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Author(s): Heinonen, Henri T.

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On Creation of a Stablecoin Based on the Morini's Scheme of Inv&Sav Wallets and Antimoney

Abstract—Decentralized Finance (DeFi) is a popular topic in blockchain and cryptocurrency world in the early 2020s, but cryptocurrencies have not yet become Decentralized Payment Systems (DPS), because of the high volatility of bitcoin and many of the altcoins. We investigated a proposed method to form a non-collateralized stablecoin called the Morini's Scheme of Inv&Sav wallets. We figured out two equations to do the rebasement for the Inv wallet balances and then compared the results. We found the second rebasement method to be more fair to the agents, but we found the issue of negative balances with both of the methods. We proposed novel solutions to overcome these issues. One of the proposed solutions was to freeze some of the money in Sav wallet if there is a negative balance in the Inv wallet. The another proposed solution was to introduce two-money economy of money and antimoney to i) turn the current centralized token distribution model decentralized, ii) make transactions more probable even if agents do not have enough money funds; this could be seen as a decentralized version of credit cards.

1. Introduction

The three functions of money are medium-of-exchange, store-of-value, and unit-of-account. One of the problems with many cryptocurrencies is the high volatility which makes their exchange rates and purchasing power to change abruptly. Stablecoins (or sometimes stabletokens) are cryptocurrencies that use some mechanism to lower the volatility. Stablecoins are pegged to some asset (e.g. euros or US dollars), so they are following the value of the asset. Stablecoins are not always collateralized to the pegged asset. For example, a stablecoin can be pegged to the US dollar and be collateralized by Ether coins.

Stablecoins can be collateralized by fiat currency, commodity, cryptocurrency or none. Non-collateralized stablecoins are stabilized by the protocol layer or application layer. We are interested in non-collateralized stablecoins because they have lots of potential to become cryptocurrencies for Decentralized Payment Systems (DPSs). [1]

1.1. Literature review

K. Ito et al. [1] classifies existing stablecoins into four collateral categories (fiat, commodity, crypto and non-collateralized) and emphasizes non-collateralized stable-

coins as potential DPSs because they have both the decentralization and the simplicity properties. The paper also classifies existing non-collateralized stablecoins into two intervention layer categories (protocol, application). Three concepts in economics are introduced: Quantity Theory of Money (QTM), Tobin tax, and speculative attack. A. Moin et al. [2] introduce a classification framework for stablecoin designs. H. Kołodziejczyk et al. [3] present a taxonomy of stablecoins. D. Bullmann et al. [4] classifies stablecoins on the key dimensions: (i) accountability of issuer, (ii) decentralisation of responsibilities, and (iii) what underpins the value of the asset.

F. M. Ametrano [5] introduces Hayek Money as the price stability solution, which uses dynamical rebasing to change the amount of money in wallets. The adjustment is based on a commodity price index. V. Syropyatov [6] investigates stablecoins as an implementation of Hayek money.

According to M. Morini [7] Hayek Money or Hayek-coins only stabilise unit-of-account, but not store-of-value, and Bitcoin only stabilise store-of-value, but not unit-of-account. Hayekcoins are good for denominating salaries, future financial investments, and loans, but they are unsuitable to store and save the money people receive through salaries or payments. Morini introduces two types of wallets: Investment (Inv) wallets and Savings (Sav) wallets to give users freedom to choose how much they want to be affected by the money supply changes. When money demand increases:

- 1) Bitcoin
 - Bitcoin wallets are stable
 - House prices (in bitcoin) decrease
 - Purchasing power of bitcoin wallets grows
- 2) Hayekcoin
 - Hayekcoin wallets are increased to meet demand
 - House prices (in hayekcoin) are stable
 - Purchasing power of hayekcoin wallets grows
- 3) Inv & Sav
 - Inv wallets are increased with leverage and Sav wallets are stable
 - House prices (in Morini's cryptocurrency) are stable

- Purchasing power of Inv wallets grows and purchasing power of Sav wallets is stable

When money demand decreases:

