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Stablecoin Billionaires

A descriptive analysis of the Ethereum-based
Stablecoin ecosystem

by

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ULG Digital Business

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Univ.-Prof. Dr. Jochen Lawrenz

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Abstract

While Ethereum, the second largest public blockchain after Bitcoin, was experiencing a story of success over the past few years, Stablecoins grew to an integral component within the Ethereum-based decentralized finance (DeFi) ecosystem. Various issuers of cryptographically-secured digital money emerged and in particular *Tether*, the most widespread dollar-pegged cryptocurrency, received much attention in recent time. Using empirical data broadcasted by seven different Stablecoins and their Smart Contracts, I statistically examine both Ethereum's Stablecoin landscape as a whole and the individual token ecosystems. By incorporating qualitative information obtained by analyzing the contracts' Solidity code, I discovered extreme concentrations of power within the token contracts of centralized Stablecoins, while decentralized tokens such as DAI lacked structural power imbalances. Analyzing the costs, empirical data revealed that transfers of Stablecoins that are primarily used in decentralized environments, were on average up to eight times more expensive than those carried out with 'centralized' tokens, which could be traced back to an efficiency trade-off in favor of decentralization. Furthermore, I found that emission- and destruction policies have a decisive impact on basic statistical measures such as the mean transfer amount or its standard deviation, both of which depend heavily on the applied distribution mechanism of a token. In an attempt to identify 'High Rollers' within the analyzed ecosystem, the exchanges Huobi and Binance were exposed as Stablecoin billionaires, who together control 20 % of Ethereum's Stablecoin supply. Finally a very unequal distribution of wealth in favour of crypto-exchanges and DeFi applications was revealed.

Contents

Abstract	i
List of Figures	iii
List of Tables	iii
1 Introduction	1
2 Background and Related Works	3
2.1 Stablecoins	3
2.1.1 Tether USD	3
2.1.2 USD Coin	4
2.1.3 Paxos Standard, Binance USD & HUSD	5
2.1.4 TrueUSD	6
2.1.5 DAI Stablecoin	7
2.2 Ethereum	9
2.2.1 ERC-20 Standard	10
2.2.2 Transactions vs. Transfers	13
2.3 Related Works	15
3 Methodology and Data	17
3.1 Descriptive Analysis	17
3.2 Data Collection	18
4 Data Analytics	21
4.1 Token Events	21
4.1.1 Transfers	21
4.1.2 Circulating Supply	28
4.2 Accounts and Balances	40
4.2.1 Stablecoin Ecosystem	40
4.2.2 Entity Identification	43
5 Conclusion	49
Appendix	56

List of Figures

1	Token Transfers	14
2	Daily Transfers	22
3	Daily Transfers - 2020	23
4	Average weekly Transfer Costs	26
5	Circulating Supplies	29
6	Supply Shares	30
7	Token Mints	33
8	MakerDAO Contract Diagram	35
9	Token Burns	36
10	Balances & Activity	44
11	Token Distribution	47

List of Tables

1	Authorized/Issued Tether	4
2	Stablecoin Landscape	9
3	ERC-20 Signatures and Hashes	11
4	Supply-controlling Functions	19
5	Transfer-Volume	25
6	Mints and Burns	31
7	Supply-Controlling Roles	40
8	Stablecoin Wealth Distribution	41
9	Addresses Analysis	42
10	Stablecoin Rich List	46

1 Introduction

Since the pseudonym Satoshi Nakamoto (2008) first described Bitcoin, more than a decade went by. As a response to the financial crisis in 2008, Bitcoin represented the first decentralized digital cryptocurrency and has experienced a story of success since its creation. Later, with the proliferation of Ethereum from 2014 onwards, the range of possibilities grew enormously with the introduction of the Ethereum Virtual Machine (EVM) and Solidity, a programming language for creating Smart Contracts. The decentralized platform allows anyone to build applications on top of it, ranging from file-storage solutions or decentralized autonomous organizations (DAOs) to tokenized assets and financial derivatives. (Buterin, 2013)

Especially, decentralized finance (DeFi) received much attention in recent years and many new projects came up with approaches integrating already existing financial applications into the decentralized environment Ethereum provides. *Stablecoins*, defined by the Financial Stability Board (2020) as “*a crypto-asset that aims to maintain a stable value...*” (p. 4), have been part of the DeFi-universe from the beginning and already in 2012, Willett (2012) published the first description of a protocol enabling the creation of new cryptocurrencies on top of Bitcoin and named it *Mastercoin*. Two years later, the first Stablecoin named *Realcoin*, later renamed to *Tether*, was issued. (Rizzo, 2014) Since then, the market has experienced enormous growth and as of July 1st, 2020, the five largest Stablecoins by market capitalisation on coinmarketcap.com are Tether, USD Coin, Paxos Standard, Binance USD and TrueUSD, with Tether representing the third most capitalised cryptocurrency after Bitcoin and Ether. All these tokens, together with the 6th and 7th largest Stablecoins HUSD and Dai, which both have a market capitalisation of more than 100 million dollars, make up the Stablecoin ecosystem examined in the following study.

Research in related fields mostly investigates Ethereum as a network via graph analysis or deals with price developments of Ether and other tokens. (Chen and Bellavitis, 2020; Baumöhl and Vyrost, 2020; Lyons and Viswanath-Natraj, 2020) This study aims at providing quantitative insights into specific activities that occur inside the individual token ecosystems and further attempts to link multi-

ple accounts to real-life entities in order to identify several ‘High Rollers’ within Ethereum’s Stablecoin landscape. The ultimate purpose of this work is to provide a descriptive snapshot of the analyzed environment as of July 1st, 2020. The result is a broad quantitative overview of both the whole ecosystem and the individual tokens, realised through descriptive statistics and carried out without neglecting more in-depth investigations regarding the circulating supply of each token and the wealthiest entities within the analyzed market. This was accomplished by relying on visualizations and further interpretations of tables, charts and the contracts’ source code. Besides the identification of Stablecoin billionaires, results show an incredible dominance of Tether, the effects of decentralized finance on certain Stablecoins, the impact of divergent issuing and burning policies on particular statistical measures and extreme wealth inequality within the analyzed ecosystem. To the best of my knowledge, no descriptive analysis of Stablecoins, which incorporates the Solidity code of specific Ethereum-based Smart Contracts to explain descriptive measures, has been carried out yet. A Github Repository¹ with the Python scripts, created to retrieve the relevant data, verify its correctness and completeness and prepare it for further processing, was published together with the complete data set² and all charts used in this thesis. Everything is accessible under an open-source licence to ensure that fellows can build upon it. As a consequence, the results of this thesis, from the data collection to the mining process up to the construction of the charts, can easily be reproduced. The following work is structured as follows: The first section deals with background information on the analyzed Stablecoins, covering the organisations behind the respective cryptocurrencies and their token-emission procedures. The second part contains an in-depth elaboration of Ethereum as the fundamental base-layer for other cryptocurrencies, with emphasis on the ERC-20 Standard and the implementation of Solidity’s *Events*. Afterwards, related works and the applied methodology are outlined in detail, followed by a description of the data set. The main part of this work first analyzes token events, continues with descriptive statistics on accounts that own Stablecoins and finishes with the identification of Stablecoin billionaires. Finally, a conclusion is drawn.

¹Github: github.com/Nerolation/Stablecoin-Billionaires [Last accessed 30 Oct 2020]

²Complete data set: toniwahrstaetter.com/stablecoin_data.html [Last accessed 18 Oct 2020]

2 Background and Related Works

2.1 Stablecoins

The following section provides a detailed description of the seven Stablecoins incorporated in this paper and outlines some noteworthy insights for the main analysis. In general, there is no common definition of a Stablecoin. Bullmann et al. (2019) in an EZB Occasional Paper Series, for example, abstractly defined Stablecoins as *“digital units of value that are not a form of any specific currency (or basket thereof) but rely on a set of stabilisation tools which are supposed to minimise fluctuations of their price in such currency(ies)”* (p. 9). The Ethereum-based tokens that are analyzed in this work can roughly be distinguished by their asset of collateral, their issuers and their contracts’ features. Moreover, internal contract restrictions and governance mechanisms are exciting differentiation criteria that are directly reflected in the figures.

2.1.1 Tether USD

Tether is the most famous Stablecoin and is issued by the Tether Limited. The asset maintains its price-stability because officially every token on the blockchain is backed by reserves that are held by the issuing company behind the Stablecoin. According to the company’s website, tether.to³, the token’s collateral does not exclusively consist of cash or traditional currency equivalents, instead, other assets like loans might be used to back the cryptocurrency. In the past, the Tether Limited and Bitfinex, a leading crypto-exchange with very close organisational relationships to Tether, faced criticism after Griffin and Shams (2018) claimed and proofed that the Stablecoin was used to manipulate Bitcoin prices during the 2017 boom. The first Tether Stablecoins were issued using the Bitcoin Omni Layer Protocol and over the years several blockchains were added. Today, Tether can be found on multiple decentralized blockchains and as depicted in Table 1, the largest share of the total Tether supply was issued on Ethereum. Among others, the cryptocurrency was created on Bitcoin, Tron, EOS and Algorand, nevertheless, with a supply of more than six billion dollars, the Ethereum-based

³Last accessed 20 Jul 2020

	USD	EUR	CNH	XAU	Σ
Ethereum	6,037	50	25	0.048	6,112
Omni	1,335	0	-	-	1,335
Tron	2,882	-	-	-	2,882
EOS	5	-	-	-	5
Algorand	4	-	-	-	4
Others	22	-	-	-	22
Σ	10,043	50	25	0.048	10,118

Table 1: Authorized/Issued Tether
The distribution of Tether over platforms in millions as of July 1st, 2020
Source: wallet.tether.to/transparency [Last accessed 1 Jul 2020]

Dollar-Token USDT constitutes by far the largest share (some 60 %) of the company’s crypto-assets and was first created in November 2017. In fact, Tether was mainly issued pegged to the US-Dollar, however, there are also Euro and Renminbi variants on the Ethereum blockchain and since January 2020 a gold-pegged token called *Gold Tether (XAUt)*⁴ exists. The *Tether EUR*⁵ token contract was created on the 1st of January 2018, but its tokens have never been distributed, resulting in a total of only 15 token holders.⁶ The Renminbi Contract⁷ was created in April 2019 and is rather inactive too.⁸ The following analysis will show the huge acceptance of the USDT token among the Ethereum community, henceforth focuses on the contract at address *0xdAC...*⁹, which refers to the *Tether USD* token contract, when referring to *Tether*. Ethereum’s Ether uses 18 decimals and many tokens follow this example, however, the USDT token has ‘only’ six decimals and is therefore still 10,000 times more divisible than traditional fiat currencies.

2.1.2 USD Coin

The second largest Stablecoin by market capitalisation is called *USD Coin (USDC)* and is issued by the crypto-exchange Coinbase. Developed by CENTRE and initiated as an open-source project by the companies Circle and Coinbase, the Stablecoin maintains its price peg to the US-Dollar through fiat money securi-

⁴ *Tether Gold: XAUt Token* Address: 0x4922a015c4407F87432B179bb209e125432E4a2A

⁵ *Tether EUR* Address: 0xAbdf147870235FcFC34153828c769A70B3FAe01F

⁶ see etherscan.io/token/0xAbdf147870235FcFC34153828c769A70B3FAe01F [Last accessed 1 Jul 2020]

⁷ *Tether CNH* Address: 0x6E109E9dD7Fa1a58BC3eff667e8e41fC3cc07AEF

⁸ see etherscan.io/token/0x6E109E9dD7Fa1a58BC3eff667e8e41fC3cc07AEF [Last accessed 1 Jul 2020]

⁹ *Tether USD* Address: 0xdAC17F958D2ee523a2206206994597C13D831ec7

ties stored in bank accounts. (Centre, 2020) As explained in the Whitepaper, customers must meet Know-Your-Customer (KYC) requirements before they can deposit fiat in exchange for tokens. This can be done through the official web application, which is maintained by Circle itself, or via a licensed token-issuing partner. Such partners are authorised to then interact with the CENTRE network in order to issue tokens in exchange for dollars. This means that every time someone requests USDC, the tokens are either freshly minted by an issuer or taken from its reserves. The same applies for the redeeming process: When tokens are redeemed, they get burned. In theory, this approach could decentralize the emission process to a certain degree, as it distributes the privilege to mint new tokens to multiple entities that are all part of the CENTRE network. (Centre, 2018) To which extend differences between a centralized issuing policy and a more decentralized one can be observed in the figures, is examined in the main part of this thesis. The USDC token contract can be found at address **0xA0b...**¹⁰ and was published to the blockchain on the 3rd of August 2018. Just like the Tether token, USDC has six decimal places and as of July 1st, 2020, the Stablecoin has a market capitalisation of around 950 million dollars.¹¹

2.1.3 Paxos Standard, Binance USD & HUSD

Paxos Trust Company is a fintech founded in 2012 that distributes its own fiat-backed Stablecoin called *Paxos Standard (PAX)* on Ethereum. The 2018 released Whitepaper states that each token is only issued in exchange for one US-Dollar, while the redeeming process works vice versa. Besides the Stablecoin business Paxos operates as provider of crypto brokerage platform solutions, acts as a custodian and offers post-trade and settlement services.¹² Similar to Tether, Paxos launched a gold-backed asset called *Paxos Gold*¹³, enabling customers to trade tokenized gold on Ethereum. According to Cascarilla (2019), the company's CEO, PAX Gold token holders can even request the “*serial number(s), purity and weighting of each bar(s) to which their tokens are allocated at any given time*” (p. 9). Additionally, the company is part of two other Stablecoin

¹⁰ USD Coin Address: 0xA0b86991c6218b36c1d19D4a2e9Eb0cE3606eB48

¹¹ see coinmarketcap.com/ [Last accessed 1 Jul 2020]

¹² see www.paxos.com/category/pax-faq/ for details [Last accessed 31 Jul 2020].

¹³ Paxos Gold Contract Address: 0x45804880De22913dAFE09f4980848ECE6EcbAf78

projects involving the crypto-exchanges Binance and Huobi, with whom Paxos developed Stablecoins that are backed by fiat reserves too. All three tokens are regulated by the *New York State Department of Financial Services (NYDFS)*¹² and FDIC-insured banks were selected to hold the fiat funds that are deposited by customers. (Cascarilla, 2018) The tokens represent the 3rd (PAX), 4th (BUSD) and 7th (HUSD) largest Stablecoins by market capitalisation on Ethereum and their contracts can be found at the addresses **0x8E8...**¹⁴ for Paxos, **0x4Fa...**¹⁵ for Binance USD and **0xdF5...**¹⁶ for HUSD. While PAX and BUSD both have 18 decimals, HUSD uses eight decimal places. Finally, the token contract of *Paxos Standard* was published on 8 September 2018, *HUSD* on the 18th of July 2019 and the contract of *Binance USD* on September 5, 2019.

2.1.4 TrueUSD

TrustToken, the company behind the 5th largest Ethereum-based Stablecoin on CoinMarketCap, published its token contract already in 2018. *TrueUSD* is a Stablecoin that is collateralized with US-Dollars and as stated on the company’s website, only customers who passed KYC procedures are able to purchase and redeem tokens. Every TUSD is freshly minted when fiat money is deposited into an escrow account and vice versa, KYC-approved customers can redeem their tokens for dollars. (TrustToken, 2020) Besides the dollar version, the company also issued Ethereum-based Stablecoins backed by reserves of British Pound (TrueGBP), Australian Dollar (TrueAUD), Canadian Dollar (TrueCAD) and Honk Kong Dollar (TrueHKD), but similar to Tether, only the US-Dollar-pegged tokens are widespread and frequently used.¹⁷ The token contract of *TrueUSD* was originally deployed on 5 March 2018 at the address **0x8dd...**¹⁸ and through the implementation of a call-forwarding mechanism into the token contract, which allows requests to be forwarded to another contract, the Stablecoin is able to perform upgrades. This feature was activated on the 4th of January 2019, when the token contract officially began delegating to the address **0x000...376**¹⁹. Since

¹⁴ *Paxos Standard* Contract Address: 0x8E870D67F660D95d5be530380D0eC0bd388289E1

¹⁵ *BUSD* Contract Address: 0x4Fabb145d64652a948d72533023f6E7A623C7C53

¹⁶ *HUSD* Contract Address: 0xdF574c24545E5FfEcb9a659c229253D4111d87e1

¹⁷ see www.trusttoken.com/currencies [Last accessed 31 Jul 2020]

¹⁸ *TrueUSD Legacy* Contract Address: 0x8dd5fbCe2F6a956C3022bA3663759011Dd51e73E

¹⁹ *TrueUSD* Address: 0x0000000000085d4780B73119b644AE5ecd22b376

then, token transfers are logged by the new contract, which is important to be considered because for this reason a complete picture of the TUSD transfers and its total supply can only be reconstructed by fetching the logs of both contracts.²⁰ In the following work, the focus is on the US-Dollar version of TrustToken’s Stablecoins because the others count significantly low numbers in transfers and token holders. Lastly, the token has 18 decimals and as of July 1st, 2020, *TrueUSD* represents the 5th largest Stablecoin on Ethereum with a market capitalisation of around 140 million dollar.

