y) \tag{42}$$

Using this two proposed values we reach the following parameters:$f_{bk} = 1472.58$ and$f_{ba} = -16438.35$

Finally the last term, which is currently balancing all the trading imbalance and acts on the POKT price is defined as:

$$f_c(\frac{\partial \varepsilon}{\partial t}) = f_{ck} \frac{\partial \varepsilon}{\partial t} \tag{43}$$

But it is not possible to analyze the derivative of the POKT value $\frac{\partial \varepsilon}{\partial t}$ in an static model, so we simplify this further to:

$$f_c(\varepsilon) = f_{ck} \varepsilon = -1.4 XN(\varepsilon, Y), \tag{44}$$

Where the current imbalance defines the slope:

$$f_{ck} = \frac{-1.4 \times XN(\varepsilon, Y)}{\varepsilon} = -1.4 \times -998 \times 10^3 \text{ POKT} \times 0.04118 \frac{\text{USD}}{\text{POKT}} = 2369 \text{ USD}, \quad (45)$$

Then the variations of the capital account with respect to the three variables (r, r^* and ε) are represented in Fig. 4.

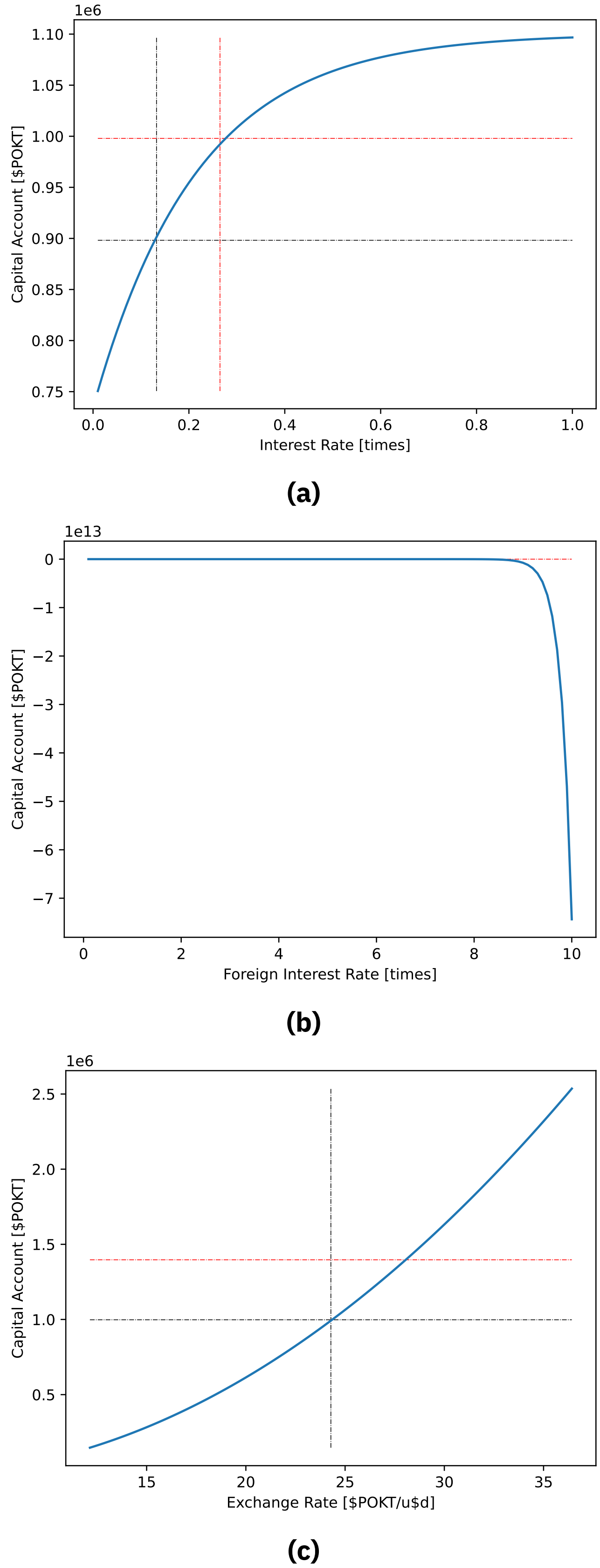


Figure 4: a, b, c: Capital account variation with respect to r, r^*, and ε, respectively.