- 1) Bitcoin
 - Bitcoin wallets are stable
 - House prices (in bitcoin) increase
 - Purchasing power of bitcoin wallets shrinks
- 2) Hayekcoin
 - Hayekcoin wallets are shrunken to meet demand
 - House prices (in hayekcoin) are stable
 - Purchasing power of hayekcoin wallets shrinks
- 3) Inv & Sav
 - Inv wallets are decreased with leverage and Sav wallets are stable
 - House prices (in Morini's cryptocurrency) are stable
 - Purchasing power of Inv wallets shrinks and purchasing power of Sav wallets is stable

R. Sams [8] also notes that the coin/token price stability is not only about stabilising the unit-of-account, but also stabilising the store-of-value. The purchasing power of Hayek Money wallet is just as volatile as a Bitcoin wallet. There is also a problem with the Morini's Inv and Sav wallets: if the price development is predictable, people will either transfer all their money to either Inv wallet (if demand will go up) or Sav wallet (if demand will go down). The offered solution here are the seigniorage shares. There should be two types of coins: coins that act like money and coins that act like shares in the system's seigniorage. According to [1] the Seigniorage Share method has a problem that would probably make speculators to not buy shares nor bonds under such a tautological mechanism. The closure of Basis project in December 2018 is given as a real-world example of the problem.

M. Schmitt et al. [9] have done the first research paper that proposes the concept of antimoney. J. Stein et al. [10] further investigate the concept of antimoney. J. Stein [11] collects the research of antimoney into this PhD thesis. Beller et al. [12] also discuss the roles of money and credit in a cryptoeconomy.

H. Heinonen et al. [13] find that degree distributions of networks based on cross-correlations of ERC-20 tokens' returns do not exhibit power-law behavior.

We know from the literature that methods that work in the stockmarket and the fiat world do not necessarily work at all in the cryptocurrency world. We also know that all the existing stablecoin solutions have some issues that make them impractical as DPSs.

What we do not know yet is how to make impractical stablecoin solutions practical stablecoin solutions for DPSs. This leads to our research question.

1.1.1. Research Question. Our research question is: How to modify Morini's Scheme of Inv&Sav wallets in a way that makes it a more practical Stablecoin for Decentralized Payment Systems?

2. Methods

We came up with the research question after figuring out from the literature review that there are several non-collateralized stablecoin designs, but they are still not practical. Morini's Inv&Sav wallet design was both novel and elegant for our studies.

The data for this research are the results from the two rebasement equations we figured out from the housecoin example in Morini's article [7]. As far as we know, at the moment of writing this article, both housecoin and Hayekcoin are not actual cryptocurrencies.

We created a simple demonstration economy of only three agents and 300 housecoins for the initial timestep $t = 0$. We assumed housecoin is pegged to euro so that $1.0 \text{ HC} = 1.0 \text{ EUR}$. The integer timesteps

$$T_{\text{in}} =] \dots, 0, 1, 2, 3, \dots [\subset \mathbb{Z}$$

are the rebasement periods and \mathbb{Z} is the set of integers. The non-integer timesteps

$$T_{\text{ni}} =] \dots, 2.5, \dots, 3.1, 3.2, \dots [\subset \mathbb{Q} \setminus \mathbb{Z}$$

are moments when transactions are done by the agents between the rebasement periods. The set \mathbb{Q} is the set of rational numbers. In the blockchain world we can assume that the set of timesteps

$$T = T_{\text{in}} \cup T_{\text{ni}}$$

can be mapped to the block height numbers.

2.1. Rebasement

Rebasement is needed to increase or decrease the money supply. For example, in Bitcoin there is only the concept of increasing the bitcoin supply with time. At the moment of writing this, there will be 6.25 new bitcoin coins about every 10 minutes. There is no concept of decreasing the bitcoin supply. This could be the reason for the high volatility of Bitcoin.

