Jax.Network economics paper

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[1]This is a direct reference to Nash Jr 2002.

Disclaimer: *This paper is a non-technical version describing the inner workings of the incentives within our network. The team is still working on the parameters' adjustments, which are therefore subject to change, but only at the margin. The paper gives you a good account of the economics behind our protocol in plain English.*

1 Introduction

This paper seeks to better explain the economics behind Jax.Network and how incentives play out. It lays out the basic microfoundations[2] of `JAX` and JAXNET (`JXN` hereafter) coins using economic analysis. We will show that the coin abides by strong economic laws. We introduce a few concepts related to monetary economics and commodity monies in the first sections.

This small detour through history is useful to put everything into perspective. As cryptocurrencies have often been compared to commodities, it also allows us to frame our analysis. Indeed, we show that `JAX` coins do not hold this comparison with commodity money or a more standard theory of money.

It follows some economic laws on its own, which are more micro-based. Miners are profit-oriented and as such will mint new coins under technical and market constraints. We compare `JAX` coin supply to Bitcoin and show that the former is a superior medium of exchange since it is transaction-oriented while monetary mass can be contained thanks to some parameters.

It is worth noting that there is a lot of economic background that might seem unrelated to the direct concern of controlling supply, but it is necessary to put the argument into an economic perspective, which might sometimes be at odds with technical issues. Then some arbitrage can be made, knowing the consequences of the directions we are taking.

It is beyond the scope of this article to cover monetary issues that have been covered by economists over the last 3 or 4 centuries at least. We just give a very brief overview of some monetary economics that has influenced this paper, but it is in no way a full account of what money is. Besides, the reader will quickly notice that the underlying economics of cryptocurrencies largely differ from conventional monetary economics, whether it is micro- or macro-founded. For one, contrary to fiat currencies, `JAX` coins are not intrinsically worthless.

`JAX` will be valued if and only if it improves the efficiency of the stablecoin market, which is our primary goal.

[2]Since there is no economy yet, and we do not know the demand functions for the coin, we will mostly focus on the supply side, especially the mining pools, which we can incentivize while maintaining a sufficient level of security.

1.1 Brief description of our technology

Please refer to our academic paper (Shyshatskyi et al. 2020), which lays out the architecture of our network.

In a nutshell, our network houses two coins: one coin on the beacon chain and another on the shard chains. To quickly add a point, the beacon chain coins are named “JAXNET” coins and the shard chain coins are referred to as “`JAX` ” coins. Let’s quickly recap how the beacon chain and shard chains work and are interlinked. Having two coins helps us decouple the transactional coins (`JAX`) from the digital asset coins (`JXN`).

The first chain, the beacon chain, works just like a clock, allowing miners to add new parallel chains (called “shards” hereafter) to the network in a timely and coordinated fashion. The time of creation of each new shard is stored in the beacon chain ledger. When miners collectively agree that the network is overloaded and needs data space due to increasing demand for transactions, a new shard can be created. Shards (or the parallel chains) are therefore the backbone of our value proposition, since they secure transactions for (mainly) consumption purposes. Any time you purchase a cup of coffee, for example, the transaction will be processed over one shard. In our view, this is the only way to securely achieve scalability.

So, contrary to Bitcoin or Ethereum, our blockchain doesn’t work with one coin, but two. When miners allocate their computing power to securing our network, they receive two different rewards. It is very important to understand this point because this is what makes our blockchain valuable to the public at large.

In designing Jax.Network, we followed three core principles:

i) The need for a global payment system in a globalized world. It doesn’t make sense to engage in global trade that can only be paid for with local currencies;

ii) The fact that currencies hold value when they have a transactional purpose;

iii) The fact that a cryptocurrency should not be cheap to produce in order to better control the money supply and maintain a good level of security.

These three basic principles helped us design a cryptocurrency that better reflects the characteristics of a transaction network that is used for day-to-day payments.

1.2 Some considerations over payment systems and money in the context of cryptocurrencies

In the history of money, fiat was chosen over all other goods because it was cheap to produce, easy to carry, and ultimately, costly to counterfeit (Banerjee and Maskin 1996). We humans then created a set of institutions—banks—to ensure that everyone could trust this medium of exchange called money.

When we turn to cryptocurrencies based on a PoW consensus algorithm, some of these characteristics do not hold true anymore and conventional monetary economics is turned upside down. Bitcoins and other crypto coins are still very easy to transport and costly to copy, but the low cost of production is no longer the case, as mining represents an irreversible investment (we will come back to that point later). This then raises the question of what differentiates cryptocurrencies from other commodities, and why they are potentially an effective medium of exchange.

Bitcoin has frequently been likened to "digital gold" by economists (Gronwald 2019), including the US regulator[3]. The claim is that the Bitcoin price function reacts similarly to a commodity, and therefore Bitcoin should be classified more as a commodity than as a currency.

But the full story is a bit more complicated than that. Blockchain-based networks have two main interlinked components that make them difficult to characterize economically. The security model and the monetary policy specifics are embedded into the code, making it difficult to argue that Bitcoin and other open blockchains are just money or just a secure and decentralized payment system. In reality, they are both.

The past ten-year Bitcoin experiment has shown that cryptocurrencies follow some economic laws of their own. The only comparison that still holds is that they are closer to digital assets than currencies. This is due to their very design, as the number of existing coins is most often capped (as is the case for Bitcoin and Litecoin). This fixed and limited supply pushes the price up for as long as demand for these coins is higher than supply, regardless of the economic fundamentals behind these cryptocurrencies.

Cryptocurrencies like Bitcoin are a good way to store value, although very volatile, but not so great for day-to-day payments.

1.3 Methodology and new monetary economics

Blockchain-based networks abide by their own economics. Economic incentives work differently when the issuance of new coins becomes decentralized. Therefore, the straightforward comparison with standard monetary economics can be misleading.

In the Banerjee and Maskin 1996 framework, money is cheap to produce, easy to carry, and ultimately, costly to counterfeit. On top of this, a set of institutions have been built over time, which gives a way for governance and regulatory framework to coin issuance. As opposed to our design, our stablecoin, if it is indeed cheap to carry and costly to counterfeit, is not cheap to produce.

As already stated in this introduction, a microeconomic analysis is in our case more relevant than standard monetary economics, which mostly deals with global aggregates.

[3] http://www.chips-corner.com/Bitcoin%20Is%20Officially%20a%20Commodity.pdf.

One might argue that a search-theoretic approach can fill the gaps[4]. These models are still useful to comprehend welfare costs of inflation or analyze frictions that money can create. They are an improvement on reduced-form models, but they fail to explain the new monetary economics that needs to be built for cryptocurrencies. There are multiple reasons to explain:

i) cryptocurrencies are new and any monetary economics, of course, predates the emergence of blockchain-based protocols;

ii) cryptocurrencies are not only money, it is a set of rules to implement a trustless global transaction network;

iii) the institutional setup between a brick-and-mortar banking system and an open-source decentralized network is radically different;

iv) most cryptocurrencies do not have discount rates (Hu and Rocheteau 2015) but offer a convenience yield (Prat, Danos, and Marcassa 2019);

v) cryptocurrencies depart from money debt;

vi) frictions known in the real world are different (Hu and Rocheteau 2015) and do not really apply to cryptocurrencies.

Therefore, cryptocurrencies, in general, borrow from different streams of economics, from game theory to two-sided markets and monetary economics, contract theory as well as law and economics, more precisely lawlessness and economics. This melting pot makes it difficult to have a unified theory on cryptocurrencies. Further, economists have only started to scratch the tip of the iceberg, despite a growing interest and publications in renowned economic journals.

1.4 Difficulties & some assumptions

As the reader will quickly understand, the economics of decentralized payment platforms are just emerging. How a representative risk-neutral agent will react to the inner workings of the network is unknown. Therefore, it is close to impossible to predict the shape of the demand curve. Some serious work has been done by Biais, Bisiere, Bouvard, Casamatta, and Menkveld 2020, Cong, Y. Li, and Wang 2021, and Pagnotta and Buraschi 2018. Albeit prestigious, this work is not representative of the incentives as designed in JaxNet. The aforementioned authors mainly focus their efforts on Bitcoin or networks with a fixed reward. Also, they investigate the case of one native coin. We cannot rely on this great work to shape demand functions for our coins. Worse, since we have two coins, we do not know how externalities will or won't be internalized by all agents. Indeed,

[4] Although some authors are now working on these aspects (Fernández-Villaverde and Sanches 2019).

we specifically have two native coins to decouple investment motives from transactional motives. Following Tirole 1985, we envision that money has utility if it has a transactional purpose. The objective here is to clearly avoid money bubbles. This is rather new in the cryptocurrency sphere. As far as we know, only a handful of projects have two different native coins, such as Terra[5] and Themelio[6].

In any case, demand shocks are not predictable, as they come mainly from exogenous factors. However, some economic models have integrated the demand side in their analysis. Although they mostly apply for Bitcoin, it is interesting to review them and see how they can be integrated into ours.

Since, like money, `JAX` coins will percolate into the economy through a complex network (Mandel, Taghawi-Nejad, and Veetil 2019), it is mathematically impossible to determine the shape of the demand side of the "`JAX` economy". We can only highlight a few phenomena that can appear alongside the adoption of this new coin. Although, these are mostly based on the analysis of the Bitcoin protocol. However, our coin departs from it in many ways. We just assume here that the technicalities do not affect consumer choices in choosing a privately minted medium of exchange and are therefore bounded by the same principles as Bitcoin:

i) Anticipated transaction costs and benefits of the network (Biais, Bisiere, Bouvard, Casamatta, and Menkveld 2020);

ii) Platform productivity, as in Cong, Y. Li, and Wang 2021: "broadly captures platform matching technologies, network security, processing capacity, regulatory conditions, users' interests, the variety of activities feasible on the platform, etc. It therefore directly affects users' utility on the platform (...)".

iii) Regulatory conditions are also analyzed by Auer and Claessens 2018, who captured how some political decisions/legal events impact the cryptocurrency market;

iv) Cross-side network effects, as in Rochet and Tirole 2006, Pagnotta and Buraschi 2018 and Cong, Y. Li, and Wang 2021. Consider a price drop. Due to the tiny size of these markets, this drop will be non-linear and not proportional to the increase of efficiency over a certain time period. This is due to the nature of the network effects in decentralized networks (Pagnotta and Buraschi 2018).

v) Coin velocity, as in Danos et al. 2021, especially in the case where the coin is immediately exchanged in numeraire. In this case, it can lead to price indeterminacy. Velocity of the coin depends on the motives of token holders: investment or transaction. The higher the investment motive, the lower the velocity. This characteristic can only be observed ex-post;

[5] https://docs.terra.money/.
[6] https://docs.themelio.org/.

vi) Demand for censorship resistance and trustlessness (Pagnotta and Buraschi 2018) are key parameters to assign some value to a decentralized network.

For the sake of transparency, the reader needs to be aware of these difficulties. Our analysis remains purely theoretical.

2 Different Forms of Money Bases and How They Relate to Cryptocurrencies

2.1 Commodities & pegs

When we turn to history, some argue that price stability was achieved thanks to commodity monies[7]. The best historical example being the 19th century where no central banks existed at that time and commercial banks were competing for seigniorage (White 1983). Gold was the standard and any dollar would be redeemable into some gold. White 2015 reviews the merits of a gold standard. Among them, he cites lower inflation and less price-level uncertainty.