4.6 Investment: I

The investment was defined in Eq. 20 as:

$$I(r,\varepsilon) = \frac{r_a}{r^{r_k}} + r_0 + r_h\left(\frac{\partial\varepsilon}{\partial t}\right) \tag{46}$$

We can argue that this formulation is lacking an important term, which is the staked POKT return r_s (for servicers, validators, gateways, etc.), but for the sake of simplicity we will leave that for future work. Given that this element is the only one that is not correctly observable from Eq. 9, we can define the current level of investment per day as:

$$\begin{aligned} I(r,\varepsilon) &= Y - C(Y,T,\varepsilon) - G(\varepsilon) - XN(\varepsilon,Y) \\ &= 523\times10^3 - 2.89\times10^3 - 3.64\times10^3 + 976\times10^3 = 1492\times10^3 \text{ POKT}, \end{aligned}$$

This investment must be obtained from several sources, the investment due to interest rate value, the investment done regardless of other variables and the holding or passive investment.

If we define the base investment as the increase/decrease of total stake POKT observing the data, we obtain $I_{base} = 690\times10^3$ POKT. However we don't know exactly how much of this is due to current interest rate/stake returns effects and how much is due to other unrelated effects. For this reason we propose to find the values of r_{ka}, r_k and r_0 that fulfill the following criteria: at current levels of r obtain I_{base} investment, if the interest rate drops by a half, observe $1.1\,r_{base}$ and if $r = 10$ (an extremely large value), the observed investment should stay almost the same $0.999\,r_{base}$. Using a modified powell method from the SciPy library, the found values are $r_{ka} = 0.015$, $r_k = 6.66$ and $r_0 = 689724$.

The term that must make up for all the production reminder is the holding term:

$$r_h\left(\frac{\partial\varepsilon}{\partial t}\right) = 1492\times10^3 \text{ POKT} - 690\times10^3 \text{ POKT} = 802\times10^3 \text{ POKT} \tag{47}$$

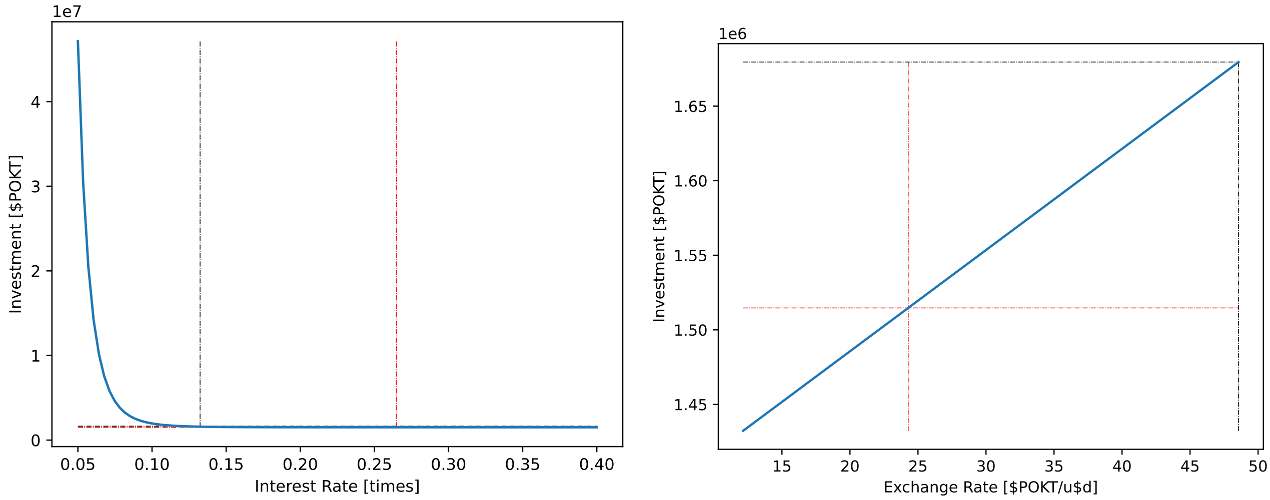
This means that the ecosystem is increasing its holding or making passive investments at a rate of 802×10^3 POKT per day. This includes all real holding and all costs absorbed by node runners that never impact the ecosystem (paying running costs in foreign currency translated to POKT). While part of this holding is unwanted currently, it is expected to go up as the price grows. Also, for simplicity we will represent this function as a linear function of ε instead its derivate:

$$r_h(\varepsilon) = r_{ha} + \varepsilon r_{hb} \tag{48}$$

And we will fit this curve using two estimated points, first that the current exchange rate results in balance: $r_h(\frac{1}{0.04118\ \text{USD/POKT}}) = 802 \times 10^3$ POKT and that if the price doubles, the holding will only increase 20%:

$$r_h \left(\frac{2}{0.04118\ \frac{\text{USD}}{\text{POKT}}} \right) = 1.2 \times r_h \left(\frac{1}{0.04118\ \frac{\text{USD}}{\text{POKT}}} \right) \tag{49}$$

Using these values we obtain $r_{ha} = 6609$ and $r_{hb} = 642038$. Then the resulting changes of investment due to r and ε is shown in Fig. 5.



(a) **(b)**

Figure 5: a, b: Capital account variation with respect to r and ε, respectively.

5 Experiments and Results

Note

Please note that while the experimental results provided here serve to showcase the capabilities of our proposed methodology, actual observed outcomes may differ due to network economic processes modeling.

The model presented in this document is created to explain the current state of the Pocket ecosystem in macroeconomic terms. Many assumptions were made to complete the formulation of the model as much data is simply not available (i.e. a credible interest rate). For these reasons the model is only expected to be informative in the points near the current equilibrium. This means that large assumptions about changes in network costs, number of relays, app burning rate, etc, will push the model to uncharted places where balance is not attainable. This is not a weakness of the model, but rather a consequence of ignoring the real relationships presented in Section 4.

5.1 Full Model Equilibrium

Here we present some results on the full model equilibrium as two factors move: the total network cost and the app burn rate. These variables were tested in the following ranges:

- Network Cost: from 10×10^3 USD/day to 40×10^3 USD/day (near current cost).
- App Burn Rate (ABR) in USD: From 0.0 USD/relay (current value) to 0.00000500 USD/relay.

The results for the current ABR and network cost variations and current network cost and ABR variations scenarios are shown in Fig. 6 and 7, respectively.