2.1.5 DAI Stablecoin

DAI Stablecoin differs in many ways from the other Stablecoins discussed. The token contract is part of the DeFi ecosystem of MakerDAO, which represents an open-source project initiated in 2014. Currently, the Maker Foundation, comprising the core members of the project, is working on the Maker Protocol until it is fully decentralized. According to the Nielsen (2019), a Danish foundation was set up “*to safeguard what cannot be technologically decentralized in the Maker Protocol, [...]*” and following the DeFi Leaderboard on etherscan.io²¹, the Maker Protocol is the second largest DeFi application on Ethereum after Compound. It allows participants to deposit an on-chain collateral like Ether or other tokens into a Smart Contract in exchange for DAI, a dollar-pegged Stablecoin. This can be seen as an equivalent to a loan: When borrowers pay back their loans to unlock their securities, they do so by returning the borrowed DAI tokens plus a *Stability Fee*. The Stablecoin is only a single component of the Maker protocol, which consists of various Smart Contracts, each of which has its own remits. Furthermore, there exists a token called *Maker (MKR)* that is publicly traded and of vital importance within the decentralized governance architecture of the protocol. Token holders are entitled to vote for changes in the Maker Protocol by depositing their MKR tokens into a voting contract, with each token corresponding to one vote. Everyone can propose changes to the protocol by deploying a *Proposal Contract* and additionally, MKR token holders are responsible for decisions about the *DAI Saving Rate (DSR)*, *Oracle Contracts*, *Emergency Shutdown*

²⁰ see blog.trusttoken.com/upgrade-80ba355f8960 [Last accessed 1 Jul 2020]

²¹ see etherscan.io/defi-leaderboard [Last accessed 1 Jul 2020]

Contracts and *Risk Parameters* for every type of collateral. Summarizing, there are two tokens powering the MakerDAO protocol, DAI, the on-chain collateral-backed Stablecoin, received in exchange for locking Ether or another crypto-asset and MKR, the governance token. By pledging a security, users can borrow DAI tokens with a worth of up to 66 % of their collateral, which guarantees that the debt position is 150 % collateralized. Should the security's value drop below the 150 % collateralisation ratio, then parts of it are liquidated and the owner has to pay a *Liquidation Penalty* that is determined by the MKR token holders and set independently for every asset. This procedure ensures that users over-collateralise their debt positions to avoid liquidations. In contrast to the already discussed Stablecoins that are backed by fiat or gold, the Maker Protocol, which is described in the Maker Docs²², is by far more complex and is composed of many different Smart Contracts interacting with each other. Before it was possible to deposit ERC-20 tokens as collateral, users could only use Ether to cover their debt positions. In November 2019 the protocol then upgraded from *Single-Collateral Dai* to *Multi-Collateral Dai* and directly introduced BAT tokens as legitimate security.²³ Additionally, the *DAI Saving Rate (DSR)* was launched, providing incentives for DAI token holders who lock their DAI tokens into the *DAI Savings Rate Contract* to earn interests at the rate of the DSR. Furthermore, the MKR token holders can adjust the DSR to regulate the demand of DAI tokens in order to stimulate its price and keep it pegged to one dollar. For example, in times of high demand they might decrease the DSR to lower the demand. The above mentioned *Stability Fee* finances the DSR and is paid by those who unlock their collateral for repaying DAI loans. The amount of the fee is determined by the MKR holders and again provides them a tool to regulate the price of DAI through an adjustment of the fee, which consequently increases/decreases the total demand. Technically, every token transferred into the DSR contract gets afterwards burned by being sent to ***address(0)***²⁴, which represents the address that is typically used to send destroyed tokens to. The same happens to DAI tokens that are paid back in loan settlements, constituting

²²see docs.makerdao.com/

²³see blog.makerdao.com/say-goodbye-to-cdps-and-hello-to-maker-vaults/

²⁴Address: 0x00

Coin	Symbol	Blockchain	Supply*	Collateralisation and issue policy	Addr.
Tether	USDT	Bitcoin, Ethereum**	6,037	Different assets held by Tether Limited	0xdAC...
USD Coin	USDC	Ethereum	950	USD held by a network of partners	0xA0b...
DAI Stablecoin	DAI	Ethereum	106***	Ether deposited in the Collateral Vault	0x6B1...
Paxos Standard	PAX	Ethereum	241	Dollar held by FDIC-insured banks	0x8E8...
TrueUSD	TUSD	Ethereum	140	Dollars held in escrow accounts	0x000...
Binance USD	BUSD	Ethereum	175	Dollar held by FDIC-insured banks	0x4Fa...
HUSD	HUSD	Ethereum	115	Dollar held by FDIC-insured banks	0xdF5...

Table 2: Stablecoin Landscape

Itemization of the analyzed Stablecoins, their circulating supply and issuing policy

*in millions **Tron, EOS, Algorand, Liquid and SLP ***without funds in the DSR
created, following Lyons and Viswanath-Natraj (2020)

an important detail for the following analysis, as it implies that users who lock their DAI and thereby apparently admit to hold their assets are not included in the official circulating supply.²⁵ As of July 1st, 2020, DAI represents the 6th largest Stablecoin on Ethereum and because of the token’s decentralized architecture, several regulatory requirements are not applicable. For example, there are no KYC procedures within the token’s ecosystem, allowing DAI holders to remain anonymous until they transfer their funds to an exchange or wallet provider with customer-verification processes. Finally, DAI has 18 decimal places, its token contract can be found at the address **0x6B1...**²⁶ and as of July ’20, the Stablecoin has a market capitalisation of around 128 million dollars, including the tokens locked in the DSR contract. (Maker Ecosystem Growth Holdings, Inc., 2020)

2.2 Ethereum

In order to conduct a deeper analysis of the discussed Stablecoins, it is essential to be familiar with the basics of their common underlying platform, namely Ethereum, the largest decentralized blockchain, which serves decentralized applications (*DApps*). Ethereum is an open-source project and was first described by Buterin (2013). The native currency on Ethereum is called *Ether* (*ETH*) and is used to reward miners by paying for transactions. After Bitcoin, Ether represents the second largest cryptocurrency, but in contrast to Bitcoin, Ethereum comes with a built-in, turning-complete programming language called *Solidity*, which allows participants to develop decentralized applications, realized through Smart

²⁵ see blog.makerdao.com/a-guide-to-dai-stats/

²⁶ DAI Stablecoin Address: 0x6B175474E89094C44Da98b954EedeAC495271d0F

Contracts, on top of the platform. Smart Contracts represent semi-automated ‘autonomous agents’ that operate inside the decentralized environment Ethereum provides. As described in the project’s Yellowpaper, the system’s runtime environment, the *Ethereum Virtual Machine (EVM)*, is a turning-complete stack-based system that is distributed over many nodes and responsible for executing the accounts’ bytecode. Every account on Ethereum has its own 20-byte address and is either a *Contract* or an *Externally Owned Account (EOA)*. While contracts are controlled by their contract code, *EOAs* are accessed using private keys. Accounts on Ethereum interact with each other via *messages calls* that are triggered by *transactions*, which in turn can only be sent from *EOAs*. *Transactions* can either create contracts or trigger *message calls*. The former is done by sending a transaction that contains the *EVM Code*²⁷ for the contract to be created to `address(0)`, representing “0x0” in hexadecimal format. A *message call transaction*, is used to simply transfer Ether to another account or to interact with a contract. The latter is done by passing additional information in binary format to the contract, alongside the transaction. As defined in Ethereum’s Yellowpaper, a transaction contains a *data* field, which can hold an unlimited size byte array and is used to pass further commands to the recipient of the transaction. Two out of many possible instructions could be a token transfer and the creation of tokens. As only *EOAs* are capable to carry out transactions, contracts interact with each other through *message calls*, which enable them to send Ether to an *EOA* or to execute another contract’s function. (Wood, 2014)

The discussed categorisation and definition of a transaction is crucial to be aware of when it comes to analyzing ERC-20 tokens. All the analyzed Stablecoins represent Smart Contracts on Ethereum and therefore require to understand the differences between *EOAs* and *Contracts*, but also the relationship between *message calls* and transactions.

2.2.1 ERC-20 Standard

Contracts on Ethereum may be used for various applications, but especially *Initial Coin Offerings (ICOs)* received much attention in recent years. ICOs allow

²⁷ see also medium.com/authereum/bytecode-and-init-code-and-runtime-code-oh-my-7bcd89065904 for further details about contract creations and the EVM Code [Last accessed 15 Jul 2020]

companies to finance themselves through the sale of (pre-mined) tokens in exchange for fiat money or other cryptocurrencies such as Bitcoin or Ether. In order to standardize the interface for the rapidly increasing number of tokens that were created on the Ethereum blockchain, Vogelsteller and Buterin (2015) proposed the *ERC-20 Token Standard*, comprising Solidity code examples of very fundamental *Methods* and *Events* to be integrated into every token contract. *Methods* are implemented via Solidity’s *function* keyword and are used to perform alterations to the state of the EVM or to read from it, while Events provide external applications an opportunity to subscribe to specific actions happening in a contract. The transfer event, for example, is emitted every time a token transfer occurs and is not directly stored on the blockchain. Nevertheless, every event can be retrieved by re-executing the transaction that originally triggered its emission. By defining a common interface for fungible tokens, wallet providers and exchanges are able to rely on the applicable standards, while tokens that reject the ERC-20 approach may not be compatible with most applications. Victor and Lüders (2019) created a table that summarizes the ERC-20 standard and additionally lists the Method and Event IDs, itemized in the last column:

Classification Signature			First 4-byte Keccak hash	
ERC20	Required	Method	totalSupply()	18160ddd
			balanceOf(address)	70a08231
			transfer(address,uint256)	a9059cbb
			transferFrom(address,address,uint256)	23b872dd
			approve(address,uint256)	095ea7b3
			allowance(address,address)	dd62ed3e
	Event	Transfer(address,address,uint256)	ddf252ad	
		Approval(address,address,uint256)	8c5be1e5	
	Optional	Method	name()	06fdde03
			symbol()	95d89b41
			decimals()	313ce567

Table 3: ERC-20 Signatures and Hashes (Victor and Lüders, 2019)

Methods

As described in Table 3, each function has its own Method ID, which consists of the first four bytes of the Keccak-256 hash of the *Signature*, which in turn is defined as “the canonical expression of the basic prototype without data location specifier.” (Read the Docs, 2020)

This can be clarified with the following example: The transfer function takes two

to represent the address that sends and the one that receives tokens. The data field is not indexed and for transfer events it usually includes the amount of tokens to transfer in hexadecimal format and padded to 32 bytes too.³⁰ Summarizing, a typical transfer event might take the following form:

```
{'address': '0xdac17f958d2ee523a2206206994597c13d831ec7',
'topics': ['0xddf252ad1be2c89b69c2b068fc378daa952ba7f163c4a11628f55a4df523b3ef',
'0x0000000000000000000000000000000000000000000000000000000000000000',
'0x0000000000000000000000000000000000000000000000000000000000000000'],
'data': '0x0000000000000000000000000000000000000000000000000000000000000000',
'blockNumber': '0x46c768',
'timeStamp': '0x5a1d82e2',
'gasPrice': '0xee6b2800',
'gasUsed': '0xd099',
'logIndex': '0x9',
'transactionHash': '0x51a2395087450379f38a866662090d6656e73929d205d8d559f5c8f2c46a2ca1',
'transactionIndex': '0x18'}
```

2.2.2 Transactions vs. Transfers

Analyzing ERC-20 tokens, it is important to carefully distinguish between transactions and transfers. Common mistakes are, to query token transfers by filtering the records for zero-value transactions to a token contract or to neglect that Smart Contracts can also trigger token transfers. Usually, zero-value transactions are used to execute transfers, however, these transactions can also simultaneously transmit Ether. Thus, it would be wrong to argue that transfer events can only be found in combination with zero-value transactions. Figure 1 illustrates how a typical token transfer looks like for external observers: A token transfer from address **0xA...** to **0xB...** requires a transaction that tells the contract **0xC...** to execute its transfer function, which consequently results in the emission of a transfer event. The contract internally updates its balance sheet, which is structured as a hash table wherein the Keccak-256 hashes of the addresses are used as keys to lookup balances.³¹ In Figure 1, on the left side, the token balance of address **0xA...** decreased by ten while the balance of address **0xB...** increased by the same amount *in state 1 (s1)*, compared to the address' balance in *s0*.

Notably, not all transfer events are triggered by transactions directly to a token contract: On the right side, Figure 1 illustrates a scenario in which a Multisignature Contract **0xM...** is involved, which triggers the transfer function of the

³⁰see *Events* at solidity.readthedocs.io/en/develop/abi-spec.html [Last accessed 20 Jul 2020]

³¹see solidity.readthedocs.io/en/v0.5.3/types.html [Last accessed 21 Jul 2020]

Figure 1: Token Transfers

Standard Token Transfer (left) - Multisignature Transfer (right)

Transfers need not necessarily be triggered by a transaction to the token contract. Instead, contracts like *Multisignature Contracts* can lie in between.

token contract **0xC...** As a consequence, the transactions directly sent to a token contract with the command to execute the transfer function only represent a subset of all token transfers. The actual number of transfers corresponds to the sum of all transfers triggered by EOAs and contracts. Multisignature Contracts are only one of many applications in which contracts invoke another contract's transfer function and especially decentralized exchanges (DEXs) such as *IDEX*, *Kyber*, *Airswap* or *Uniswap*, to just mention a few of them, have been contributing to much more transfers occurring without a transaction to the actual token contract.³² Another point of distinction between transaction and transfers is their uniqueness: In contrast to transactions, transfers are not necessarily unique and therefore often not distinguishable. While transactions have unique 256-bit *transaction hashes*, transfers always rely on their 'envelopes', which are the transactions that triggered them and the blocks that then incorporate these transactions. This leads to the theoretical scenario in which certain events are not distinguishable from others, except by the order in which they were recorded, resulting from multiple transfer events originating from one contract and executed within one transaction. Practically, such situations happen more frequently than one might expect and in particular the rise of DeFi caused many duplicate transfers. The transaction **0xe49...**³³ represents a great example to confirm the above: On 14 June 2020 this transaction to the contract **0x3b7...**³⁴, which is publicly labeled with *Bitpie: Batch Sender v2* and belongs to

³²Example Tx: 0x8230cc9d3bf17f332acbe8d1aec40a1ae44e56159797673204f720d68b488732

³³Tx hash: 0xe49af17de711d7ca1f034f2fb821082a83a50b53d8b4a649addbc0b87d0c3faf

³⁴*Bitpie: Batch Sender v2* Address: 0x3b7E71a9f15EEBb541C82f88Ef020Ae7040484f1

the wallet provider Bitpie, triggered 40 independent transfers of Tether tokens. In total, around 118,292 USDT were sent to 19 different accounts, including seven transfers of 1,970 tokens to address *0xd4d...*³⁵, representing seven duplicated and 100 % identical entries in the data set used in this analysis. This is due to the fact that these transfers all have exactly the same values for the following attributes: $Block_{timestamp}$, $block_{number}$, $transaction_{index}$, $transaction_{hash}$, $transfer_{from}$, $transfer_{to}$, $transfer_{amount}$, gas_{price} and gas_{used} .