However, most economists questioned[8] the feasibility of such a system and the fact that such a system was at the core of the Great Depression (Bernanke and James 1990). Besides, the efficiency of such systems is dubious (Sargent 2019) due to the fact that price stability cannot be thoroughly achieved (Friedman and Schwartz 1965). Finally, a currency based on a commodity today is rather rare and is mostly used in countries with weak institutions that can be easily manipulated such as Venezuela.

Furthermore, a peg on a commodity, like so many developing countries which rely heavily on that commodity exports do, makes those countries have less control over monetary policy and more prone to shocks (Wills 2014). For instance, when the price of oil is going down, pegging the money to its price would make the price of other resources relatively more expensive.

The link between commodity and Bitcoin has often been made (Gronwald 2019), including by the US regulator[9]. The claim is that the Bitcoin price function reacts similarly to a commodity and, therefore, Bitcoin should be classified more as a commodity and less as money. If Bitcoin is a means of payment as well as a commodity, then we should

[7]A useful definition is provided by Rolnick and Weber 1997: "By a monetary standard, we mean the objects that serve as the unit of account and that back the objects that circulate as generally accepted means of payment (that is, the objects that back the objects that are money). Under a commodity standard, the unit of account is a fixed amount of the commodity. Government currency consists of coins made of the commodity and notes redeemable in the commodity; private monies, such as bank notes, are also redeemable in the commodity."

[8]In a 2012 poll, a panel of economists was asked whether a return to a gold standard was desirable. The answers are unequivocal. http://www.igmchicago.org/surveys/gold-standard/.

[9]See: http://www.chips-corner.com/Bitcoin20Is20Officially20a20Commodity.pdf.

look for another type of classification to better understand its underlying economics. The same applies to JAX coins.

2.2 Synthetic commodity money

Proof-of-Work-based blockchain networks have two main interlinked components that make it difficult to characterize them economically. The security model and the monetary policy specifics are embedded into the code making it difficult to argue that Bitcoin and other open blockchains are just money or just a secure and decentralized payment system. They are both. Selgin 2015 has an interesting perspective on cryptocurrencies that allows us to better analyze their economic characteristics and eventually make some better assumptions on how Jax.Network will behave when it goes live. Selgin uses the term "synthetic commodity money" to specify Bitcoin-like payment networks. He (Selgin 2015) uses a two-by-two matrix to qualify different types of monies that are accepted, which we reproduce below:

		Non-monetary use?	
		Yes	*No*
	Absolute	Commodity	Synthetic Commodity
Scarcity	*Contingent*	Coase durable	Fiat

Synthetic commodity money has no other use than monetary and is absolutely scarce. It is not clear though if the monetary mass should have an upper bound. For instance, Ethereum has no limited supply, although there is a limited supply per block. In the shards of Jax.Network, the supply is not bounded by code, but by economic incentives.

3 Monetary Policy: Insights for Blockchain-Based Protocols

The merit of Bitcoin is to provide a secure online payment system where the coin supply cannot be tampered with by any government or centralized authority. However, its rigid reward per block system makes it difficult for it to become an efficient medium of exchange, as pointed out by many economists.

3.1 Some background

Indeed, money solves an important coordination problem (Lagos and Wright 2005), when someone is willing to buy a good in exchange for another one, both agents in this transaction need to agree beforehand that they accept the good of the other agent. This problem of "double coincidence of wants" was settled by introducing money into the economy. Cryptocurrencies are not there yet.

When analyzing Bitcoin in the light of monetary economics, it is argued that PoW would entail a welfare loss (Chiu and Koeppl 2017); (Saleh 2019). In Chiu and Koeppl 2017, welfare loss is incurred by users switching from cash to Bitcoins. This welfare loss is explained by the money supply rules embedded in the Bitcoin protocol and the mining costs to fully secure the system. According to their analysis, welfare is optimal where a constant range of inflation is kept around 2%, i.e. where money growth is contained around that value. This loss comes from the reward system embedded in the Bitcoin protocol. However, they link inflation with monetary mass. However, this welfare loss comes mainly from the reward system itself, which is what we try to avoid.

3.2 Rules *vs.* authority

A heated debate in monetary economics concerns rules vs. discretion. The former would bound the monetary authority in a particular country to abide by a set of rules, while the latter would allow central bankers to have more flexibility and tools to respond to complex economic environments. Blockchains allow to enforce and automate a set of rules the coin supply should follow. There are two proponents of these policy recommendations: Friedman and later Taylor. They both wanted to constrain the power of central bankers.

These rules mainly target inflation, interest rate, or other economic variables to constrain or loosen money supply in an economy. They have been vastly debated among economists, although they haven't been fully implemented. The closest case being inflation targeting by the Federal Central Bank in the US.

Our coin supply management is inspired by rule-based monetary economics. Although these policies are not implemented in today's central banks' policies, they are relevant to manage the coin supply efficiently in Jax.Network.

Furthermore, `JAX` coins are not affected by the type of long-term deflationary problems that are inherent to Bitcoin or other commodity monies, because coin supply will adapt to demand through a non-cooperative game (as we will see below). Ultimately, the fundamental value of our coin is correlated to the costs of mining, much closer than Bitcoin can be. Besides, the implementation of a K-coefficient further contracts the money supply. The main objective of the protocol is to provide a stable coin with simple issuance rules inspired by the monetary economics of Taylor 1993[10] and Friedman 1960. Friedman suggested a constant rate of money supply.

3.3 "Ideal money"[11]

Money is a moving concept that has constantly evolved over time. From 5000-years-ago gold coins, to today's scriptural fiat currency based on fractional reserves, the banking sys-

[10] For a review of the rule, see Woodford 2001.

[11] This is a direct reference to Nash Jr 2002.

tem has undergone tremendous change. Cryptocurrencies hold the promises of reshuffling the payment system and the way we understand money.

Talking about money is talking about frictions. Ultimately, money serves one purpose: easing the double-coincidence of wants. As Nash put it, money is a useful tool to transfer utility, so that consumers can order their preferences. That is why the relative value of money, either expressed relatively, in terms of a basket of goods or in another currency matters. It must be stable in order to perform the simplest form of contracts: where someone gets paid for some services he or she delivered.

In order to be stable, Nash 2009 has described a system of ideal money, one which is controlled based on an Industrial Consumption Price Index. This in a way ties the issuance and destruction of money to how industries perform and this will be ideal for a global currency that can facilitate global trade and commerce.

3.4 Simple rules

As you will see, rules on Jax.Network are rather simple. An algorithmic monetary policy seems irrelevant at best, if not dangerous. There are many arguments against this type of stablecoins. For one, the designer needs to parametrize every aspect of coin issuance, including during demand shocks. It renders the policy inflexible when things go berserk. Secondly, one would need an excessive amount of data to be able to anticipate shocks. These data need to be retrieved and analyzed outside the blockchain, defeating the purpose of decentralization in the first place.

We argue that placing the issuance power in the hands of miners is the best way to defend a decentralized cryptocurrency against shocks. Indeed, only they have an economic incentive to not see the devaluation of the exchange rate or inflate the network, as we will see in the following sections.

Our coin supply management is inspired by rule-based monetary economics to constrain our monetary supply. Although these policies are not implemented in today's central banks' policies, they are relevant to manage the coin supply efficiently in Jax.Network. Besides, we do not apply these rules right on, they are amended to fit the technical aspects of blockchain-based protocols.

This paper details the economics behind Jax.Network two coins and their incentive compatibility, ensuring both security and stability in issuing coins.

4 Why Jax.Network: Why Now and How?

4.1 The need for a reliable stablecoin

Economics is a major factor for any currency. Especially for decentralized currencies. The reason is the lack of any enforcing authority over a decentralized currency. For instance, in Venezuela, the local currency has experienced hyperinflation however people still use it because it's enforced strictly by the local government.

Existing decentralized currencies like Bitcoin, Ethereum, and almost every other currency have been designed to be deflationary and, hence, have been treated mostly as assets.

USDT is the most used stable currency in the decentralized currency space however it's mostly centralized around some issuing companies. Whether these USDT tokens are collateralized is another question altogether and we believe that sooner or later, these concerns will crop up and the market will go for a correction. Besides, being pegged to the USD, it cannot be global.

In "The World of Yesterday", Stefan Zweig described hyperinflation in the 1930s in Germany, where, by the time his manuscript arrived to his editor and he received the check by post for his work, the amount agreed upon had completely devalued and was worth almost zero. The other side of the token is also damageable, two pizzas worth $10,000$ BTC ten years back cannot value only 0.0018 BTC today. Money needs stability because it is used for transactions. These examples explain why the crypto industry is looking at stablecoins as the go-to for mass adoption. However, stablecoins are not so much a technical problem to solve, but rather an economic one.

Designing a stablecoin might be one of the trickiest tasks in economics and even more so in the cryptocurrency sphere. Indeed, cryptocurrencies are global currencies while standards of value measurements are mostly local. Pegging your coin to another currency leads to other problems linked to macroeconomic stability of the region you rely upon. One wants to always be aware of black swans! Algorithmic supply relies one way or another on external data feeds. While a fully decentralized stablecoin relies always on an external blockchain-based network that might not scale enough to absorb the entire demand for a stablecoin.

Ultimately, the industry needs a coin to measure value thanks to data that are intrinsic to the system itself (Sams 2015), so that the value is accurate and reliable without compromising on security. Besides, this coin needs to be scalable and cannot rely on an external network. That is why ERC-20 contracts are so far very limited in scope and will slow down adoption.

4.2 Demand for stablecoins

There is a very strong demand for stablecoins. As the table below indicates, it has very high volumes and very high velocity, as shown in table 1.

