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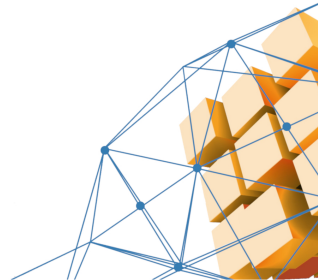
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The Maker Protocol

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Motivation

- Cryptocurrencies are the main application of a blockchain; nevertheless, most of them are too volatile to be used for payments.
- In the last years, some companies and banks tried to build a stable coin: examples are Tether and USD Coin.
However, they are not truly decentralized, since they are controlled by an institution.

Maker is the first DAO which completely relies on the Ethereum blockchain to build a money pegged to the american dollar, without getting control over our money.

Platform phases

The whitepaper was published in 2015, but the project started almost 3 years later, in December 2017. Maker had two distinct phases:

- *MonoCollateral phase*: Dec 2017 - Nov 2019;
- *MultiCollateral phase*: Nov 2019 - Now;

Both phases are characterized by some actors who have the role to keep safe the platform from malignant users.

We are going to describe what happens today in the protocol, during the MultiCollateral phase.

Maker Coin and Token

Maker is based on smart contracts.

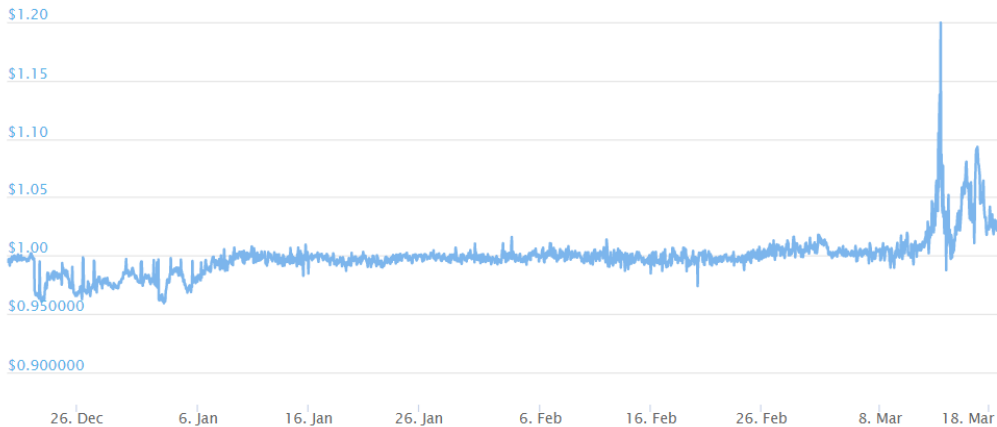
- The stablecoin minted and stabilised from Maker is called **Dai**. On perfect market conditions, a Dai is worth exactly a dollar.



Dai can be used exactly like Euros: they are usually generated to get a loan or to go long over the cryptocurrency deposited as a collateral (e.g. Ether).

- Maker has also a token, called **MKR**, which gives control over the platform to the people who hold it.
Due to its importance, it was not distributed through an ICO.

Dai value



Keepers and Oracles

- A *Keeper* is a node (usually a bot) which provides liquidity on the platform in change of profit opportunities. They can buy or sell Dai, and they participate to liquidation auctions.

Everyone can be a keeper, but it is needed to run a full node on the blockchain.

- A *Price Oracle* is an external infrastructure which updates the system with price feed informations, like the current Dai market price or the ratio between Ether and USD.

Oracles are chosen by MKR holders. To avoid malignant actions, their updates are decentralized and the median of the price feeds is taken by Maker to update its internal price feeds.

MCD Vault

During the MultiCollateral phase, Dai are backed up by a list of different Ethereum-based cryptocurrencies. As of March 2020, it is possible to generate Dai using as collateral Ether, BAT or Sai.

People who need Dai have to follow a simple procedure:

- Convert their fiat into one of the cryptocurrencies listed above;
- Create a *Vault*, depositing into a smart contract, through an interface like Oasis, the collateral;
- Generate the amount of Dai desired, keeping in mind the constraint imposed by the protocol.

Liquidation Ratio and Stability Fee

- The ratio between the collateral and the amount of Dai generated by our vault must be above a fixed value called *Liquidation Ratio*. If the ratio goes below this level, the system gains the control of the collateral locked into the vault.