2.3 Related Works

During and after the ICO hype in 2017 the focus of research shifted to topics such as corporate financing and many papers were published dealing with ICOs, their success factors and the value-creation mechanisms behind crypto-tokens (Fisch, 2019; Catalini and Gans, 2018; Florysiak and Schandlbauer, 2019). Several studies conducted descriptive and quantitative (network) analyses on Bitcoin, Ethereum or other cryptocurrencies (Bartoletti and Pompianu, 2017; Anoaica and Levard, 2018; Chen et al., 2020; Ferretti and D’Angelo, 2019; Somin et al., 2018; Pinna et al., 2019; Dyson et al., 2020). The work of Bartoletti and Pompianu (2017) itemizes common patterns in the source code of Smart Contracts, while Anoaica and Levard (2018) and Pinna et al. (2019) dealt with the identification of high-influence accounts. Chen et al. (2020) pointed out characteristics of Smart Contracts and their creators and showed that most contracts were created by EOAs, however, several contracts were created by other contracts. Latest literature devotes much attention to decentralized finance and decisions-making, including newly emerging business models, their challenges and regulations (Chen and Bellavitis, 2020; Hughes and Smith, 2014; Zetzsche et al., 2020; Mertzanis, 2020). Very related literature is relatively new and especially 2019 and the first half of 2020 brought several papers focusing on Stablecoins, their price dynamics and stability mechanisms: Griffin and Shams (2018) showed evidence that Bitcoin purchases with Tether were timed following market downturns. By analyzing both Bitcoin and Tether in detail, they claimed that Bitfinex, a large exchange with a close relationship to Tether, issued new tokens to buy large amounts of Bit-

³⁵ Address: 0xd4d7B764EC071A0A8a6f9dCe928fA1f8D7C0E6a6

coin, suspiciously at prices around round numbers, and thereby manipulated the market price. A very recent work by Hoang and Baur (2020) analyzed the stability of Stablecoins and found a high correlation between excess volatility in the Bitcoin prices and the stability of Stablecoins. In total, six Stablecoins including *Tether*, *USD Coin*, *TrueUSD*, *Paxos Standard*, *Single Collateral Dai* and *Gemini Dollar* were evaluated and their research indicates that Stablecoins have major influence on the volatility of Bitcoin and thus play a key role in cryptocurrency markets. Under the title '*Stablecoins as a crypto safe haven? Not all of them!*', Baumöhl and Vyrost (2020) agreed to Hoang and Baur (2020) and analyzed certain properties of the largest Ethereum-based Stablecoins and compared them to cryptocurrencies like Bitcoin, Ether, XRP (Ripple), Bitcoin Cash and Litecoin. They elaborated why TrueUSD, Paxos Standard, and Gemini Dollar were the best 'safe haven' candidates, resulting from a negative dependence on non-stable coins. Recently, Lyons and Viswanath-Natraj (2020) analyzed the stability mechanisms behind the largest Stablecoins as of March 2020 and integrated the tokens USDT, USDC, PAX, BUSD, TUSD and DAI into their study. They pointed out how arbitrage possibilities contribute to the price-stabilization of USDT tokens, while the emission-policy only played a secondary role. In addition, they were able to confirm the *safe haven* hypothesis by analyzing the Covid-19 crypto-downturn. In contrast to existing work, the following analysis will provide basic statistical measures to describe the Stablecoin landscape and integrates additional information gained by examining the contracts' Solidity code to explain the empirical data conclusively. This interdisciplinary approach allows the study of quantitative data through the interpretation of code to obtain a holistic picture of the whole ecosystem. While price data is completely ignored, qualitative information is included in an attempt to identify specific powerful accounts that have been granted certain rights within a token ecosystem. Additionally, the applied methodology pushes the boundaries of existing research because it enables not only a comparison of the largest Stablecoins by numerical measures, but also by qualitative ones and enables to characterise token contracts based on how they implement and restrict certain functions and events within their code.

3 Methodology and Data

3.1 Descriptive Analysis

As outlined in the chapter *Related Works*, the most common approach to analyse blockchain data is taking a network-theory perspective to examine an ecosystem consisting of nodes and edges. In addition, a quantitative-descriptive approach can be applied by analyzing the data with statistical measures to provide a static snapshot of the token landscape. Since the data of many famous blockchains like Bitcoin or Ethereum is publicly available and accessible without any restrictions, related domains are perfectly suited for quantitative data science. Furthermore, the source- and byte codes of most contracts are publicly available, verified by Etherscan and can be reviewed on etherscan.io. This allows to link qualitative information, gained from analyzing contract codes, with numerical event data. In the first part of the following analysis, descriptive statistics were used to describe transfer-event related data, including transfer counts, transfer amounts and the gas costs. The emitted events were plotted against time and further analyzed to uncover the reasons for particular characteristics and outliers and additionally, the circulating supply of each token as an indicator of its acceptance could nicely be compared and examined more closely. Quantitative summaries and visualisations then provide deeper insights into the distinct characteristics of each token contract. The second part of the analysis focuses on the distribution of wealth within both the token networks and the whole Stablecoin ecosystem. Since all of the analyzed Stablecoins are pegged to the US-Dollar, the units of each token may either be expressed in the token's *symbol* (e.g. USDT) or simply in US-Dollars, which allowed to pool together balances consisting of different tokens in order to draw a more complete picture of the entire landscape. In an attempt to identify *Stablecoin Whales*, which are those entities with the largest number of Stablecoin assets, balances of different accounts were linked to real-life entities and aggregated to obtain a more holistic overview of the actual distribution of wealth within the whole market. Therefore, Etherscan's *Label Word Cloud*³⁶ was an essential source of information on account holders. In total, the source codes

³⁶see etherscan.io/labelcloud [Last accessed 1 Jul 2020]

of 14 different contracts (see Appendix 1) were analyzed and incorporated to provide both revealing insights into the individual Stablecoins and explanations of contract functions and their internal restrictions. These contracts are all verified and publicly available on Etherscan. Furthermore, a list of all identified accounts, their labels and addresses, can be found in Appendix 6.

3.2 Data Collection

The data used for the quantitative part of this work was retrieved using the public API of Etherscan.io³⁷, which is an alternative to setting up a full-node or using an Infura node³⁸ and allows to filter a defined block range for addresses and indexed topics. Hence, as a first step, the Solidity code of each contract was reviewed to determine the functions that lead to event emissions. The canonical expressions of the identified events were then hashed as shown in the subsection *Events* and applied to filter the Ethereum blockchain for relevant transactions. This was realised with a Python script that was created to fetch the needed data and store it as a csv-file on the local machine. Since only a maximum of 1,000 results per request are returned by the API, the script automatically adjusts the requested block range with respect to the number of results retrieved. By applying this method, information about 5,735,525 blocks was gathered, filtered by events that were logged by eight different contracts, namely *Tether USD*, *USD Coin*, *Paxos Standard*, *TrueUSD_{legacy}*, *TrueUSD*, *DAI Stablecoin*, *HUSD* and *Binance USD*. All these token contracts are compatible with the ERC-20 Standard, which means that they emit events for every token transfer. The descriptive statistics part starts with block number 4,634,748, which is the block that contains the transaction with the creation bytecode of the Tether token contract and was confirmed on November 28, 2017 at 12:41:21 AM (+UTC).³⁹ The last block incorporated in the analysis of this thesis is block number 10,370,273, which was mined on June 30, 2020 at 11:59:40 PM (+UTC) and represents the last block of June '20. The data set consists of 48,983,417 rows, each representing an event with seven to nine columns, depending on the type of the event. For transfer events, the

³⁷see etherscan.io/apis [Last accessed 1 Jul 2020]

³⁸see infura.io/ [Last accessed 1 Jul 2020]

³⁹Tx hash: 0x2f1c5c2b44f771e942a8506148e256f94f1a464babc938ae0690c6e34cd79190

following attributes were collected: $Block_{timestamp}$, $block_{number}$, $transaction_{index}$, $transaction_{hash}$, $transfer_{from}$, $transfer_{to}$, $transfer_{amount}$, gas_{price} and gas_{used} . The same fields apply to all the events that influence the supply of tokens, except that $transfer_{from}$ and $transfer_{to}$ turn to $transfer_{address}$, representing the account where tokens were burned from or issued to. In total, the analysis is based

Token	.sol Implementation of Event	Event ID
USDT	Issue(uint256)	0xcb8241...176a
	DestroyedBlackFunds(address,uint256)	0x61e6e6...98c6
	Redeem(uint256)	0x702d59...9a44
USDC	Mint(address,address,uint256)	0xab8530...c9f8
	Burn(address,uint256)	0xcc16f5...7ca5
PAX	SupplyIncreased(address,uint256)	0xf5c174...8797
	SupplyDecreased(address,uint256)	0x1b7e18...8a63
BUSD	SupplyIncreased(address,uint256)	0xf5c174...8797
	SupplyDecreased(address,uint256)	0x1b7e18...8a63
TUSD	Mint(address,uint256)	0xf6798a...6885
	Burn(address,uint256)	0xcc16f5...7ca5
DAI	-	-
	-	-
HUSD	Issue(address,uint256)	0xc65a3f...3c16
	Redeem(address,uint256)	0x222838...67a6

Table 4: Supply-controlling Functions
Event Implementation of supply-controlling functions of the largest Stablecoins and their *Event ID* (*topic[0]*), which is the keccak-256 hash of the canonical Solidity expression.

on 440, 498, 614 observations and 99.28 % of all events are standard EIP-20 compatible transfer events. The remaining 0.72 % are events that directly affect the circulating supply of tokens and are named *Mint*, *Burn*, *SupplyIncreased*, *SupplyDecreased*, *Issue*, *DestroyedBlackFunds* and *Redeem*. An overview of all events, their Solidity implementation and their *topic[0]* is depicted in Table 4. Notably, the DAI token contract does not broadcast any specific event when tokens are created or burned, however, the circulating supply can be tracked by subtracting the amount of tokens transferred to address(0) from those transferred from address(0). To be even more precise, since not every token transmitted to address(0) was burned, which is implied by the positive DAI balance of this account displayed on Etherscan, the above suggested calculation method of DAI’s sup-

ply is not one hundred percent correct: A total of 215.83 DAI were sent to the address(0) without being deposited into the DSR contract or repaid to settle a loan.⁴⁰ This could have happened accidentally and since no one has access to the funds of this account, this insignificant amount can safely be treated as burned for the rest of this work. The emission of such ‘artificial’ transfer events from or to address(0) when tokens are issued or burned has already been proposed by Vogelsteller and Buterin (2015) in their EIP-20 and allows external software providers such as wallet providers or exchanges to easily keep track of the circulating supply of a token by subscribing only to the emitted transfer events. With the exception of Tether, all the analyzed tokens adhere to this part of the EIP-20 proposal, nevertheless, the *Tether USD* contract emits specific events named *Issue*, *Redeem* and *DestroyedBlackFunds* to broadcast changes of its circulating supply. However, directly with the contract creation 100,000 USDT tokens were minted to the account that deployed the token contract and these tokens were neither logged as a transfer- nor an issue event in the respective transaction. As a consequence, these 100,000 tokens were integrated into the data set as if they had been issued like all other USDT tokens. Furthermore, there are two separate events in the Tether contract that can be triggered when the circulating supply decreases, namely *DestroyedBlackFunds* and *Redeem*. As of July 1st, 2020, the latter event has never been emitted and was therefore neglected in the following analysis. In general, the token events can be roughly divided into two categories: The EIP-20 compatible transfer events, indicating network activity, and events that influence the circulating supply. Although the naming of the supply-controlling events might vary from token to token, the principles remain the same, namely that tokens are either minted, thereby the circulating supply increases, or the opposite occurs: Tokens are burned and the circulating supply decreases. Consequently, these events, no matter how they were named, can be treated in the same way with regard to the decimals of each token. Finally, the scripts created for the data collection-, verification-, preparation- and mining processes and all the charts were made publicly available on Github and are fully reproducible. The same applies to the data set.

⁴⁰ see etherscan.io/address/0x00 [Last accessed 1 Jul 2020]

4 Data Analytics

With all the knowledge about the ERC-20 Standard in the context of Ethereum and after having described in detail how events work, the focus can now shift to the actual analysis of the data, which is divided into several sections: The first part sheds light onto the different events that emanate from the contracts under discussion. This includes transfer events and events directly affecting the circulating supply of a token. The second part examines the entities behind the accounts and, by linking labels to accounts, balance-sheets based on real-life entities were drawn up. The descriptive part is supported by charts and tables, which are best suited to illustrate comparisons between the tokens and highlight the huge differences in penetration rate.

4.1 Token Events

4.1.1 Transfers

Transfer events clearly occur most frequently in the data set. In total, 48,631,352 transfers were carried out by the seven Stablecoins under discussion, or more precisely by their token contracts. These events were integrated into 46,204,011 transactions, which corresponds to about 1.05 transfers per transaction. The *Tether USD* contract is responsible for most of the transfer events found in the data set. Approximately 39,5 million USDT transfers have been conducted, which equals 81.2 % of all transfer events gathered since November '17. This enormous dominance is visualized in Figure 2, in which each token's transfers were plotted over time. The increase in transfers of the Tether token began around July 2019, although the contract was created more than a year and a half earlier. By that time, many popular exchanges including Binance, Bittrex and Poloniex switched from the Bitcoin-based Tether version to the ERC-20 token. This upgrade allowed faster and cheaper transfers and many exchanges publicly announced the switch to the Ethereum-based token around July '19.⁴¹ The final conversion happened later around the beginning of September 2019 and caused a massive peak in transfers.

⁴¹see bittrex.zendesk.com/hc/en-us/articles/360031291791, binance.com/en/support/articles/360030263211 and medium.com/poloniex/erc-20-based-usdt-is-live-8a8418e16fe4 for the public announcements of Bittrex, Binance and Poloniex [Last accessed 10 Aug 2020]

Figure 2: Daily Transfers

Number of daily *USDT* transfers compared to *USDC*, *DAI*, *PAX*, *TUSD*, *BUSD* and *HUSD*. The x-axis represents time and respectively ranges from the first day a *Transfer Event* occurred until June 30th, 2020. The y-axis shows the *transfers/day*.

According to an analysis of TokenAnalyst (2019), by that time, Tether’s number of transfers on Ethereum, first passed the daily number of Tether transfers that were carried out on Bitcoin/Omni. On 9 September 2019, the number of daily transfers spiked up to 188,621 transfers, which remained the all-time high until 21 May 2020, when the threshold of 200,000 transfers per day was exceeded for the first time. Focusing on 2020, Figure 3 clearly shows a remarkable increase in the daily transfers of *Tether USD*. In numerical terms, between January 1st and July 1st, the number of daily transfers increased by 516.8 % from 49,590 to 256,262 transfers, while the other Stablecoins expanded their daily volume by 367.4 % from 9,304 to 34,151 transfers. Summarising, these gains point to an unprecedented level of acceptance among the users of cryptocurrencies. *USD Coin*, *Dai Stablecoin* and *Paxos Standard* gained traction in 2020 and count five-digit transfer numbers, while *TrueUSD*, *Binance USD* and *HUSD* play negligible roles. A possible explanation for the low number of *BUSD* and *HUSD* transfers could be the fact that these Stablecoins are traded almost exclusively on the issuing exchanges’ platforms⁴² and consequently, users might simply lack the reasons to transfer their tokens out of the exchanges’ wallets and instead utilize the token as a transition currency from dollar to another ERC-20 token or Bitcoin. In addition, the exchanges might track the balances of their users in their internal databases and thus do not require costly ‘on-chain’ transactions for users trading tokens.