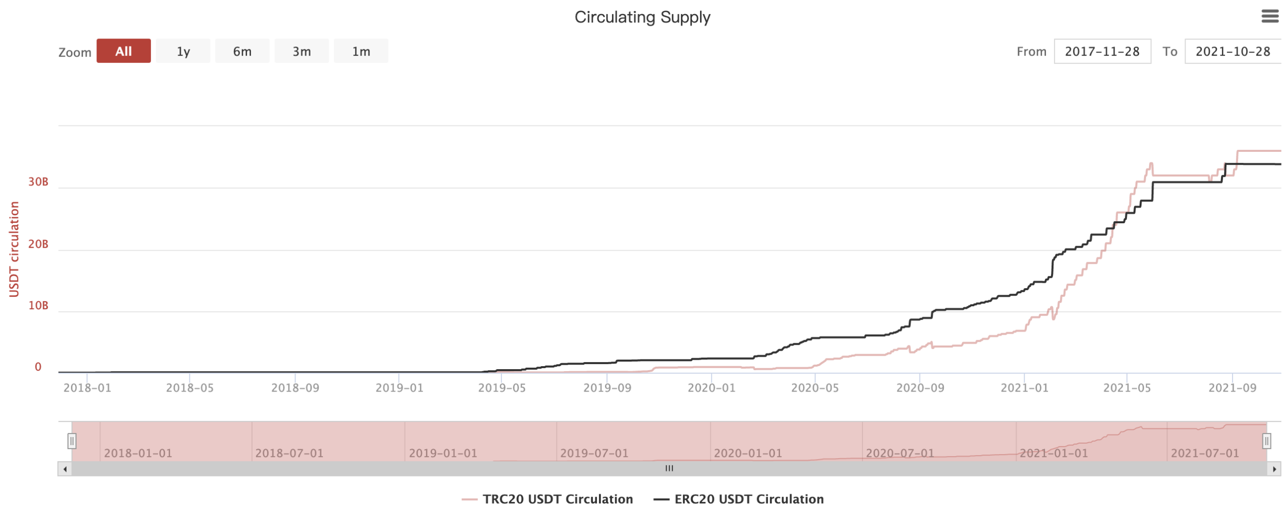
Table 1: Stablecoins market cap (Above 100 mil, as of the end of July 2021)

Name	Market cap	Tx volume
USDT	61,833,572,290	44,516,366,243
USDC	26,938,665,433	1,846,914,839
BUSD	11,519,564,371	3,933,582,362
DAI	5,486,186,425	290,792,456
TerraUSD	2,026,041,253	25,870,446
TrueUSD	1,270,243,575	82,598,523
PAX	905,938,426	81,175,879
HUSD	550,808,060	312,047,214
NeutrinoUSD	407,379,113	13,283,223
Gemini USD	317,750,779	13,283,223
Rsv Rights	285,650,950	39,314,647
FEI	2,051,421,002	13,375,618
Liquidity USD	722,687,634	507,089
FRAX	243,417,274	5,311,570
sUSD	209,127,110	6,874,276
Stasis EUR	104,751,912	980,894
TOTAL	114,873,205,607	51,182,278,502

USDT is still the leader, and the 2020/2021 market boom has reinforced its position. The company has printed more coins in the last 6 months than during its entire existence, since the stablecoin was accessible in 2014, as the reader can see in the graph below taken from TRON scan.

However, USDT stability relies on the trust that one USDT in circulation is always backed by some collateral or USD. The skyrocketing supply begs the question of this backing process, which is putting the entire crypto ecosystem at risk if the company behind Tether fails to do so. Indeed, even Bitcoin price is somehow linked to the printing of new USDT (Griffin and Shams 2020).

Other stablecoins such as PAX or USDC are more willing to comply with laws and regulations and are therefore deemed more trustworthy. Nonetheless, stablecoins backed by some collateral and reserves are difficult to scale, since the company that emits them constantly needs to back the growing demand with specific collateral. Conversely, USD and other currencies are not backed by 100% collateral or more, but backed by trust.



4.3 A decentralized currency

There are four main aspects to consider while designing a decentralized currency:

i) An indicator to know how the economy is performing;

ii) A universal exchange rate for the coin;

iii) A decentralized method to print new coins based on demand for circulating supply;

iv) A decentralized method to burn coins based on stagnation in the economy.

We have addressed all these concerns while designing Jax.Network to host its own native stablecoin.

4.4 Technology

Unlike conventional PoW blockchains, `JAX` supply does not grow at a pre-specified growth rate. Instead, miners must adjust their supply to both their cost structure and the new transaction needs of the network.

Scarcity of money supply is economically bounded by the fact that a miner will not allocate resources if it's not profitable for him. Money supply, although theoretically unlimited, cannot grow above the cost of energy and the productivity gains observed in the hardware mining equipment.

The indicator that's required to understand how the economy is performing is determined by the hashrate of the network.

We assume that if the economy is performing well, then there should be an increase in the hashrate.

If the economy is stagnant, then the hashrate should also be stagnant. If the economy is receding then there should be a decline in the hashrate.

This is usually the difficulty of the network as evident in networks such as Bitcoin.

In order to print new currency, we employ merged mining and Proof of Opportunity Cost or Proof of Value in order to decouple economics from the security of the network. This way miners are mostly printing currency only when it's needed.

4.5 Choice of Proof-of-Work over Proof-of-Stake

In order for a currency to be utilized as a transactional currency and not as an asset like existing cryptocurrencies, it has to be slightly inflationary, as if it's deflationary, it will be utilized as an asset.

This is evident by looking at the daily transaction volume of BTC with its market cap and comparing it to the USDT transaction volume and market cap, as per table 2.

Table 2: Marketcap & daily volumes of different stablecoins vs. Bitcoin (June 2021)

Name	Market cap (mil USD)	Volume (24h, mil USD)	Circulating supply (mil of units)
Bitcoin	677,000	39,400	18.7
Tether	61,400	59,100	62,000
USD Coin	24,400	2,000	24,400
Binance USD	9,400	4,000	9,400
True USD	1,400	76	1,400
HUSD	660	530	660

Even in PoS such as Themelio, where coinbase reward for their transactional coins is elastic to the Proof of Sequential Work, these networks ultimately rely on external world data which is like the hashrate or the performance of an Industrial Consumption Price Index, as indicated by John Nash. We could somehow have this data linked from a decentralized oracle. The choice of this oracle then becomes centralized. Hence, we chose a Proof-of-Work consensus which provides us the hashrate data and also serves as a security mechanism, since such data become intrinsic to the network and are reliable.

As mentioned earlier, for any stablecoin that can be used to build integrated balance sheets to function effectively, there should be a way to print more coins when required, a way to burn coins when the economy is not doing fine, a universal exchange rate that's attached to this coin and in a decentralized network, you additionally need a minimum cost of production of the coin to ensure its valuation.

Finally, most projects are currently choosing PoS over PoW, mostly, as they claim, for environmental and efficiency reasons. At first, it seemed that PoS networks would scale more easily. That being said, standalone PoS networks are more akin to a shareholding system. Agents hoard coins and stake them in the hope to earn some interest in return. The main incentive is therefore to increase the value of the coin, or rather the asset. In turn, this would be detrimental to our system, as it has been shown (Saleh 2021) that PoS networks, to work efficiently, require a very low coinbase reward. As we will see, this is at odds with the mechanism we propose to stabilize value.

4.6 PoW incentives

We need to incentivize miners and users to follow our economic policies for the governance of our coin.

The following are the items that need to be incentivized:

i) An indicator to know how the economy is performing;

ii) A universal exchange rate for the coin;

iii) A decentralized method to print new coins based on demand for circulating supply;

iv) A decentralized method to burn coins based on stagnation in the economy;

v) We also need to incentivize the maintenance of the blockchain itself.

We copy Nakamoto's incentives from Bitcoin to promote the maintenance of the blockchain in the form of:

i) `JXN` coin rewards of 20 `JXN` coins per 10-minute block on the beacon chain;

ii) `JAX` coin reward proportional to $K \cdot D$ in the shards for the maintenance of shards;

iii) `JXN` and `JAX` transaction fees add up to the block rewards.

We also ensure that `JAX` tx fees are high enough (by setting a protocol level floor value for tx fees) for miners to be motivated to verify and add `JAX` transactions in the shards without suffering from the Verifier's Dilemma (Luu et al. 2015).

In order to ensure that `JAX` coins have a universal exchange rate, we tie a minimum value for them at their production cost. Since the production cost of `JAX` coins could go down due to Koomey's law, we attach a K-coefficient which is chosen on Layer-2 and use it across Jax.Network shards to contain the cost of production of `JAX` coins.

As miners are profit-motivated, they will never print `JAX` coins, if their cost of production is higher than the market rate of `JAX` coins, this way we ensure that `JAX` coins are printed only when there's a demand for them. The peculiar coinbase reward system on `JAX` is also incentive-compatible, even when the reward is zero (Schrijvers et al. 2016), if miners choose to not print them.

Also, we have separately proposed a Decentralized Autonomous Corporation setup for governance where governance tokens are issued when `JAX` coins are burnt and this helps when the economy gets stagnated and there's a lot of `JAX` coins in circulation. In return, the governance tokens holders would get to influence the K-coefficient and get rewards in the form of validator fees (mining rewards on Layer-2).

5 Two-Coin Network and its Economics

5.1 `JAX` coins

`JAX` coins are the coins in the transactional shards of the Jax.Network blockchain. `JAX` coin issuance rate is $= K \cdot D$.

In order for `JAX` coins to be issued, the K-coefficient on the shard block should be equal to the K-coefficient of the beacon during the current epoch AND the `JXN` reward + BTC reward should be given up through a Proof-of-Value mechanism.

JAX coins by nature are inflationary due to Koomey's law and could be a very good candidate for creating a stablecoin in a decentralized network. However, `JAX` coins only represent the productivity gains in a few sectors:

i) Geo-political improvements, as mining requires government support;

ii) Energy production efficiency improvements, as it reduces the cost of production of `JAX` coins;

iii) Application-specific integrated circuits' (ASIC) power consumption efficiency as it reduces the cost of production of `JAX` coins by consuming less electricity per 1Th/s.

If everyone would use `JAX` coins, then the world would end up in a quest for cheaper and more energy-efficient equipment OR people may decide that such a quest is too demanding and decide to use a different currency that allows representation of productivity gains from a wide range of industries rather than simply the energy / chip manufacturing industry.

To avoid such an exodus event, we have designed a K-coefficient voting mechanism that allows the market to set the cost of production of `JAX` coins to ensure supply is limited, as required through a stakeholder weightage-based vote mechanism. This has been detailed further down in this document.

5.2 JXN coins

JXN coins are coins that are issued in the beacon chain of Jax.Network. JXN coins have utility (Leger, 2021) in terms of:

i) Registering important transactions in the network, including exchange agent;

ii) Registrations, Schnorr-signature aggregation based L-2 D.A.O. creation transactions, etc.;

iii) Serving as a secondary asset to BTC in the merge-mined network;

iv) Saving the Bitcoin network with regular incentives when the BTC reward drops to zero;

v) They act as a hedge against inflation of JAX coins.

The Proof-of-Value mechanism ensures that there's an opportunity cost to produce JAX coins. As we have noticed that this opportunity cost affects the market price of goods and services, including mining equipment in this industry, eventually the miners, who don't take into account this opportunity cost will be put out of business due to incurred losses.

5.3 JXN & JAX transaction fees

JXN and JAX transaction fees are collected in the beacon chain and the shard chain respectively for all transactions, including regular value transactions on both the shards and the beacon, peer registration transactions on the beacon, exchange agent registration transactions on the beacon, etc.

All tx fees (BTC tx fees + JXN tx fees + JAX tx fees) are collected regardless of where the miner decides to collect his block reward either in JXN + BTC or JAX. Assuming that miners are profit-motivated, JAX tx fees are incentives for miners to add as many transactions as possible.

5.4 Decoupling transactional motives and investment motives

"What distinguishes cryptocurrencies from other assets (e.g., stocks, bonds) is the relationship between transactional benefits and prices. On the one hand, transactional benefits are akin to dividends for a stock, hence, affecting the price agents are willing to pay to hold the cryptocurrency. But unlike dividends, the magnitude of transactional benefits in turn depends on the price of the currency: the transactional advantages of holding one bitcoin are much larger if a bitcoin is worth $15,000 than if it is worth $100. This point, which applies to all currencies, not only cryptocurrencies, was already noted in Tirole (1985, p. 1515-1516)" (Biais, Bisiere, Bouvard, Casamatta, and Menkveld 2020).

In a world with competitive privately issued monies, demand will converge on coins that pay interest on money holdings (Klein 1974)[12]. Bitcoin is born in a world where nominal interest rates around the globe tend to zero. If the trend would be to reverse, would Bitcoin and other cryptocurrencies still be seen as attractive? Would that be desirable and technically feasible to assign an interest rate to coin holders?

