The MAHA Protocol: ARTH Whitepaper

Version 1.1.2 – Draft

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Abstract

In this paper we describe ARTH digital asset, the world's first non-depreciating currency: a decentralized algorithmic cryptocurrency designed to maintain its purchasing power over time, irrespective of which direction the market moves.

A brief about Inflation and Stablecoins

You don't need to dive too deep into the evolution of society to pick up on the fact that greater centralization of power has been the trade-off for advancing forms of organisation. While centralization has its merits, it has always, in one form or another, come with one integral requirement; trust. To participate, you must place trust in the authority at the centre. A gradual erosion of trust in such centralized structures has given rise to the phenomenon of decentralization.

The Loss of Purchasing Power

Whilst there have been efforts to decentralize aspects of decision making in the past, nothing has been as profound as the decentralizing of money. During an important period in our history, gold was the de-facto global reserve and the underlying asset that gave us trust in sovereign currency or paper money. The 1971 US government under President Richard Nixon "unpegged" the US Dollar from gold, effectively bringing the gold standard to an end. Various political and economic events before and after that pivotal decision left the US Dollar the new global reserve currency, albeit backed by nothing but trust.

The Federal Reserve, freed from the constraints of pegging their "paper" to gold, has been constantly expanding the money supply since under various pretexts. However, it is an indisputable fact that virtually all fiat currencies, including the dollar, have lost anywhere between 50-100% of their value over the last few decades. Little is spoken of enduring inflation and permanent loss of "purchasing power" becoming a mainstay in our modern economic system.

Reduction of the purchasing power of the Dollar. [Know More](#)

Decentralizing Money and Beyond

We cannot mention decentralized money without pointing to the pioneering success of Bitcoin, which made it possible to transfer value without a centralized authority through intricately designed, immutable infrastructure. Ethereum, by way of a programmable and smart contract based system, has catalysed blockchain adoption to open up the possibility of absolute decentralization, seen in various forms of apps, platforms, and most notably; entire organizations.

It is in this element of decentralization of organizations that MakerDAO homes in on, implementing the concept of a two-token infrastructure, namely the Maker Token and DAI. This project showed that it was possible to create decentralized stablecoins that are algorithmic and backed by crypto collaterals.

The Solution

In the context of chronic declines in purchasing power and the decentralisation of money, the ARTH ecosystem builds upon MakerDAO's concept of DAI to pioneer new mechanisms, resulting in a coin that's both value-stable and a raw measure of an asset's buying power.

We hereby introduce ARTH, a decentralized algorithmic value-stable coin protocol that aims to maintain, and in some cases even appreciate, the buying power or value of the coin irrespective of which direction the market moves.

ARTH is able to do this as it's backed to stable collaterals, which are complete hedges of one other, so that if one asset depreciates in buying power, the other in turn asset appreciates, keeping the net buying power of the coin stable.

ARTH uses a special method of measuring an asset's buying power that's not tied to any fiat currencies, which in turn makes ARTH inflation-proof.

Calculating the buying power of an asset

Most assets in the cryptocurrency space are denominated in US Dollars. However, as outlined in the previous sections, USD itself has lost most of its purchasing power over the past few decades, which causes issues for anybody who holds USD or has assets that are backed by USD, as they will also have to account for inflation.

To create an asset that is designed to protect the buying power of its holder, we need to come up with an absolute unit of measure to translate the buying power of an asset, which is not measured in US dollars. A natural suggestion could be to calculate buying power in terms of how many units of gold an asset can be traded for, as gold was once the standard measure of wealth.

Understanding how to measure the buying power of an asset is important, in order to make accurate decisions based on whether or not the asset's absolute buying power has appreciated or depreciated.

Global measurement unit

One of the features that will differentiate ARTH coin from the other stable coins and MahaDAO from the other DAOs is our Global measurement unit (GMU). Designed uniquely and precisely to fulfil MahaDAO vision, creating timeless value currency – ARTH coin. Initially ARTH will be pegged 1:1 to USD, and backed by a basket of assets.

The global measurement unit is responsible for keeping ARTH coin resistant to depreciation.
In other words, GMU represents a basket of assets carefully selected with adequate weights to present strong hedge strategy against all economic turbulences and many risks regarding, especially inflation and currency risk.

The basket consists of the key currencies and main global commodities like gold as it's a typical example of a safe haven. What stands behind the decision to peg GMU with several prominent currencies is the fact that these sovereign currencies have a sound and stable macroeconomic position, superb AAA credit rating and significant share in world GDP. Given this fact, we can observe their Treasury bond rates and compare them to inflation which will help us deciding which currency holds real value.