It was not entirely clear from [7] how to calculate the rebasement for Inv wallets. We figured out the following Rebasement Equations to calculate the new coins/tokens in agent i 's Inv wallet at time t

$$\Delta I_i(t) = \frac{I_i(t-1)}{\sum_{j=1}^n I_j(t-1)} \cdot \Delta M(t) \quad (1)$$

and

$$\Delta I_i(t) = \frac{M_i(t-1)}{\sum_{j=1}^n M_j(t-1)} \cdot \Delta M(t) \quad (2)$$

with the following definitions

$$\Delta I_i(t), I_i(t-1), \Delta M(t), M_i(t-1) : T \longrightarrow \mathbb{R}.$$

Here $\Delta I_i(t)$ is the amount of new coins/tokens in agent i 's Inv wallet at time $t \in T$, $I_i(t-1)$ is the amount of coins/tokens in agent i 's Inv wallet at time $t-1$, $\sum_{j=1}^n I_j(t-1)$ is the total amount of coins/tokens in the whole economy's Inv wallets at time $t-1$, $n \in \mathbb{N}$ is the number of agents in the economy (\mathbb{N} is the set of natural numbers), $\Delta M(t)$ is change in money supply (the amount of new coins/tokens) at time t , $M_i(t-1)$ is the amount of coins/tokens in agent i 's Inv and Sav wallets at time $t-1$, and $\sum_{j=1}^n M_j(t-1)$ is the amount of coins/tokens in the whole economy's Inv and Sav wallets at time $t-1$, T is the set of timesteps, and \mathbb{R} is the set of real numbers. It must be noted that Equation (1) is not defined when all the Inv wallets are zero.

2.2. Antimoney

Antimoney is not related to stablecoins, but it could be a useful concept when creating a stablecoin economy. Antimoney is a concept from econophysics. It got inspiration from particle physics, where a particle and an antiparticle can be created in pairs from energy. They can also be annihilated (destroyed) in pairs. It is a well-known topic from science fiction that matter and antimatter will destroy each other in a close contact. Money and antimoney do not annihilate each other, but they are created and destroyed in pairs: both money and antimoney supply are always equal. Antimoney is not simply negative money, because there is a constantly changing exchange rate between them. Money and antimoney units also cannot be simply added or subtracted, because they have different currency units like euros (EUR) and US dollars (USD) [9], [10], [11]. We propose a prefix a for the antimoney currency units. For example, the antimoney currency unit of housecoin (HC) would thus be aHC and the long name of the unit would be *antihousecoin*. If there ever was an antimoney version of bitcoin (BTC), it could be named *antibitcoin* (*aBTC*).

What can be done with antimoney? If a buyer runs out of money, a purchase could still be done if the buyer accepts receiving some antimoney from the seller. In a way, antimoney could be seen as a decentralized version of credit cards.

According to [9] a real monetary wealth in a symmetric monetary system is given by

$$\omega = \frac{a}{p_a} - \frac{l}{p_l}, \quad (3)$$

where a denotes the asset (money) holdings, l denotes the liability (antimoney) holdings, p_a is the price level for money, and p_l is the price level for antimoney. There is also a way to provide liquidity to agents by giving money and antimoney units away at the same time [9]. If both price levels in equation (3) are equal, then an agent X can transfer $\Delta a = \Delta l$ money and antimoney units to a liquidity-seeking agent Y without changing monetary wealth of either of the agents. There is also the option to set a nominal price for the liquidity.

TABLE 1. TIMESTEP $t = 0$. ONE HOUSECOIN (HC) EQUALS ONE EURO (EUR). THERE WERE 300 HOUSECOINS IN THE WHOLE ECONOMY.

agent	Inv	Sav	total
A	40.00 HC	60.00 HC	100.00 HC
B	50.00 HC	50.00 HC	100.00 HC
C	60.00 HC	40.00 HC	100.00 HC
sum	150.00 HC	150.00 HC	300.00 HC

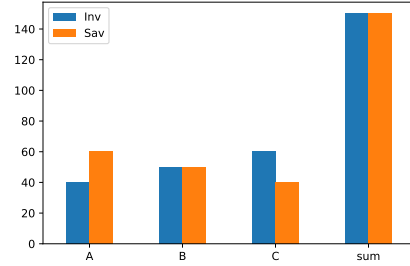


Figure 1. The demonstration economy of housecoins at the initial state $t = 0$.

