Bancor
Token Economics Paper

An independent research report

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This case study is **not** sponsored by Bancor, no funding was received for any projects mentioned. This is an objective independent research report.

Summary

This report shares about Bancor and its token design model, as part of the economics of token engineering (aka token economics).

Bancor is part of the decentralised finance (DeFi) movement as it acts as an automatic market maker. To be an automatic market maker, Bancor allows for instant and continuous liquidity of less traded tokens that exist in Bancor ecosystem. The prices and supply of the token is defined mathematically, governed by a smart contract

There are two types of tokens in the ecosystem, a liquid token (utility function) that provides liquidity in the ecosystem and a relay or array token that represents the reserve pool.

Some areas can be more technical, and an ELI5 (explain like I'm 5) section is created to support a more basic understanding of the topic.

Section 1 is a high-level introduction to Bancor and what its objectives, understanding the tokens in the ecosystem and use-cases are in the decentralised finance (DeFi) industry. Section 2 recaps what token design is, and what are the factors to consider when designing tokens. Section 3, 4 and 5 will go in-depth on how Bancor designs its token economics according to the three sections of token design: token policy, financial incentives and architecture. All the math in Bancor is discussed in section 5.3. Section 6 concludes this report.

Terms used in this report and are interchangeable:

- Smart token = native token = network token = common denominator token
- Connector balance = collateral = market value of total reserve token = reserve value = reserve base
- Bancor ecosystem = bancor network
- Relay = money pot = reserve basket = reserve bucket = reserve pool
- Connector weight = constant reserve ratio = fractional reserve ratio = reserve ratio

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1. Introduction to Bancor

Bancor is a solution to tokens with liquidity problems. Bancor provides continuous liquidity[1] and the liquidity is governed by an algorithm in a smart contract[2].

Continuous Liquidity Bancor does not require exchanges or oracles to provide prices of tokens, exchange rates and liquidity function. It uses an autonomous liquidity mechanism that provides automatic price determination of the tokens.

Governed by Smart Contracts The liquidity is executed and governed by smart contracts using a common denominator[3] token that exists in the Bancor ecosystem. They are called network token[4], more commonly known as liquid token. In the rest of this article, the term “liquid token” will be used to refer to the common denominator token.

Smart contracts hold balances of other tokens and provide instant liquidity between the tokens available in the Bancor ecosystem.

Simple Introduction (ELI5[5])
Bancor basically makes it easy to change something into another.

The world has peanut, butter and jam.

- Let’s say Peter has lots of peanuts. He wants some jam.
- Johan has lots of jam. He wants to get some butter.
- Barry has butter, and he is alright at where he is now.

How can Peter get jam and how can Johan get butter? Johan can give Peter some jam, but Johan does not want peanuts.

I open a sandwich shop that sells bread. Everyone wants bread. You can buy peanut, butter, jam or bread at my shop. A few days before, Barry came to my shop to buy some bread with butter.

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[1] Continuous liquidity is where a token can be converted to another token all the time. It does not require someone else to buy or sell the token, it can be converted (liquidated) anytime.
[2] A smart contract is a simple software program that, once committed to a blockchain, is guaranteed to run unchanged for as long as the underlying blockchain remains operational. Smart contracts have many of the same capabilities as regular blockchain users, i.e., they can invoke other smart contracts and hold balances of tokens in escrow. A well-defined smart contract can be viewed as a reliable, incorruptible, and fully automated middleman.
[3] Common denominator is a common feature that exists in a network. For example, most central banks in the world have US dollars in their reserves. This makes US dollar a common denominator between many central banks. Having a common denominator makes it easier to match between parties.
[4] Network Token: These are tokens in the network, that facilitates liquidity. Any token in the network can be converted to the network token easily, which can easily be converted to another token in the network.
[5] Explain like I’m 5. Simplified explanation to help you grasp the concept of Bancor.

Now, Peter can come to my shop and buy some bread, in exchange for jam. Then he gives Johan some bread, and Johan gives him some jam. Johan then takes the bread to my shop, and I give him some butter.

In this peanut butter jam with bread world, bread is the common denominator. My sandwich shop always has peanut, butter, jam and bread. So, Peter, Johan and Barry can always come to my sandwich shop to get their items.

Applying that to Bancor, peanut, butter and jam are the various tokens in the ecosystem. The Liquid Token is bread. It will always allow anyone to buy peanut, butter or jam if they have bread. The sandwich shop, which makes the exchange from bread to peanut, is the smart contract in Bancor.

Technical Introduction

Bancor is a non-custodial exchange that uses pooled liquidity to facilitate trade. It does not require order books nor third party intermediaries. Instead of matching buyers with sellers, a market-matching algorithmic mechanism provides liquidity through smart contracts. The ratio between the reserve collateral in the smart contract and liquid token is fixed and embedded in the algorithmic mechanism.

Other than liquidity between two tokens on the same blockchain platform, Bancor also allows liquidity across different blockchains[6].