⁴²see Market Pairs at coinmarketcap.com/currencies/binance-usd/markets/ and coinmarketcap.com/currencies/husd/markets/ [Last accessed 1 Jul 2020]

Figure 3: Daily Transfers - 2020
Number of daily *USDT* transfers compared to *USDC*, *DAI*, *PAX*, *TUSD*, *BUSD* and *HUSD* for the first half of 2020

Focusing on *Paxos Standard* and its representative chart, an increase in transfers has been recorded from January 2020 onwards. According to recent research by Le Calvez (2018), the *Paxos Standard* token has been heavily infiltrated by scammers, namely by the organisation *MMM BSC*, which utilizes the Stablecoin for its fraudulent operations. The Paxos Trust Company is aware of the organisation’s questionable operations and dissociated itself publicly in the FAQs published on the company’s website⁴³, however, *MMM BSC* with the address **0x8a9...**⁴⁴ accounts for 650,256 transfers of PAX token, representing 25.2 % of the total number of PAX transfers. Additionally, the account⁴⁵ with the 3rd most transfers, 135,484 in total, is suspect of belonging to a fraudulent network too, as further investigations unveiled that several users complained about deceitful and criminal behaviour in regard to this account in the comment section of Etherscan.⁴⁶ These two scammer addresses together account for 30 % of Paxos’ total 2.58 million transfers. In conclusion of this finding and in anticipation of what would have been covered in the section on balances, the *MMM BSC* account represents the seventh richest PAX holder in the entire PAX ecosystem and has a balance of 5,572,046 tokens.

The USDC and DAI token contracts both experienced extreme volatility on very specific days and for USDC, an explanation might be the general Covid-19 related

⁴³ see paxos.com/what-is-mmm-is-it-affiliated-with-paxos/ [Last accessed 19 Jul 2020]

⁴⁴ *MMM BSC* Address: 0x8a91c9a16cd62693649d80afa85a09dbbdc8b8508

⁴⁵ Address: 0xC88F7666330b4b511358b7742dC2a3234710e7B1

⁴⁶ see etherscan.io/address/0xc88f7666330b4b511358b7742dc2a3234710e7b1 [Last accessed 9 Jul 2020]

crypto-market downturn and people’s desire for stability, as the CEO of Circle, Allaire (2020) stated on March 14, 2020 using Twitter⁴⁷:

*“While not as exciting to see markets so crushed, it’s still rewarding
to see that this entirely new, blockchain based monetary
infrastructure is working.” - J. Allaire*

Regarding the peak in transfers observable at *DAI Stablecoin*, it can be seen that the skyrocketing numbers occurred at the beginning of the Covid-19 crisis too, which might already explain the outliers: Further analyzing the four accounts that normally account for most of the transfers within the network shows that on March 12th and 13th, DAI withdrawals from the DSR contract, the *Savings Contract* of the Maker ecosystem, increased from 647 daily transfers, by 635 % and 560 %, while deposits into the DSR contract increased from 723 transfers by 826 % and 686 %, compared to the overall daily average. The same effects can be observed for contracts such as *OasisDEX*, *Uniswap: DAI* and *Kyber: Contract*, which sent and received about five to seven times more DAI transfers on these two days than usual. As the latter discussed contracts are decentralized exchanges, the peak in DAI transfers that occurred during the Covid-19 crash in the first half of March may have caused an increased demand for Stablecoins, which supports the assumption of Allaire (2020) and the *Safe Haven* hypothesis by Baumöhl and Vyrost (2020). Nevertheless, as not only the withdrawals from the DSR contract increased, but even more the deposits, it cannot be concluded that there was an increased demand for liquidity.

Analyzing the amount of transferred tokens (see Table 5), some similarities can be identified between all analyzed Stablecoins, with the exception of *Binance USD* and *HUSD*, which both appear like outliers compared to the other tokens. This is due to their relatively small number of transfers and following, the main focus will remain on *Tether USD* and the other four Stablecoins. For Tether, the mean transfer amount in tokens is about 8,173 USDT, while the median transfer amount equals 460 USDT. This indicates a heavily positive-skewed distribution and in fact, 90.7 % of all USDT transfers are smaller than the mean. The largest Stablecoin transfer happened in July ’19 and was initiated by Bi-

⁴⁷see twitter.com/jerallaire/status/1238604280036278272 [Last accessed 21 Jul 2020]

	Total Transfers*	<i>Mean</i>	<i>Std Dev</i>	<i>Q_{0.25}</i>	<i>Q_{0.50}</i>	<i>Q_{0.75}</i>	<i>Max*</i>
USDT	39.501	8,173	292,562	118	460	1,827	549.04
USDC	2.992	19,654	273,110	49	399	2,500	100.14
PAX	2.581	8,880	162,386	20	100	500	57.85
BUSD	0.058	181,104	924,061	199	5,232	74,999	80.67
TUSD	0.815	15,169	222,554	76	500	3,343	69.41
DAI	2.648	6,699	52,366	19	266	3,086	12.00
HUSD	0.037	236,995	641,696	14,950	90,001	188,999	50.00

Table 5: Transfer-Volume
Descriptive Statistics of the Transfer-Volume of the largest Stablecoins on Ethereum as of July 1st, 2020. The numbers are rounded and represent tokens. *in Mio.

nance. The crypto-exchange shifted 549,037,905 tokens from one of their wallets⁴⁸ into another one⁴⁹ and paid fees of around 0.00058 Ether (some 0.12 \$ with $1 \text{ Ether} = 200 \text{ USD}$). Table 5 highlights descriptive statistics calculated on all transfers of each token. Notably, the median and even the 75 % quantile are lower than the mean for each token, indicating that the vast number (75 %) of Stablecoin transfers consist of relatively small-amount transfers that range from maximum 500 to 3,343 dollars, depending on the Stablecoin. Although the *DAI Stablecoin* represents only the 6th largest coin regarding market capitalisation and is the youngest of the contracts analysed, it has the 3rd most transfers, which indicates great usability. A rational explanation, why the average transfer amount of DAI tokens is smaller than those from the others, in particular *Tether USD*, can be found in the varying emission- and distribution policies of the respective contracts. While Tether tokens are issued to very few accounts, which then distribute the tokens and consequently trigger transfer events with huge amounts of tokens, DAI tokens are not minted to just a handful of entities, instead, DAI tokens are issued to the account that locked up a collateral, so that no transfers of hundred million tokens were necessary solely for the distribution of the coin.

Incorporating the cost factor of a transaction, namely the gas fee, the focus was narrowed down to the first half of 2020 to allow an objective comparison, as gas costs have fluctuated heavily over the last years.⁵⁰ It can be observed that trans-

⁴⁸ *Binance 6* Address: 0x4E9ce36E442e55EcD9025B9a6E0D88485d628A67

⁴⁹ *Binance 7* Address: 0xBE0eB53F46cd790Cd13851d5EFf43D12404d33E8

⁵⁰ see etherscan.io/chart/gasprice [Last accessed 25 Jul 2020]

Figure 4: Average weekly Transfer Costs

The average weekly gas costs of *USDT* transfers compared to *USDC* and *DAI*. The y-axis shows the average transfer costs in Ether, aggregated on a weekly basis.

fers of USDT have been the cheapest ones in comparison to the other Stablecoins. On average, a transfer involving the Tether contract costed around 0.00189 Ether, which equals 0.38 dollars, assuming a conversion rate of $1 \text{ Ether} = 200 \text{ USD}$. In comparison, DAI and BUSD transfers costed around 4.1 times more (0.00791 and 0.00775 Ether) than USDT transfers and those of USDC even 4.8 times as much (0.00916 Ether). PAX, TUSD and HUSD transfers costed on average 0.00227 to 0.00239 Ether and were therefore slightly more expensive than Tether transfers. A plausible explanation for these huge differences lies in the fact that some Stablecoins are primarily used on centralized exchanges, especially USDT, BUSD and HUSD, which were mainly transferred from and to the exchanges Huobi and Binance, while others like DAI and USDC are predominantly used on decentralized exchanges such as IDEX, Uniswap, Tokenlon or Kyber: Decentralized services that perform token transfers require much more gas, as such transactions usually involve various Smart Contracts that are all powered by gas. As a consequence, the user pays not only for the processing of the actual token transfer, but also for various computing-intensive activities that take place in the background and are essential for the application to offer its decentralized services.

For example, a deposit of DAI tokens into the *DAI Savings Rate* contract involves actions of six different Smart Contracts, namely *Maker: Proxy Actions DSR*⁵¹,

⁵¹*Proxy Actions DSR* Address: 0x07ee93aEEa0a36FfF2A9B95dd22Bd6049EE54f26

*Maker: MCD Join DAI*⁵², *Maker: MCD Pot*⁵³, *Maker: MCD Vat*⁵⁴, *DAI Stablecoin*⁵⁵ and a *DS Proxy*⁵⁶ and costed 0.00879 Ether on averaged, equaling 4.6 time more than the average USDT transfer. Considering the DSR contract and eight Smart Contracts⁵⁷ that operate decentralized services, it can be observed that they are involved in 58.4 % of all DAI transfers over the whole period and costed on average around 0.00924 Ether, equaling 4.9 times more than the average Tether transfer. For the time interval between May and July 2020, the share of transfers involving the mentioned decentralized services decreased to 41.9 %, while their average transfer costs further increased by 69 % to 0.0156 Ether. This corresponds to about 3.12 dollars and is therefore 8.2 times higher than the fee for USDT transfers. In general, DAI transfers in May and June were on average 646.4 % more expensive than those carried out by the Tether contract.

For USDC the situation is similar: 28 % of all transfers involved ten identified DeFi-contracts, namely *Disperse.app*, *Uniswap: USDC*, *Kyber: Contract*, *Compound USD Coin*, *1inch.exchange*, *Kyber: Old Contract*, *BlockFi*, *Nexo: Wallet*, *Celsius Network: Contract* and *Nuo Network: Kernel Escrow* (see Appendix 2). These contracts represent the most active participants in the USDC ecosystem, alongside the exchanges Binance and, far less relevant, Poloniex and transfers involving these contracts costed on average around 0.0217 Ether and were therefore 11.5 times more expensive than the average Tether transfer. From May '20 until Jul '20, USDC transfers were on average 814.8 % more expensive than USDT transfers, while the mean transfer costs for the mentioned DeFi-contracts increased in the respective period to 0.04176 Ether, which corresponds to about 8.35 dollars and is therefore 22 times more expensive than the average Tether transfer. In general, this examination suggests that decentralization within Stablecoin ecosystems is accompanied by a loss of efficiency in terms of costs. Decentralized services require various contracts to interact with each other, which directly contributes to an increasing complexity within token networks and leads to more

⁵²*MCD Join DAI* Address: 0x9759A6Ac90977b93B58547b4A71c78317f391A28

⁵³*Maker: MCD Pot* Address: 0x197E90f9FAD81970bA7976f33CbD77088E5D7cf7

⁵⁴*Maker: MCD Vat* Address: 0x35D1b3F3D7966A1DFe207aa4514C12a259A0492B

⁵⁵*DAI Stablecoin* Address 0x6B175474E89094C44Da98b954EedeAC495271d0F

⁵⁶see docs.makerdao.com/dai.js/advanced-configuration/using-ds-proxy [Last accessed 9 Sep 2020]

⁵⁷OasisDEX, Uniswap: DAI, Kyber: Contract, Eth2Dai: Old Contract, Compound DAI, 1inch.exchange, Disperse.app and Kyber: Reserve (see Appendix 2)

expensive transfers. Interestingly, the most expensive transfer included in the data set happened on June 30th, 2020 and involved the Tether token contract and Smart Contracts of the Oracle provider *NEST Protocol*⁵⁸. This transfer of 2,252.6 USDT tokens and 10.1 Ether costed around 9.9 Ether (approximately 1,980 dollars) and was integrated in the transaction with the hash *0x2ba...*⁵⁹

4.1.2 Circulating Supply

The following section is divided into two parts, beginning with an analysis of the circulating supply of both the entire Stablecoin ecosystem and the individual tokens and continuing with an in-depth study of the respective token contracts and their supply-regulating functions and policies, which were elaborated and interpreted on the basis of the collected data and the contracts' Solidity code.

To begin with, the Ethereum-based Stablecoin ecosystem, represented by the tokens analyzed, has a market capitalisation of 7,800,726,550 dollars. The circulating supplies of the individual tokens were plotted against time in Figure 5 and clearly demonstrate the leading position of Tether. Focusing on the left-side chart, which compares Tether to the other Stablecoins analyzed, it can be seen that Tether's circulating supply is more than twice as large as the one of the other tokens. By July 1st, the total supply of USDT amounts to 6,037,847,551 tokens, while the sum of the other tokens' supplies equals 1,762,878,999. Thereby the amount of Tether Stablecoins on Ethereum is more than 3.4 times larger than USDC, DAI, PAX, TUSD, BUSD and HUSD combined. Moreover, Tether's USDT token represents the only Stablecoin on Ethereum with a supply of more than one billion tokens, however, USDC with 985,540,180 tokens in circulation is very close to this benchmark. For the tokens DAI, PAX, TUSD, BUSD and HUSD the circulation supplies range from 106,576,743, observed for DAI, to 241,123,247 tokens, for PAX.

It is remarkable that almost all Stablecoins show positive and negative fluctuations in their circulating supply, except for Tether, whose chart appears to only increase, which is in fact not the case: The contract's supply was decreased

⁵⁸ *NEST Protocol*: Oracle Address: 0x43D99D54F14c64994FD9666BEAB6023b0069De20

⁵⁹ Tx hash: 0x2baf54b20e026b1efacf307feb5d46dd4574355c61cc3f2c6522ef6f127d8ac4

Figure 5: Circulating Supplies

The circulating supply of *USDT* compared to *USDC* and *DAI*. The y-axis shows circulating supply in tokens.

49 times through token-burns that might be associated with scams or other crimes and do not constitute redemptions, which can be deduced from the fact that the circulating supply of the Tether contract has always been regulated with the *destroyBlackFunds* function, which empties the balance of a blacklisted account, while the contract's *redeem* function has never been called by July 1st, 2020. The lack of negative fluctuations in the Tether chart can be justified by the fact that *Tether USD* does not offer the end-user any possibility to redeem tokens independently, which would reduce the circulating supply, while the other Stablecoins all offer more or less automated and transparent ways to enter and exit the respective Stablecoin's ecosystem via Smart Contracts that automatically mine and burn tokens in correspondence to the fiat balance of an escrow account. Focusing on the Ethereum Stablecoin market as a whole, Figure 6 clearly demonstrates the lead of Tether by comparing the tokens' market shares and in numerical terms, 77.4 % of the total 7.8 billion Stablecoins are Tether tokens. As stated above, the switch from Bitcoin/Omni to Ethereum happened around July 2019 and as illustrated in Figure 5, the creation of these tokens happened earlier in April '19. Since the beginning of July '19, Tether's dominance has never dropped below 60 % again and from July '19 until July '20, the market share of Tether grew by almost 20 %, as depicted in Figure 6.

Table 4 showed that each token contract analysed has its own methods to let external observers track *when*, *how much* and *to which address* new tokens were minted. The same applies to the implementation of events recording the destruc-

Figure 6: Supply Shares 2019/20

The market share of *USDT* compared to *USDC*, *DAI*, *PAX*, *TUSD*, *BUSD* and *HUSD*. The y-axis shows the share of each token in the total Stablecoin stock.

tion of tokens. Every contract is free to choose the functions that influence its supply and as a consequence, the data set analyzed comprises seven different Stablecoins with six distinct *Mint* and *Burn* methods. Only *BUSD* and *PAX* follow the same approach, as both broadcast *SupplyIncreased* and *SupplyDecreased* events. In the following part, all these supply-controlling functions and their events were treated equally, regardless of how they were named and therefore each time the supply increases/decreases, the terms *mint* and *burn* were used as synonyms for *issue* and *destroy*. This terminology was even applied for *DAI Stablecoin*, although the contract does not emit any specific event to track its supply. However, by tracking the transfers from and to address(0), the circulating supply of *DAI* tokens could be fully reconstructed.