The usual way to get cryptocurrency is to use fiat money to buy bitcoin or Ether coins. With Ether it is possible to buy ERC-20 tokens. The problem with this is the centralizations of the fiat world and the cryptocurrency exchanges. The second usual way to distribute cryptocurrency is to participate in the Proof-of-Work consensus method called the mining. This method is energy-intensive and bitcoin ASIC mining is famous for its heavy electricity usage [14]. The third usual way to distribute cryptocurrency is the airdrop method. With that method the creators of the cryptocurrency give away some free coins/tokens. The problem with this is that it usually only works when the cryptocurrency is new and when the monetary value of the cryptocurrency is low or zero. Our proposal of passing on money and antimoney coins/tokens at the same time is a novel method to distribute cryptocurrency.

3. Results

The results were calculated for a demonstration economy of three agents and 300 housecoins (HC) that were pegged to euros with an exchange rate of 1 HC = 1 EUR. The initial state is listed on Table 1, which can also be seen on Figure 1.

3.1. Rebasement Option I

The demand for housecoins was going up; 1.0 housecoin was worth 1.2 euros. We used the Rebasement Equation (1) for the state on Table 1 to evolve the economy from timestep $t = 0$ into timestep $t = 1$. The new state after the first rebasement is listed on Table 2.

The demand for housecoins was going down; 1.0 housecoin was worth 0.8 euros. We used the Rebasement Equation

TABLE 2. TIMESTEP $t = 1$. THE DEMAND FOR HOUSECOINS CHANGED SO THAT $1.0 \text{ HC} = 1.2 \text{ EUR}$. THE ECONOMY OF 300.0 HC BECAME 360.0 HC , WHICH MADE THE EXCHANGE RATE BACK TO $1.0 \text{ HC} = 1.0 \text{ EUR}$. EQUATION (1) WAS USED TO CALCULATE THE REBASEMENT.

agent	Inv	Sav	total
A	56.00 HC	60.00 HC	116.00 HC
B	70.00 HC	50.00 HC	120.00 HC
C	84.00 HC	40.00 HC	124.00 HC
sum	210.00 HC	150.00 HC	360.00 HC

TABLE 3. TIMESTEP $t = 2$. THE DEMAND FOR HOUSECOINS CHANGED SO THAT $1.0 \text{ HC} = 0.8 \text{ EUR}$. THE ECONOMY OF 360.0 HC BECAME 288.0 HC , WHICH MADE THE EXCHANGE RATE BACK TO $1.0 \text{ HC} = 1.0 \text{ EUR}$. EQUATION (1) WAS USED TO CALCULATE THE REBASEMENT.

agent	Inv	Sav	total
A	36.80 HC	60.00 HC	96.80 HC
B	46.00 HC	50.00 HC	96.00 HC
C	55.20 HC	40.00 HC	95.20 HC
sum	138.00 HC	150.00 HC	288.00 HC

TABLE 4. TIMESTEP $t = 2.5$. AGENTS B AND C PREDICTED THAT THE DEMAND OF HOUSECOINS WILL GO DOWN AT $t = 3$, SO THEY EMPTIED THEIR INV WALLETS AND TRANSFERRED THOSE HOUSECOINS TO SAV WALLETS. AGENT A WAS NOT AWARE OF THE SITUATION.

agent	Inv	Sav	total
A	36.80 HC	60.00 HC	96.80 HC
B	0.00 HC	96.00 HC	96.00 HC
C	0.00 HC	95.20 HC	95.20 HC
sum	36.80 HC	251.20 HC	288.00 HC

(1) for the state on Table 2 to evolve the economy from timestep $t = 1$ into timestep $t = 2$. The new state after the second rebasement is listed on Table 3.

At timestep $t = 2.5$ agents B and C predicted that the demand of housecoins will go down at $t = 3$, so they emptied their Inv wallets and transferred those housecoins to Sav wallets. Agent A was not aware of the situation. Table 4 shows the new state of the economy after agents B and C have emptied their Inv wallets.

The demand for housecoins was going down; 1.0 housecoin was worth 0.1 euros. We used the Rebasement Equation (1) for the state on Table 4 to evolve the economy from timestep $t = 2.5$ into timestep $t = 3$. The new state after the third rebasement is listed on Table 5.

3.2. Rebasement Option II

We used the Rebasement Equation (2) for the state on Table 1 to evolve the economy from timestep $t = 0$ into timestep $t = 1$. The new state after the first rebasement is listed on Table 6.