To take back the control of the collateral, the user has to return the generated Dai plus a *Stability Fee*. The fee must also be paid in Dai, and it is inserted into the *Maker Buffer*.

- The stability fee has a crucial role, since it is also used to soft peg the Dai to the american dollar.

Dai generation: an example

Suppose Alice wants to generate a number of Dai equal to 100 USD. She has to:

- Convert a minimum of $100L$ dollars into, e.g., Ether, where L is the liquidation ratio of the cryptocurrency used;
- Insert the Ether into her vault and generate the amount of Dai desired.

Suppose now the stability fee is 4% (the current fee, as of 16 March 2020). If after a year she wants to take back the collateral, she must give back the amount of Dai she loaned, plus the fee (which is 4 Dai).

The starting loan is burned, while the additional 4 Dai are inserted in the Buffer.

Dai Saving Rate (DSR)

The *Dai Saving Rate* was introduced during the second phase. Generated Dai can be inserted into the *DSR contract* to earn savings automatically.

The saving is regulated by the *Saving Rate*, which establishes how many Dai we gain every year if we put them into the DSR.

- DSR is completely free, with no limitations on the number of Dai inserted;
- An user can withdraw any amount of Dai from the DSR in any moment: he doesn't lose control over his money.
- Extra Dai given for the saving are taken from the Maker Buffer.

The DSR, together with the Stability Fee, helps to keep stable the value of the Dai with respect to the USD.

MKR Token

A MKR token can be seen like a stock share of MakerDAO.

- In 2017, the Maker foundation has minted 1 million of tokens, most of which were distributed to users who helped the development of the platform.
- The foundation still has around the 25% of the total of the tokens.
- MKR has his own value: it is not linked to the dollar, and it is supposed to go up with time, since MKR will be burned if the protocol works as expected.
- MKR is used to vote on new proposals and it is the main source of recapitalization of the platform.

Protocol risks

The protocol must peg the value of Dai to the US dollar. There are two main risks which can screw up the link between the two coins:

- the oscillation of the market price of the Dai: its value can be higher or lower than the target price. This can happen if there is too much demand or supply. An user wants to be sure a stablecoin is really stable;
- the change of value of the underlying asset. Since it is a cryptocurrency, it has a high volatility. The user and the protocol want to be sure there is always enough collateral into Maker to withdraw in case of emergencies.

The first risk is handled by the stability fee and the DSR, while the second risk is handled by an auction system.

Supply and Stability Fee

A change in the stability fee is needed to modify the Dai supply, in the case the market price is too low or too high with respect to the target price.

- If the market price is too low, the stability fee is increased. Less Dai will be generated, causing a decrease of the Dai supply.
- If the market price is too high, the stability fee is decreased. More Dai will be generated, causing an increase of the Dai supply.

The stability fee reached 20% during the first phase. It can seem high, however the *right* stability fee is the one such that the market price is close to the target price.

Demand and Saving Rate

A change in the saving rate is needed to modify the Dai demand, in the case the market price is too low or too high with respect to the target price.

- If the market price is too low, the saving rate is increased. More people will want to put Dai in the DSR, causing an increase of the Dai demand.
- If the market price is too high, the saving rate is decreased. People will have less interest in putting their Dai into the DSR, causing a decrease of the Dai demand.

Stability fee and saving rate are correlated, since demand and supply are highly correlated in a liquid market.

Collateral volatility and Liquidation

The value of the collateral put into a vault can vary with time: the updated price feeds are given from the decentralized oracles.

- If it goes up, Maker has no trouble: every user can generate a higher amount of Dai, without risk.
- If it goes down, however, the system could become undercollateralized, i.e. there could be more Dai in circulation than collateral to back up for it.

To avoid this risk, the liquidation ratio was introduced. The higher the volatility, the higher the ratio.

If the vault of an user is undercollateralized, the system takes control of its collateral and inserts it into an auction.

Collateral Auction

The auction is used to repay the debt produced by the liquidated vault, plus a *Liquidation Penalty*, which is (for now) fixed to the 13% of the value of the collateral.

Let's call D the total debt.

- The liquidated collateral is inserted into a *Collateral Auction*.
- Keepers have the opportunity to bid with offers in Dai.