A liquidity network exists when there are various tokens that exist in the ecosystem, and they are each connected to a common denominator token, the liquid token (butter-token). If Lisa-token and Economics-token both trade with the liquid token (butter-token), then by transitive property[7], you can easily liquidate Lisa-token for Economics-token (via butter-token).

Think of the US dollar (USD) as the common denominator for the global currency. Most central banks around the world has USD in their reserves. Hong Kong wants to change some Hong Kong dollars (HKD) to Swiss Francs (CHF). But Switzerland is not too interested in CHF. What can Hong Kong do? Hong Kong can change HKD to USD. And give Switzerland some USD to get their CHF. USD enables the trade to happen because both countries have USD and accepts USD.

In the same vein, USD is the Liquid Token in Bancor ecosystem. It allows for trade to happen easily, because every cryptocurrency (e.g. country) have the Liquid Token and accepts the Liquid Token.

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[6] Cross-chain liquidity is the act of converting a token based on one blockchain into a token based on a different blockchain. E.g. DAI, which is an ethereum-based token to LEO, which is an EOS-based token.

[7] Transitive means if a is greater than b, and b is greater than c, it means that a is greater than c. E.g. if 10 is greater than 5 and 5 is greater than 1, it means that 10 is greater than 1.

1.1 Objectives of Bancor

The main objective of Bancor Protocol is to provide liquidity by being an automatic market maker[8]. The purpose is to enable privately issued tokens a liquidity function, even if the token is new, only used by a niche community of users or have low demand in general.

Problems with Liquidity

Double coincidence of wants Traditionally, liquidity happens when there is a match between buyers and sellers. Both users have to want the *same quantity* at the *same time* and *same place* to execute an exchange. The challenge today is to find a match between buyer and seller. This can be difficult when the demand for the item is very low.

Reliability of exchange Liquidity problems can be solved with exchanges. However, unless the token is a significant trade volume to be an efficient marketplace to find buyers and sellers, it is not a reliable exchange. Only the top 10% of tokens are traded actively on exchanges. The rest of the 90% have low demand and low frequency, hence low reliability that trade can occur[9].

Long-tail problem The barrier to entry for a person to release a privately issued cryptocurrency is very low. Thus, we see a boom in many cryptocurrencies. However, only the top 10% tokens are actively traded (e.g. representing more than 95% of trading volume). This means that there are a lot of tokens (90% of tokens) that are in the market with low trade volume, hence the lack of liquidity. This is the long tail problem, where the tail includes many small tokens with low trade volume, which represents 90% of the trade. This can be due to a niche token with a small community or new tokens with low initial adoption rate.

Solutions for Liquidity

Manual Market Maker The traditional solution in the financial market today is to have market makers. Market makers always buy and sell any financial products, which solves the liquidity problem. They are typically large financial institutions with significant reserve capital. They gain profits because they can hold bigger risks and earn the spread. The crypto market is very volatile and risky, so we do not see as many market makers in the market as the traditional financial market.

Automated Market Maker The other solution is to create decentralised liquidity via a token. This token has liquidity mechanism built in, hence Liquid Token. It will always be bought and sold through smart contracts. Prices are determined algorithmically via a formula and governed by a smart contract. This allows for continuous buying and selling of tokens. It

[8] An automatic market maker is a program that will continuously buy and sell tokens according to the algorithmic prices. It replaces order books with code.
[9] Trade occurs when the marketplace (exchange) finds a buyer and seller, and they can engage in an exchange of goods (or tokens). This will be rare when there is a lack of buyer and seller of the specific goods (or tokens).

is linked to more than one other token in the network, as the base denominator that enables trade between the token pairs.

1.2 Tokens in Bancor

Bancor uses a two-tier token model in its ecosystem: Liquid Token and Relay Token[10].

> Note: As Bancor is the platform that allows for other tokens to be liquidated, the other tokens present as known as Reserve Tokens. They are ERC-20 or EOS-compatible tokens like ETH, BAT, DAI, EOS, EMT, DICE.

Liquid Token in Bancor is a smart token with a single reserve that mints and destroys itself by sending or withdrawing the reserve token to or from its smart contract. In order to connect to Bancor Network, a Liquid Token must use BNT or a derivative of BNT as its reserve token. BNT is itself a Liquid Token backed by ETH. It serves as the network token that connects the Bancor Network. This is because all liquidity pools have BNT in their reserve.

Relay tokens are used to provide liquidity staking. The token holders are entitled to a fraction of the future cash flow. Relay tokens represent proportion of the value in the reserve pool (aka relay). This is further discussed in the financial incentives factor below.

[10] Relay tokens represent a proportion of the reserve pool.

Token Features in Bancor

There are 3 types of tokens that Bancor can create: (1) Liquid Token, (2) Relay Token, (3) Array Token.

Table 1 shows the types of tokens native to Bancor, explanation and number of those tokens in the ecosystem.