The demand for housecoins was going down; 1.0 housecoin was worth 0.8 euros. We used the Rebasement Equation (2) for the state on Table 6 to evolve the economy from

TABLE 5. TIMESTEP $t = 3$. THE DEMAND FOR HOUSECOINS CHANGED SO THAT $1.0 \text{ HC} = 0.1 \text{ EUR}$. THE ECONOMY OF 288.00 HC BECAME 28.80 HC , WHICH MADE THE EXCHANGE RATE BACK TO $1.0 \text{ HC} = 1.0 \text{ EUR}$. EQUATION (1) WAS USED TO CALCULATE THE REBASEMENT.

agent	Inv	Sav	total
A	-222.40 HC	60.00 HC	-162.40 HC
B	0.00 HC	96.00 HC	96.00 HC
C	0.00 HC	95.20 HC	95.20 HC
sum	-222.40 HC	251.20 HC	28.80 HC

TABLE 6. TIMESTEP $t = 1$. THE DEMAND FOR HOUSECOINS CHANGED SO THAT $1.0 \text{ HC} = 1.2 \text{ EUR}$. THE ECONOMY OF 300.00 HC BECAME 360.00 HC , WHICH MADE THE EXCHANGE RATE BACK TO $1.0 \text{ HC} = 1.0 \text{ EUR}$. EQUATION (2) WAS USED TO CALCULATE THE REBASEMENT.

agent	Inv	Sav	total
A	60.00 HC	60.00 HC	120.00 HC
B	70.00 HC	50.00 HC	120.00 HC
C	80.00 HC	40.00 HC	120.00 HC
sum	210.00 HC	150.00 HC	360.00 HC

timestep $t = 1$ into timestep $t = 2$. The new state after the second rebasement is listed on Table 7.

At timestep $t = 2.5$ agents B and C predicted that the demand of housecoins will go down at $t = 3$, so they emptied their Inv wallets and transferred those housecoins to Sav wallets. Agent A was not aware of the situation. Table 8 shows the new state of the economy after agents B and C have emptied their Inv wallets.

The demand for housecoins was going down; 1.0 housecoin was worth 0.1 euros. We used the Rebasement Equation (2) for the state on Table 8 to evolve the economy from timestep $t = 2.5$ into timestep $t = 3$. The new state after the third rebasement is listed on Table 9.

Tables 10, 11, and 12 show antimoney enabled transactions constructed on the case of Rebasement Option II. We omit antimoney option for Rebasement Option I, because according to Table 5 there is a negative total money balance in agent A's wallet and that could predict the agent also possibly having equal amount of *negative* antimoney, which we did not want to study in this research article. At timestep $t = 3.1$ on Table 11 agent B buys/receives liquidity ($2.00 \text{ HC} + 2.00 \text{ aHC}$) from agent C. At timestep $t = 3.2$ on Table 12 agent A receives 10.00 aHC from agent B.

4. Discussion

4.1. Third rebasement showed the difference

On Figures 2, 3, and 4 nothing seems to be very different between the two Rebasement Options (subfigures (a) and (b)); agents' Inv and Sav wallet balances seem to be almost the same for both of the Rebasement Options. The difference comes at timestep $t = 3$ (Figure 5), where one can clearly see that Equation (2) gives more fair outcomes between the

TABLE 7. TIMESTEP $t = 2$. THE DEMAND FOR HOUSECOINS CHANGED SO THAT $1.0 \text{ HC} = 0.8 \text{ EUR}$. THE ECONOMY OF 360.00 HC BECAME 288.00 HC , WHICH MADE THE EXCHANGE RATE BACK TO $1.0 \text{ HC} = 1.0 \text{ EUR}$. EQUATION (2) WAS USED TO CALCULATE THE REBASEMENT.

agent	Inv	Sav	total
A	36.00 HC	60.00 HC	96.00 HC
B	46.00 HC	50.00 HC	96.00 HC
C	56.00 HC	40.00 HC	96.00 HC
sum	138.00 HC	150.00 HC	288.00 HC

TABLE 8. TIMESTEP $t = 2.5$. AGENTS B AND C PREDICTED THAT THE DEMAND OF HOUSECOINS WILL GO DOWN AT $t = 3$, SO THEY EMPTIED THEIR INV WALLETS AND TRANSFERRED THOSE HOUSECOINS TO SAV WALLETS. AGENT A WAS NOT AWARE OF THE SITUATION.