Compared to the International Monetary Fund's SDR, which only consists of main currencies and is not protected against political influence, the GMU will also include small portion of riskier assets in form of Bitcoin and will be undoubtedly immune to political influence. Bitcoin is the right choice for a riskier asset because its price basically represents spillovers from world stock exchanges. Another advantage of GMU is that the initial basket of currencies can be changed; both the shares of the assets and the assets themselves can be replaced in order to adapt to the given economic circumstances, providing stability that ARTH coin stands for from a dynamic viewpoint.

The ARTH Vault

The vault was a concept first introduced in MakerDAO as a way of managing the underlying collaterals that have been locked to generate a token.

The ARTH vault builds further on this, borrowing concepts like the DSR (DAI Savings Rate), emergency shutdown, stability fees, amongst others, to create a system that behaves similar to what would be the equivalent of a decentralized reserve bank.

The ARTH vault generates ARTH tokens by locking in collaterals and minting new ARTH tokens against them in the form of debt; and releases collaterals when this debt is paid back, thereby burning the ARTH tokens.

The vault will facilitate the buying and selling of underlying collaterals in various market scenarios to maintain the net buying power of the ARTH coin to be pegged 1:1 to USD.

Essentially the main purpose of the ARTH vault is two-fold:

1. Ensure that the buying power of the minted ARTH tokens never go below a certain point.
2. Employ strategies to enable the vault to increase the net buying power by locking in greater collaterals as the market fluctuates.

Creating ARTH tokens using the ARTH Vault

To create ARTH, a vault needs to be created and collateral needs to be deposited and locked inside of it. Against that value of the locked collaterals, ARTH tokens are minted and given to the vault owner as debt.

To release the collaterals locked in the vault, the vault owner pays back his debt along with a stability fee, which can be paid in ARTH or in MAHA tokens. When the debt is paid off, the ARTH tokens are burnt and removed from the supply.

Debt-to-Collateral ratio

The debt-to-collateral ratio will ensure that ARTH tokens are always issued at a value less than the net value of the vault. This gives some contingency to price volatility for any of the collaterals before a vault stands a chance of being liquidated.

For example, a collateral with a 150% debt-to-collateralization ratio will allow for 50% of the collateral's value to be issued in the form of ARTH tokens.

Vault Liquidation & Liquidation Ratio

A vault risks liquidation when the collaterals that have been locked in depreciate in value and the position held by the vault nears the liquidation ratio.

When a vault is marked as to be liquidated, the ARTH minting stops and the locked collaterals are sold to any buyer willing to pay back the debt in ARTH, at a discount to the vault owner.

These liquidation ratios mean that despite potential price swings, the ARTH market itself as a whole is never undercollateralized. This also ensures value stability for the ARTH coin.

Collateral Buying Power Ratio

The buying power ratio of each of the collaterals deposited in the vault is a predefined value, used to define exactly how much of each collateral should be in the vault.

For example, a vault designed with two assets A and B, and with a collateral buying power ratio of 1:1, should result in the buying power of both assets remaining the same, at all times.

Any deviation from this ratio will force the vault to perform a rebalancing, where it will sell one collateral for the other, bringing the balance back to the ratio.

Rebalancing the underlying collaterals

Since the ARTH vault is backed by collaterals, it will eventually be subject to market fluctuations. Hence, the net buying power of the vault can either appreciate or depreciate due to market effects on the underlying collaterals.

In cases where the net buying power of the vault depreciates, the vault does not do any rebalancing to counter this depreciation. The depreciation of the vault is a weighted average of the depreciation across all the collaterals.

In cases where the net buying power appreciates, the vault will perform a rebalance to try and maintain the buying power ratios.

Which means just like a reserve bank, the ARTH vault will systematically buy or sell the underlying collaterals for one another, so that all of the collateral's buying power ratios are met, to achieve the 1:1 peg to USD.

Rules for Rebalancing

The strategy employed for rebalancing by the vault will follow the following rules:

1. That the buying power of all collaterals maintain the ratio defined at all times.

2. The collateral being sold is the asset which has appreciated in buying power and the amount to be sold is calculated based on the increase in buying power.

3. The collateral being bought is the asset which has depreciated in buying power and the amount to be bought is calculated based on the amount of other collaterals we can sell.

4. The collaterals are sold in such a way that we are not left with less than 50% of the quantity we started off with. This is known as a stop-sell.

Understanding the Stop-sell

Because we are selling an appreciating asset for a depreciating one, we end up in a scenario where if one side continues to appreciate, the vault strategy will continue selling off the appreciating collateral to maintain the buying power ratio.

This causes a situation where the vault will end up having sold one side of the collateral fully and end up having a full exposure to the other collateral.

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The stop-sell ensures that the vault will never sell collateral more than a percentage of what it had initially started with.