Analysing the entire data set, a total of 352,065 mint and burn events were identified and in contrast to the transfer events, Tether is far behind regarding the number of emitted supply-controlling events, which is demonstrated in Table 6. Despite representing the oldest contract investigated, *Tether USD* broadcasted the lowest number of mint and burn events among all contracts analyzed. A detailed investigation of these events leads to the conclusion that Tether’s very centralized emission- and distribution policy resulted in large amounts of tokens being issued in waves. Furthermore, it lacks transparent and automated proce-

dures for users to redeem tokens independently: In fact, 6,039,909,022 USDT tokens, accounting for 99.99 % of the total amount created, have been issued to the account at address **0xC6C...**⁶⁰, representing a Multisignature Contract of the crypto-exchange Bitfinex. Additionally this account acts as the sole *owner* of

	Total Mints	Total Burns	Mean Mint	Mean Burn	Max Mint*	Max Burn*
USDT	74	49	81,623,216	46,336	300	0.88
USDC	5,358	4,659	493,706	356,243	35	44
PAX	940	906	1,843,898	1,646,955	22	25
BUSD	339	332	2,277,252	1,797,560	14	18
TUSD	6,552	4,179	162,716	221,635	11	16
DAI	150,131	167,956	9,306	7,684	10	12
HUSD	6,992	3,598	220,325	396,324	10	10

Table 6: Mints and Burns

Descriptive Statistics of the Mints and Burns of the largest Stablecoins on Ethereum as of July 1st, 2020. The columns *Total Mints* and *Total Burns* represent the total number of mint and burn events emitted by the relevant token contracts. The average and max values are rounded and expressed in tokens of the respective contract. *in million

the Tether contract, which is a role that only exists inside the contract’s personal environment and authorizes the respective account to execute certain restricted functions. The rest of Tether’s supply, a total of 100,000 tokens, was issued in parallel with the contract creation in 2017. Back then, the beneficiary was the account that deployed the contract, which can be found at address **0x369...**⁶¹, is publicly known as *Bitfinex: Deployer 5* and directly forwarded the tokens to the Bitfinex Multisignature account. As a result, all Tether tokens were directly issued to the crypto-exchange Bitfinex and then further distributed. Moreover, every single token of the around six billion available passed through Bitfinex’s Multisignature account, which emphasises the close relationship between Bitfinex and Tether, indicated in the general section on Tether. Considering the temporal dimension, Figure 7 illustrates the cumulated token mints per day and shows that most of the Tether tokens were issued around April ’20. In figures, 61.9 % of the total Tether supply was created in the first half of 2020 and as depicted in Figure 7, the three largest emissions each covered 300 million tokens, two of

⁶⁰ *Bitfinex: MultiSig 2* Address: 0xC6CDE7C39eB2f0F0095F41570af89eFC2C1Ea828

⁶¹ *Bitfinex: Deployer 5* Address: 0x36928500Bc1dCd7af6a2B4008875CC336b927D57

which occurred in the first half this year. Shifting the focus to the burned tokens, further analysis reveals that a total of 2,270,455 USDT tokens were burned from 32 different accounts. This means that only 0.038 % of the issued tokens got destroyed afterwards, which constitutes an outlier compared to the other tokens. It also emphasises the low usage of supply-controlling functions such as *redeem* and *destroyBlackFunds* and underlines the lack of automated procedures that could allow users to redeem tokens for dollars independently. Figure 9 visualizes the few burn events of the *Tether USD* contract and shows that the largest token-burn took place on 26 September 2019, when a total of 884,664 USDT were destroyed from `address(0)`. This is possible because the contract code of Tether enables the *owner* of the contract, which is the *Bitfinex Multisig* account, to burn tokens from every address, as long as it is blacklisted, which is again a decision determined by the contract’s *owner*. Blacklisted accounts are then no longer able to execute the contract’s functions. Users of the USDT token are unable to mint, burn or redeem tokens on their own and thus cannot influence the circulating supply of the asset. By code, only the *owner* of the *Tether USD* contract is allowed to execute supply-controlling functions such as mint, burn and redeem, which results in a highly centralized distribution of responsibility and power within the *Tether USD* ecosystem. Apart the above functions, the *owner* is exclusively authorised to introduce fees to the Tether contract. The Bitfinex Multisig account could do so by executing the *setParams* function and providing two unsigned integers as input to determine both the fees as a percentage of the transfer amount and the maximum fee, while the total charge cannot be increased above 0.002 % of the transfer value and also the maximum transfer fee is hard-coded to never exceed 50 USDT. Furthermore, it is incumbent upon the *owner* to *pause* and *unpause* the contract in order to initiate emergency shutdowns in which every balance is immediately frozen and transfers cannot be further processed. Finally, if the *owner* calls the *deprecate* function, he will do so by providing an address as input, whereupon the original contract at address ***0xdAC...*** is replaced by forwarding each incoming call to the new address specified by the *owner*. This shows that although the Tether contract was created at a very early stage, it does not lack of opportunities to introduce fees or even upgrade itself.

Figure 7: Token Mints

The token mints of *USDT* compared to *USDC*, *DAI*, *PAX*, *TUSD*, *BUSD* and *HUSD*. The x-axis represents time and respectively ranges from the day, the first issue event appeared until June 30th, 2020. The y-axis shows the amount of minted tokens.

Very different figures can be observed for *DAI Stablecoin*, which is the youngest contract analysed and at the same time represents the one with the most fluctuations in its circulating supply. In total, the DAI token contract counts 318,087 transfers from or to address(0), accounting for 90.3 % of the total mint and burn events in the whole data set. A total of 1,397,176,190 DAI tokens were created and distributed to 35,150 different accounts and on the other hand, 1,290,599,447 tokens got burned from 15,471 unique addresses. This corresponds to a burn/mint ratio of 92.4 %, which can be interpreted as 92.4 % of the generated DAI tokens were either burned to settle a loan or deposited into the DSR contract. The remaining 7.6 % constitute the ‘official’ circulating supply, excluding the DAI tokens locked in the DSR contract. An explanation for the high numbers in token-burns is the opportunity for DAI holders to lock their tokens into the DSR contract wherein they get burned. Consequently, when users want to unlock their funds, DAI tokens are freshly minted and sent to them. This feature is an important distinction to the other Stablecoins and has a dramatic effect on the token’s circulating supply. Additionally, DAI gets minted from address(0), when a user sends a collateral such as Ether, USDT or USDC to a *Maker Vault*⁶², which is a contract within the MakerDAO ecosystem that facilitates the generation of DAI in exchange for a security deposit. This process is designed

⁶² *Maker: MCD Join ETH A* Address: 0x2F0b23f53734252Bda2277357e97e1517d6B042A see community-development.makerdao.com/makerdao-mcd-faqs/faqs/vault for further information about Vaults [Last accessed 20 Aug 2020]

to work fully decentralized, which means that everyone who locks an approved collateral in the contract will receive DAI tokens in exchange. Consequently, the circulating supply of DAI is entirely in the hands of its users and no central entity determines whether or not the supply shall be increased. As a corollary, the DAI ecosystem cannot be split into a primary and secondary market, resulting in much lower average mints and burns as shown in Table 6. Finally, adding a temporal dimension as done in Figure 7 and 9, a peak during the already discussed Covid-19 crash can be observed: More precisely, on 12 March the number of newly minted tokens reached 50,010,514 DAI that were issued to 1,395 different accounts, representing an increase of 826.8 % in minted tokens compared to the average daily issue volume. On the burn-side, a total of 49,257,316 DAI were destroyed, accounting for an increase of 881.6 % compared to the average number of tokens burned daily, which amounts to 5,587,011 DAI. Delving deeper into the supply regulation policies of the *DAI Stablecoin* contract, it is deficient to consider only the actual token contract, instead, a network comprising several interacting Smart Contracts must be analyzed in order to obtain a holistic picture. To begin with, there is only one account capable of directly minting DAI tokens. By “directly” is meant that there are no further contracts in between the actual *Minter*, which is the account that finally executes the mint function, and the token contract. The account authorized to do so can be found at address **0x975...**⁶³ and is officially labeled with *Maker: MCD Join DAI*. This account represents a contract and is able to access certain restricted functions within the *DAI Stablecoin* contract. The mint function is one such restricted method inside the *DAI Stablecoin* contract and will be called, if a user executes the *exit* function of the *Maker: MCD Join DAI* contract. The *exit* function allows users to “exit” DAI tokens out of the Maker system and can be addressed directly by the user or via a *DSS Proxy* contract, which is a convenient solution in the form of a Smart Contract that can be used to interact with the Maker Protocol.⁶⁴ On the other hand, the user can target a function named *join*, which consequently leads to the burning of DAI tokens. This process, as an excerpt from a much more complex picture, is illustrated in Figure 8. The system is fully decentral-

⁶³*Maker: MCD Join DAI* Address: 0x9759A6Ac90977b93B58547b4A71c78317f391A28

⁶⁴see docs.makerdao.com/smart-contract-modules/proxy-module [Last accessed 10 Sep 2020]

ized, with no restrictions such as KYC procedures to receive freshly minted DAI tokens in exchange for depositing a security. Finally, the *Maker: MCD Join DAI* contract can be summarized as an interface to regulate the circulating supply of tokens and for the sake of completeness, there is the theoretical possibility for users to directly call the burn function within the actual token contract, which would not make any sense. Remarkably, the DAI contract also contains a func-

Figure 8: MakerDAO Contract Diagram

Visualization of the contracts and their respective functions that impact the circulating supply of DAI tokens, without including the DSR. The Join/Exit functions are used to repay/withdraw DAI that is backed by a staked collateral. The *DAI* contract in the diagram represents the actual *DAI Stablecoin* token contract.

Source: Based on docs.makerdao.com/ [Last accessed 10 Sep 2020]

tion called *cage*, which can inhibit the creation of DAI tokens. Only authorized accounts can execute this function and by code the last account involved in the deployment of the *Maker: MCD Join DAI* contract has been directly authorized and is therefore able to successfully target and execute the *cage* function. This account can be found at address **0x64a...**⁶⁵ and represents a contract. Finally, the DAI token contract is not upgradable as it does not provide any mechanism that could forward incoming commands.

Proceeding with the *USD Coin* contract, an in-depth analysis reveals that a total of 2,645,276,542 tokens were issued to three different addresses, namely **0x55F...**⁶⁶, **0x28C...**⁶⁷ and **0x895...**⁶⁸ On the other hand, 1,659,736,363 tokens were burned from the addresses **0xe7a...**⁶⁹ (1,659,736,144 tokens),

⁶⁵ Address: 0x64a84e558192dd025F3A96775FEE8FB530f27177

⁶⁶ Address: 0x55FE002aefF02F77364de339a1292923A15844B8

⁶⁷ Address: 0x28C5B0445d0728bc25f143f8EbA5C5539fAe151A

⁶⁸ Address: 0x895F07957B863f4AB6086035a6990d8366Bc3266

⁶⁹ Address: 0xe7ab0dD2A069FA115c0D7878AF6FD95bA0F9100a

Figure 9: Token Burns

The token-burns of *USDT* compared to *USDC*, *DAI*, *PAX*, *TUSD*, *BUSD* and *HUSD*. The x-axis represents time and respectively ranges from the day, the first burn event appeared until June 30th, 2020. The y-axis shows the amount of burned/destroyed tokens.

0x24B...⁷⁰ (200 tokens) and **0xd4C...**⁷¹ (18.34 tokens), corresponding to a burn/mint ratio of 62 %. Summarizing the figures, *USDC*'s issuing policy appears to be very centralized and the figures seen revealed a situation wherein two accounts have been responsible for regulating the vast bulk of the asset's circulating supply. Moreover, the token contract lacks possibilities for the end user to mine and burn tokens independently. An examination of the code revealed no possibilities for specific entities to burn foreign tokens from other addresses, as seen in Tether, however, the contract keeps track of so called *Minters*, which are accounts authorized to mint and burn tokens. By executing the contract's *burn* function, *Minters* are privileged to destroy their own tokens and consequently reduce the circulating supply. The determination of such *Minters* is up to the so called *MasterMinter* that is currently attached to the address **0xE98...**⁷² In addition, there exists another role with a special purpose in the *USDC* ecosystem, namely the *Blacklister*, which is assigned to the account at address **0x5dB...**⁷³ By calling the *blacklist* function, the *Blacklister* is able to freeze the balance of every other account, thus preventing the execution of transfers. The *owner* of the *USDC* contract, which is an EOA at address **0xFcb...**⁷⁴, is entitled to assign the roles *MasterMinter* and *Blacklister* to specific accounts

⁷⁰ Address: 0x24BDd8771b08C2EA6FE0e898126e65BD49021BE3

⁷¹ Address: 0xd4C1315948125Cd20C11C5E9565a3632C1710055

⁷² MasterMinter Address: 0xE982615d461DD5cD06575BbeA87624fda4e3de17

⁷³ Blacklister Address: 0x5dB0115f3B72d19cEa34dD697cf412Ff86dc7E1b

⁷⁴ *USDC* Owner Address: 0xFcb19e6a322b27c06842A71e8c725399f049AE3a

and consequently represents the most powerful account within the USDC ecosystem. Finally, the token contract is upgradable as it features a proxy contract solution, which means that the contract at address **0xA0b...** points to another account that is located at address **0x088...**⁷⁵ and provides the actual functions the token contract needs. By changing the target address within the proxy contract, upgrades could be implemented, but until July 1st, the contract has never been upgraded and basically only the account privileged with the *Admin* role inside the proxy contract would be able to do so. By July '20, the EOA acting as the *Admin* can be found at address **0x807...**⁷⁶

Continuing with the token contract of *TrueUSD*, the figures shown in Table 6 are quite similar to the ones seen at USDC. Nevertheless, the emission- and distribution policy appears to be more decentralized compared to *USD Coin*: A total of 1,066,112,357 tokens were minted to 793 different accounts, while on the other side, 926,210,674 tokens got burned from 483 unique addresses. This implies that 86.9 % of the minted tokens have already been burned again. Remarkably, the contract code allows anyone to burn their own tokens by addressing the contract's burn function, however, the mint function can only be invoked by the *owner* of the contract, which is the contract at address **0x000...cc9**⁷⁷, publicly known as *TrueUSD: Token Controller*. In addition, the *owner* is entitled to blacklist accounts and burn tokens from third party addresses. This was implemented with a function named *wipeBlacklistedAccount*, which sets the balance of a blacklisted address to zero. The said indicates that power is very centrally distributed within the *TrueUSD* contract, as there is only one address with access to several important functions, including those affecting the circulating supply. Nevertheless, the relatively large number of unique accounts to which TUSD was minted to may suggest that *TrustToken* distributes freshly embossed tokens directly(!) to customer accounts whenever fiat money is deposited into an escrow account. Similar to the USDC contract, *TrueUSD* was implemented via a proxy contract that retrieves its functions from the contract at address **0x205...**⁷⁸, but unlike USDC, TUSD has already been upgraded 13 times.⁷⁹

⁷⁵ Address: 0x0882477e7895bdC5cea7cB1552ed914aB157Fe56

⁷⁷ *TrueUSD: Token Controller* Address: 0x0000000000075EfBeE23fe2de1bd0b7690883cc9

⁷⁸ Address: 0x20594f0B1F549D19B5DD81590d93Bd131c657e01

⁷⁹ see Appendix 3 for the transactions hashes of the upgrades

Proceeding with *Paxos Standard* and *Binance USD*, in total 1,733,264,062 and 771,988,400 tokens were issued to two, respectively one account. For PAX, the account at address **0x519...**⁸⁰ was mainly used to distribute freshly minted tokens. With one exception in October 2018, when address **0xcba...**⁸¹ became the new distribution channel, address **0x519...** always acted as the supply-controlling account. The *Binance USD* tokens were minted to the account at address **0x519...** too and were then further distributed. On the burn-side, 1,492,140,815 PAX tokens were burned from the same two accounts to which the tokens were originally issued. For *Binance USD*, 596,789,972 tokens were burned from address **0x519...**, which has also already been used for emissions. The examination of the Solidity code of both tokens leads to the conclusion that their basic features are exactly the same: Both contracts do not provide any possibility for users to mine and burn tokens themselves independently, however, each of them has a *SupplyController*, which is a role capable of creating new tokens and destroying its own. Additionally, the *SupplyController* is responsible for the further distribution of the minted tokens since every created token is directly issued to the account behind this role, dividing the ecosystem into a primary and secondary market. As of July 1st, this role is granted to the account at address **0x519...** for both Paxos and Binance USD, which implies that a single account controls the entire supply of two individual Stablecoins. In addition, within both contracts the *AssetProtectionRole* can be assigned to an account, empowering it to *freeze* and burn third party funds. For Paxos, the account behind the *AssetProtectionRole* can be found at address **0x87f...**⁸² and for BUSD, it is the account at address **0xb87...**⁸³. The latter account simultaneously acts as the *owner* of both contracts and is thus responsible for the allocation of the discussed roles. This indicates that both Stablecoins, *Paxos Standard* and *Binance USD*, follow a highly centralized approach, firstly because users cannot directly interact with the contract to mint and burn tokens and secondly, the possibility for specific accounts to burn third party tokens implies a massive power imbalance between participants inside the ecosystem. In addition, both Stablecoins

⁸⁰ Address: 0x5195427ca88DF768c298721dA791B93AD11ECa65

⁸¹ Address: 0xcba1766e19f32d79E3BA7A2764f04a7042324F0A

⁸² AssetProtectionRole Address: 0x87f1aA3037AE65E141cd895dCa066dB872a94e95

⁸³ AssetProtectionRole Address: 0xb87cec7BaA2ce4a055F8563e9cC5a210CeDC329F

share a very close organisational relationship, as often the same accounts have access to fundamental functions within both contracts. Finally to complete, both tokens were implemented via proxies similar to *USD Coin* and *TrueUSD* and are therefore upgradeable.