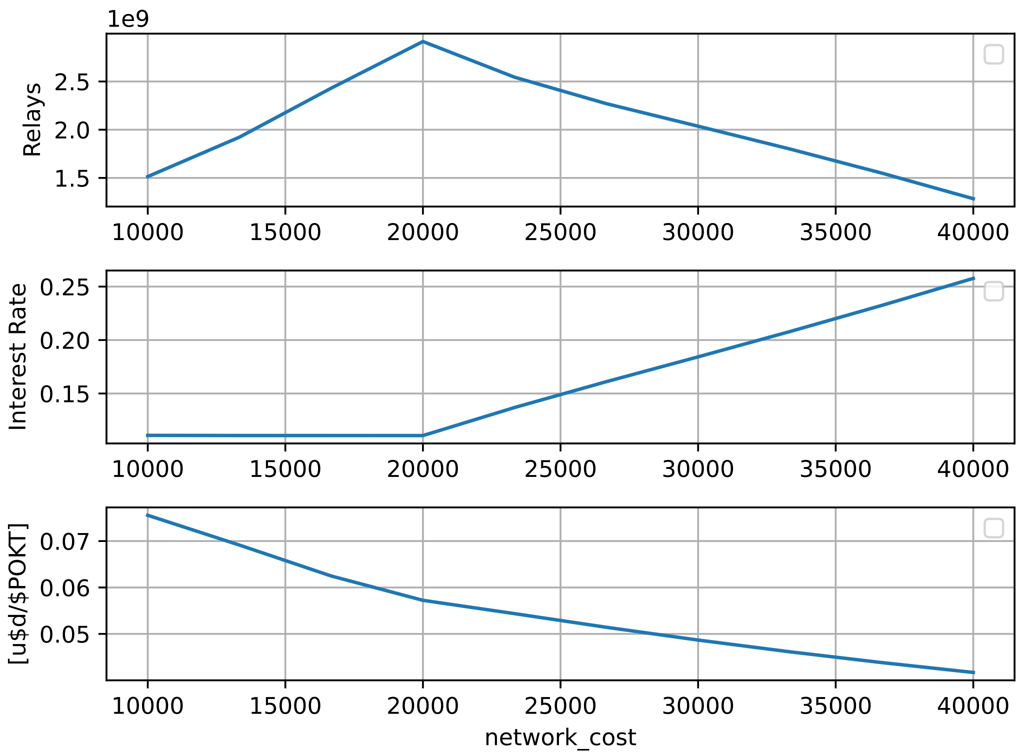


Figure 6: Full model equilibrium for current ABR and network cost variations.

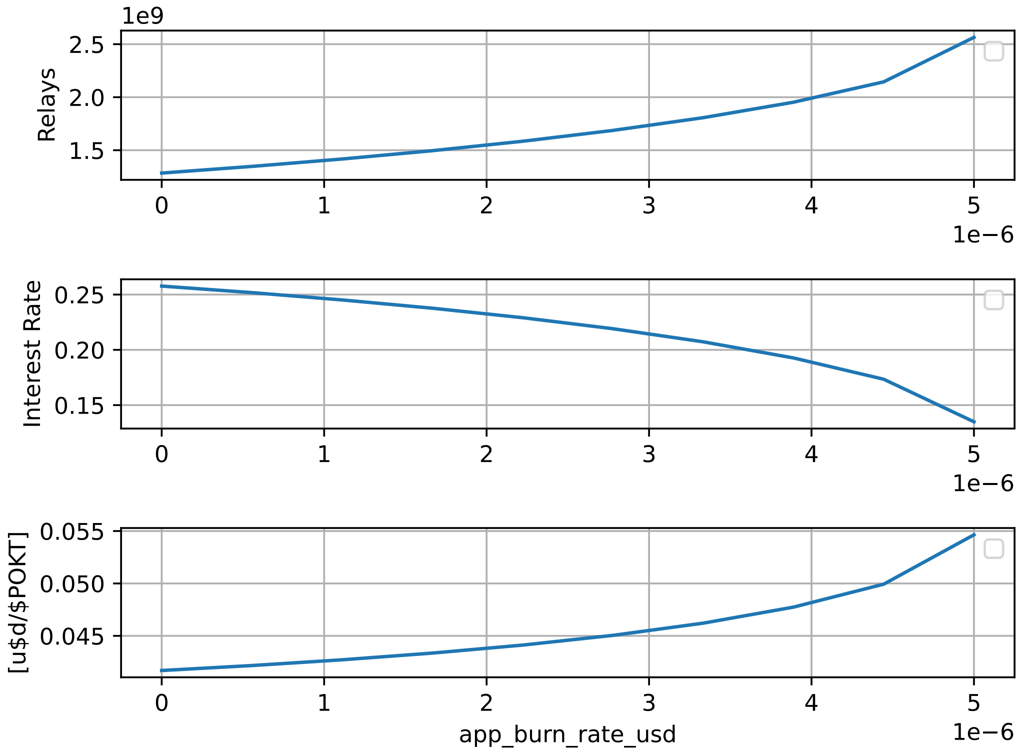


Figure 7: Full model equilibrium for the current network cost and ABR variations.

As expected the POKT price and production grows with the ABR price and with the decrease in network cost. However the increase is not monotonically as the model is limited (as explained before). If we focus on the ε, we can show the expected growth velocity as a function of both parameters in Fig. 8.