For example, if the vault had a stop sell of 10% and one of the collaterals, say, asset A appreciates by 50%. Then this will trigger the vault to trigger a rebalance and make a trade selling 16% of asset A. But since selling 16% is more than our stop sell of 10%, this trade does not execute.

Rebalancing Strategy Example

To elaborate how the rebalancing strategy works in a real-world scenario where one asset appreciates, we have drawn up a visualisation. In this example, we have two assets, namely A and B, and a vault which maintains a 50-50 ratio with respect to the buying power of each asset. The following diagram demonstrates how the vault will behave in this scenario.
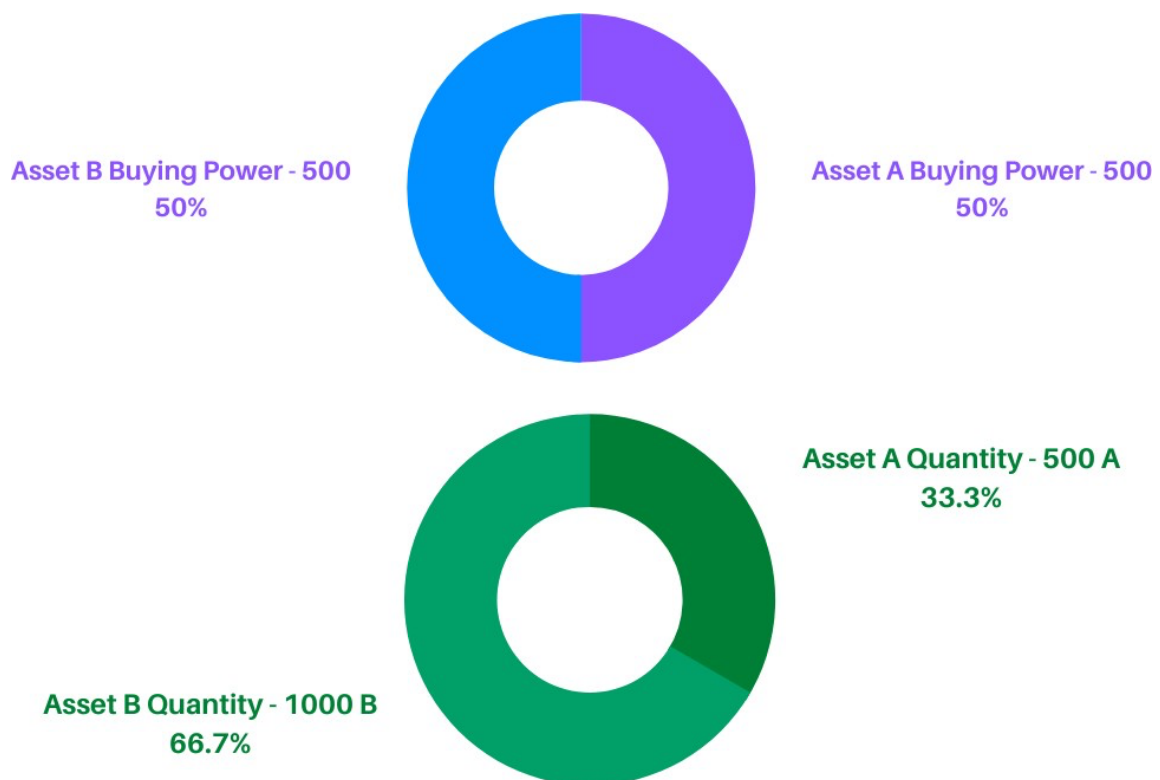
A vault with two assets holding a 50-50 ratio between them in buying power. Asset A is worth 1 unit of buying power and Asset B is worth 0.5 units of buying power. Creating a vault with a net buying power of 1000 units.