The last Stablecoin analyzed, HUSD, counts a total of 1,540,511,785 tokens that were issued to 129 different addresses. On the burn-side, more than 92.5 % of the minted tokens have already been burned again, representing the highest burn/mint ratio among all token contracts analyzed. In total, 1,425,973,065 tokens were burned from 75 accounts. Furthermore, the HUSD contract counts 10,590 mint and burn events, accounting for 22.3 % of its total number of events (mints, burns and transfers), which is again the highest value observed among all Stablecoins analyzed. Even *DAI Stablecoin*, where the mints and burns account for 10.7 % of the total events, lags behind HUSD. This indicates that, in contrast to the other tokens, the functions influencing the circulating supply were called relatively often, while only a few transfer events were emitted (36,821 transfers). Finally, an examination of HUSD's Solidity code revealed several roles inside its ecosystem: The issue- and redeem functions are reserved for the account assigned to the *CoinFactoryAdmin* role. The functions used to add and remove accounts to and from the blacklist are within the scope of action of the *BlacklistAdmin* role. Notably, neither the *BlacklistAdmin* nor the *owner* are capable of burning third party tokens, however, the account behind the *CoinFactoryAdmin* role could exploit the *redeem* function to burn from third party addresses. Finally, there remains the *Pauser* role, which entitles accounts to pause the contract and thereby prevent any further activity. All the mentioned roles are allocated by the *owner*, representing a role that can only be assigned to a single account inside the HUSD contract, while the other roles can be granted to multiple accounts. As of July 1st, the ownership of the contract belongs to the Multisignature contract at address **0x2Bd...**⁸⁴ and as far as the *CoinFactoryAdmin* role is concerned, two EOAs, which can be found at the addresses **0xcA1...**⁸⁵ and **0xc2F...**⁸⁶, are privileged to issue and redeem tokens.

⁸⁴ *HUSD owner* Address: 0x2Bd9caa19a724608BeF32dD3C10c0fd1f70B309D

⁸⁵ *CoinFactoryAdmin* Address: 0xcA13054592cfEf49Cf345800ad276c879919691e

⁸⁶ *CoinFactoryAdmin* Address: 0xc2FbF9b9084e92f9649Ca4CeC9043DaAc9092539

Table 7 below concludes the analysis of the contracts’ circulating supplies and their specific contract-internal peculiarities and provides a recapitulatory representation of the said:

	mint	burn	burn/freeze 3rd party	upgradeability
USDT	owner	owner	owner	✓
USDC	minters	minters	Blacklister	✓
DAI	<i>anyone</i>	<i>anyone</i>	-	✗
PAX	SupplyController	SupplyController	AssetProtectionRole	✓
TUSD	owner	<i>anyone</i>	owner	✓
BUSD	SupplyController	SupplyController	AssetProtectionRole	✓
HUSD	CoinFactoryAdmin	CoinFactoryAdmin	CoinFactoryAdmin	✗

Table 7: Supply-Controlling Roles

Itemization of the supply-controlling roles within the token ecosystems and each contract’s upgradability; each role was implemented through Solidity’s *function modifiers*⁸⁷

4.2 Accounts and Balances

The following section focuses on specific identities within both the Ethereum-based Stablecoin landscape and the individual token networks. In an attempt to gain insightful information on the distribution of wealth, real-life entities were linked to on-chain identities and basic account-related information was depicted in charts and tables. The first part of this section deals with descriptive statistics on the analysed Stablecoins and outlines both similarities and contrasts between the individual tokens. Through the accumulation of balances based on real-life entities, it was possible to determine realistic shares of certain entities in the overall Stablecoin market. This consequently led to the identification of several ‘High Rollers’, which were further examined in the last part of this section.

4.2.1 Stablecoin Ecosystem

To begin with, the whole data set includes 8,372,918 different accounts and as of July 1st, 1,842,166 (some 22 %) of them have a positive balance, which means that they own at least $1/10^{18}$ of an US-Dollar in Stablecoins. The mean balance of the positive addresses is 4,235 dollars in Stablecoins with a standard deviation

⁸⁷see solidity.readthedocs.io/en/v0.4.24/contracts.html

of 542,735 tokens. The median balance amounts to five tokens, and even the 75th percentile address (Q_3), with a balance of 68 tokens, is well below the mean, which indicates a heavily right-skewed distribution of wealth: In numerical terms, the Stablecoin ecosystem contains 775,459 accounts (some 42 %) possessing equal or less than one dollar in tokens. Summing up the balances of these accounts, a total

	accounts	cum. balance in millions
Top 10 %	184,217	7,755 (99.42 %)
Top 5 %	92,108	7,715 (98.91 %)
Top 1 %	18,422	7,482 (95.92 %)
Top 0.1 %	1,842	6,356 (81.48 %)
Top 0.01 %	184	4,325 (55.45 %)

Table 8: Stablecoin Wealth Distribution
The cumulative balance of the richest accounts within the Stablecoin ecosystem.

of 193,561 token are spread over almost 780,000 addresses as fractions of a dollar. In addition, 22.4 % of all positive accounts have a balance in Stablecoins smaller than 0.01 dollar. These 402,217 accounts accumulate funds worth around 246.46 dollars, which equals 0.00000316 % of the entire Stablecoin supply. On the other hand, 845 accounts in the analyzed ecosystem own more than a million dollar in Stablecoins. These accounts represent 0.04 % of the total number of positive accounts, but control 5,720,399,093 tokens, accounting for 73.3 % of the entire Stablecoin supply analyzed. Based on the above, the distribution of wealth among the positive accounts within the Ethereum-based Stablecoin ecosystem can be described as extremely unequal. This finding is further stressed in Table 8, which states that the wealthiest 1 % posses almost 96 % of the total Stablecoin supply, while the richest 0.01 %, represented by 184 accounts, own more Stablecoins than the rest, 1,841,983 different accounts in total. In summary, the contrast between accounts with balances even smaller than the average transaction fee and those that are millionaires contributed to a strongly positive-skewed distribution of wealth, while the large number of possible decimal places further reinforced the skewness. Finally, the largest balance in the data set (some 400 Mio.) is about 4×10^{26} times larger than the smallest one ($1/10^{18}$).

Remarkably, the whole data contains only eleven accounts that own all seven Stablecoins analyzed. Their addresses are listed in Appendix 4 and the labeled

ones are all decentralized exchanges, namely *EtherDelta*, *Bitcratic* and finally *dForce*, which represents a DEX that offers Stablecoin-asset swaps.⁸⁸ Merely 1.33 % (19,703) of the accounts with a positive USDT balance own at least one other Stablecoin. This figure is very different to those observable for USDC, PAX and DAI where 8.85 %, 9.44 % and 9.89 % of the accounts possess at least two different Stablecoins. For TUSD, this percentage is even higher at 22.73 % and only surpassed by HUSD and BUSD, whose tokens are held together with other Stablecoins in 33.66 % and 54.92 % of the cases.

	Total Addr.*	Positive Addr.*	> 10 \$ Addr.*	Mean	Std*	Min	25%	50%	75%	Max**
USDT	6,300	1,477	722	4,088	512	1e-6	0.03	10	75	400
USDC	779	177	41	5,552	529	1e-6	0.05	1	9	204
PAX	1,030	86	33	2,804	363	1e-18	0.13	5	45	104
TUSD	145	30	12	4,735	133	1e-18	0.05	3	100	16
DAI	250	100	35	1,064	38	1e-18	0.08	2	40	5
BUSD	10	5	2	33,796	1,174	1e-18	1.00	1	100	73
HUSD	4	1	.8	81,003	2,938	1e-8	3.58	13	56	111

Table 9: Accounts Analysis

Descriptive Statistics of the largest Ethereum-based Stablecoins and their token holders as of July 1st. The columns on the left side represent the number of unique addresses while on the right-side basic statistics are calculated to describe the distribution of the balances. The column ‘> 10 \$ Addr.’ shows the number of accounts with a balance larger than 10 dollar.

*in thousands **in millions

Focusing on the individual tokens that have been statistically examined in Table 9, Tether is by far the most widespread Stablecoin. Four out of five positive accounts in the data set own at least 0.000001 USDT, which stresses the already highlighted broad acceptance of Tether within the Ethereum-based Stablecoin market. In total, 721,859 addresses possess more than 10 dollars in USDT, and the wealthiest account, which is deeply analyzed in the following subsection, owns 400 million USDT tokens. In contrast, the DAI token shows unusually small numbers comparing the mean balances and the standard deviations. This is due to the distinctive issuing policy of the DAI Stablecoin, which does not require a centralized distribution of tokens to specific accounts such as centralized exchanges, who then spread them. The above discussed unilateral distributions of BUSD and HUSD in favor of the issuing exchanges Binance and Huobi, who own 75.7 % and 97 % of the token supplies, in combination with the remarkably high mean balances

⁸⁸see trade.dforce.network/ [Last accessed 5 Sep 2020]

shown in Table 9, supports the hypothesis made, claiming that these tokens are more likely transferred ‘internally’ within the exchanges’ internal databases to avoid transaction fees. The reason behind the fact that there are more individual accounts that have already possessed PAX than USDC and even four times more compared to DAI, while their numbers of accounts with a balance over 10 dollars are quite similar, remains open. Assuming that the number of real-life entities within each ecosystem is the same, PAX holders would have to use more accounts per person, which could indicate that certain entities circulate their tokens between various accounts. Such strategies are often applied by scammers to blur their tracks and as mentioned above, *Paxos Standard* has been heavily compromised by fraudsters. Consequently, the finding above could be explained by scammers who put their tokens into circulation for tactical reasons, however, further research into the on-chain activities of suspicious accounts belonging to *MMM BSC* would be necessary to confirm this hypothesis.

4.2.2 Entity Identification

As highlighted above, the Stablecoin market contains several outlier accounts that are responsible for heavily right-skewed distributions of wealth within both the whole Stablecoin landscape and the individual token ecosystems. Figure 10 shows an extract of 26,332 accounts and displays information about the activity of each account and its balance. This was accomplished by drawing the number of transfers an address received against the number of transfers initiated by the same address. Finally the dot-size is related to each account’s balance. It can be seen that the wealthiest accounts, which are the labeled ones, are spread over both axis, which indicates that high-balance accounts might be used for distinct purposes and as a consequence, either a very high to moderate number of in- and outgoing transfers is observable, or the opposite occurs. Furthermore, without conducting a correlation analysis, a linear relationship between the number of in- and outgoing transfers can be assumed.

The account with the largest share of Stablecoins can be found at address ***0x7b8...***⁸⁹ and has a balance of around 400 million dollars. Although this account is not

⁸⁹ *Huobi* Address: 0x7b8c69a0f660cD43ef67948976daaE77BC6A019B

Figure 10: Balances & Activity

The wealthiest 26,332 accounts, which have a unique combination of in- and outgoing transfers, plotted on a logarithmic scale. The size of the dots indicates the amount of tokens the account owns. The ten largest dots are labeled. The x-axis shows the number of out-going transfers (account is the *sender*) and the y-axis represents the number of in-going transfers (account is the *recipient*).

publicly labeled on Etherscan, the transfer history suggests that it belongs to the cryptocurrency exchange Huobi and acts as a Tether treasury for the company: Between the 15th and 20th of May 2020, a total of four ‘tranches’ with respectively 100 million USDT tokens were transmitted from the address **0x674...**⁹⁰, which publicly belongs to Huobi, to **0x7b8...** and each tranche consisted of five transfers: First, a test transfer of one USDT, followed by 24,999,999 tokens and finally 75 million tokens split into three transfers. This whole procedure is further described in Appendix 5, in which the transaction hashes of the transfers in discussion are listed. As of July 1st, address **0x7b8...** received a total of 26 transfers and once sent one USDT token to itself, which represents the only token transfer from this account. In addition to the above investigation, the *Tether Rich List*⁹¹, which is officially maintained by Tether Limited, confirms that the exchange Huobi is the entity behind the account in discussion, which holds the largest share (some 6.6 %) of the entire Tether supply on Ethereum, as illus-

⁹⁰ Huobi 2 Address: 0x6748F50f686bfbcA6Fe8ad62b22228b87F31ff2b

⁹¹ see wallet.tether.to/richlist [Last accessed 19 Jul 2020]

trated in Figure 11. Moreover, the addresses **0x674...** and **0xfdb...**⁹², which are labeled with *Huobi 2* and *Huobi 3*, represent the 4th and 5th wealthiest identities within the Stablecoin ecosystem and the 3rd and 4th largest token holders amidst the USDT community. Finally, the account with the 6th largest Stablecoin balance, located at address **0x106...**⁹³ and labeled as *Huobi 9*, controls 110,481,722 HUSD and 1,845,258 USDT tokens, which equals around 96.5 % of the entire HUSD supply. The latter mentioned accounts at the addresses **0x674...**, **0xfdb...**, **0x106...** count about one million in- and outgoing transfers and are in 2nd, 3rd and 4th position in this category, which encourages the fact that Huobi plays a major role in the Ethereum-based Stablecoin ecosystem. The cumulative balance of all accounts that were identified belonging to Huobi (see Appendix 6) accounts for 11.5 % of the total Stablecoin supply in the analyzed ecosystem and expressed in figures, the exchange holds 897,573,359 dollars in Ethereum-based Stablecoins. Incorporating Huobi's accounts⁹⁴ on the Omni Layer protocol, which have been published on wallet.tether.to/richlist, as of July 1st, another 189,070,747 dollars may be added to the companies balance sheet. As a result, Huobi owns 1,086,644,106 dollars in Stablecoins, whereby 82.5 % are Ethereum-based assets, and consequently represents a billionaire of Stablecoins. Especially within the Tether and HUSD ecosystems, Huobi is in a very dominant position with control over 12.7 % of the supply of the largest Ethereum-based Stablecoin and 97 % of its own token. Finally, around every 10th Stablecoin is owned by Huobi, underpinning the company's supremacy.