Another issue is the adoption rate. Most models in economics assume that the adoption rate for new technologies follows a logistic function. Then, the value is directly affected by other coin holders, who join the network, taking into account that agents use Bitcoins as both for speculative and transaction motives (Athey et al. 2017).

6 Inflation & Network Parameters

In the next three sections, we will analyze the main forces that drive the supply of `JAX` and `JXN` coins and what are the incentives that are implemented at the protocol level so that miners tightly control the coin supply.

In our system, although monetary supply is not capped, scarcity is managed through three strong economic forces:

i) Miners are profit maximizers, they will not mine new coins, if they do not profit from them. They invest according to their maximum hash power constrained by electricity costs and mining equipment costs. Block reward is operating costs-driven and not time-driven like on Bitcoin. This has a dramatic consequence on the supply mechanism. The reward being not fixed, each mining pool will adjust their supply according to their respective cost structure, the quantity of coin produced by other firms, and the demand side;

ii) We internalize the opportunity cost mining by enforcing a new mechanism at the protocol level: miners have to forgo their $BTC +$ `JXN` block reward if they want to print `JAX`;

iii) We apply a K-coefficient to adjust the monetary supply that can be minted in the current epoch. This parameter is directly linked to the aggregated hashrate across all shard chains.

[12] See also our documentation on https://jax/money.

Coin scarcity can be subject to technological changes (what we will refer below to efficiency gains in the mining equipment), which need to be taken into account.

The value of the coin is driven by three main factors:

i) Electricity costs;

ii) Hardware efficiency gains;

iii) Network's demand for transactions and investment.

The first two exogenous factors can be controlled by our K parameter (*see infra*). As for demand for transaction and investment purposes, it is based on coin holders' behaviors as we analyzed previously. However, by giving the proper incentives to miners, supply can adjust more smoothly to demand shocks over time.

6.1 Paying security with inflation?

Since the rise of central banking in the early 20th century, inflation targeting, i.e. maintaining a low level of price fluctuations for goods and services denominated in a particular currency has been the main concern. Economists have debated the role of such institutions to issue money. However, they all agree that inflation has wrecked economies in the past and, if not contained, will continue to do so. Good examples of hyperinflation can be found in the early 1920s in Germany or more recently in Zimbabwe in the early 2000s.

Are `JAX` coins inflationary? To answer this question, we must first give some definition. We adopt a textbook definition, where inflation strikes, if and only if prices of goods and services are globally increasing, therefore bringing about a loss of purchasing power for the holders of that particular currency.

Following the most common literature in monetary economics, we can use the insights of the quantitative theory of money supply to better understand the effects of the large coin supply and the impact on its value.

The equation reads as follows:

$$M \cdot V_T = \sum_{i=1}^{N}(p_i \cdot q_i) \tag{6.1}$$

M is the money supply;
V_T is the velocity of money, how much time a unit of money passes through different hands over a definite period;
p_i and q_i are the price and quantity of the $i-th$ transaction, respectively.

Inflation being a tax on money holding, too much inflation would destroy the store of value of the coin. Let us assume for a moment that $p_i \cdot q_i < M$ miners will hold on to the extra coins to avoid a crash in the price and sell their coins at a loss. In this context, money supply will increase and an unspent stack of coins will be held in miners' accounts. In the next period, miners will reduce their hashrate in order to compensate for the oversupply.

As we can see, inflation is related to prices and real outputs. At early stages, these prices will not be denominated into JAX coins, as it needs first to be considered as a medium of exchange. Inflation concerns are set at a more mature stage of JAX coin history. Furthermore, the implementation of smart contract functions into Jax.Network will mix things up, as JAX coins will not be only a medium of exchange but also a utility token, assuming JAX is also used as gas[13].

That being said, the primary concern for JAX coins is a currency crash. Assuming JAX coins will follow a logistic adoption rate of adoption, prices will not be denominated in JAX at early stages. At this stage, the platform still needs to attract a sustainable network effect in a two-sided setup.

The primary concern is that the currency would not be stable because of oversupply and will depreciate against other fiat or cryptocurrencies.

In modern times, Reinhart and Rogoff 2009 "define as currency crash an annual depreciation in excess of 15 percent. Mirroring our treatment of inflation episodes, we are concerned here not only with the dating of the initial crash but with the full period in which annual depreciations exceed the threshold."

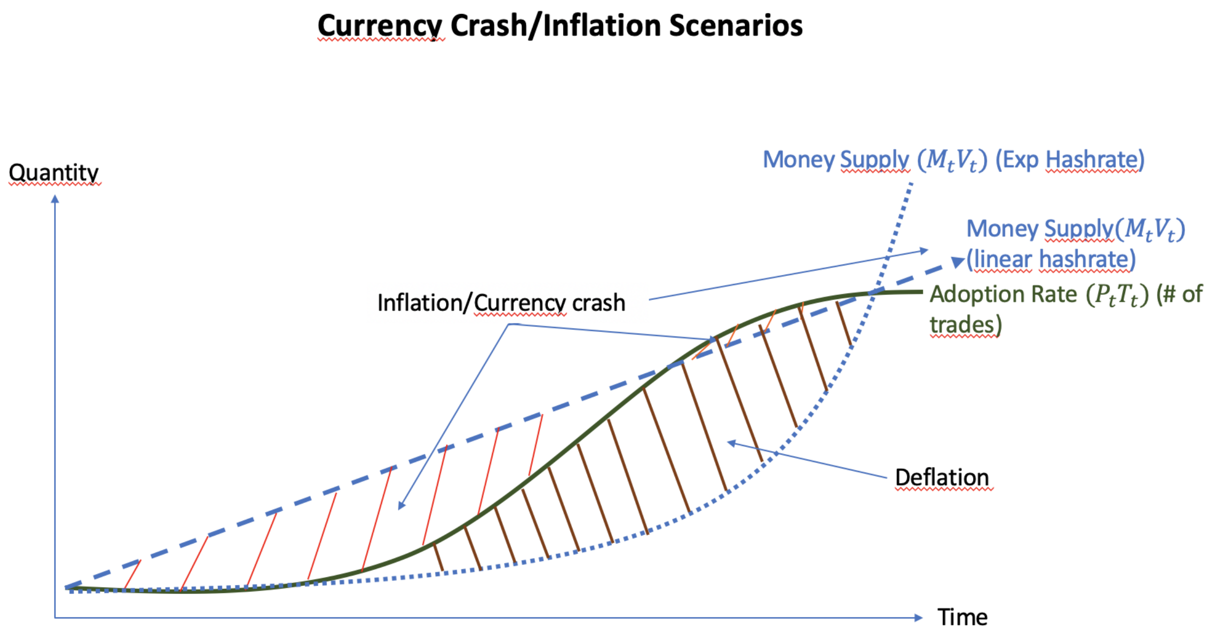
A GPU-based supply would increase the money supply up to 15-20% year on year, according to our worst-case scenario. Indeed, the efficiency gains of mining equipment are forecasted to increase by this rate. This will affect primarily the exchange rate, as the coin will first be denominated in other currencies or cryptocurrencies. Only in a second time period, after the adoption diffusion has reached a certain level, that some inflation can arise.

Therefore, what needs to be analyzed is the eventuality of a currency crash triggered by too much supply or a sudden drop in demand.

Inflation scenarios have multiple equilibria as seen in the graph below. Interestingly, it is implicitly assumed here that productivity gains fully translate into JAX issuance. In other words, the elasticity of demand[14] for computing power: $\epsilon = \frac{\frac{dQ}{Q}}{\frac{dP}{P}}$ is equal to one. Price

[13]We assume here that the token value on every shard is equal. Intuitively, the implementation of smart contracts should imply a separation between JAX coins and gas. However, no smart contract will run on our network at launch. This is why Jax.money runs on Binance smart chain at the beginning. New wrapped tokens are only created if there are sufficient on-chain (Layer-1) locked balances.

[14]Generally, as rules of thumb, if the quantity of a good demanded or purchased changes more than the price changes, the product is termed elastic (The price changes by +5%, but the demand falls by −10%). If the change in quantity purchased is the same as the price change (say, 10%/10% = 1), the product is said to have unit (or unitary) price elasticity. Finally, if the quantity purchased changes less than the price (say, −5% demanded for a +10% change in price), then the product is termed inelastic.



reaction for computing power is an important variable to take into consideration. If this ratio is $= |\pm 1|$, this means that a price variation in hardware is perfectly correlated with the demand, and, thus, the aggregated hashrate on the network. This price is known, as it depends directly on the aggregated hashrate across the network. In Bitcoin, this elasticity is directly induced.

Let's assume that miners can tolerate some inflation/currency depreciation such as the outputs (i.e. the newly minted quantity y') minus the depreciation rate of the coin $|i|$, meaning it brings about more revenues than the outputs y minus the marginal cost variation $|c'|$:

$$y' - |i| > y - |c'| \tag{6.2}$$

If we rearrange the terms, we get:

$$y' - y > |i| - |c'| \tag{6.3}$$

Everything else being equal, if the new quantity of coins $y' - y$ is superior to the depreciation rate of the coins minus the variation of marginal costs, there is an incentive for miners to print more `JAX`.

Our example assumes that, on the demand side, users do not anticipate the short-term currency depreciation due to an excessive supply. But, we can posit that as soon as a spike in supply of `JAX` on shards is observed, they adjust their behavior, ideally swapping shard coins for beacon chain coins.

In this case, miners have to commit to a certain level of coin supply for users to adapt their behavior and avoid a vicious circle. However, in the current setting, decisions are not "time-consistent" (Kydland and Prescott 1977). We saw that the decision of the leader to mine new coins is dependent on how many JAX they can release. If we follow the same argument made by Kydland and Prescott 1977, miners will have an incentive to inflate slightly more than what is expected by the users, if it is profitable to do so.

Therefore, the monetary rule becomes rather discretionary instead of rule-based, as it is originally intended. Over the short term, miners may have an advantage to inflate the shard. In other words, security is paid with long-term looming inflation. Can a simple rule be implemented to avoid such disastrous scenarios?

6.2 Proof-of-Value mechanism

This is exactly why we introduced an opportunity cost for miners to arbitrage between printing JAX or JXN. Miners will also adjust their behaviors according to the benefit of not mining other cryptocurrencies. How many units of Bitcoin (or other cryptocurrencies for that matter depending on the equipment use) do miners have to give up to mint one unit of JAX?

In other words, miners will do an arbitrage between mining different cryptocurrencies. It implies that mining JAX should be more profitable than mining other cryptocurrencies, assuming that miners allocate their scarce resources where marginal profit is the highest.

In Jax.Network, we have innovated a merged-mining Proof-of-Value mechanism, where multiple coins can share their network security under the 51% honest hashrate assumption without giving up their intrinsic coin value.

For example, in the Jax.Network blockchain, miners get:

$$\texttt{JAX}\text{ tx fees} + \text{BTC tx fees} + \texttt{JXN}\text{ tx fees} \tag{6.4}$$

And additionally, miners either choose to get:

i) BTC reward + JXN reward

(OR)

ii) JAX reward

Let's see how this mechanism helps us. First, we have combined the security of both the BTC anchor shard, plus JXN beacon shard, plus JAX transactional shard to utilize the same 51% honest hashrate for their defense against double-spend attacks.