Now assuming that the buying power for Asset A appreciates by 50% and that it remains the same for Asset B, we end up with the following composition in our vault.
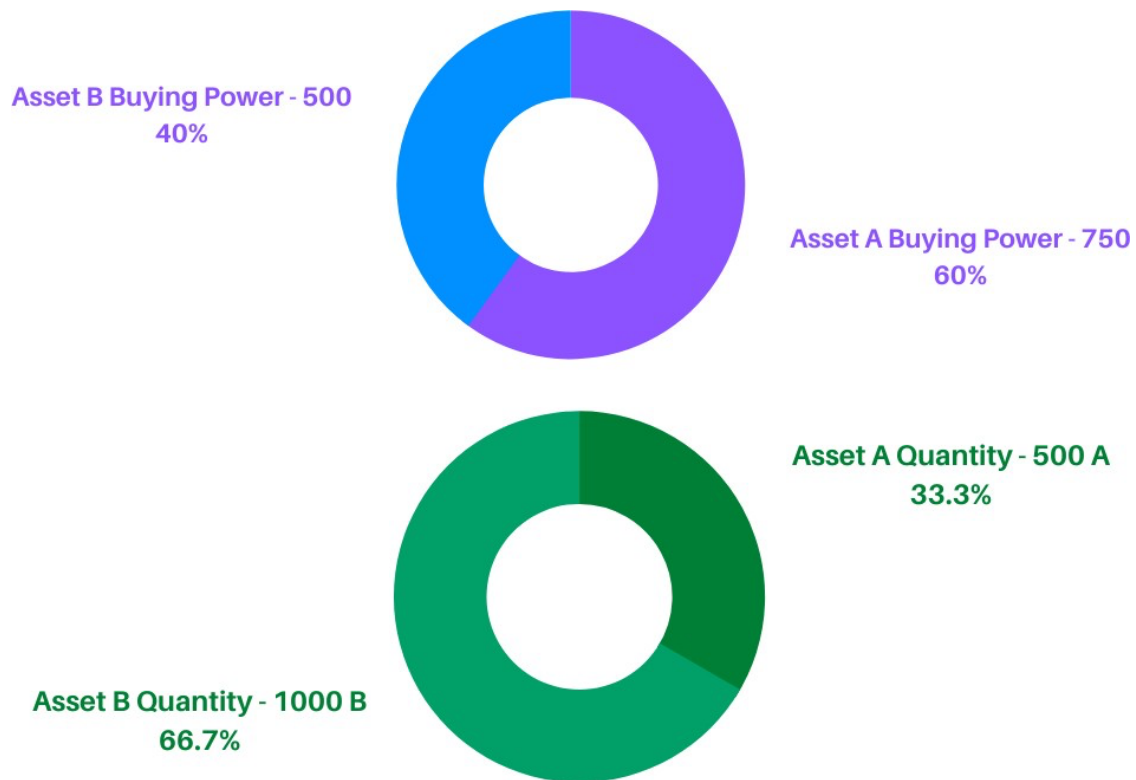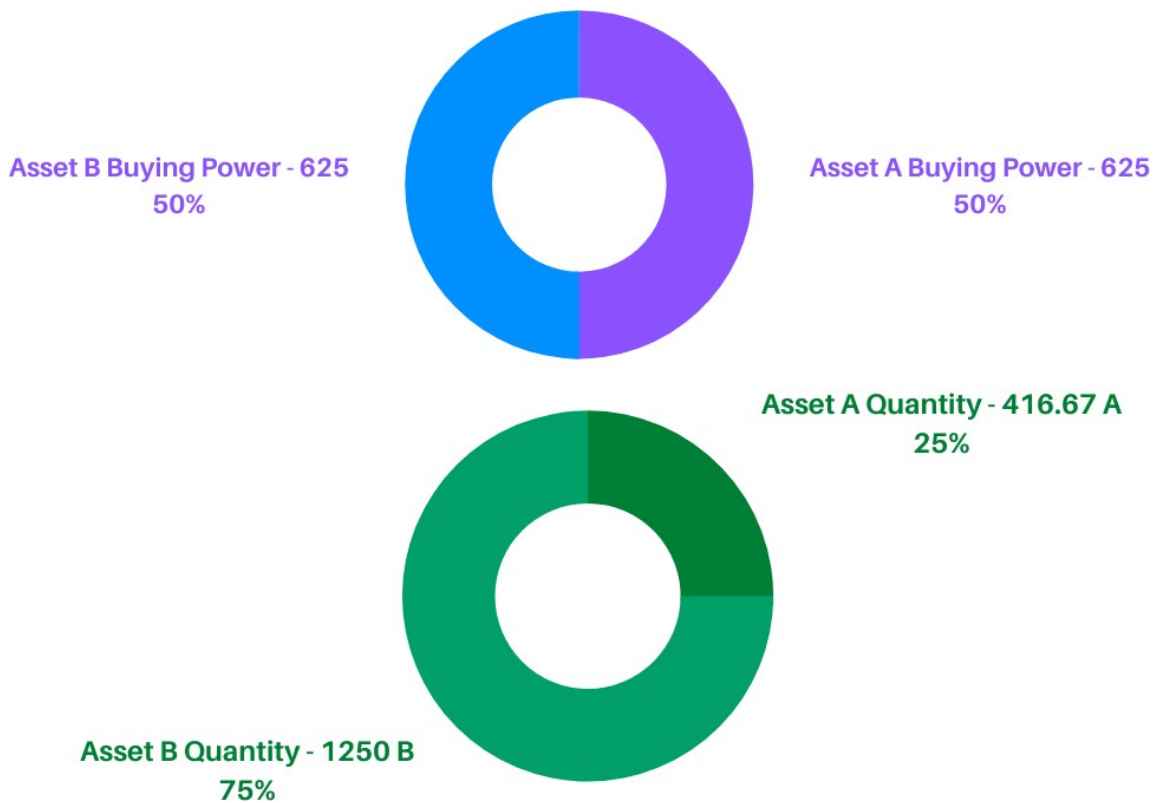

Status of the vault when asset A appreciates by 50%. Net buying power of the vault is 1250 units

When asset A appreciates by 50% in buying power, the quantities held by the vault of both assets remain the same. However, the net buying power of the vault has now become 1250 units which is an increase of over 25%.