agent	Inv	Sav	total
A	36.00 HC	60.00 HC	96.00 HC
B	0.00 HC	96.00 HC	96.00 HC
C	0.00 HC	96.00 HC	96.00 HC
sum	36.00 HC	252.00 HC	288.00 HC

TABLE 9. TIMESTEP $t = 3$. THE DEMAND FOR HOUSECOINS CHANGED SO THAT $1.0 \text{ HC} = 0.1 \text{ EUR}$. THE ECONOMY OF 288.0 HC BECAME 28.80 HC , WHICH MADE THE EXCHANGE RATE BACK TO $1.0 \text{ HC} = 1.0 \text{ EUR}$. EQUATION (2) WAS USED TO CALCULATE THE REBASEMENT.

agent	Inv	Sav	total
A	-50.40 HC	60.00 HC	9.60 HC
B	-86.40 HC	96.00 HC	9.60 HC
C	-86.40 HC	96.00 HC	9.60 HC
sum	-223.20 HC	252.00 HC	28.80 HC

TABLE 10. TIMESTEP $t = 3.0$. THIS IS EQUIVALENT TO TABLE 9, BUT WE ARE ALSO SHOWING THE ANTIMONEY BALANCES.

agent	Inv	Sav	total	Ant
A	-50.40 HC	60.00 HC	9.60 HC	9.60 aHC
B	-86.40 HC	96.00 HC	9.60 HC	9.60 aHC
C	-86.40 HC	96.00 HC	9.60 HC	9.60 aHC
sum	-223.20 HC	252.00 HC	28.80 HC	28.80 aHC

TABLE 11. TIMESTEP $t = 3.1$. AGENT B BUYS/RECEIVES LIQUIDITY ($2.00 \text{ HC} + 2.00 \text{ aHC}$) FROM AGENT C.

agent	Inv	Sav	total	Ant
A	-50.40 HC	60.00 HC	9.60 HC	9.60 aHC
B	-86.40 HC	98.00 HC	11.60 HC	11.60 aHC
C	-86.40 HC	94.00 HC	7.60 HC	7.60 aHC
sum	-223.20 HC	252.00 HC	28.80 HC	28.80 aHC

agents. According to Table 9, agents B and C both have -86.40 housecoins and agent A have -50.40 housecoins in Inv wallet. This is a strong difference to the rebasement from Equation (1), which gives agents B and C no Inv wallet decreasing at all, but agent A gets a Inv wallet balance of

TABLE 12. TIMESTEP $t = 3.2$. AGENT A RECEIVES 10.00 aHC FROM AGENT B.

agent	Inv	Sav	total	Ant
A	-50.40 HC	60.00 HC	9.60 HC	19.60 aHC
B	-86.40 HC	98.00 HC	11.60 HC	1.60 aHC
C	-86.40 HC	94.00 HC	7.60 HC	7.60 aHC
sum	-223.20 HC	252.00 HC	28.80 HC	28.80 aHC

-222.40 housecoins (Table 5)! Equation (2) is more fair because the equation takes into account the total balance of agent's Inv and Sav wallet, but Equation (1) only takes into account the Inv wallet balance of the agent. The Inv wallet balances of agents B and C are zero after the timestep $t = 2.5$.

4.2. Negative balances of Inv wallets

It is obvious from our results (both rebasement options) that Morini's Scheme of Inv&Sav wallet can eventually lead to negative Inv wallet balances. What does it mean? How can a wallet have negative money? This resembles the concept of antimoney, which can be seen as a form of negative money even though it is not exactly negative money, because money and antimoney have different currency units and a changing exchange rate between them. One solution to handle the issue of negative money in Inv wallets could be locking or freezing some of the money in Sav wallets, preventing money transfers to external wallets, until the agent will transfer positive money from Sav wallet to Inv wallet. Future rebasements might change all the balances to positive numbers again. This might not be enough for rebasements based on equation (1), because agent A does not have enough money in Sav wallet to make Inv wallet balance zero or positive at timestep $t = 3$ (Table 5). We propose that Sav wallets could act as an income generators to refund negative Inv wallets. For example, money in Sav wallets could help to fund routes on the Lightning Network or on other Layer 2 solution. Yet another proposed solution is to use money in Sav wallets to run Proof-of-Stake system; something quite similar was proposed by Morini [7]. Also, antimoney could possibly be used to do business even during when the agent's money funds are low, zero, or negative.