Table 1: Types of Tokens in Bancor and their Figures

Token Type	**Explanation**	**# tokens Bancor ecosystem**[11]
Liquid Token	Common token found in all reserve pools (relays). They are the common denominator in all reserve pools, which enables instant liquidity.	1
Relay Token	Token that represents a proportion of the reserve pool (relay). This reserve pool is made up of two tokens, reserve tokens and liquid token. (E.g. DAI and BNT, called DAIBNT).	39
Array Token	Similar to relay token, but instead of the reserve pool having just two tokens, the reserve pool can have three or more tokens. (E.g. DAI, BAT, BNT.) One of the tokens has to be a Liquid Token.	None

Liquid Token

What: Liquid Token is a utility token that enables conversion in the Bancor ecosystem. It enables instant convertibility to any number of other tokens in the network.
How: Liquid Token is the common denominator token in all reserve pools (relays) in Bancor ecosystem. It is like US dollars, the universal currency that is in most central bank's reserve. It also never faces liquidity risk, thanks to the in-built automatic market maker, governed by the smart contract.
Why: This makes it easy to transfer tokens within each reserve pool, using the Liquid Token.

Anyone can purchase Liquid Tokens by transferring reserve token to the smart contract. In return, the person will receive newly minted Liquid Tokens.

Example: ERC-20 Token, *DAI* and Liquid Token, *BNT*.

1. You use DAI to purchase BNT.
2. Send DAI to the smart contract, and it will calculate the amount of BNT you will receive in return.

[11] As of end of 2019Q3

3. This is the amount of BNT that is newly minted for you.
4. You can get DAI back by sending BNT tokens back to the smart contract. It will burn the BNT and issue DAI from the reserve pool, to you.

Price Calculation

Prices are determined by the amount of supply in the market and a fixed ratio. It is similar to a bonding curve[12]. This fixed ratio is the reserve ratio (RR)[13]. This ratio is fixed and set by the token issuer. This ratio is calculated using the value of the reserve pool against the value of the liquid token, $Reserve\ ratio = \frac{Value\ of\ reserve\ token\ pool}{Value\ of\ liquid\ token}$. This is used to maintain price stability of the Liquid Token.

Bancor Token (BNT)

BNT is a Liquid Token in Bancor network. It is present in all reserve pools. Its value comes from the ability to trade between all token trading pairs in the ecosystem. There are no fees incurred from transacting BNT, but it can result in higher transaction fee (i.e. gas in Ethereum) because the smart contract requires more power.

Since Bancor is a utility token, its purpose is to access the Bancor ecosystem. Valuation comes from intrinsic factors like network effects (more reserve pools using BNT) and usage volume and frequency of BNT in the ecosystem. BNT also has a limit on supply (total supply is 75,843,715), so the increase in minting and usage will drive the valuation up. This, however, adds value to the reserve pool, since the reserve pools are also made up of BNT.

Relay Token

Relay tokens are used to own part of the reserve pool (relay). This allows for decentralised participation in the pools. Participants are incentivised to join as they will be rewarded with transaction fees when the reserve tokens are being transacted. Relay tokens can be bought on Bancor.

When someone buys a Relay Token they are adding liquidity to the Relay's reserves by increasing the reserves. The Relay Tokens they receive in return represent their contribution. Transaction fee is incurred when the reserve token or relay token is traded. The transaction fee is then added to the reserve pool. When Relay Tokens are burnt, the token holders are entitled to the proportion in the reserve pool, which includes earnings from fees.

Price calculation

Prices are determined by the tokens in the reserve pool. In Relay Tokens, two tokens are used in the reserve pool, governed by a smart contract. It typically maintains a fixed 50% reserve ratio between the two token reserves.

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[12] Check out Lesson 8 to learn more about bonding curves on the token economics business blueprint course at https://education.economicsdesign.com/outline/.
[13] Other terms include constant reserve ratio, fractional reserve ratio, connector weight

Tokens Summary Table

Table 2 shows the comparison between the two existing token types (native to Bancor ecosystem) and the reserve token (not native to Bancor ecosystem).

Table 2: Token Types in Bancor

Variables	Liquid Token	Relay Token	Reserve Token
Other Names	Network token, native token	Smart token, staking token	Base token, reserve currency, connector token
Example	BNT, USDB[14]	DAIBNT	DAI, BAT, EOS, EMT
Purpose	Enable liquidity, instant convertibility and access to any token in the network.	Enable staking and reduce price slippage in the relay Access to future cash flow generated from transaction fees	This token is any token that joins the Bancor ecosystem to attain liquidity. It can be an ERC-20 token or EOS-based token. They exist in their original forms in the Relays (aka reserve basket) of Bancor.
Reserves Needed	Single reserve token	50% reserve token & 50% BNT	Not applicable
How is value derived	$P = \frac{Value\ of\ reserve\ pool}{Supply\ of\ Liquid\ Token\ x\ RR}$ Algorithmically with a fixed ratio, governed by a smart contract.	Based on the value of the relay (aka money pot)	However the individual token's policy is
How is supply created	Minted or burned when people send collaterals (reserves) to smart contract or smart token to retrieve connector balance.	The token issuer determines it	However the individual token's policy is

[14] USDB is a stable version of BNT. Read more here: https://medium.com/peg-network/introducing-the-peg-protocol-cfc1c4002574

1.3 Features in Bancor

Bancor has other features in the token design that are also essential.