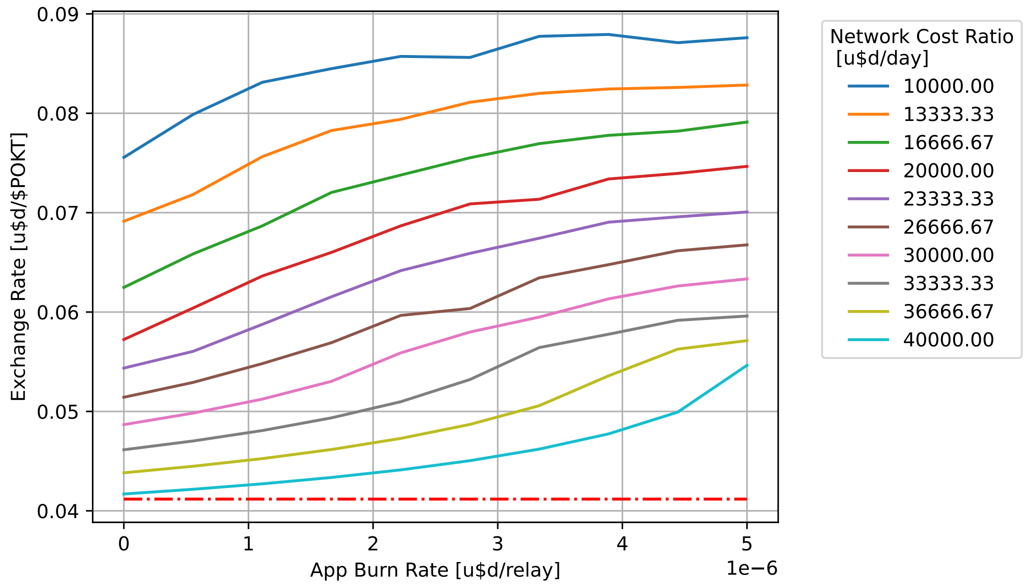


Figure 8

The result is expected, less sell pressure and more burn are the main drivers of price.

5.2 Restricted Mode Equilibrium (Balance of Payments only)

As we mentioned before the model works only in places near equilibrium, however it is interesting to analyze what happens when we try to balance only the balance of payments. The balance of trade is the main source of buy/sell pressure in the ecosystem. Using the same ranges as before we can show how Fig. 8 is modified by this restriction in Fig. 9.