Secondly, we contain the printing of the stablecoin JAX through this mechanism. Here's how we do it.

Let $p(\texttt{JAX})$ be the equilibrium price of JAX coins, $p(H)$ be the cost of hashrate for one unit of difficulty D. Let $m(\texttt{JAX})$ be the market price of JAX coins.

$$\text{At equilibrium, we have } p(\mathtt{JAX}) = m(\mathtt{JAX}) \tag{6.5}$$

Now, let $m(\mathtt{JXN} + BTC)$ be the market price of $(\mathtt{JXN} + BTC)$ coins. For the sake of simplicity, let's assume the K-coefficient value to be 1. When we ask people to choose between $(\mathtt{JXN} + BTC)$ or $(\mathtt{JAX})$, miners have an opportunity cost:

$$o(\mathtt{JAX}) = \frac{m(\mathtt{JXN} + BTC)}{K \cdot D} \tag{6.6}$$

For miners to print JAX coins, $m(\mathtt{JAX})$ should be greater than $o(\mathtt{JAX})$ and $D \cdot p(H)$.

Hence, for miners to print JAX coins:

$$m(\mathtt{JAX}) > \frac{m(\mathtt{JXN} + BTC)}{K \cdot D} > p(H) \tag{6.7}$$

This helps in the early stages to ensure that excessive JAX coins are not printed without demand due to our choice of anchoring with the Bitcoin network.

Also, this Proof-of-Value mechanism helps us decouple the economics of JAX coin from the security incentives of the network. Now, the shards are incentivized in the form of transaction fees and JAX coins are only issued when there's an economic demand for them. In other words, we have internalized the opportunity of mining.

JXN value is also influenced by the utility of shards. Thus, JAX coins will have an impact on the price of JXN. Thus, the JXN price reflects both the fundamental value of JXN as well as captures part of the transactional benefits of JAX.

It was argued that the fundamental value of Bitcoin was derived from its marginal cost of production (Hayes 2017). However, the econometric robustness of the model was challenged (Kjærland et al. 2018). Hashrate cost cannot explain the fundamental value of Bitcoin due to its deterministic supply. You can see the contrast with JAX coins immediately here since supply is solely dependent on hashrate. In the case of cryptocurrencies, "while for stocks dividends cause fundamental value and therefore prices, in contrast, for the currency, prices cause transactional benefits and therefore fundamental value." (Biais, Bisiere, Bouvard, Casamatta, and Menkveld 2018).

(Tirole 1985) demonstrated that there can be a "multiplicity of market fundamentals" for money. "A corollary to the latter fact is that there is a fundamental dichotomy in the formalization of money: Either it is essentially depicted as a store of value (bubble) as in Samuelson, or it is assumed to serve transaction purposes. The two representations are in the long run inconsistent."

By decoupling transactional and investment motives with our two coins we can posit that JAX coins first and foremost serve a transaction purpose, thus avoiding the dichotomy. The value of JAX coins is, thus, derived from both its cost of production and transactional utility.

JAX coins are not absolutely bound and are not redeemable in electricity spent. We assume here that its transactional value depends on the adoption path on the stablecoin market. We also assume that JAX retains its purchasing power in the long run. Therefore, it has the minimum price, which depends on an intrinsic cost of $2^{-64} H/s$.

Besides, this minimum cost of production is maintained only at time t since the efficiency of rigs reduces the cost of production by some factors. To prevent the value from depreciation, we have set a K-coefficient voted by miners (Manoharan, Leger, and Shyshatskyi 2021). In the long term, the JAX market price cannot fall down below its price of production, assuming miners are profit-oriented and risk-neutral agents.

In order to grasp the potential market of JAX coins, we need to understand the issuance of JAX, which is bound by the hashrate of Bitcoin. At the current cost of Bitcoin production, the cost of printing 1 JAX denominated in USD is:

$$1\ JAX = \frac{c(BTC) \cdot 6.25/600}{1\ (H/s)/2^{64}} \sim \$9.72 \tag{6.8}$$

With $c(BTC)$ being the current cost in hashrate for printing one Bitcoin, and H/s, the hashrate per second. The average H/s over the past year is 138 million TH/s, and the $c(BTC)$ is about \$7,000. We set the number of JAX per hash at $Jax/\text{Hash}2^{-64}$. Hence, the cost of production of 1 JAX is approximately \$9.72. If the hashrate were to crash down to say, the average hashrate of the past 5 years *ceteris paribus*[15], the price would increase to \$21.63. Overall, this setup ensures that the cost of production of JAX is always well above \$1.

What are the incentives for miners? The value per second generated by mining one Bitcoin is given in the table 3 below. It gives the opportunity cost of mining 1 BTC vs. 1 JAX.

One might ponder why should I mine JAX? The transnational coin is directly pegged to the electricity cost of Bitcoin. It will be used as collateral to print a soft-pegged stablecoin based on on-chain Proof-of-Reserves in JAX. However, with Bitcoin volatility and the fact that miners have to choose between mining JXN $+ BTC$ or JAX, then there is an opportunity cost to print JAX, which depends on the price of BTC and its hashrate, as indicated in the table above. As of the end of July 2021, the hash per second was around 100 TH/s and the price per BTC was around \$40,000. This means that the market price of JAX should reach 5 or 6 times its cost for it to be printed by miners with a higher value than BTC. This is an issue since the market price of JAX would have the same variance as BTC. How to counter that? One way is to sell JAX at the cost of production plus a small markup, regardless of the price of Bitcoin. The opportunity cost will be just a backstop against inflation. This is the reason why Jax.Network is implementing its own mining pool in order to print JAX on demand.

[15]This assumption is rather inaccurate, the example is here to show that the protocol parameters are set such as the cost of mining 1 JAX is always above \$1. Usually, if the hashrate drops too sharply, the difficulty is adjusted downward, along with the cost of mining. Everything moves in the same proportions.

Table 3: Opportunity cost of mining

BTC price (USD)	**BTC value generated per hash**	**Value of 1 JAX**
5000,00	52,08	6,95
10000,00	104,17	13,89
15000,00	156,25	20,84
20000,00	208,33	27,79
25000,00	260,42	34,73
30000,00	312,50	41,68
35000,00	364,58	48,62
40000,00	416,67	55,57
45000,00	468,75	62,52
50000,00	520,83	69,46
55000,00	572,92	76,41
60000,00	625,00	83,36
70000,00	729,17	97,25
75000,00	781,25	104,20

The unitary cost above sets a maximum supply of `JAX` coins that can be calculated per day, based on the above formula. This is the upper bound of coin volume per day, provided the velocity of 1.

6.3 Internalizing externalities?

It is shown that the mining game creates negative externalities on other miners (Biais, Bisiere, Bouvard, and Casamatta 2019), since they compete for block space, they have an incentive to increase their computing power, hence diminishing the expected returns of other miners, all else being equal.

On shards in our network, externalities on other miners are such as miners would both exert higher computing power and lower prices. Does the upper bound, or opportunity cost of mining, help curb those externalities? We argue that having two coins helps to do arbitrage and partly internalize them, besides decoupling the investment motives and transactional motives.

To show the multiple equilibrium paths, let's consider a simple game. For simplicity, there are only two users. They can either join to do a transaction or decide to hold the token for a future transaction (i.e. investment). The payoff matrix is the following:

		Player A_j	
		Investment	*Transaction*
	Investment	$(3, 3)$	$(0, 4)$
Player A_i	*Transaction*	$(4, 0)$	$(2, 2)$

In this non-cooperation game, we assume that the utility derived from investment is greater than the one derived from consumption because the investment brings about higher revenues in the long term. This assumption is verified, at least in the early stages of a decentralized network. In this typical Prisoner's Dilemma setup, the transaction is the dominant strategy. Users will therefore be enticed to consume instead of investing. This will have a ripple effect on the value of the coin.

Another short-term strategy, this time for the miners, can also play out: an arms race to the reward, putting negative externalities on the network, as the network will grow exponentially due to the proportionality of the reward. The "dynamic adjustment of mining difficulty required for ensuring a stable block production rate leads to an arms race, creating a negative externality in which each individual's acquisition of hash rates directly hurts others' payoffs."

What matters is the opportunity cost of the Bitcoin hashrate and its volatility. This ensures that the arms race is avoided because now Bitcoin miners have an alternative revenue scheme that allows them to balance their risk and their hashrate more in order to optimize their revenue. If there is enough adoption for `JAX`, we can expect Bitcoin miners to switch their computing power and not switch their rigs off during a slump, thereby avoiding dramatic peaks and troughs in hashrate.

Hashrate can be analyzed as a marketplace where resources are allocated to the most profitable coins for any given miners (Bissias, Levine, and Thibodeau 2019). This resource allocation of course depends on the equipment of miners.

Hashrate is a marketplace with negative externalities that are not internalized by individual miners, but slightly by mining pools (Cong, He, and J. Li 2021). In this context, we need to understand what the opportunity cost of one hash across multiple chains is. For simplicity, we can assume that the efficiency loss in merge-mining our network along with Bitcoin is equivalent to the switching costs from one chain to another.

The peculiarity of our shards is that the coinbase reward is not fixed, but depends on the aggregated hashrate on the shards. How can we define the value of one hash intrinsically, and what is the variance of hash allocation? The variance will give us some insights about the volatility of computing resources allocated to the overall SHA-256 market place. This variance is an important parameter since it is an indicator of the time-lag adjustment between the cost of production of one coin and the opportunity cost of printing `JAX`. The lower the variance, the higher the stability of `JAX` coins.

6.4 Setting a floor value for transaction fees

Since the Bitcoin network allows up to 10^{-8} divisions of BTC i.e Satoshi, we allow the same in the JXN beacon chain, and they have been named after the inventors of blockchain technology as Haber-Stornetta i.e 10^{-8}JXN = 1Haber-Stornetta. However, the transactional shards are primarily for transactional purposes, so we allow the maximum divisibility of JAX coins to be 10^{-4} or 0.0001 JAX in order to ensure that the minimum JAX transaction fee will be sufficient incentive for miners.

This helps in ensuring that the transaction fees and incentives for the shards are sufficient for the shards to be maintained by miners.

7 Marginal Costs of Mining and Stabilizing JAX Coins Value

Cryptocurrency with a cost: The existence of productive capital provides a fundamental value for the entrepreneur's cryptocurrency-issuing business and eliminates equilibrium paths that converge to worthless money. In Garratt & Wallace, from Fernández-Villaverde and Sanches (2016).

7.1 "Cost-based" peg

As already shown by Friedman 1951, the value of commodity monies is subject to technological changes. For instance, money is backed by oil, when new technologies such as fracking were discovered, a substantial amount of oil could be retrieved, and the price of the commodity dropped on the London and New York markets. The same applies to JAX coins, meaning technological improvements of ASIC and GPU. Efficiency gains in the hardware market allow miners to mine more outputs (i.e. coins) for the same amount of inputs (i.e. electricity). Everything else being equal, miners will race to have the latest mining equipment and beat the competition. Over time, this R&D arms race (Alsabah and Capponi 2019; Ma, Gans, and Tourky 2018) will affect the price, as miners will issue too many coins due to productivity gains in the hardware industry (see infra for a more detailed analysis).