When this happens, the vault triggers a rebalance by selling the excess appreciated amount of asset A for asset B. Since asset A appreciated by 250 buying power units (500 - 750), the vault decides to sell off half of that, 125 buying power units of A, for asset B; to come back to the 50-50 buying power ratio.

Which means a trade is published *selling 125 buying-power units of A for 125 buying-power units of B*.

After taking into account the price of A and B, we come up with the final trade which is selling *X units of A for Y units of B*.

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Asset B Buying Power - 625
50%

Asset A Buying Power - 625
50%

Asset A Quantity - 416.67 A
25%

Asset B Quantity - 1250 B
75%

The vault after it has rebalanced and sold asset A for asset B

After the rebalance the vault is back to a 50-50 ratio in buying power, but the quantities of both A and B have changed.

Moreover, if asset A keeps on further appreciating, then the vault will continue to sell more of asset A to buy more of asset B; but the vault will stop selling asset A if it has already sold more than 50% of what it had initially started off with.

This is done to avoid selling off too much of asset A and to also allow the vault owner to realise the continuous upside of having an appreciating asset.

All parameters for the strategy can be changed upon vote by the governance token holders.

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Holding auctions to buy/sell the underlying collateral

When the vault decides to buy/sell locked collaterals, it'll automatically open a trade/swap, placing the collateral to be sold on one side and requesting the collateral to be bought on the other side.

The rate for which the collaterals are sold are determined by two variables.

1. A price feed, which is given by price oracles.
2. A market maker discount.

The market maker discount is a reduction applied to the trade price to make the it more attractive to market makers, who'll fulfil the order to realise a profit through arbitrage in other markets.

Since the amount being sold is from the profits of vault, the vault can risk giving away a discount as the change in net buying power still remains positive.

Initially, a market maker discount can be set to promote more engagements with market makers.

The auction parameters are community governed and can be changed upon vote by MAHA token holders.

MAHA token holders may also vote on issues relating to the 1:1 peg to USD.

Choosing the right kind of collaterals for ARTH

An ARTH vault's true value is derived from the value of the underlying assets inside of it. As a result, it's crucial to choose the right kind collaterals and their ratios when deciding the value of ARTH.

The ARTH vaults are designed to appreciate in value when one of the underlying assets appreciates in value and contributes to the net vault's value as a whole. In certain scenarios when all of the collaterals locked inside the ARTH vault depreciate, the ARTH vault would also depreciate.

Hence, it's important to choose collaterals that are perfect hedges of each other to come up with a strategy that would the best chances of holding its value regardless of the direction of the market.

Therefore, when choosing a collateral, the following points need to be considered:

- **High Market Capitalization:** Collaterals with large enough market capitalization should be preferred over smaller ones. Small market cap collaterals would not only limit the amount of value that can be captured by the vault but would also be more liable to manipulation. Choosing high market cap assets will ensure steady price-movements and avoid vaults getting liquidated during major price swings.

- **Uncorrelated to other assets or negative beta**: Ideally collaterals should be chosen such that they have a negative beta with other collaterals. In other words, they are perfect hedges of each other and when one collateral goes down, the other collateral should go up to keep the value stable. Fiat collaterals are often heavily correlated with the US dollar. Crypto collaterals are often heavily correlated with Bitcoin. The collateral ratios decide how

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much of each collateral is stored within the vault and can be governed by MAHA token

holders. This will allow MAHA token holders to easily introduce or phase out collaterals as and when needed.

For example, a vault with three different collaterals with a buying power ratio of 1:1:1, will try to maintain a reserve with equal buying power for each collateral as per the strategy mentioned above.

In cases where one of the underlying collaterals becomes unstable or is deemed as "high" risk, it can slowly and gradually be removed from the ARTH vault by reducing its buying power ratio to 0. This can be a community governed decision made by MAHA token holders.

MAHA token

The native digital cryptographically-secured governance token of the ARTH network (**MAHA token**) is a transferable representation of attributed functions specified in the protocol/code of the ARTH network, which is designed to play a major role in the functioning of the ecosystem on the ARTH network and intended to be used solely as the primary utility token on the network.