Two different scenarios are possible at this point of the auction.

Inverse Collateral Auction

If the last offer equals D , the auction is modified into an *Inverse Collateral Auction*, where the amount of Dai is fixed and keepers bid on decreasing amount of collateral.

- The winning keeper pays the debt with its Dai and obtains its part of collateral. Dai are inserted into the Maker Buffer.
- The liquidated user gets the remaining part of the collateral.

Debt Auction

If the auction ends and no keeper has offered an amount of Dai equal to D , the keeper with the last offer receives the whole collateral. The remaining part of the debt is converted into protocol debt.

- The debt is paid with Dai in the Maker Buffer, if there are enough.
- If the Dai in the Maker Buffer are not enough, a *Debt Auction* takes place.

In a debt auction, keepers offer a fixed amount of Dai in change of decreasing quantities of MKR tokens.

MKR tokens are minted to recapitalize the system and given to the winning keeper.

Surplus Auction

If the auction system goes well, there will be a big amount of Dai into the Maker Buffer. If the number of Dai exceeds a fixed parameter called *System Surplus*, a third auction, called *Surplus Auction*, starts.

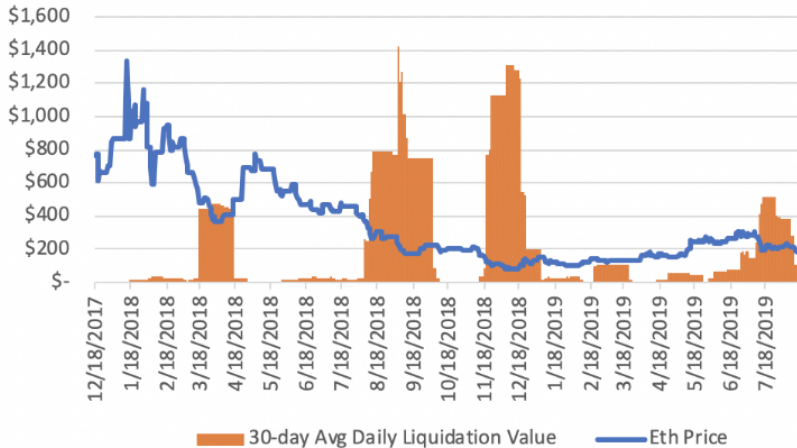
- Keepers offer increasing quantities of MKR tokens in change of a fixed amount of Dai, the surplus.
- The winning keeper receives the surplus and pays the offered amount of MKR.

MKR tokens exchanged during this auction are burned to recapitalize the system.

Market value of Liquidations (2017-2019)

Market Value of Liquidations			
Percentile	Lower Bound	Upper Bound	Total Market Value
10%	-	0.96	\$ 315
20%	0.96	2.37	\$ 584
30%	2.37	3.14	\$ 1,035
40%	3.14	11.08	\$ 2,418
50%	11.08	55.66	\$ 10,300
60%	55.66	308.35	\$ 58,381
70%	308.35	1,225.83	\$ 268,617
80%	1,225.83	4,322.73	\$ 933,578
90%	4,322.73	16,745.35	\$ 3,480,090
100%	16,745.35	7,580,631.81	\$ 52,418,856
TOTAL			\$ 64,754,805

ETH price and MakerDAO liquidations (2017-2019)



Emergency Shutdown

The described methods could not be enough if the market is too nervous. In this rare case, or if the system needs a planned upgrade, the protocol activates an *Emergency Shutdown*.

- A shutdown is used to hard peg the value of the Dai to the US dollar.
- It is a drastic event, so its use is not recommended unless something unpredictable occurs.

If users want a shutdown, they have to put a total amount of 50000 MKR into the *Emergency Shutdown Module* (ESM).



Shutdown phases

The shutdown can be divided into three phases:

- In the first phase, oracles price feeds are frozen and both the vault and the DSR are blocked. Vault owners can immediately withdraw the collateral in their vault which is not actively backing debt;
- In the second phase, all the collateral auctions are terminated. This phase requires some hours to be completed;
- In the last phase, Dai holders can exchange their Dai for a fixed amount of collateral. They are not forced to claim the collateral immediately, however they are under haircut.