Continuous Liquidity

Users can always buy or sell tokens (liquid tokens, relay tokens, base tokens) in the ecosystem via the smart contract. Since the prices are dependent on the supply in the market, not the demand of another trader, the trade will always happen. Prices are also calculated dynamically,

Bancor Relays

Bancor relays are the reserve pools. They are also known as liquidity pools with two reserves, the reserve token and BNT. They facilitate token-to-token conversion and cross-blockchain platform token conversion.

ELI5: Think of it like a breakfast cereal box. It has Corn Flakes and Honey Stars. Take 50% of Corn Flakes and 50% of Honey Stars and put it in the breakfast cereal box. The breakfast cereal box is the reserve pool, aka Bancor relay.

Traditional exchanges are matchmaking markets. They match the demand by people (buy order) and willing to sell (sell order) using order books or machine to match the trade. When there are enough buyers and sellers, the system works well because there will always be someone demanding and someone selling the item. That results in trade, which is why exchanges exist. However, if the item (a token) has little buyer or seller, the volume is low and it is difficult for the exchange to match buyers and sellers.

ELI5: Everyone loves these breakfast cereal. Traditional exchange is like sunday farmer's market. People bring their breakfast cereal to the market and they can trade their Corn Flakes for Honey Stars. Since people like both of them, it is easy to find someone who wants to trade my Corn Flakes for their Honey Stars. Imagine now, a new breakfast cereal enters the farmer's market. It is new and no one has tried them. It makes it difficult to trade the new cereal for someone else, because no one wants to trade them.

In Bancor, there is no need to match buyers and sellers. It uses a reserve that provides constant liquidity for tokens. Reserves are known as relays. Relays are programmed to mint and burn tokens according to a mathematical formula. Since Relays hold two tokens, they are priced in terms of each other.

ELI5: Let's call new cereal Chocolate Charms. A breakfast cereal box (relay) will be made up of Chocolate Charms (reserve token) and Corn Flakes (liquid token). Chocolate Charms will be priced in Corn Flakes. I can sell Corn Flakes and get Chocolate Charm in return. This increases quantity of Corn Flakes and reduce Chocolate Charm in the breakfast cereal box. So, the prices will change. Since we have more Corn Flakes now, the price of Corn Flakes will decrease. We have less Chocolate Charm now, so the price of Chocolate Charm will

increase. This is to encourage people to see Chocolate Charm to breakfast cereal box and get the ratio back to 50% and 50%.

Liquidity Providers

Liquidity providers people who own relay tokens. They provide liquidity by staking tokens in the reserve pool (relay). This is to allow for immediate convertibility between all the tokens in the ecosystem. There is no need to execute trading-pairs concurrently, it can happen anytime. This is known as asynchronous liquidity.

Liquidity Fees

There are 2 types of liquidity fees: fees from liquid token and fees from relay tokens.

Liquid Token

BNT is a utility token and it does not trade to generate revenue nor charge transaction fees on the network. The only fee incurred is gas fee on Ethereum, when the smart contract is executed.

However, it is possible to add fees into the liquid token's formula.

Relay Token

Relay token owns proportion of the relay. For example, the relay has DAI and BNT tokens. The relay token is DAIBNT, which owns part of the value of the reserve pool.

When a trade is executed in the relay, a transaction fee is incurred. The transaction fee is returned to the reserve pool. When a user burns the relay token, they are entitled to the proportion of the reserve pool, which includes their stake and earning from transaction fees. For example, I own 10% of the DAIBNT relay. When someone trades DAI and increase or decrease DAI in the pool, a transaction fee is incurred. I earn 10% of the transaction fee. When I burn my DAIBNT tokens, I am entitled to 10% of the total value in the reserve pool. That includes my initial stake and transaction fees earned.

No Spread

Spread is the difference between the buy and sell price. Usually, the buy price is lower than the sell price. It allows market makers to make money. In Bancor, there is no spread in the formula. This is because Bancor does not require profits from the spread. The value of Bancor network is the growth in usage of the ecosystem and active trading volume of BNT. Hence, there is no incentive to make money from each trade. It goes against the main objective of Bancor.

Adjustable price sensitivity

Price sensitivity is the elasticity of prices, with respect to supply of liquid tokens. It is a measure of how fast prices change when the supply changes. It is price sensitive when supply changes by a little, and prices changes by a lot.

This is an important aspect, as rapid changes in price can lead to short-term speculation and manipulation. A small trade can affect huge changes in price. This makes the reserve pool (relay) very volatile and susceptible to short-term speculation.