MAHA token is a non-refundable functional utility token which will be used as the medium of exchange between participants on the ARTH network. The goal of introducing MAHA token is to provide a convenient and secure mode of payment and settlement between participants who interact within the ecosystem on the ARTH network (for example, fees charged to the vault liquidator), and it is not, and not intended to be, a medium of exchange accepted by the public (or a section of the public) as payment for goods or services or for the discharge of a debt; nor is it designed or intended to be used by any person as payment for any goods or services whatsoever that are not exclusively provided by the issuer. MAHA token does not in any way represent any shareholding, participation, right, title, or interest in the DAO, the Distributor, their respective affiliates, or any other DAO, enterprise or undertaking, nor will MAHA token entitle token holders to any promise of fees, dividends, revenue, profits or investment returns, and are not intended to constitute securities in Singapore or any relevant jurisdiction. MAHA token may only be utilised on the ARTH network, and ownership of MAHA token carries no rights, express or implied, other than the right to use MAHA token as a means to enable usage of and interaction within the ARTH network.

It is anticipated that the community of MAHA token holders would comprise a diverse field of developers, professionals and supporters of the project to develop the ARTH network (including without limitation experts in software development, blockchain technology, cryptography, artificial intelligence, law or finance), which will be able to share and exchange balanced views on the overall direction of the project. It is these community members which would drive development of the ARTH network, so MAHA token incentives would need to be distributed to compensate them for their time, expertise and effort. In order to promote community governance for the network, MAHA token would allow holders to propose and vote on governance proposals to determine features and/or parameters of the ARTH network, with voting weight calculated in proportion to their token holdings. For the avoidance of doubt, the right to vote is restricted solely to voting on features of the ARTH network; the right to vote does not entitle MAHA token holders to vote on the operation and management of the DAO, its affiliates, or their assets, and does not constitute any equity interest in any of these entities.

MAHA token are designed to be consumed/utilised, and that is the goal of the MAHA token distribution. In fact, the project to develop the ARTH network would fail if all MAHA token holders simply held onto their MAHA token and did nothing with it. In particular, it is highlighted that MAHA token:

1. does not have any tangible or physical manifestation, and does not have any intrinsic value (nor does any person make any representation or give any commitment as to its value);
2. is non-refundable and cannot be exchanged for cash (or its equivalent value in any other virtual currency) or any payment obligation by the DAO, the Distributor or any of their

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respective affiliates;

3. does not represent or confer on the token holder any right of any form with respect to the DAO, the Distributor (or any of their respective affiliates), or its revenues or assets, including without limitation any right to receive future dividends, revenue, shares, ownership right or stake, share or security, any voting, distribution, redemption, liquidation, proprietary (including all forms of intellectual property or licence rights), right to receive accounts, financial statements or other financial data, the right to requisition or participate in shareholder meetings, the right to nominate a director, or other financial or legal rights or equivalent rights, or intellectual property rights or any other form of participation in or relating to the ARTH network, the DAO, the Distributor and/or their service providers;

4. is not intended to represent any rights under a contract for differences or under any other contract the purpose or pretended purpose of which is to secure a profit or avoid a loss;

5. is not intended to be a representation of money (including electronic money), security, commodity, bond, debt instrument, unit in a collective investment scheme or any other kind of financial instrument or investment;

6. is not a loan to the DAO, the Distributor or any of their respective affiliates, is not intended to represent a debt owed by the DAO, the Distributor or any of their respective affiliates, and there is no expectation of profit; and

7. does not provide the token holder with any ownership or other interest in the DAO, the Distributor or any of their respective affiliates.

Notwithstanding the MAHA token distribution, users have no economic or legal right over or beneficial interest in the assets of the DAO, the Distributor, or any of their affiliates after the token distribution.

Simulating across various market scenarios
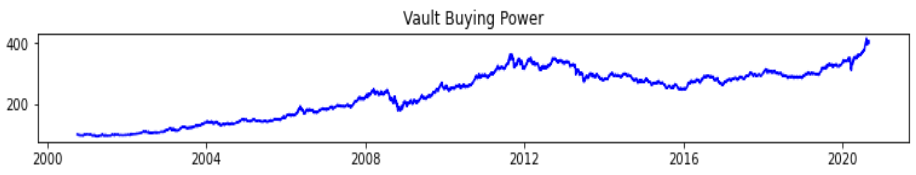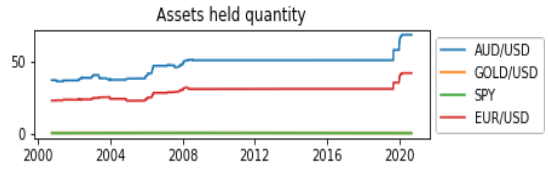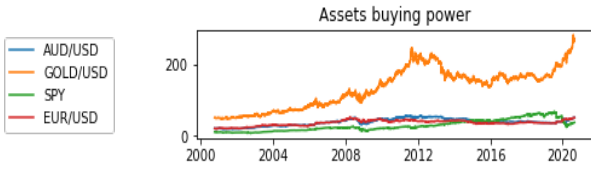
We use the following parameters:

1. Stop sell of 30%
2. Stop loss of 30%
3. 5% slippage for every rebalance
4. Rebalance to happen once every 7 days
5. 50% of the appreciated value from the appreciating asset, is sold off during every rebalance
6. Starting with a buying power of 100 (so that it is easy to measure % increase)

Using a basket of Forex, Gold and US Equities

Here we try with data from 1990-2020 and keep 50% of the vault's buying power in GOLD and the remaining in Australian Dollar, Euro and SPY500 ETF. AUS and EUR will represent the fiat markets and SPY500 ETF will represent the stock market. Since usually gold is often used as a hedge against the stock & forex markets, we keep a 50% ratio in gold.

Buying power for this simulation is calculated in USD. Assets chosen are distributed with the following ratios:

1. Australian Dollar (20% starting buying power)
2. Gold (50% starting buying power)
3. S&P 500 ETF (10% starting buying power)
4. Euro (20% starting buying power)

Assets price

Assets buying power

Assets held quantity

Vault Buying Power

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Using a basket of Stablecoins, Gold and Cryptocurrencies

The purpose of this simulation is to understand how ARTH would perform in a real-world scenario, as if it had launched around the year 2019. Here we choose a basket of stablecoins, gold and cryptocurrencies keeping stablecoins on one side of the hedge and fiat currencies on the other side.

Buying power for this simulation is calculated in USD. Assets chosen are distributed with the following ratios:

1. WBTC (20% starting buying power)
2. Gold (10% starting buying power)
3. ETH (20% starting buying power)
4. Euro (50% starting buying power)
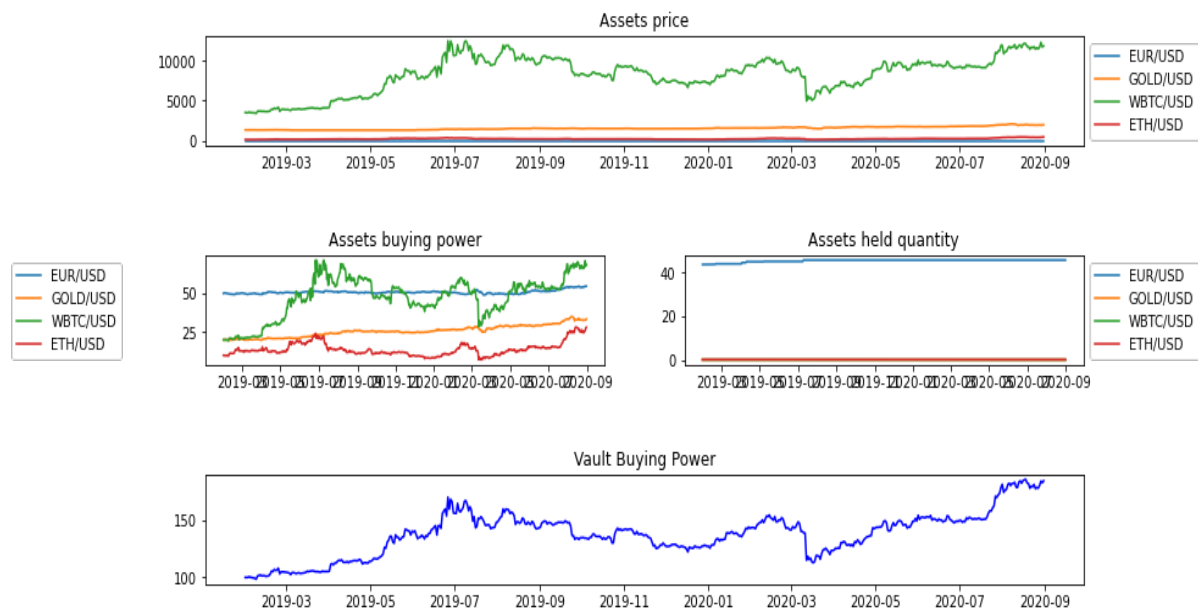
At the end of the simulation, the vault has rebalanced itself around 6 times over the course of 1 year and has appreciated itself by over 80%. (Full analysis and code can be found [here](#))

Stability Fees

To control the supply of ARTH tokens in the market, the ARTH vault will charge a fee in MAHA tokens to the vault liquidator whenever he/she wishes to release the locked collaterals in the vault.

A high fee will discourage creation and liquidation of ARTH vaults and a low fee will encourage creation and liquidation of ARTH vaults.