4.3. Antimoney

Let's assume there was antimoney already in the demonstration economy, but the antimoney balances (Ant) were just hidden from the previous steps to make things easier for the reader. On Figure 6a we are using the same wallet balances as in Figure 5b, but we are also showing the antimoney balances. According to Schmitt et al. [9] there should be equal number of antimoney and money units in the economy.

At timestep $t = 3.1$ on Figure 6b agent B buys/receives liquidity ($2.00 \text{ HC} + 2.00 \text{ aHC}$) from agent C.

At timestep $t = 3.2$ agent A wants to buy a book (money price: 9.80 HC, antimoney price: 10.00 aHC) from agent B, but agent A does not have enough money funds. Agent A's unfrozen Sav balance or total wallet balance is less than the book price: $9.60 \text{ HC} < 9.80 \text{ HC}$. Agent A accepts the transaction between agents A and B that sends 10.00 aHC from agent B to agent A as seen on Figure 6c. The purchase of the book was done by using antimoney instead of money. At this step agent A has more antimoney units than total money units. How to handle this to prevent any gaming of the economy? It is not clear, but, again, freezing any unfrozen money funds left on the Sav wallet could be one of the solutions.

4.4. Further research

Further research would include simulating the Inv-Sav-Ant economy for hundreds or thousands of agents and long timescales. cadCAD could be used for simulating dynamical systems like cryptocurrency economies.

Antimoney needs stricter rules than regular money, because the system will fail if people hoard antimoney, get rid off antimoney without contributing to the society, or send antimoney to agents without their permission. These rules must be established before making more complex simulations.

It would be interesting to simulate or test in a real-world setting Universal Basic Income (UBI) that consists of money and antimoney. One of the common arguments against UBI is that it could passivate citizens [15]. Antimoney could motivate UBI receivers to actually contribute to the society; antimoney UBI receivers would pass antimoney (with items or services) on to other agents of the economy which means that they are contributing to the society. Further research could compare different UBI models - some with antimoney and some without antimoney.

5. Conclusion

Our research question was: How to modify Morini's Scheme of Inv&Sav wallets in a way that makes it a more practical Stablecoin for Decentralized Payment Systems? Our answer is to design a system that can handle cases when Inv wallet balances go below zero.

We have proposed a solution that freezes some of the money in Sav wallet, if Inv wallet balance goes below zero. That should prevent the agent from gaming the system.

By introducing two-money economy of money and antimoney, agents could probably still do business even if the money funds are low, zero or even negative.

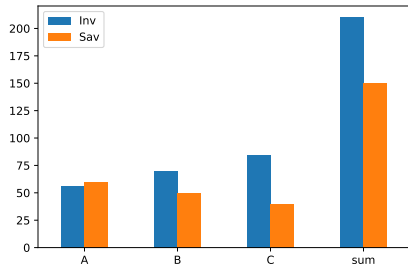
An economy of money and antimoney could also solve the distribution problem of tokens. With the current token distribution methods in order to get some ERC-20 tokens, one has to use fiat money first to buy some Ether coins and then with Ether coins one can buy ERC-20 tokens. That is a centralized procedure. With cryptocurrency system of money and antimoney, one could directly receive money

and antimoney tokens to the wallet. That is a decentralized procedure.