The price sensitivity is defined by the reserve ratio. It can be adjusted by the token issuer[15]. This ratio is fixed and always held constant. That means the prices of liquid tokens will change to maintain this ratio. Higher ratio leads to less price sensitivity, which makes the price more stable. The mathematical formula and explanation is available in 5.3.

Predictable Prices

Since prices are defined mathematically, it is possible to calculate the prices before executing a conversion. This reduces information asymmetry and allows users to make better informed decisions when liquiding tokens.

Liquidity Network

Since Bancor is an ecosystem with many tokens, it forms a network of tokens that can be easily converted to each other. We call this a liquidity network[16]. This is done by having Liquid Token, BNT, as the common denominator between all the conversions.

Example: There may not be a trading pair between DAI and BAT tokens, but this is solved with a liquid token like BNT.

1. Sell DAI and get BNT
2. Sell BNT and get BAT

In the end, you receive BAT by selling DAI.

1.4 Bancor in DeFi

DeFi is decentralised finance. DeFi hopes to transform the financial landscape by bringing transparency, speed and accessibility to the industry. It is not about a radical change, but to introduce new use-cases, new products and improve efficiency using new technology. An important aspect of the financial space is liquidity. When assets are liquid, it is easier to trade and move the asset around.

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[15] Token issuers can people, companies, communities, organizations or foundations. They want to provide continuous liquidity to the existing token.

[16] Liquidity network is a network that allows for constant conversion of tokens. This is done through smart contracts that are programmed to provide liquidity. The smart contract will mint and burn tokens in the network to enable autonomous exchange between tokens in the ecosystem.

How is Bancor involved in DeFi?

Liquidity

Bancor provides the liquidity solution in DeFi, under the DEX[17] function. Other than just providing liquidity on Ethereum based tokens, it also allows for conversion in EOS and POA network. It is possible to convert ERC-20 tokens to EOS-based tokens in Bancor.

Community Staking

Traditionally, market makers have huge reserves, which allows them to be a market maker and take advantage of spread. Because a huge reserve is required, this becomes centralised to a few institutions.

With DeFi, the community can now own part of the reserve through staking and earning fees from it. The community can do this via owning relay tokens.

[17] DEX refers to decentralised exchange. An exchange that is decentralised and not owned by a central entity.

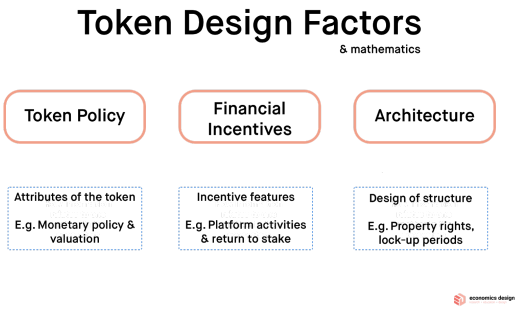
2. Token Design in Token Economics

Token design is the design and engineering of the token. It seeks to design how tokens will be managed and governed, and the functions and rights it could hold.

The token economics model[18] has many factors that are worth pondering upon when designing and engineering the tokens. However, it is important to remember that not all factors are equally relevant to a particular decentralised ecosystem. Some are more important than others. It all depends on the token function, token use-case, business model and more.

The 3 main factors of token design are

1. Token Policy
2. Financial Incentives
3. Architecture



2.1 Token Policy

Token policy designs how tokens will be managed and governed. It may include a mix of automation through smart contracts and participants' inputs through governance mechanisms.

How tokens are governed is the **monetary policy**. This can be automated or a mix of automation and nonautomation.
How tokens and/or ecosystem is being valued is the **valuation**.

2.2 Financial Incentives

Economics is all about incentives. The most direct incentive is financial incentive. This is to encourage specific behaviour to coordinate actions of participation towards a shared objective of the ecosystem[19]. The key goal is the shared objective, not valuation on secondary markets[20].

How activities in the ecosystem incentivises behaviours is the **platform activities**.
How the ecosystem and token project enable returns is the **return to investment**. This is closely linked to the token policy implemented.

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[18] Token Economics model reference:
https://www.economicsdesign.com/portfolio/economics-engineering/
[19] Check out Lesson 2 on the token economics business blueprint course at
https://education.economicsdesign.com/outline/.
[20] Check out Lesson 8 on the token economics business blueprint course at
https://education.economicsdesign.com/outline/.

2.3 Architecture

As tokens can be embedded with programs, architecture defines the building blocks of the token and tokens as a whole. This can include the technical aspects like underlying algorithmic formulas coded in the smart contract and property rights issued to the tokens or non-technical aspect like allocation and distribution of the tokens as a whole.

What rights the token hold is the **property rights**.
How the tokens are distributed and allocated in the entire ecosystem is the **distribution**.
Coded governance of the token in terms of algorithm and mathematics is the **algorithm and code**.