The 2nd largest account identified in the Ethereum-based Stablecoin ecosystem can be found at address **0xBE0...**⁹⁵, is labeled as *Binance 7* and thus belongs to the cryptocurrency exchange Binance. The account pools together many tokens, including Tether, USD Coin and Binance USD and its Stablecoin balance of around 390,111,090 tokens consists of 301,118,650 USDT -, 15,590,718 USDC - and finally 73,401,722 BUSD tokens, which constitutes 41.9 % of the entire BUSD supply, as visualized in Figure 11. Moreover, the exchange controls

⁹² *Huobi 3* Address: 0xfdb16996831753d5331ff813c29a93c76834A0AD

⁹³ *Huobi 9* Address: 0x1062a747393198f70F71ec65A582423Dba7E5Ab3

⁹⁴ see omniexplorer.info/search/35hK24tcLEWcgNA4JxpvbkNkoAcDGqQPSP and omniexplorer.info/search/1HckjUpRGcrrRatFaaCAUaGjsPx9oYmLaZ [Last accessed 1 Jul 2020]

⁹⁵ *Binance 7* Address: 0xBE0eB53F46cd790Cd13851d5EFf43D12404d33E8

	Entity	USDT	USDC	DAI	PAX	BUSD	TUSD	HUSD	Σ
0x7b8	Huobi	400.00	-	-	-	-	-	-	400.00
0xBE0	Binance	301.12	15.59	-	-	73.40	-	-	390.11
0x39A	Compound	-	204.07	-	-	-	-	-	204.07
0x674	Huobi	198.61	-	-	-	-	-	0.31	198.92
0xfdb	Huobi	152.46	-	-	-	-	-	-	152.46
0x575	-	139.29	-	-	-	-	-	-	139.29
0x106	Huobi	1.85	-	-	-	-	-	110.48	112.33
0x3f5	Binance	48.90	18.12	-	5.94	22.59	12.50	-	108.05
0xE62	-	-	-	-	103.64	-	-	-	103.64
0x742	Bitfinex	99.10	0.12	-	-	-	-	-	99.22
0xF97	Binance	-	30.00	-	17.30	30.00	16.00	-	93.30
0x504	-	58.99	1.10	-	1.59	-	0.40	-	62.08
0x66f	Bittrex	52.00	-	-	-	-	-	-	52.00
0xf65	Compound	50.34	-	-	-	-	-	-	50.34
0x876	Bitfinex	47.87	1.42	0.85	0.08	-	0.11	-	50.32
0xd30	-	45.75	0.27	-	0.04	-	0.14	-	46.19
0x92d	-	-	43.19	-	-	-	-	-	43.19
0x778	-	40.20	-	-	-	-	-	-	40.20
0x8ce	-	-	40.00	-	-	-	-	-	40.00
0x570	-	34.65	-	-	-	-	-	-	34.65
Σ		1,671.11	353.88	0.85	128.59	125.99	29.14	110.79	2,420

Table 10: Stablecoin Rich List

The 20 wealthiest accounts in the Ethereum-based Stablecoin ecosystem and their respective token balance in millions. The entities behind the addresses were identified through the *Label World Cloud*⁹⁷ provided by Etherscan, except for **0x7b8...**, where wallet.tether.to/richlist was used as source.

the 8th richest account identified in the data set, located at address **0x3f5...**⁹⁶ This account owns all analyzed Stablecoins except HUSD and DAI and as illustrated in Table 10, USDT represents the largest fraction of the address' balance, followed by more than 22.5 million BUSD tokens, constituting 12.9 % of the total BUSD supply. Additionally, as depicted in Figure 10, **0x3f5...** records the largest number of transfers: A total of 1,519,422 transfers have been sent and received by this account. Cumulating the balances of all known accounts that are officially controlled by Binance (see Appendix 6), a total of 642,624,504 dollars in Ethereum-based Stablecoins can be attributed to the company's balance sheet, which accounts for 8.2 % of the entire Stablecoin supply analyzed. Similar to what has already been observed for the HUSD token, the distribution of the company-owned Stablecoin *Binance USD* heavily centralises around its issuing company, as 75.7 % of the total BUSD supply is controlled by accounts

⁹⁶ *Binance* Address: 0x3f5CE5FBFe3E9af3971dD833D26bA9b5C936f0bE

belonging to Binance. Adding the Omni Layer Tether funds⁹⁸, which account for 112,413,357 dollars, the exchange’s balance equals 755,037,861 dollars. As of

Figure 11: Token Distribution

The distribution of tokens of the respective Stablecoins. For USDT, USDC, DAI, PAX and TUSD, the pie charts show the 42 largest accounts. For BUSD and HUSD only twelve addresses are shown.

July 1st, only by adding Binance’s Tether balance issued on Tron⁹⁹ and thereby incorporating a third blockchain besides Bitcoin and Ethereum, Binance can call itself a Stablecoin billionaire, as an extra of 257,387,652 Tether on Tron¹⁰⁰ results in a total balance of 1,012,425,513 dollars. Within the individual token ecosystems, the exchange can be described as a ‘High Roller’ too: For example, its account at address **0xF97...**¹⁰¹ is among the 20 richest ones as illustrated in Table 10 and represents the 2nd largest PAX holder throughout the entire PAX ecosystem. Furthermore, **0xF97...** is the wealthiest account regarding TUSD tokens, closely followed by the 2nd richest account in the *TrueUSD* ecosystem, address **0x3f5...**, which belongs to Binance too. Summarizing, the crypto-exchange Binance is definitely a major stakeholder within Ethereum’s Stablecoin landscape and managed it to exert far-reaching influence on various tokens, including the Stablecoins USDT, BUSD, PAX and TUSD.

The 3rd wealthiest account with the address **0x39A...**¹⁰² refers to the label *Compound USD Coin* and represents the USDC treasury of the DeFi provider *Compound Labs, Inc*¹⁰³. It has a wealth of 204,069,453 dollars in the form

⁹⁸see omniexplorer.info/search/1FoWyxwPXuj4C6abqwhjDWdz6D4PZgYRjA [Last accessed 1 Jul 2020]

⁹⁹see wallet.tether.to/richlist [Last accessed 19 Jul 2020]

¹⁰⁰see tronscan.org/#/address/TWd4WrZ9wn84f5x1hZhL4DHvk738ns5jwb [Last accessed 1 Jul 2020]

¹⁰¹Binance 8 Address: 0xF977814e90dA44bFA03b6295A0616a897441aceC

¹⁰²Compound USD Coin Address: 0x39AA39c021dfbaE8faC545936693aC917d5E7563

¹⁰³see compound.finance/ [Last accessed 19 Jul 2020]

of USDC tokens and holds the largest share of these tokens within the entire ecosystem. In total, **0x39A...** controls 20.7 % of the total USDC supply, which is depicted in Figure 11. Notably, Compound represents the only entity among the richest accounts identified in Table 10, which is not an exchange. Additionally, the number of transfers distinguishes the address in discussion from the largest two accounts at the addresses **0x7b8...** and **0xBE0...**: Compound's account at address **0x39A...** counts a total of 88,470 transfers, which is illustrated in Figure 10, and hence has been much more active than the wealthiest accounts of Huobi and Binance. The 2nd richest account that belongs to Compound can be found at address **0xf65...**¹⁰⁴, owns around 50 million USDT tokens and represents the Tether treasury of the company. Summarizing, Compound Labs represents the largest DeFi provider listed on Etherscan, is a fairly prominent player within the Tether ecosystem and in particular the company's supremacy in USDC tokens is truly remarkable.

Finally, although every single USDT token passed through accounts of Bitfinex at least once, the exchange with its identified accounts represents only the third largest Tether holder behind Huobi and Binance and with a cumulated balance of 287,133,110 dollars in USDT, Bitfinex controls around 4.75 % of the Ethereum-based Tether supply.

In conclusion, for every token analyzed except DAI, the exchanges Huobi and Binance were among the most wealthiest users. In contrast, the three richest and labeled accounts in the DAI ecosystem belong to the decentralized exchanges *dYdX*¹⁰⁵, *Curve.fi*¹⁰⁶ and *Uniswap*¹⁰⁷, whereas the identified accounts belonging to Huobi and Binance accumulate DAI balances of 0 and 7 DAI and thereby do not play any role in the decentralized Stablecoin market. Lastly, the wealthiest account within every individual token ecosystem made it among the 20 richest addresses illustrated in Table 10, except for *DAI Stablecoin*. The above-mentioned account of the decentralized exchange dYdX with a balance of 4,793,577 DAI and 7,026,340 USDC tokens represents the richest DAI holder, however, is only

¹⁰⁴ *Compound Tether* Address: 0xf650C3d88D12dB855b8bf7D11Be6C55A4e07dCC9

¹⁰⁵ *dYdX: Solo Margin* Address: 0x1e0447b19bb6ecfdae1e4ae1694b0c3659614e4e

¹⁰⁶ *Curve.fi: sUSD v2 Swap* Address: 0xa5407eae9ba41422680e2e00537571bcc53efbfd

¹⁰⁷ *Uniswap V2: DAI 2* Address: 0xa478c2975ab1ea89e8196811f51a7b7ade33eb11

the 83rd wealthiest account throughout the Stablecoin ecosystem and thus lags far behind in the *Stablecoin Rich List* depicted in Table 10. Remarkably, the crypto-exchanges Huobi and Binance together control almost 20 % of the entire Stablecoin supply on Ethereum.

5 Conclusion

The aim of this thesis was to provide a statistical description of the largest Ethereum-based Stablecoins, their events and the accounts within their ecosystems. Stablecoins have been an essential component of the DeFi evolution, are continuing to grow in importance and observing the soaring circulating supplies, I can deduce that acceptance has already been quite high, but is still increasing. By breaking down events to a very low-level, a deeper understanding of the EVM was obtained, which was crucial for the data collection step to avoid too many transactions being filtered as false negative. The empirical part integrated around 49 million events with more than 440 million observations, ranging from November '17 to July '20 and thus covering the entire life span of all major Ethereum-based Stablecoins. First, the visualization of transfers and the market shares plotted over time clearly underlined Tether's dominance within the market. Subsequently, it was possible to confirm the finding by Le Calvez (2018), claiming that fraudsters heavily infiltrated the *Paxos Standard* ecosystem. Moreover, I could link the Covid-19 related crypto-crash to unusual high traffic inside the token networks of Stablecoins that are primarily used on decentralized exchanges. Additionally, the impact of DeFi on the gas fees was examined in detail and without delving deeper into correlations, a clear pattern could be observed: While USDT transfers were the cheapest, DAI and USDC transfers costed up to 6.5 and 8 times more in May and June 2020, which was due to the fact that transfers of these tokens often involved several Smart Contracts of decentralized exchanges, all of which require gas to operate their services. Interpreting the said, I come to the conclusion that decentralized tokens like *DAI Stablecoin* or *USD Coin* are much more used in interaction with other contracts and therefore simple transfers are included into transactions that are on average more expensive. This finding suggests that decentralized services are in general more expensive than central-

ized ones and that even on the decentralized Ethereum blockchain, centralisation pays off in economic terms. However, the gains in efficiency are accompanied by losses in decentralization resulting from power imbalances within contracts and therefore contradict the fundamental spirit of Ethereum - decentralising power. This has been further emphasised in the section focusing on the functions that affect the circulating supply: While Stablecoins like Tether demonstrated a very centralised organisation model, wherein a single account controls the circulating supply without constraints, tokens such as USDC, PAX, BUSD and HUSD have already implemented some kind of access management with specific roles responsible for a predefined set of actions. Only *DAI Stablecoin* allows anyone to mint and burn tokens without any third party involvement and therefore constitutes the most liberal contract analysed. The identification of Huobi and Binance as Stablecoin billionaires was accompanied by the fact that wealth is extremely unequally distributed throughout the ecosystem, with centralized exchanges such as Huobi, Binance, Bitfinex and Bittrex hoarding most of the available USDT, PAX, TUSD, BUSD and HUSD tokens in several different accounts, while decentralized Stablecoins like DAI play a negligible role in centralized markets. Ultimately, about every 5th Stablecoin is owned by Huobi or Binance.

Providing an outlook for the future, I argue that the time delta analyzed in this paper only shows the beginnings of the rise of DeFi. Stablecoins have been a crucial component of cryptocurrency markets and in particular the development of on-chain collateralized Stablecoins like DAI represented a milestone for the DeFi movement. Major cryptocurrency exchanges and a handful DeFi providers with their control over huge amounts of Stablecoins might tap new sources of income in the future, as the growing acceptance of DeFi services goes hand in hand with the need for liquidity providers and arbitrageurs. Moreover, exchanges that dispose of their clients' funds may rise to an incredible powerful position because they could exploit their wealth to leverage their influence and even use their customers' governance tokens to intervene in 'political' votes within contracts.

Finally, the Smart Contracts used by companies such as MakerDao, Compound or Uniswap can be publicly reviewed, which opens up many opportunities for further research: Both descriptive and inferential statistics could be applied to

measures such as for example the interest rates within the systems, the spreads on decentralized exchanges, results of governance votes, profits on arbitrage trading or the relationship between the number of transfers and the circulating supply of a token. In particular, Stablecoins backed by a basket of different currencies could carry a lot of economic potential for future applications and open entirely novel fields for research. Furthermore, comprehensive analyses on the governance structure and its impact on the stability of such systems, could be carried out, as almost every activity that occurs inside the token networks is broadcasted as an event. Lastly, the application of different social science theories might shed more light onto internal blockchain activities that are attributable to human decision making and governance processes. For example, a game theoretical approach could be applied to examine inefficiencies within decentralized protocols caused by irrational behaviour of the actors. Such studies might go hand in hand with research into the relationships among participants of blockchain networks and could contribute to a much more holistic and transparent landscape. Moreover, an investigation of the legal compliance of decentralized protocols could be carried out, as there are usually no KYC procedures and nobody except for the pseudonymous governance token holders is able to adjust certain parameters of the protocol.

Ultimately, blockchain data is always complete and has no measurement errors, providing excellent conditions to fruitfully apply data science.

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Appendix

1. Analyzed Contracts

The source codes of the following accounts were analyzed on Etherscan.io to gain a comprehensive overview of the actual technical possibilities of each contract.

0xdAC17F958D2ee523a2206206994597C13D831ec7	Tether USD
0xA0b86991c6218b36c1d19D4a2e9Eb0cE3606eB48	USDC
0x6B175474E89094C44Da98b954EedeAC495271d0F	Dai Stablecoin
0x000000000000085d4780B73119b644AE5ecd22b376	TrueUSD
0x4Fabb145d64652a948d72533023f6E7A623C7C53	Binance USD
0xdF574c24545E5FfEcb9a659c229253D4111d87e1	HUSD
0xC6CDE7C39eB2f0F0095F41570af89eFC2C1Ea828	Bitfinex: MultiSig 2
0x0882477e7895bdC5cea7cB1552ed914aB157Fe56	Proxy for USDC
0x20594f0B1F549D19B5DD81590d93Bd131c657e01	Proxy for TUSD
0x8dd5fbCe2F6a956C3022bA3663759011Dd51e73E	TrueUSD: Legacy Contract
0x2Bd9caa19a724608BeF32dD3C10c0fd1f70B309D	HUSD Multisignature
0x9759A6Ac90977b93B58547b4A71c78317f391A28	Maker: MCD Join DAI
0x197E90f9FAD81970bA7976f33CbD77088E5D7cf7	Maker: MCD Pot
0x35D1b3F3D7966A1DFe207aa4514C12a259A0492B	Maker: MCD Vat

2. DeFi Contracts

The following DeFi applications are responsible of much traffic within the token networks of Dai Stablecoin and USD Coin.

0x00	DSR
0x794e6e91555438afc3ccf1c5076a74f42133d08d	OasisDEX
0x2a1530c4c41db0b0b2bb646cb5eb1a67b7158667	Uniswap: DAI
0x65bf64ff5f51272f729bdcd7acfb00677ced86cd	Kyber: Contract
0x39755357759ce0d7f32dc8dc45414cca409ae24e	Eth2Dai: Old Contract
0x5d3a536e4d6dbd6114cc1ead35777bab948e3643	Compound DAI
0x11111254369792b2ca5d084ab5eea397ca8fa48b	1inch.exchange
0xd152f549545093347a162dce210e7293f1452150	Disperse.app
0x31e085afd48a1d6e51cc193153d625e8f0514c7f	Kyber: Reserve Uniswap
0x97dec872013f6b5fb443861090ad931542878126	Uniswap: USDC
0x39aa39c021dfbae8fac545936693ac917d5e7563	Compound USD Coin
0x9ae49c0d7f8f9ef4b864e004fe86ac8294e20950	Kyber: Old Contract
0x04046027549f739edfd5b2a78efdbaf0f0bf4514	BlockFi
0x65b0bf8ee4947edd2a500d74e50a3d757dc79de0	Nexo: Wallet
0x32a3256a4b15badd4a6e072a03d23404d925a5cf	Celsius Network: Contract
0xaf38668f4719ecf9452dc0300be3f6c83cbf3721	Nuo Network: Kernel Escrow

3. TUSD Upgrade Transactions

The following table lists the transaction hashes of the transactions that included the command to upgrade the TrueUSD proxy contract, however, the upgrade from the *TrueUSD_{legacy}* contract to the proxy contract was carried out with a delegated call and does not represent a upgrade within the proxy contract. As a result, the code of the TrueUSD token is spread over 3 accounts. The first upgrade of the proxy contract took place on 3 January 2019 and the last one on 17 September 2020.