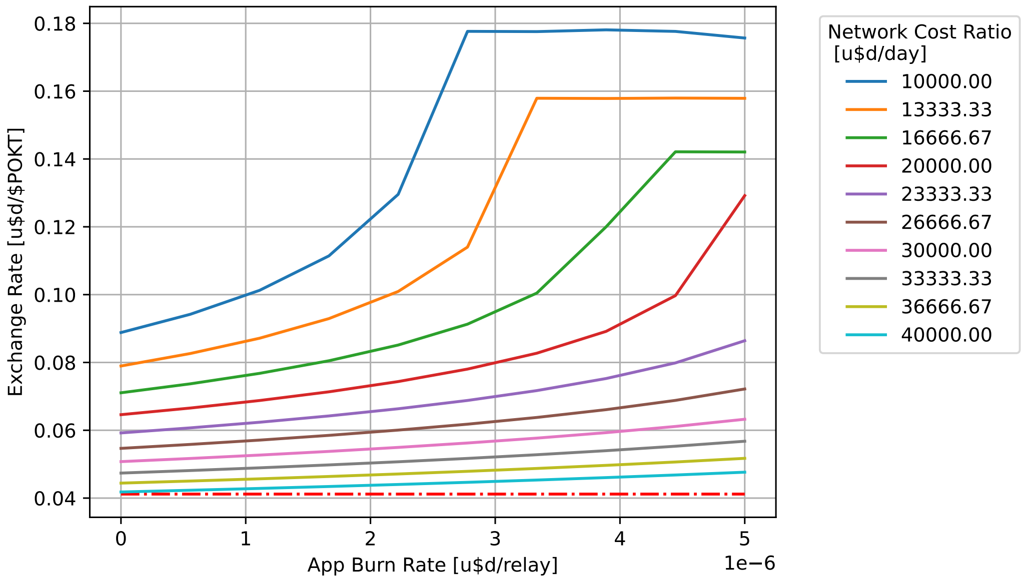


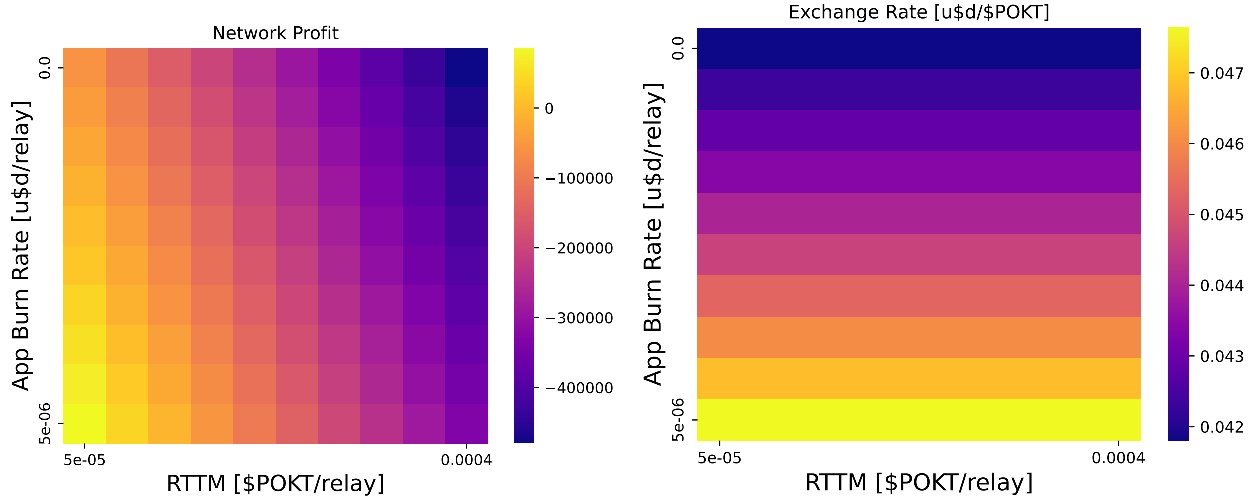
Figure 9

We can see that the increase now more monotonically, until a point is reached where the model saturates since it is too far from current equilibrium. Also price absolute value changes, due to no resistance exists by increase in interest rates or production.

With this restricted model we can be more ambitious and test how it is affected when changing:

- Relay To Token Multiplier (RTTM) : From 0.00005 relay/POKT to 0.0004 relay/POKT (near current value).

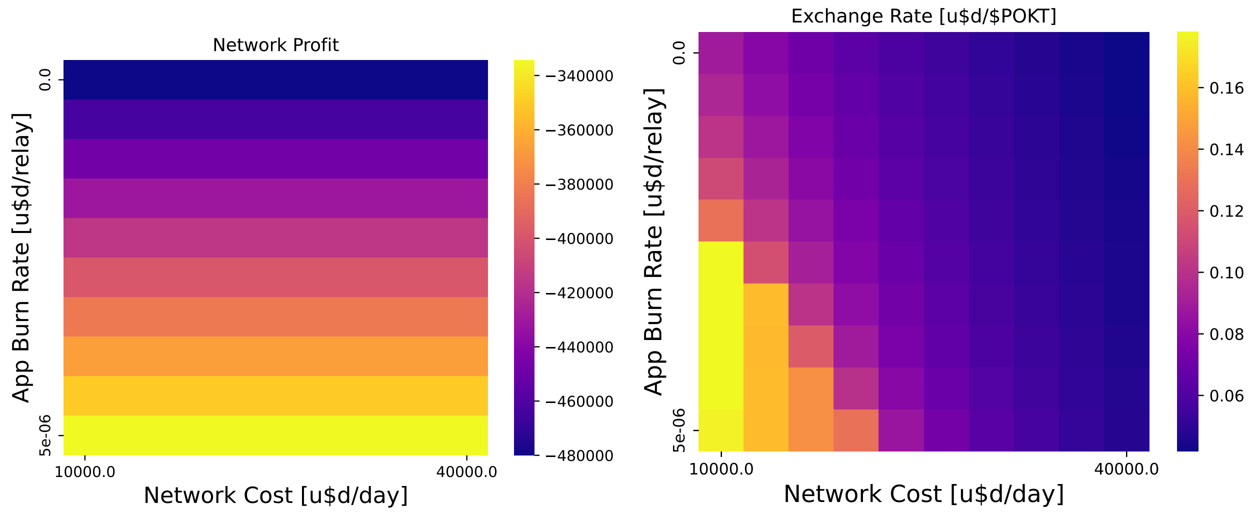
Using this full sweep of three parameters we analyze the Pocket Network profit [12] and the price trend. First we show how the RTTM and the ABR affect the network profit and price trend in Fig. 10