3. Token Policy

Bancor has two types of tokens (Liquid Token is a utility token and Relay Token). We will name the tokens in the section, where it is applicable.

3.1 Monetary Policy

Monetary policy discusses how the supply of token is managed and governed. All the math is discussed in 5.3.

Supply & Price of Liquid Token

The supply and price is governed by a smart contract. In the smart contract, there is a mathematical formula that defines the supply and price. The smart contract executes the formula, hence managing the issuance and governance of liquid tokens.

Since the smart contract will always mint and burn tokens, it changes the supply and price of tokens in the Bancor ecosystem (primary market). The prices, when traded in a secondary market, is not governed by the monetary policy discussed here.

The effective price of the liquid tokens exchanged is, $effective\ price = \frac{reserve\ tokens\ exchanged}{liquid\ tokens\ exchanged}$.

Connector Weight of Liquid Token

This is also known as reserve ratio, constant reserve ratio, fractional reserve, exchange rate. It is the fixed ratio between token's value and value of reserve pool.

This means that the prices of Liquid Token (eg BNT) changes with respect to the reserve token. This price is constantly recalculated to maintain the fixed ratio.
For example: The price of HKD changes in terms of USD. Instead of changing the prices of HKD in terms of USD, we want it fixed. So the supply and price of HKD will change, to ensure that the price of HKD in terms of USD remains fixed.

Initiating a New Relay

It is possible to create a new reserve pool with a new reserve token and BNT. A liquidity provider[21] has to deposit an equal amount of BNT and the new reserve token. The minimum total value of reserve is US$20,000, of which $10,000 worth of BNT is needed.

3.2 Token Valuation

Token valuation is how the token is being priced and valued.

[21] This can be an institution, foundation of the reserve token, group of people or an individual.

Token Bonding Curve for Liquid Token (1 Reserve Token)

The price of liquid token is defined by the formula, $P = S^{\alpha}e^{A}$.

P is the price of the token, S is the supply, α is the function of the constant ratio and A is an arbitrary constant.

The cost payable to purchase liquid tokens in the reserve token is defined by the formula,

$$E = Ro\,(\sqrt[F]{1 + \frac{T}{So}} - 1)\,.$$

E is the amount payable in terms of reserve token, Ro is the initial monetary value of reserve tokens, F is the constant ratio, T is the change in liquid token supply and So is the initial liquid token supply.

Token Bonding Curve for Liquid Token (Multiple Reserve Tokens)

Trade in one reserve token will affect the price of liquid token in terms of the other currency. Since this is not implemented in Bancor ecosystem yet, this paper will not go into details about the valuation, but will provide the math formula.

Supply of liquid token (BNT), $S = So\prod_{i=1}^{M}(\frac{Ri}{Rio})^{F_i}$

Prices of Reserve Pool for Relay Token

Relay tokens are tokens that own proportion of the relay. The price is derived from the value of the relay, with includes the reserve token and BNT. The relay token can be calculated as a fraction of the sum of value of reserve token and the value of BNT in the reserve pool.

4. Financial Incentives

4.1 Platform activities

Price Slippage of Liquid Token (BNT)

Price slippage refers to the change in the price of the liquid token. Price slippage occurs due to market depth (size of reserve pool), not from the difference in buy and ask price.

Relay token represents the relay (reserve pool), which holds reserve token and liquid tokens. The reserve mints and burns liquid tokens to fulfill the trade and determine prices. When a person sells BNT to the relay to get the reserve token, it increases the supply of BNT in the reserve and reduce the supply of reserve token. This changes the reserve ratio, so the price of BNT will be changed to ensure that the reserve ratio is constant.

The larger the amount of tokens exchanged relative to the size of reserve, the larger the price slippage (changes in price). Technically, one does not need to hold BNT to execute the trade. BNT is the common denominator for all reserve tokens and act as a medium of exchange.

Transaction Fees in Bancor

Although there is spread in the exchange, transaction fees exist. They are like a commission fee payable to execute the conversion. This is to incentivise users to stake tokens in the reserve pool to reduce price slippage.

ELI5: If you want to exchange USD for GBP, you go to the money changer. Let's say, £1 GBP costs $1.25 USD. This is the amount you find on google. At the money changer, they can charge you two types of fees, exchange rate fees and commission fee.

1. The exchange rate the money changer gives you can be something like £1:$1.30. This means that to buy £1, it costs $0.05 more. This is the profit the money changer earns. It is called exchange rate fee, or spread.
2. The money changer can also charge a commission to accept this conversion. This can be 5% of the total amount transacted. This is the commission fee he can earn.

Bancor is the money changer. It does not charge an exchange rate fee, because that is fixed. But it can charge a commission fee, which is the transaction fee. These fees will be awarded to the corresponding relay token holders.

Liquidity Mechanism

Smart contract governs the liquidity mechanism. It will constantly burn and mint tokens accordingly.