Emergency Shutdown Module

Every user which holds MKR can put its tokens in the ESM module to trigger the shutdown.

What happens to these tokens?

- If the shutdown is justified, users will have back the tokens when it ends;
- If the shutdown is an attack, however, it can be annulled by the other users and the MKR tokens are distributed between the honest MKR holders.

The reallocation is handled with an executive vote.

MakerDAO Applications

Most vault owners decide to open a vault to borrow Dai or to gain a risk-free interest over time.

However, MakerDAO is a lot more than just that.

- Dai is a resource for people living in countries where the inflation is too high, like Argentina or Bolivia.
- Dai is the solution for some little and forgotten countries like Vanuatu Islands. They have to pay high transaction fees to convert their money into dollars; with Dai, the fee is just the gas price on the Ethereum blockchain.
- Dai was also successfully used for the activation of some start-up projects.

12 March 2020's Crisis

Due to Covid-19's panic, banks had a black thursday, which caused big losses over the most known indexes like Dow Jones.

Cryptocurrencies were also heavily hit by this market crash. In particular, a lot of people were trying to retire their Ether from the blockchain, causing a slowdown of Ethereum.

Miners were giving the precedence to the transactions with higher gas fees, while normal transactions could take up to 1h before they were inserted into a block.

The Ether value went down by approximately 30% in just three hours. MakerDAO is based on Ethereum, and the blockchain congestion caused problems to their users.

12 March 2020's Crisis

- Problem 1: The oracle price feed was not updated because one of the oracles failed to give the new feed price.

This incidental freeze actually helped a lot of users: the on-chain ether price was higher than the current, real, ether exchange price, giving them time to add more ether into their vault or to withdraw the collateral from it.

However, users which were offline in that moment, together with users whose transactions took too much time before they were inserted into a block, did not have this luck.

They experienced the biggest failure of the MakerDAO platform, until today.

12 March 2020's Crisis

- Problem 2: Keepers were winning the collateral auction with a 0-Dai bid.

The number of active keepers is not high, and usually they are bots. This means they just do a set of fixed operations, following the programmer conditions.

The incredible raise of the gas fee blocked most keepers from doing transactions: in fact, there was a single keeper up during these hours. Without competition, he was able to "gain" (steal?) around 5.5 Millions of USD from Maker.

12 March 2020's Crisis

- Problem 3: MKR lost about 40% of its value, and it is supposed to go further down.

Since every auction ended in deficit, Dai were not paid by the keeper, but through the Maker Buffer.

-5,363,172.43
System Surplus (Dai)

The buffer is now empty, but there is still a huge debt, which will be covered with a Debt Auction, starting 19 March.

12 March 2020's Crisis

- Good news: the market value of Dai was higher than the target price (it went up to 1.20\$).

Ethereum annulla totalmente il rialzo che aveva all'inizio faticosamente e poi ben consolidato tra fine gennaio e metà febbraio, con il ribasso di oggi che segue per intensità quello di Bitcoin.

Un ribasso che si estende oltre il 35% in quei 15 minuti e torna con le quotazioni a ridosso dei **120 dollari**, i minimi registrati a metà dicembre.

Tra le prime 100 altcoin nessuna è in territorio positivo, con qualche eccezione come **Multi Collateral DAI**, (DAI) unico token sopra la parità che riesce a drenare i forti ribassi di oggi.

This is a problem for a stable coin, however it could also mean people have more trust in Dai than in USD.

12 March 2020's Crisis

Solutions:

- Stability fee and Saving rate lowered (currently: 0.5% and 0%);
- Change in auction parameters (total length, lot size, etc.);
- Introduction of a stable coin as source of collateral: USDC.

USDC users can convert their stable coin into Dai, sell it for ether and then go back to USDC. This leads to an arbitrage opportunity, which lowers the market price of Dai.

\$1.02

Dai Price

Conclusion

- The Maker Protocol is one of the largest applications on the Ethereum blockchain and it was the first *Decentralized Finance* (DeFi) application to earn significant adoption.
- The capitalization of the system is growing, meaning people are recognizing the qualities of the protocol.
- Running a keeper is expensive, and this can lead to huge profit opportunities for the few online.
- The Maker foundation still has a fundamental role into the system, meaning the project can't be (still) considered truly decentralized.

References

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