Friedman 1951 also claims that in a commodity system, the money base would be too narrow to act as a counter-cyclical force in the economy and would just worsen price movements. However, JAX coins do not rely on such forces.

Linking coin supply to a "cost-based" incentive mechanism has some advantages. First, we avoid backing up our coin with some fiat currencies or other baskets of assets denominated in fiat, like stablecoins on the market. As such, JAX prices should not be as much correlated as other assets with fiat currencies. In the crypto sphere, stablecoins have been a hot topic for some years, as investors need some stability in prices. A lot of coins provide some mechanisms to smooth out peaks and troughs but they are always pegged to some assets or fiat currencies that defeat the purpose of a decentralized payment system backed by mathematical rules in the first place.

Finally, since our coin is not redeemable into other assets, there is no need for JaxNet to hold on to cash or collateral, which decreases the financial risks for the company. The price of the coin will float on market exchanges according to simple supply and demand economics. Our claim is that miners, just like on Bitcoin, cannot mint coins at a loss. But unlike Bitcoin, supply growth is volume-dependent (how much hash power over all shards) and not time-dependent (a fixed reward per block). With this setting, we can avoid technical flaws and some economic flaws of cryptocurrencies.

7.2 Maintaining stability in a market-driven issuance of outside money

Paper money is intrinsically useless, i.e. its price fundamental is zero (Tirole 1985). In our setting, there is a cost of production of money, with a positive marginal cost, unlike fiat currencies. This positive marginal cost changes the rationale of price stability and money bubbles. But as fiat, `JAX` coin is both inconvertible and intrinsically useless (Wallace 2010).

However, there are no legal restrictions that give `JAX` its value, which will be purely market-driven. For this reason, we can define `JAX` as private outside money, meaning that when balance sheets are reconciled it is not in zero net supply.

7.2.1 Value of `JAX` coins: how to achieve price stability?

1 `JAX` coin is usually equal to the value of the cost of 1 unit of hashrate. At the protocol level, it's conceived to be the expenditure in order to compute 2^{64} hashes. However, this cost goes down due to Koomey's law and we accommodate this effect by allowing the network, if required, to decide on a K-coefficient value which is supposed to indicate the reduction of the cost of hashrate due to technological breakthroughs.

`JAX` coins are stable to themselves or stable to the cost of hashrate in the real world. We note that it's very difficult to design a scalable blockchain which has an internal currency pegged to a traditional fiat currency without the involvement of a centralized entity.

Jax.Network blockchain scaling happens due to a cross-shard exchange agent mechanism which works seamlessly because the coin value across the shards is the same. This is because it's easy to equate the value of `JAX` coins across the shards, as they are all linked to the amount of hashrate expended to find a block.

Adding the K-coefficient that's synchronized with the beacon chain over different epochs is something that could cause some slight volatility in the price equation of `JAX` coins across various shards. However, this is addressed to a large extent by having the K-coefficient embedded in the beacon chain block header in order to prevent people from issuing `JAX` coins in different shards especially during an EPOCH transformation.

7.2.2 What would the price of `JAX` be relative to USDT?

USDT is just another stablecoin which is backed by 100% reserves. Let's now understand what would be the price of any goods, in our case `JAX` coins.

$$p(\texttt{JAX}) = Demand(\texttt{JAX}) \tag{7.1}$$

There is already a demand for stablecoins in the crypto market. But, contrary to other stablecoins, `JAX` coins have a production cost. Also, `JAX` coins have an opportunity cost, i.e. an upper bound, as the miner has to choose between getting $\texttt{JXN} + BTC$ reward or `JAX` reward. So, $p(\texttt{JAX}) < p(H)$ where $p(H)$ is the cost of hashrate.

There are two phases in which we could consider the price of `JAX`. Phase 1 would be a USDT phase and Phase 2 would be a Post-USDT phase. In the USDT phase, the K-coefficient coupled with the cost of hashrate would help maintain the cost of `JAX` above 1 USDT.

As miners are profit-motivated, they would print more `JAX` if $p(\texttt{JAX}) > p(H)$ and $p(\texttt{JAX}) > o(\texttt{JAX})$. And, $o(\texttt{JAX}) = \frac{\texttt{JXN}+BTC}{D}$.

Hence, we arrive at:

$$p(\texttt{JAX}) > \frac{p(\texttt{JXN} + BTC)}{D} > p(H) \tag{7.2}$$

Hence, $p(\texttt{JAX}) = Demand(\texttt{JAX})$ would always be less than or equal to $p(H)$, which translates into:

$$p(\texttt{JAX}) \cdot D \leq D \cdot p(H) \tag{7.3}$$

Taking into consideration the K-coefficient, we get:

$$p(\texttt{JAX}) \cdot K \cdot D \leq D \cdot p(H) \tag{7.4}$$

Or,

$$p(\texttt{JAX}) \cdot K \leq p(H) \tag{7.5}$$

So,

$$p(\texttt{JAX}) \leq \frac{p(H)}{K} \tag{7.6}$$

Since K is always less than 1, $p(\texttt{JAX})$ will be greater than the hashrate and we believe that the market through the K-coefficient mechanism will select a value of K so that $p(\texttt{JAX})$ will be around 1 USDT, as the market needs a stablecoin and the cost of production of 1 JAX is approximately 1 USDT.

7.2.3 What parameters are needed for JAX to be better than USDT?

As discussed in the previous section, there are general circumstances under which the price of JAX is better than USDT.

As we already mentioned earlier: $p(\texttt{JAX}) < \frac{p(H)}{K}$. As long as the network agrees on the value of K which brings p(H) / K to be greater than 1 USDT, the price of JAX $p(\texttt{JAX}) > 1USDT$, hence making it a better currency than the USDT.

7.3 JAX coins issuance

When will miners print JAX coins? Miners will print JAX coins when:

$$p(\texttt{JAX}) > \frac{p(H)}{K} p(H) \text{ and } p(\texttt{JAX}) > o(\texttt{JAX}) \tag{7.7}$$

Where,

$$o(\texttt{JAX}) = \frac{p(\texttt{JXN} + BTC)}{K \cdot D} \tag{7.8}$$

This ensures that JAX coin production follows the demand. Usually, no miner will increase D, if JAX coin production is not profitable for him. Hence, we contain the coin issuance and allow JAX coin production to follow the demand.

When will miners NOT print JAX coins? Miners will not print JAX coins whenever:

$$p(\texttt{JAX}) < \frac{p(H)}{K} p(H) \text{ and } p(\texttt{JAX}) < o(\texttt{JAX}) \tag{7.9}$$

Where,

$$o(\texttt{JAX}) = \frac{p(\texttt{JXN} + BTC)}{K \cdot D} \tag{7.10}$$

In this scenario, miners will still be securing the network by printing JXN coins. If printing JXN coins becomes unprofitable too, then miners will move to reduce the hashrate attached to the network.

7.4 Asymmetric costs

Certainly, miners face asymmetric costs, i.e. the cost structure is different from one miner to another, and what might turn profitable for miner A might not be the case for miner B. But this is already the case for Bitcoin, which has a tendency to concentrate mining power (Arnosti and Weinberg 2018). Economies of scale can also play out on shards, as maintaining them requires more bandwidth and data storage space. However, having two coins with different reward functions helps again to maintain some level of decentralization, as miners can always choose to reduce the number of shards they mine and still get the same expected payoff.

8 Efficiency Gains, Currency Crash

8.1 Efficiency gains and bargaining split

Also, it is increasingly hard to distinguish between the difficulty that is adjusted because of the spike in demand for transactions or because of new hardware. On Bitcoin, the R&D arms race is pushing miners to update their rigs as fast as possible to maintain their market dominance (Alsabah and Capponi 2019; Ma, Gans, and Tourky 2018). Productivity gains are usually divided between different stakeholders, i.e. the electricity provider, the chip manufacturer, and miners. Those with the highest bargaining power will reap out the benefits.

In this context, let's reduce the number of players to two for simplicity, viz. the chip manufacturer and the miner. In a Nash 2016 setting, the bargaining power over a set of agreements between two players is extracted from both the information contained in the utility functions and the set of agreements. In this game, if the chip manufacturer takes all the profits, then miners have no incentives to buy a new rig. Thus, assuming that the chip manufacturer is not also a miner (the opposite case is discussed below), the productivity gains should be split. For instance, if the bargaining power of one party is $\frac{1}{2}$, then at least part of the new profit will be retained at the level of the chip manufacturer and will not translate into a potential issuance on par with total productivity gains witnessed in the mining rig industry.

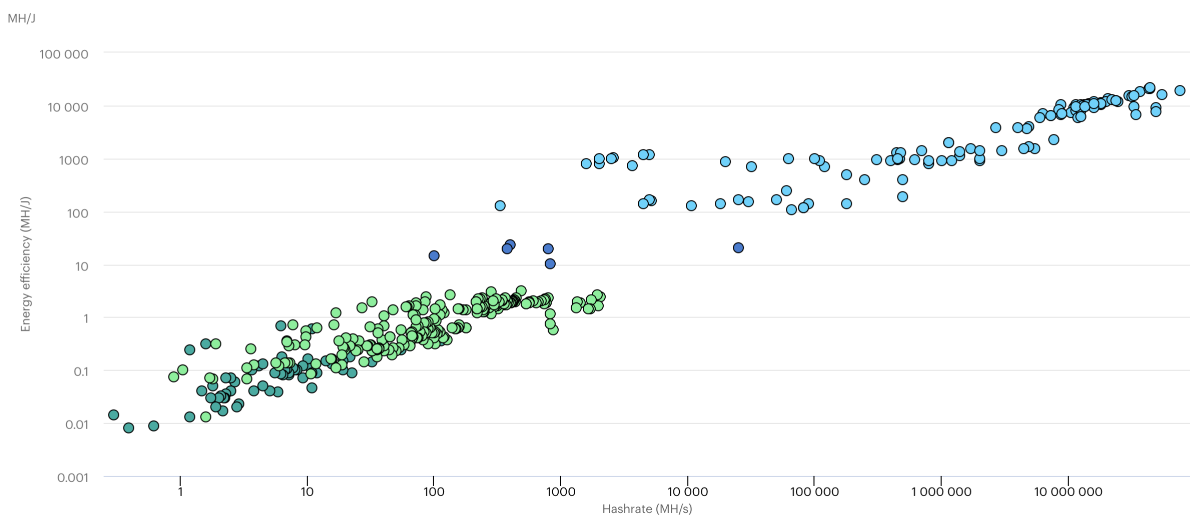
That being said, the main chip manufacturer also operates the two biggest mining pools, AntPool and BTC.com. Over the last year, these two mining pools had the control over a bit more than 22% of the total BTC hashrate on average[16]. In this case, Bitmain eventually could set the price they want and have a continuous market price advantage. Besides, the company can control the chip supply so that it stays competitive. Interestingly, a pool gathers mining power from different sources and all the rigs from these pools are not the property of the pool, but rather individual miners, who have probably nothing to do with Bitmain. Data and financial reports are scarce and the only data we found traced back to 2017. At that time, almost 90% of Bitmain revenues stemmed from the sale of chips and reportedly less than 8% were from its self-mining activities. The average yearly growth rate of self-mining was about 300% for Bitmain between 2015

[16] https://btc.com/stats/pool?pool_mode=year.

and 2017, compared with 1000% for its hardware sales branch[17]. Provided these numbers have remained constant, we can assume that Bitmain is also part of this bargaining gain[18]. Another argument is that Bitmain has competitors and it forces them to not retain all surplus from R&D.