4.2 Return of Investment

Staking in Bancor: Transaction Fee in Relay Token

Every time there is a conversion in the reserve pool, a small fee is charged. It is usually 0.1 and 0.3%. This fee is charged per conversion and is deposited into the reserve pool. The fees are an incentive for liquidity providers to stake their tokens to reduce price slippage. The larger the reserve, the lower the slippage.

Currently, the relay determines the transaction fees. In the future, the amount can be voted on by the relay token holders.

Arbitrage of Liquid Token Prices

BNT is a utility token within the Bancor ecosystem and used in all trading pairs. However, it is also traded on various exchanges (secondary market). The prices on the secondary market can be different with prices in Bancor. This difference will not last for long, as it shows a clear arbitrage opportunity.

Arbitrage is when the same item has different prices. It is possible to buy the item at the market with a lower price and sell it at the market with a higher price. Traders will take this low-risk opportunity to earn profits (difference in prices). They will purchase BNT until prices on exchanges are the same as prices in Bancor ecosystem.

Liquid Token in Secondary Market

Since BNT can be traded on a secondary market, how does it affect the price and supply in Bancor ecosystem, the primary market? It is not affected at all. The price in Bancor ecosystem is determined by supply of BNT. Since BNT can only be created in Bancor ecosystem itself, the total supply does not change. The only thing that changes in the secondary market is ownership of BNT. The supply remains the same.

Prices only change when interacting with BNT directly. That means converting tokens via the reserve pools in Bancor.

Relays with USDB instead of BNT

USDB is a stable version of BNT. USBD[22] is a derivative of BNT, which can be used as a liquid token. This is to reduce volatility of the reserve pool. Instead of having two tokens with high volatility, BNT is replaced with a stable version called USDB. Liquidity providers can increase their profitability by having less volatility in the reserve pool.

[22] Read more about PEG protocol and USDB on https://medium.com/peg-network/introducing-the-peg-protocol-cfc1c4002574

5. Architecture

Since Liquid Token and Relay tokens are different, they have different architecture and building blocks.

5.1 Property rights

There is no property rights in liquid token, other than to facilitate conversion. They act as a medium of exchange and access to Bancor ecosystem.

Property Rights of Relay Tokens

Relay tokens have the rights to be entitled to future cash flow, generated from the transaction fees incurred.

When a trade is executed in the relay, a transaction fee is incurred. The transaction fee is returned to the reserve pool. When a user burns the relay token, they are entitled to the proportion of the reserve pool, which includes their stake and earning from transaction fees.

For example, I own 10% of the DAIBNT relay. When someone trades DAI and increase or decrease DAI in the pool, a transaction fee is incurred. I earn 10% of the transaction fee. When I burn my DAIBNT tokens, I am entitled to 10% of the total value in the reserve pool. That includes my initial stake and transaction fees earned.

5.2 Distribution

Token Distribution of BNT

Total supply of BNT is 75,843,715.

In the initial distribution, half of it is distributed to contributors, while the other half is kept by the foundation for future use[23].

Breakdown of distribution

- 20% held by the ETH reserve pool of BNT
- 40% to develop Bancor protocol and other technology (technological R&D)
- 12% is for marketing and developing the ecosystem (marketing)
- 10% is for setting up relay tokens, array tokens, proxy tokens for digital assets and cryptocurrencies (admin)
- 18% is for operational overhead and legal expenses (operations)

[23] This is locked for 2 years. Future use includes long-term budget, future team and advisor, partnership and community grants.

5.3 Algorithm and Code

Price Formula for Liquid Token

There are 4 variables in the formula,

- R is the value of the reserve token. E.g. if ETH is $160 and I have 10 ETH in the reserve pool, the value is $1600.
- S is the supply of liquid token
- P is the price of liquid token
- F is the (fractional) reserve ratio. It has a value between 0 and 1, hence the use of the term “fractional”.

Reserve ratio is the ratio between the value of the reserve token and market value of liquid token.

$$Reserve\ Ratio\ =\ \frac{Value\ of\ reserve\ token}{Market\ value\ of\ liquid\ token}$$

This means that the value of the reserve token is a fraction of the value of liquid token.

$$Value\ of\ reserve\ token\ =\ (Reserve\ ratio)\ \times\ (Market\ value\ of\ liquid\ token)$$

Market value of liquid token is also known as the market cap.

$$Market\ value\ of\ liquid\ token = P_{liquid\ token}\ x\ S_{liquid\ token}$$

Price of liquid token is then,

$$Price\ of\ liquid\ token\ =\ \frac{Value\ of\ reserve\ token}{Supply\ of\ liquid\ token \times reserve\ ratio}$$

Scenario: a tiny supply of liquid token is bought (dS).