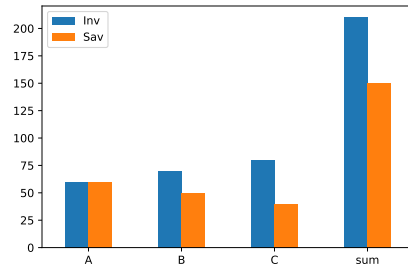
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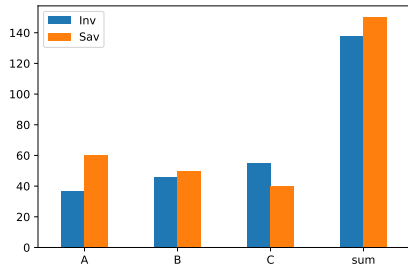


(a) Rebasement Option I

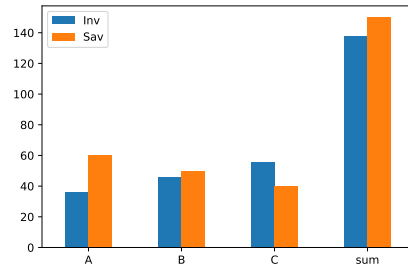


(b) Rebasement Option II

Figure 2. Wallet balances at timestep $t = 1$ after the first rebasement of Inv wallets.

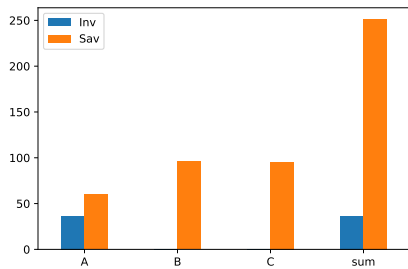


(a) Rebasement Option I

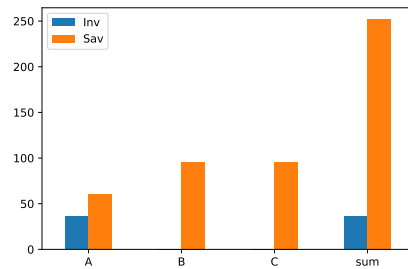


(b) Rebasement Option II

Figure 3. Wallet balances at timestep $t = 2$ after the second rebasement of Inv wallets.

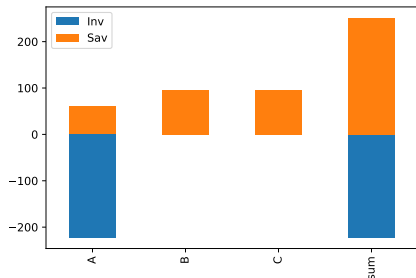


(a) Rebasement Option I

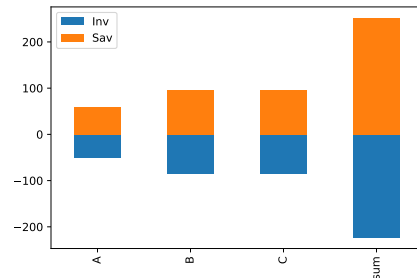


(b) Rebasement Option II

Figure 4. Wallet balances at timestep $t = 2.5$. Agents B and C have emptied their Inv wallets.

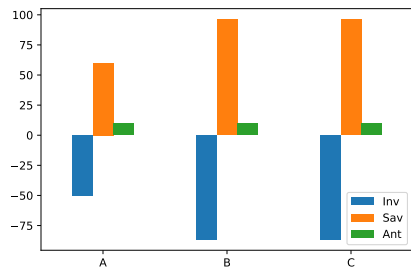


(a) Rebasement Option I

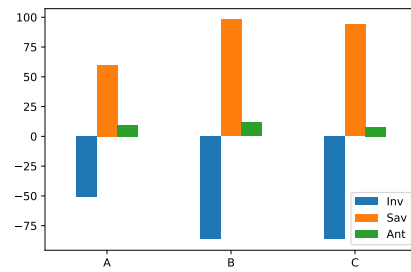


(b) Rebasement Option II

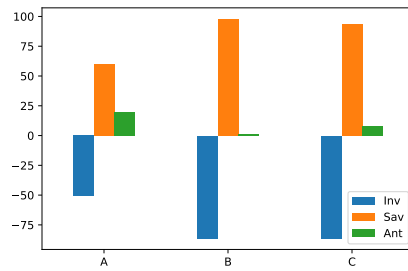
Figure 5. Wallet balances at timestep $t = 3$ after the third rebasement of Inv wallets.



(a) Rebasement Option II with Antimoney, timestep $t = 3.0$



(b) Rebasement Option II with Antimoney, timestep $t = 3.1$



(c) Rebasement Option II with Antimoney, timestep $t = 3.2$

Figure 6. Wallet balances with Antimoney after timestep $t = 3$.