Overall, the chip manufacturer will retain part of the productivity gains in the form of profit. Machines are certainly more efficient but also more expensive.

What is the amplitude of these efficiency gains? For that, we have to take into account two variables: the hashrate and the energy efficiency. The graph below gives an account on a logarithmic scale. If we consider only ASIC mining chips (in light blue), the energy efficiency has increased by 22.75 times between the AntMiner U1 and the ASICminer 8 nano Pro. As for the computing power, it skyrocketed by a 70 000-fold between 2014 and 2019.



However, every 2016 block there is a difficulty adjustment, which can be simplified as follows: more miners imply more hashrate, therefore decreasing slightly the average block time. An adjustment is made to compensate for that. In the short run, situations can emerge such that the difficulty increases faster than the efficiency gains, forcing less profitable miners to reduce their hashrate or invest in new rigs. In the long run on Bitcoin, productivity gains are internalized such as $\gamma = \frac{6.25}{D}$, where γ is a constant rate of efficiency gains, and D is the difficulty of the network. Miners take their decision on a daily basis, and not every halving for the next four years.

This aggressive competition over a fixed block reward has been discussed by many economists, who concluded that an R&D arms race is destructive for the chip manufacturer itself (Alsabah and Capponi 2019), especially in bear markets. In this article, miners

[17] https://templatelab.com/bitmain-ipo-prospectus/.

[18] https://craft.co/bitmain.

fail to capture surplus because of the aggressive competition in R&D. This behavior is explained in Biais, Bisiere, Bouvard, and Casamatta 2019, showing that miners' payoffs are an increasing function of the number. However, the theoretical framework in Alsabah and Capponi 2019 is a slightly off the reality, as we have shown, miners are not necessarily the ones who are undertaking the R&D risks, as it is assumed in their game. Thus, a bargaining game applies when surplus is split between agents.

Besides, a reduction of the marginal cost up to the same proportion of the energy efficiency gains would imply that all miners always update their rigs fully. It also means that efficiency gains of the mining chip take up to 100% of this cost, regardless of the other components of this cost, such as electricity. It also means that the hashrate always adjusts to this rate. However, marginal costs have been increasing on Bitcoin.

Delving into mining pools such as BitDigital, it is clear that miners own different machines and do not fully upgrade their rigs. One main reason is that new machines are not necessarily available for all. It would be as if a car manufacturer would produce its new car for all car owners. Another reason is that miners have to invest in a highly uncertain environment, making their investment irreversible (Danos et al. 2021) in a bear market, where mining rigs start becoming unprofitable. The BTC price being volatile makes new investments riskier. In this context, the investment decision is optimal not only when the net present value is above zero, and assuming that expenditures can be recovered by reselling the rigs. On the other hand, "irreversibility creates an opportunity cost of investing when the future value of the project is uncertain, and how this opportunity cost is accounted for when making the investment decision." (Abel et al. 1996) show that the opportunity cost translates into a similar analysis as a call option in the stock market.

Another important point, new issuance could be negligible when compared to the circulating supply. The problem arises when the yearly productivity gains are higher than the `JXN` convenience yield. In this context, it becomes more profitable to mine `JAX` instead of `JXN`, even if it triggers some inflation.

All these considerations apply when the block reward is fixed. That happens when the reward is proportional to the computing power, like for `JAX` coins.

8.2 Stackelberg equilibria

In this context, miners, since they compete through quantity and not prices, play a non-cooperative game well observed in the oligopoly literature. The quantity of hash power allocated by one agent, say player 1, is defined by the computing power of other players, as well as their quantities are determined by the quantity allocated by player 1. Therefore, we can argue that the game played to maximized all players' expected profits is of the Stackelberg competition.

In the following scenario, a new technology is found, which can either increase computing power outputs (e.g. mining hardware) or improve the cost efficiency of mining (e.g.

more efficient energy source). In both cases, the miner who has access to this technology first has a competitive advantage, where they can either increase their margins by minting new `JAX` coins at a lower cost than their competitors or just mine more `JAX` coins for the same cost. The second option would have an impact on the market price for the shard coin by inflating the coin supply. The best strategy for this particular miner depends also on the best strategy of other miners. Do they choose to implement this new technology too? And should they increase their margin or the coin supply?

In the simplest form of the Stackelberg game, the equilibrium path is such that player 1 can produce more, since player 2 can adjust his quantities such that the price does fall too much. For simplicity, we assume only two mining pools are in competition. Let's consider a numerical example.

Let's assume the inverse demand function is equal to:

$$p = 50 - 2(q_1 + q_2), MC_1 = 2 \text{ and } MC_2 = 10 \tag{8.1}$$

With p being the price and q_1 the quantity produced by firm 1 and q_2 the quantity produced by firm 2. MC is the marginal cost. We set the marginal cost equals 2 for firm 1 and 10 for firm 2.

To find the reaction function of firm 1:

$$R_1 = pq_1 = 50q_1 - 2q_1^2 - 2q_1q_2 \tag{8.2}$$

$$MR_1 = \frac{\partial R_1}{\partial q_1} = MC \tag{8.3}$$

$$q_1 = 12 - 0.5q_2 \Leftrightarrow \text{Reaction function of Firm 1} \tag{8.4}$$

$$\text{Similarly: } q_2 = 10 - 0.5q_1 \Leftrightarrow \text{Reaction function of Firm 2} \tag{8.5}$$

Now that we know the reaction functions of both firms, we can find the Stackelberg equilibrium for this very simple set of equations.

Firm 1 is set to be the market leader and determine the quantities it will produce first. The revenues of the market leader (R_1) are determined by plugging the reaction function into the inverse demand equation. Since firm 1 is the first mover (and knows the marginal costs of firm 2), it can determine the optimal quantity of coins to produce. In our example, with $MC_1 = 2$, and $MC_2 = 10$, the quantity produced by firm 1 is 14, while it's 8 for firm 2. However, with similar marginal costs $MC = 2$, firm 1 would still produce 14, but firm 2 would produce 12, a much bigger volume.

What does this simple example teach us?

i) Global production depends on the sum of marginal costs;

ii) Changing marginal costs will always affect the quantities produced by firm 2;

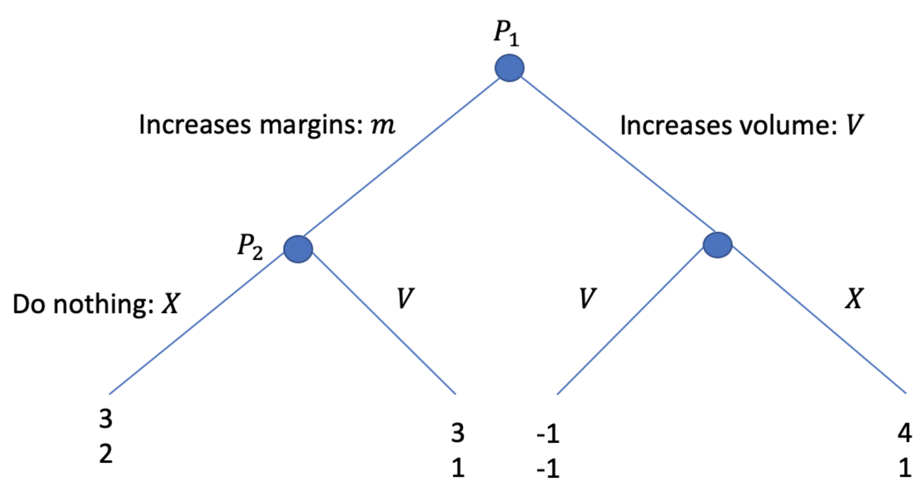
iii) The wider the gap of marginal costs between firm 1 and 2, the bigger the production opportunity for firm 1;

iv) Following point ii), this means that firms will get a big competitive advantage in striving for efficiency gains to reduce their costs.

However, this simple model assumes that the market price is not impacted by the quantity of coins in circulation and the newly minted coins. This is a very limited framework. Let's move to a more sequential visualization of this game to understand the options that miners face.

What is the rational move for a miner to mint more coins knowing other miners' strategies? In our context, it is reasonable to say that miners play this game sequentially. One miner will gain a competitive advantage by discovering a new technology and using it. Other miners can choose to follow them and invest in this technology. It will have an impact on coin production. For the stability of the network, it is paramount to understand the possible payoffs for miners. Is it more profitable to mint more coins or to improve upon miners' markups?

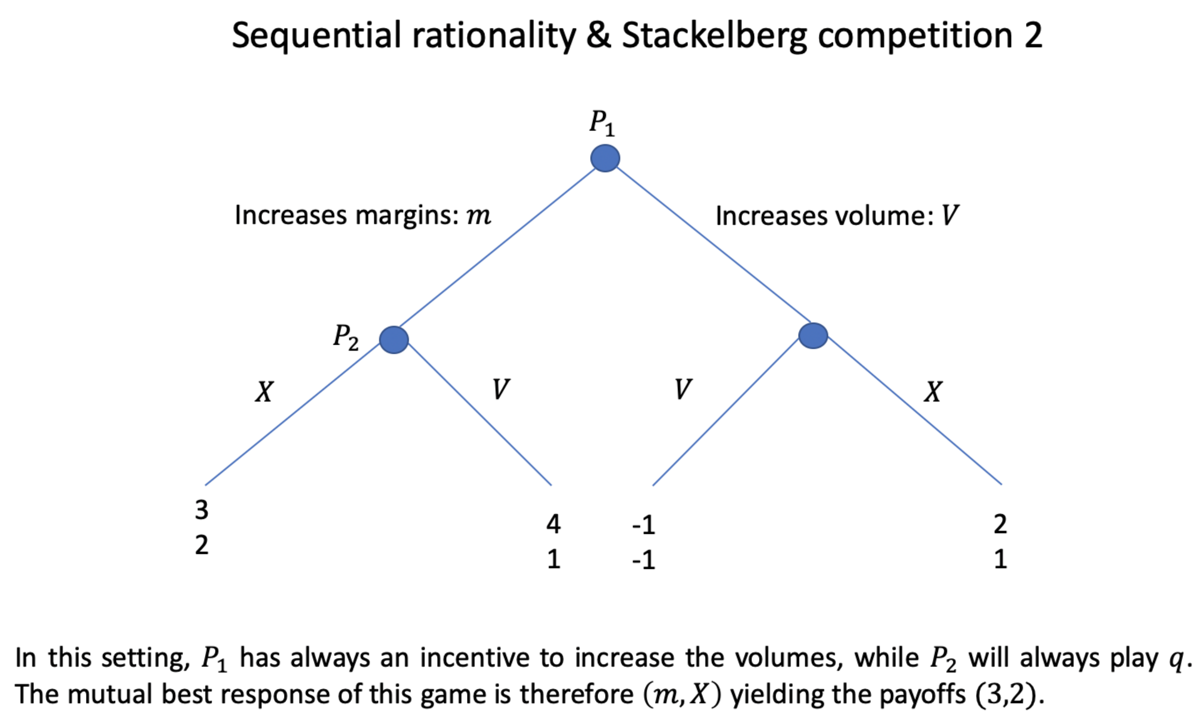
Sequential rationality & Stackelberg competition 1



In this setting, P_1 has always an incentive to increase the volumes, while P_2 will always play X. The mutual best response of this game is therefore (V, X) yielding the payoffs (4,1).