(a) **(b)**

Figure 10: RTTM and the ABR affecting the network profit a and price trend b.

It can be seen that Pocket Network Foundation (PNF) strategy to maximize network profit is correct, however it does not translate into perfect alignment with price increase, since RTTM does not directly affect the balance of payments. Now, if we observe how the network cost and the ABR affect the network profit and price trend in Fig. 11, we will see the inverse behavior:



(a) **(b)**

Figure 11: RTTM and the ABR affecting the network profit a and price trend b.

The network profit is not affected by the network cost, but it greatly affects the balance of payments.

In the following section we will derive conclusions over these results.

6 Conclusions

We have shown how the Pocket Network can be modeled in terms of macroeconomic theory. We presented our base modeling and ran some basic experiments. Now we will derive some conclusions on the main topics that we have addressed.

First, a few words on the model and it implications. While the presented model is successful in explaining some Pocket Network macroeconomics behavior, the model is only a first approximation. It's mainly intended to show how the Pocket Network's tokenomics can be modeled by means of macroeconomic theory. It should not be regarded as a definitive model and the presented results are only rough approximations of the real mechanics that drive the Pocket Network ecosystem. We believe that this modeling has the power to order how we approach the Pocket economy, simplify economic variable tracking, provide common ground to analyze economic proposals and use macroeconomic theory to support and propose new ideas. Nevertheless implementing such a model requires planning. We believe that it is important to:

- Track all the presented (and future) variables over time. The model will need to feed from historical data to approximate its functions.
- Track the volumes across all known exchanges to have a better estimate of sell pressure. This will improve the balance of trade calculations.
- Refine the proposed functions to match observed behavior. We only propose a simplified view of many functions (such as Consumption, Investment, etc.), these will probably won't match observations and will be required to be re-engineered over time.
- The economy is not a factual science, it changes with society, for this reason the model should be reviewed regularly and updated for changes in sentiment around the ecosystem.

6.1 Pocket Network V1 requirements

The next iteration of the Pocket Network will need to address the subject of burning in a simple way. Simplicity must prevail over any economical mechanism such as ABR. We believe that:

- All relays must incur into burning. Free relays must be subsided in other forms, such as DAO grants. This will bring clarity to what is subsided, it's important to have a strong control on how many relays are free, who is receiving these relays and for how long they are free.

- Relays can have different prices (as different products) but producing them should cost the same (no stake weighting). This makes easier to compare and set prices of our relays when comparing to other ecosystems denominated in foreign currencies.
- All work in the network should be consumption and all consumption should be burning. This means that we must consider all fees from transactions as burning. You can think of them like the gas you need to put in a train to move the goods from one place to another. This also applies to any other future work done in the network.

6.2 Experiment Results

The experiments we ran on the model were simple illustrations of the model's descriptive power. The absolute values that they provide are probably off, especially when the test parameters are too far from the equilibrium point. Nevertheless the trends and intensity that they indicate are correct. This means that if we accept the underlying modeling of all equations proposed in section 4, we can draw some conclusions. It is also important to note that sociological effects are difficult to model, i.e. the exponential growth that can provide phenomena like "Fear Of Missing Out" (FOMO) or "Fear Uncertainty and Doubt" (FUD) will be difficult to take into account and play a central role in emerging ecosystems. So once more we remind that the model is accurate on variations near the observed equilibrium.