1. The reserve pool changes. The person pays reserve tokens to buy the liquid tokens. $dR\ =\ P\ dS$
2. Since $R\ =\ FSP$, $dR\ =\ P\ dS$.
3. Combining it, we get $PdS\ =\ FSP$.
4. When supply changes, prices change too. But the reserve ratio remains the same and is not affected. Using chain rule, we get $P\ dS\ =\ F(S\ dP\ +\ P\ dS)$.
5. Bringing dS to one side, we get $P\ dS(1-F)\ =\ F\ S\ dP$.
6. Bringing F to one side, we get $P\ dS\ (\frac{1}{F}-1)\ =\ S\ dP$.
7. Let $\alpha = (\frac{1}{F}-1)$, we get $P\ dS\ \alpha\ =\ S\ dP$.
8. Bringing all the S to one side, we get $\alpha\frac{dS}{S}\ =\ \frac{dP}{P}$.
9. Expanding that, we get $\alpha\ \frac{1}{S}\ dS\ =\frac{1}{P}\ dP$.
10. Using inverse differentiation of log function, $\alpha\ d\ logS\ =\ d\ logP$.
11. Since S and P are both variables, not a function. Integrating the equation gives us $\alpha\ log\ S\ +\ A\ =\ log\ P$.
12. Expanding that, $log\ S^{\alpha}\ +\ log\ 10^{A}\ =\ log\ P$
13. Simplifying that, we get $S^{\alpha}e^{A}\ =\ P$

A is an arbitrary constant and e is the natural number. This is the price formula that the smart contract holds.

Conversion Formula for Liquid Token

Now consider this scenario. I have some reserve tokens, E. I want to convert them to T -liquid tokens, so that I can use them later. How much liquid tokens do I receive?

The formula above cannot be used, since it does not have the variable of reserve tokens in there. So we have to use backward method to figure it out.

1. What is the new price in terms of new supply?
2. What is the cost payable to buy new tokens, given the change in supply?
3. What is the change in supply as a function of cost payable?

This formula can be used as the conversion formula[24].

1. New price, given the increase in supply is $P = (\frac{S}{S_0})^{\alpha} \times P_0$
2. New cost payable, in terms of reserve currency is the area under the curve. So $E = \int_{S_0}^{S_0+T} P\,dS$. Solving that, we get $E = R_0(\sqrt[F]{1 + \frac{T}{S_0}} - 1$.
3. Rearranging the equation in terms of T, $T = S_0((1 + \frac{E}{R_0})^F - 1)$.This is the amount of liquid tokens received when paying E reserve currency.

Impact of Reserve Ratio

Since the price formula is an exponential function, subjected to the reserve ratio, the shape of the curve changes, depending on the ratio. The reserve ratio is a figure between 0 and 1.

Reserve Ratio = 1

When the reserve ratio is 1, the curve is a horizontal line. This means that prices do not change, and are always constant. It is not responsive to the supply in the ecosystem. This is also known as a fixed peg. E.g. 1 Panama dollar is pegged to 1 USD.

Reserve Ratio = 0.5

When the ratio is 0.5, the curve is upward sloping and straight. This means that prices moves linearly with the supply. Since it is not possible to gain profits with BNT, a straight-line curve makes the most sense.

However, if it is possible for the liquid token to be earning transaction fees, where the transaction fees will increase the reserve base, a 0.5 reserve ratio might not be a good model. This is because the first few token holders are rewarded too much in comparison to the rest of the token holders.

[24] Details of the conversion formula can be found https://drive.google.com/file/d/0B3HPNP-GDn7aRkVaV3dkVl9NS2M/view.

0 < Reserve Ratio < 0.5

The curve is now an upward sloping exponential graph. The further the reserve ratio is to 0.5, the steeper the curve. That means the prices are more sensitive to the change in supply.

Exponential functions are good as they increase prices slowly initially, which encourages the holding of tokens. However, the function accelerates aggressively in the last 20%. This makes it volatile as it opens the market to speculation and the growth rate can be unmanageable.

0.5 < Reserve Ratio < 1

The curve is now an upward sloping exponential graph. The closer the reserve ratio is to 1, the higher the steeper the curve is at the start, where the prices at the start increases rapidly, which creates speculation and volatility.

Since Bancor uses this formula as part of the BNT, which has no objectives other than to be the medium of exchange in the ecosystem, the best model for the reserve ratio is to be 0.5. However, this could change when the liquid formula has other objectives.

6. Conclusion

Bancor provides liquidity in their network of tokens using a liquid token, BNT. BNT is used in all reserve pools, that enable instant conversion between tokens.

In this paper, we discussed the objectives of Bancor and the various tokens that exist in the ecosystem. We also shared how Bancor plays a role in the DeFi movement. Next, we recapped the three foundations of token design and the factors that make up what token design is. Lastly, we applied the token design foundations to Bancor and explained how Bancor design its tokens.

The liquid token, BNT, is a simple token that provides the medium of exchange to allow for liquidity. It is defined with a mathematical formula and governed by a smart contract. The relay token represents the reserve pot, relays. Users can purchase relay tokens to stake in the reserve pot and earn transaction fees. These are the two tokens types in the Bancor ecosystem today.

References and Resources

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