The game is played only once, assuming that once a technological breakthrough occurs, other miners will try to access this technology. Player 1, the leader, moves first to define the volumes she chooses to produce with this new technology. Player 2, the follower, observes player 1's move and adjusts his quantities accordingly. In this simplified version of the game, if the mutual best responses of miners are to increase their margins/do nothing and not coin supply, we then have the Nash equilibrium.

A second version of the game is given below, where the payoffs are slightly changed. Now, the subgame perfect equilibrium is when player 1 chooses to increase her margins (and not coin supply). In this game, player 1 always has an incentive to choose m, while player 2 will choose X.



As the reader will quickly understand, the last two games show that the stability of the shard coin value depends on the probability for player 1 to inflate (i.e. increasing coin supply) or not in the network. Player 1 will always choose the most profitable option for her, knowing player 2's best response. In any case, if the coin value depreciates too much, players will opt for increasing their margins instead of the coin supply.

This game does not show conclusive arguments in favor of one action or the other that should be played by player 1. All we learned is that player 1 has a strategic advantage and can inflate the network, only if it's profitable to do so.

8.3 Currency depreciation and K-coefficient

In our peculiar setup, efficiency gains lead to a potential depreciation of `JAX` coins, since it becomes cheaper to produce them.

The objective is to find a K that optimizes money supply under constraints, such as setting K so that our cryptocurrency converges towards its fundamental value (Tirole 1985)[19], and correct for the negative externalities arising from the productivity gains in the chip manufacturing sector.

In setting up incentives for miners to make a profit and the coin not to crash in value by restricting the supply when it is needed. This supply-side monetary rule also seeks to avoid currency crashes in the adoption period and inflation afterwards, once it's adopted and used by the public at large.

The K-coefficient is required to control the cost of production of `JAX` coins which in turn sets its value. While the economics of a cryptocurrency could play out differently compared to the economics of a real-world currency, we still have to consider the effect of Koomey's law on the cost of production of `JAX` coins.

Ideally, we should contain the cost of production of `JAX` coins to a value that we consider to be stable, in our case the dollar.

Since the cost of hashrate drops by approximately 18% year-on-year compared to the dollar, we will need to attach a coefficient to contain this technological breakthrough event.

While we can't fully vouch that this productivity gain has no positive impact on the economy, we still leave a voting mechanism to set this coefficient.

8.4 Optimal K-coefficient and miners' incentives

What is the incentive for miners to set K at the optimal level? (Manoharan, Leger, and Shyshatskyi 2021)

If miners get greedy and would like to constantly keep setting the K-coefficient to always be the initial value of 2^{64}, this won't go well as it will be in the interest of the network participants to set the right value of K in order to ensure that their `JAX` coins don't become worthless. Additionally, the majority of big mining pools will be banking on the transaction fees in the shards and the cross-shard transfer fees. These transfer fees are calculated in `JAX` coins and it's in their interest to preserve the transactional value of `JAX` coins. Hence, big mining pools will ensure that they vote for an optimal value of K for the ecosystem and they will promote for other people to follow the same value of K in their vote. This makes it a very high-risk strategy for miners to try to vote for a higher value of K which might affect the production cost of `JAX` coins and, hence, their market value.

[19]In our design, the fundamental value of the coin should converge to its marginal cost of production plus its transactional value.

9 Exchange Rate Risks and the Crucial Role of JXN Coins

"Much of the uncertainty in the value of bitcoin comes from the ease of creating perfect substitutes. It is easy to clone bitcoin and the creation of very close substitutes makes the value of bitcoin rest on beliefs that may be hard to pin down. In btc 1, btc 2." (Garratt and Wallace 2018) This is obviously the case for every cryptocurrency, which relies on an open-source code base. What does it mean in terms of exchange rate, especially against fiat currencies?

9.1 Economics of JAXNET

9.1.1 What is the role of JAXNET?

JXN coins are the hard-coded native digital assets of the Jax.Network beacon chain. They are also utility tokens (see JXN utility paper). JXN coins are used on the beacon chain as an asset secondary to BTC in the anchor BTC shard. Also, JXN coins store critical transactions like exchange agent listing, peer registration transactions, etc.

The beacon chain is the most important chain in the Jax.Network ecosystem, as it maintains the shard registry and JXN coins act as an incentive for maintaining this registry securely.

Also, in the far future, when the BTC reward drops to zero, we expect JXN coins to come to the rescue, as they have a fixed reward of 20 JXN coins per block.

9.1.2 The beacon shard to broadcast information across Jax.Network

As mentioned earlier, the beacon chain is the most important chain in Jax.Network, as it helps to look up very important information regarding exchange agents, peers in certain shards, conduct the K-coefficient election, store critical information about current K-coefficient that will affect coin production cost and also to avoid printing JAX coins across different shards, which are running on different EPOCHs.

Since all the miners will be mining the beacon chain, it serves as the important source of common information within Jax.Network.

9.1.3 JAXNET as a secondary savings account

In addition to the utility of JXN coins, they also act as a savings account secondary to BTC and it ensures that miners and other users have a long-term interest to defend the network, even during the times of economic crisis / slumps.

9.1.4 JAXNET for registering DAOs

`JXN` coins can be used to register Layer-2 transactions which could later be used for the creation of "security-as-a-service" type of validator pools and DAO registrations which could open up a whole range of applications on Layer-2.

9.1.5 JAXNET for registering colonies

We anticipate that all of the world's organizational systems could eventually be managed through Jax.Network and `JXN` coins could be used for registration of transactional tax information, UBI (Universal bassic income) tax information and the organizational hierarchies of the different communities in the universe.

9.1.6 Decoupling economics from security

`JXN` coins, through the Proof-of-Value mechanism described above, help decouple the economics / coin issuance of `JAX` coins by removing the economics aspect (coin issuance) from the incentive to secure transactional shards. Transactional shards are now secured in return for `JXN` value growth and `JAX` transaction fees. This improves the economic design of `JAX` coins greatly.

9.1.7 What happens when the `JXN` price crashes / doesn't stick to the expected growth in valuation?

When `JXN` valuation doesn't grow and stays stagnant, which would usually be the case during network user base saturation, we might have a scenario where: $p(\texttt{JAX}) > o(\texttt{JAX})$, or: $o(\texttt{JAX}) = \frac{p(\texttt{JXN}+BTC}{K \cdot D}$. In this scenario, it's more motivating for miners to keep printing `JAX` coins until: $p(\texttt{JAX}) > p(H)$ where $p(H)$ is the cost of hashrate. This is where the K-coefficient comes into play to ensure that `JAX` coins are not printed without demand. Hence, $p(\texttt{JAX}) > \frac{p(H)}{K}$ where K is the coefficient that's elected in the `JXN` beacon chain. This mechanism ensures that there's no currency value crash of `JAX` coins in the event of `JXN` coins valuation stagnation.

9.1.8 Fixing JAX price volatility by fixing issuance rate of JAXNET coins

As we now know: $p(\texttt{JAX}) <= o(\texttt{JAX})$. Since in the beginning, we might have a variable amount of `JXN` being issued in the beacon chain blocks, this total reward multiplied by the `JXN` coin price would experience a sudden drop, if we follow a halving model similar to that of BTC.

Hence, we have made a choice of drip feeding the `JXN` reward in a slowly decreasing fashion until the block reward reaches 20 `JXN` coins at which the reward remains the same.

9.1.9 Avoiding JAX currency volatility due to JAXNET price volatility

Although production of JAX coins have a cost $o(\texttt{JAX})$, which is: $o(\texttt{JAX}) = \frac{p(\texttt{JXN}+BTC)}{K \cdot D}$.

This is fine because miners could increase D until a point where JAX coins could be printed for a profit. This way, the volatility of $\texttt{JXN} + BTC$ doesn't affect the price of JAX coins. During an extreme bull run, there could be some fluctuations in the price of JAX coins, however, as we have insisted before, JAX coins are stable to themselves and one can be sure that they will always be equal to or slightly better than USDT.

9.2 Attacks on JAX/JXN exchange rate

"This aspect is crucial. As Klein 1974 points out, if a competing currency were issued by a private supplier, then, under a "fixed exchange rate, the private supplier would have incentives to continually increase supply leading to an infinite price level." This is exactly what is happening with some stablecoins. On the contrary, money with a cost allows us to avoid equilibria with worthless money (Garratt and Wallace 2018).

Do miners have an incentive to defend the pair? Miners can make printing decisions in regard with the decorrelation between the JAX/JXN exchange rate at the protocol level and at the market level. Since miners can switch costlessly between mining JXN or JAX, its arbitrage is easy to make.

9.3 Run on JAXNET?

"The third main result of Fernandez-Villaverde and Sanches (2019) is that even if in those situations where because of either the cost function of minting money or the design of the automaton issuing money we have an equilibrium with price stability, we still have other equilibria with self-fulfilling inflationary paths. These paths are closely related to the self- fulfilling inflationary paths in Obstfeld and Rogoff (1983) and Lagos and Wright (2005) in economies with government-issued money. In other words, self-fulfilling inflationary episodes are intimately associated with any decentralized ledger implemented with intrinsically useless tokens, even when those tokens are electronic and issued by private profit-maximizing, long-lived entrepreneurs. The intuition is simple: since the tokens are intrinsically worthless and only traded because of their liquidity services, we can, in general, build many paths of their values that satisfy individual optimality and rational expectations." (Fernandez-Villaverde 2021)

A run on JXN when JAX cannot be discarded since it's not a fractional reserve system. We have witnessed recently a crypto-bank run with Iron Finance. This would not be the first and needs to be considered thoroughly. Please refer to our Jax.Money documentation to know how this is avoided through constant recollateralization and a stablecoin backed by 100% reserves in JAX, an energy-pegged cryptocurrency.

10 Conclusion & Future Research

In this paper, we have discussed general monetary economics, and how it relates to the economics of Jax.Network, the various incentive schemes, the methods to mimic the activity of the central bank in a decentralized fashion and create a global decentralized stablecoin that can improve the efficiency of global commerce.

We have also discussed the various mechanisms in place to help defend the network during the times of economic crisis and hinted about the potential future that's made possible by the utilization of blockchain technology and decentralized stablecoins.

Use cases for `JAX` are multiple. The first that comes to mind is obviously remittance. We are also implementing Jax.Money, which is a platform for issuing stablecoins backed by `JAX` that run on other blockchains such as Binance Smart Chain.

Countries that are suffering from inflation and/or poor institutional framework might be also a good use case. Eventually, governments can embrace this single global decentralized currency, i.e `JAX`, and can start taxing citizens through a transactional tax and this taxation system could be much more efficient, as they make it very easy for the government to collect taxes. In case the government wants to regulate the economy more minutely and tax citizens based on the category of payments, they could always put up `JAX` as collateral and create their own Layer-2 chains where they can minutely manage the economy and tax goods and services as they see fit.

This paper, albeit very long, is just a very brief introduction to the new economics that cryptocurrencies bring about. A lot of research continuously needs to be done from different perspectives, such as lawlessness and economics (Dixit 2011), mechanism design, incentives and adoption for this new type of economy, the list is almost endless. We hope Jax.Network will be able to contribute to this debate as a prevalent use case.

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