Emergency shutdown

To protect the ARTH holders against attacks on the infrastructure, an emergency shutdown module can be invoked as a last resort.

Upon activation, the emergency shutdown module will deploy a two-pronged safety mechanism in which new vaults will stop getting created and all existing vaults will be instructed to stop creating new ARTH tokens. This will enable vault owners to reclaim their collaterals against the circulating ARTH and the overall rebalancing activities will come to a halt as well.

MAHA Minority can use this Emergency Shutdown Module to specifically thwart three types of attacks:

1. Malicious governance
2. Critical bug in smart contract code
3. Long-term market irrationality

The MAHA voters will determine a quorum (initially 1,000,000 MAHA) that is required to be deposited to trigger the Emergency Shutdown.

ARTH Savings Rate - ASR

An ARTH Savings Rate system has been put into place to allow token holders to be compensated for holding ARTH. The model incentivizes the balance of supply and demand of ARTH and allows for capital to be deployed more efficiently while still holding true to the protocol's core role of providing strong, decentralized stability.

The ASR is a basic interest system. Token holders can lock and unlock ARTH in an ancillary "savings" contract which would continuously accrue interest based on ASR, a global system variable. If the prevailing ASR is 3%, a holder who locks 100 ARTH tokens for a full year, will earn three additional ARTH when they unlock the same. The funds needed for the ASR come from the stability fees paid by CDP's. For example, average stability fees of 4% collected on CDP's could easily fund an ASR of 3%.

Beyond keeping the balance of demand and supply of ARTH, this system will prove to be a major monetary policy lever that the decentralized governance can control. This will be a global parameter that will be adjusted often to deal with short-term changes in the market conditions of the ARTH economy.

These two mechanisms in conjunction, provide a powerful array of tools to guard both short-term and long-term stability of the ARTH token.

Known Risks

The following risks have been identified as risks to the stability of ARTH.

- **New economic model** - Any uncertainties with any new economic model

- **Smart contract bugs** - Possibility of any bug in the smart contract can bring the entire system down, no matter how much code-review has been done on the smart contracts.

- **Low liquidity -** If there isn't enough liquidity to support the various rebalances or generate enough ARTH, then ARTH can see itself depreciate in value.

- **Collapse of one of the underlying collaterals -** An unstable collateral which collapses can cause ARTH to lose its value proportionate to how much value exposure was there to the collateral.

- **Collapse of the price feeds** - The price feeds are a crucial piece for the ARTH vaults to determine the situation of the market. Any collapse in these price feeds would cause the ARTH vaults to make decisions based on incorrect data.

- **Centralization of MAHA tokens -** Majority of the decisions made for ARTH are decided upon MAHA token holders. Therefore a centralisation of MAHA tokens will cause the decisions to be one-sided which might not possibly result in the best outcome.

- **Regulatory -** The regulatory status of ARTH and MAHA token and distributed ledger technology is unclear or unsettled in many jurisdictions. The regulation of virtual currencies has become a primary target of regulation in all major countries in the world. It is impossible to predict how, when or whether regulatory agencies may apply existing regulations or create new regulations with respect to such technology and its applications, including MAHA token, ARTH token and/or the ARTH network. Regulatory actions could negatively impact MAHA token, ARTH token and/or the ARTH network in various ways.

- **Regulatory -** There is the risk that the development of the ARTH network will not be executed or implemented as planned, for a variety of reasons, including without limitation the event of a decline in the prices of any digital asset, virtual currency, MAHA token or ARTH token, unforeseen technical difficulties, and shortage of development funds for activities.

- **Security -** Hackers or other malicious groups or organisations may attempt to interfere with MAHA token and/or the ARTH network in a variety of ways, including, but not limited to, malware attacks, denial of service attacks, consensus-based attacks, Sybil attacks, smurfing and spoofing. Furthermore, there is a risk that a third party or a member of the DAO, the Distributor or their respective affiliates may intentionally or unintentionally introduce weaknesses into the core infrastructure of MAHA token and/or the ARTH network, which could negatively affect MAHA token and/or the ARTH network.

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References

- MakerDAO Whitepaper - https://makerdao.com/en/whitepaper/

- Introducing MahaDAO - https://medium.com/p/5bd52476883e

- ARTH Collateral Modeling - https://github.com/MahaDao/arth-collateral-modeling

- Purchasing Power Parity - https://en.wikipedia.org/wiki/Purchasing_power_parity

- The Decrease in Purchasing Power of the U.S. Dollar Since 1900 - https://observationsandnotes.blogspot.com/2011/04/100-year-declining-value-of-us-dollar.html

Important Websites

MahaDAO.com

Arthcoin.com

MahaSwap.com

Uniswap.com