When we analyze the results of running the scenarios proposed in the PNF ABR activation document [12], we found out that while the ABR does have a direct impact on the POKT price, its growth is not aligned with the network profit feature. This does not mean that it won't affect the price. We expect that it would have a great impact on the price as the sentiment over the Pocket Networks future improves and Pocket starts to climb on the charts like the Web3Index [13] and Token Terminal [14]. However we must be aware that the network profit can be positive without necessarily meaning that the POKT price skyrocketed.

Another observed effect is that the effect of RTTM has no direct effect on the POKT price. The RTTM is the only parameter that we have been controlling so far, and that many proposals [7, 8, 9, 10] pretend to control. The reason for this is that we have not model (or observed) a direct relation between scarcity and price as we think that it is purely sociological or speculative, which are difficult to model without proper data. This could be a weakness of our modeling and we should discuss how and if such a mechanism can be included.

Finally, we observed that the most important feature that drives the price is the Network Cost. This is not something ignored in the community, and almost all economic proposals have a common objective to drive the network cost down. However it is difficult to act on this variable because it is not something that we can control.

6.3 Observed Network State and Main Conclusions

The current state of the Pocket Network's economy is dire, necessitating prompt action for short-to-mid-term remediation. The initiation of ABR is indeed a step in the right direction, but additional measures are essential. Our analysis identified the following major issues:

1. The trade balance is entirely lopsided. Currently the imbalance is 998×10^3 POKT (or 41.1×10^3 USD) by day. This immense selling pressure must be counterbalanced by capital inflow into the system through the capital account. Assuming the estimates provided by PNF [4], this represents the first and most critical challenge for the network.

2. The network's costs currently surpass emissions, which presently approximate 523×10^3POKT. Despite operating at a loss, numerous Pocket Network operators continue to run, and there haven't been significant departures from the network. Consequently, we question whether focusing solely on emissions will restore our economy's equilibrium. Additional strategies are needed to address this issue, including greater R&D aimed at more streamlined and efficient clients, scaling the demand side, and implementing ABR to increase the price.

3. Our calculations indicate that the revenue from running a node, adjusted for POKT devaluation, hovers around $\sim 26\%$. This is extremely low considering the risk of investing in the Pocket Network, it's token depreciation history, and the reality that investments typically yield a risk-free return of both 5% [3, 2]. The initial fervor and attractive revenue of the Pocket Network have faded, and investors seem hesitant to enter the ecosystem. This reluctance is driving the price down as selling pressure from the operators persists.

4. We require more tools to attract capital and stabilize the POKT exchange rate. This could be achieved by tapping into futures markets, expanding to larger exchanges, and supporting wrapped tokens. While establishing a robust futures market takes time, it could provide us with a proxy for the interest rate, thereby preventing capital from exiting the ecosystem.

Solving these problems is no simple task, and it is not our intention to provide immediate solutions. Rather, we aim to guide efforts in the right direction. Transforming the current economic climate will take time, and our approach should be two-pronged:

1. A technical perspective to ensure each decision is informed by thorough fact-checking and rigor.

2. A social perspective to guarantee the changes we make within the ecosystem reach both our community and the broader public. Economics is a social science, thus building confidence and a historical narrative is crucial for any plan's success. Economic decisions shouldn't be based solely on the current state of affairs but should take into account future expectations. In other words, managing market expectations is vital for a thriving economy.

Establishing a company with an innovative product is challenging in and of itself. However, creating a balanced economic ecosystem is an even more formidable task...

List of Acronyms

r	interest rate
C	consumption
T	taxes
Y	production
ε	exchange rate
r^*	foreign interest rate
ABR	App Burn Rate
BOP	balance of payments
CA	current account
CFA	capital and financial account
DAO	Decentralized Autonomous Organization
PNF	Pocket Network Foundation
RTTM	Relay To Token Multiplier

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