0x1b947f74158a8be613985620e979b706108d699f959b0f04770acde9f84a383f
0x10c46913e9da21b7b6ce6f96f7a717db5f6a316392433428bec4ed0a29f4e9ba
0x695a17a59aad7ce334f24bb2411579c909e6fb4b025ec82ede5cf3be65428b5b
0xf2a616e8364b06e50c47daf0981adb70852c5c7f010657dcd323c6c403ea5741
0x963292c34dc045fcc85092b5175a61773dc76d2de31098f5697777cbf1df412d
0x1f82a568c3bc4d25215c75a88a906419058e072109b4f94e60b3226a55fb2377
0x0ce49183d328daee25c6415142844572c6e0932ab33a2ff1e105821fbbda6cf
0x2f05475a016ad0f910dabc95304968d8c4fe8283dddc2f7bc73cd864b69cdac8
0xc09df83f468932dfc343a723d013a5f030a92a1f7a3a3add8d9daf88dbe31688
0xb9ffc7797bc01e24f5003b44b7e83162c3393ed9da66c0622b735cad4c136dff
0x2fb06a28af05a55489dbcdf2581afa00820472be107bf60fbcf705bd18a41ae2
0xa01f46f5693518da506b08e38b5073cf7cfc60895fa1c9e4114c275db7c24827
0xbe0ee01abff79c4f4106c1924b1541d279501ada8a2a35db4d8ba885b246279a

4. Addresses that own every Stablecoins analyzed

The following addresses were identified to possess all seven Stablecoins analyzed, which are Tether, USD Coin, Paxos Standard, True USD, Binance USD, HUSD and Dai Stablecoin.

Address	Nametag
0x395e0bd2e6f95c66ba427306c9d5774f4b752aea	-
0x8d12a197cb00d4747a1fe03395095ce2a5cc6819	EtherDelta 2
0x3c020e014069df790d4f4e63fd297ba4e1c8e51f	Bitcratic
0x7cd860672c477e4c312cdde6f922c51235caf52d	-
0xd77459d138f27a20ff23e1132c48d6bdbd9d8dea	-
0x41f8d14c9475444f30a80431c68cf24dc9a8369a	-
0xfa453aec042a837e4aebbadab9d4e25b15fad69d	-
0x81f7ef7586c7da8fdb0bb94032f3ad06ae21f644	-
0x9df7c98c933a0cb409606a3a24b1660a70283542	-
0xf67b7969c0e85fdd47a48c9514be53ff10f4dbf1	-
0x03ef3f37856bd08eb47e2de7abc4ddd2c19b60f2	dForce: Swap

5. Huobi address 0x7b8... transactions

The following transaction hashes represent the transactions that were used to fund the wealthiest account in the ecosystem. The first transaction occurred on 15 May 2020 and the last one on 20 May 2020. Every transfer of tokens originated from the same account, publicly belonging to Huobi and was incorporated into a separate transaction.

Tx hash	USDT amount
0xc180dafa23a8bf22178babebc7147d21a36b601755654024c92f012ac845dd3e	1
0x40b6917430426221587ba17d9a7427d9042d6ed7da9c8f8b2a76ce9717246891	24,999,999
0x9bb279ba338b0f57b2b8e60b5b22b088a327f62907977de2c64375e5fc8f46ce	25,000,000
0xf466dd5fb3abfb512aa4919cedf480f21a093bbc8b83bbadc5982f1c1367fea0	25,000,000
0x2b2843581cd840763f317982123bd87cebd96e88fa78a164774a874ecbbbedda	25,000,000
0x31bc32a8575ff8554d10b6d66a4918a0f80cf5953ebfe48cd0902889226bb8d3	1
0x2bfcfd199f278a3a83bddd47606fc6e913f28951a6f7b26d5bf05fe5206f244c	24,999,999
0x55439eed3549adcedfb6b3d5e2bba34b56c8f9e1928c8a827f94a5e4c622857	25,000,000
0xafcfbe92e95bf6d9f3f96f9673cbe444e13d0b1b8e63e1693369201ddf3a983b	25,000,000
0xa6c1bd9e14e579e3958a041b3ea5d071bf06b19970be51d639055be1ca55bc3e	25,000,000
0xcddab180be4b2c18b37660666775997a0236c7922641cd939fcc005681a0ed0c	1
0xa50e0a96466b6ae19f1923a155f905c68ce249b1df9d3ad3ddc5017af60ef2c2	24,999,999
0x1f177a5349c4cf26c6147211207e3da9a570a63d39f881edf0bedef708b32613	25,000,000
0x0ac1776e063470d44a34aaffaca2fa5b1e06ee4ea9e46840ff2a04dd91caabe3	25,000,000
0xb415febf767092a6c03b0207a6f14b80185bff3f53881d7f13f7dd7dcc3550e	25,000,000
0xb4d20a665927fca21e67736947f9bd85e8870f9216c8f891d5d8f7b5ac10787d	1
0x09eb3f1e69a4ba5e3dc21b27bec35207f6beec24fc362aa7bd43e0ceebc04578	24,999,999
0x12a10529af0d65e3c4713b3f18dac78ef7cd29eb0ba26faaef99e7e2572f0f4	25,000,000
0x944a54b61adaa5d4493769f770962bd8c4a0fc6e768fd50e95b9aec8d64ddf77	25,000,000
0x742ca7d841ac5454db294c4b16da3ae9b043da91a492e8c3dc7ad02ae036e6f9	25,000,000

6. Address/Entity allocation

The labels to the addresses were determined using Etherscan's *Label Word Cloud*, which is accessible under etherscan.io/labelcloud and provides a convenient and reliable opportunity to link accounts to addresses, while including a wide range of different applications and service providers and their correspondent accounts.

Address	Nametag
0xab5c66752a9e8167967685f1450532fb96d5d24f	Huobi 1
0xe93381fb4c4f14bda253907b18fad305d799241a	Huobi 10
0xfa4b5be3f2f84f56703c42eb22142744e95a2c58	Huobi 11
0x46705dfff24256421a05d056c29e81bdc09723b8	Huobi 12
0x32598293906b5b17c27d657db3ad2c9b3f3e4265	Huobi 13
0x5861b8446a2f6e19a067874c133f04c578928727	Huobi 14
0x926fc576b7facf6ae2d08ee2d4734c134a743988	Huobi 15
0xeec606a66edb6f497662ea31b5eb1610da87ab5f	Huobi 16
0x7ef35bb398e0416b81b019fea395219b65c52164	Huobi 17
0x229b5c097f9b35009ca1321ad2034d4b3d5070f6	Huobi 18
0xd8a83b72377476d0a66683cde20a8aad0b628713	Huobi 19
0x6748f50f686bfbca6fe8ad62b22228b87f31ff2b	Huobi 2
0x90e9ddd9d8d5ae4e3763d0cf856c97594dea7325	Huobi 20
0x18916e1a2933cb349145a280473a5de8eb6630cb	Huobi 21
0x6f48a3e70f0251d1e83a989e62aaa2281a6d5380	Huobi 22
0xf056f435ba0cc4fcd2f1b17e3766549ffc404b94	Huobi 23
0x137ad9c4777e1d36e4b605e745e8f37b2b62e9c5	Huobi 24
0x5401dbf7da53e1c9dbf484e3d69505815f2f5e6e	Huobi 25
0x034f854b44d28e26386c1bc37ff9b20c6380b00d	Huobi 26
0x0577a79cfc63bbc0df38833ff4c4a3bf2095b404	Huobi 27
0x0c6c34cdd915845376fb5407e0895196c9dd4eec	Huobi 28
0x794d28ac31bcb136294761a556b68d2634094153	Huobi 29
0xfdb16996831753d5331ff813c29a93c76834a0ad	Huobi 3
0xfd54078badd5653571726c3370afb127351a6f26	Huobi 30
0xb4cd0386d2db86f30c1a11c2b8c4f4185c1dade9	Huobi 31
0x4d77a1144dc74f26838b69391a6d3b1e403d0990	Huobi 32
0x28ffe35688fffd0659aee2e34778b0ae4e193ad	Huobi 33
0xcac725bef4f114f728cbcf744a731c2a463c3fc	Huobi 34
0x73f8fc2e74302eb2efda125a326655acf0dc2d1b	Huobi 35
0xee28d484628d41a82d01e21d12e2e78d69920da	Huobi 4
0x5c985e89dde482efe97ea9f1950ad149eb73829b	Huobi 5
0xdc76cd25977e0a5ae17155770273ad58648900d3	Huobi 6
0xad2b42f6bd96f5c65920b9ac88619dce4166f94	Huobi 7
0xa8660c8ffd6d578f657b72c0c811284aef0b735e	Huobi 8
0x1062a747393198f70f71ec65a582423dba7e5ab3	Huobi 9
0x9d6d492bd500da5b33cf95a5d610a73360fcaaa0	Huobi Mining Pool
0xa66daa57432024023db65477ba87d4e7f5f95213	Huobi Pool Token
0x6f259637dcd74c767781e37bc6133cd6a68aa161	Huobi Token
0x0316eb71485b0ab14103307bf65a021042c6d380	Huobi: HBTC Token
0x1d1e10e8c66b67692f4c002c0cb334de5d485e41	Huobi: Old Address 1

0xea0cfef143182d7b9208fbfeda9d172c2aced972	Huobi: Old Address 10
0x0c92efa186074ba716d0e2156a6ffabd579f8035	Huobi: Old Address 11
0x91dfa9d9e062a50d2f351bfba0d35a9604993dac	Huobi: Old Address 12
0x8e8bc99b79488c276d6f3ca11901e9abd77efea4	Huobi: Old Address 13
0xb9a4873d8d2c22e56b8574e8605644d08e047549	Huobi: Old Address 14
0x170af0a02339743687afd3dc8d48cfd1f660728	Huobi: Old Address 15
0xf775a9a0ad44807bc15936df0ee68902af1a0eee	Huobi: Old Address 16
0x75a83599de596cbc91a1821ffa618c40e22ac8ca	Huobi: Old Address 17
0x48ab9f29795dfb44b36587c50da4b30c0e84d3ed	Huobi: Old Address 18
0x90f49e24a9554126f591d28174e157ca267194ba	Huobi: Old Address 19
0x1b93129f05cc2e840135aab154223c75097b69bf	Huobi: Old Address 2
0xe3314bbf3334228b257779e28228cfb86fa4261b	Huobi: Old Address 20
0xf6edb9d6547befc3397801c94bb8c97d2e8087e2f	Huobi: Old Address 21
0x8aabba0077f1565df73e9d15dd3784a2b0033dad	Huobi: Old Address 22
0xd3a2f775e973c1671f2047e620448b8662dcd3ca	Huobi: Old Address 23
0x1c515eaa87568c850043a89c2d2c2e8187adb056	Huobi: Old Address 24
0x60b45f993223dcb8bdf05e3391f7630e5a51d787	Huobi: Old Address 25
0xa23d7dd4b8a1060344caf18a29b42350852af481	Huobi: Old Address 26
0x9eebb2815dba2166d8287afa9a2c89336ba9deaa	Huobi: Old Address 27
0xd10e08325c0e95d59c607a693483680fe5b755b3	Huobi: Old Address 28
0xc837f51a0efa33f8eca03570e3d01a4b2cf97ffd	Huobi: Old Address 29
0xeb6d43fe241fb2320b5a3c9be9cdfd4dd8226451	Huobi: Old Address 3
0xf7a8af16acb302351d7ea26ffc380575b741724c	Huobi: Old Address 30
0x636b76ae213358b9867591299e5c62b8d014e372	Huobi: Old Address 31
0x9a755332d874c893111207b0b220ce2615cd036f	Huobi: Old Address 32
0xecd8b3877d8e7cd0739de18a5b545bc0b3538566	Huobi: Old Address 33
0xef54f559b5e3b55b783c7bc59850f83514b6149c	Huobi: Old Address 34
0x956e0dbecc0e873d34a5e39b25f364b2ca036730	Huobi: Old Address 4
0x6f50c6bff08ec925232937b204b0ae23c488402a	Huobi: Old Address 5
0xdf95de30cdf4381b69f9e4fa8dddce31a0128df	Huobi: Old Address 6
0x25c6459e5c5b01694f6453e8961420ccd1edf3b1	Huobi: Old Address 7
0x04645af26b54bd85dc02ac65054e87362a72cb22	Huobi: Old Address 8
0xb2a48f542dc56b89b24c04076cbe565b3dc58e7b	Huobi: Old Address 9
0x3f5ce5fbfe3e9af3971dd833d26ba9b5c936f0be	Binance
0xd551234ae421e3bcba99a0da6d736074f22192ff	Binance 2
0x564286362092d8e7936f0549571a803b203aaced	Binance 3
0x0681d8db095565fe8a346fa0277bffde9c0edbbf	Binance 4
0xfe9e8709d3215310075d67e3ed32a380ccf451c8	Binance 5
0x4e9ce36e442e55ecd9025b9a6e0d88485d628a67	Binance 6
0xbe0eb53f46cd790cd13851d5eff43d12404d33e8	Binance 7
0xf977814e90da44bfa03b6295a0616a897441acec	Binance 8
0x001866ae5b3de6caa5a51543fd9fb64f524f5478	Binance 9
0x8b99f3660622e21f2910ecca7fbe51d654a1517d	Binance Charity
0xab83d182f3485cf1d6ccdd34c7cfef95b4c08da4	Binance JEX
0xb8c77482e45f1f44de1745f52c74426c631bdd52	Binance Token
0x4fab145d64652a948d72533023f6e7a623c7c53	Binance USD
0xc9a2c4868f0f96faaa739b59934dc9cb304112ec	Binance: BGBP Token
0x0b95993a39a363d99280ac950f5e4536ab5c5566	Binance: Contract
0x5754284f345afc66a98fbb0a0afe71e0f007b949	Bitfinex
0x1151314c646ce4e0efd76d1af4760ae66a9fe30f	Bitfinex 1
0x742d35cc6634c0532925a3b844bc454e4438f44e	Bitfinex 2
0x876eabf441b2ee5b5b0554fd502a8e0600950cfa	Bitfinex 3
0x7727e5113d1d161373623e5f49fd568b4f543a9e	Bitfinex: Contract 1

0x0e55c54249f25f70d519b7fb1c20e3331e7ba76d
 0x5dbdebcae07cc958ba5290ff9deaae554e29e7b4
 0x2ee3b2df6534abc759ffe994f7b8dcdfaa02cd31
 0xe1f3c653248de6894d683cb2f10de7ca2253046f
 0x2903cadbe271e057edef157340b52a5898d7424f
 0x36928500bc1dcd7af6a2b4008875cc336b927d57
 0x14d06788090769f669427b6aea1c0240d2321f34
 0x2af5d2ad76741191d15dfe7bf6ac92d4bd912ca3
 0xab7c74abc0c4d48d1bdad5dcb26153fc8780f83e
 0xc6cde7c39eb2f0f0095f41570af89efc2c1ea828
 0xcafb10ee663f465f9d10588ac44ed20ed608c11e
 0x7180eb39a6264938fdb3effd7341c4727c382153
 0x69c6dcc8f83b196605fa1076897af0e7e2b6b044
 0x8d5a41e85f4ce2433beef476305d307b9205d98d
 0xabdf147870235fcfc34153828c769a70b3fae01f
 0x4922a015c4407f87432b179bb209e125432e4a2a
 0xdac17f958d2ee523a2206206994597c13d831ec7
 0x5041ed759dd4afc3a72b8192c143f72f4724081a
 0x6cc5f688a315f3dc28a7781717a9a798a59fda7b
 0x236f9f97e0e62388479bf9e5ba4889e46b0273c3
 0xa7efae728d2936e78bda97dc267687568dd593f3
 0x75231f58b43240c9718dd58b4967c5114342a86c
 0xfbb1b73c4f0bda4f67dca266ce6ef42f520fbb98
 0xe94b04a0fed112f3664e45adb2b8915693dd5ff3
 0x66f820a414680b5bcd5eeca5dea238543f42054
 0xa3c1e324ca1ce40db73ed6026c4a177f099b5770
 0x88d34944cf554e9ccc4a24292d891f620e9c94f
 0x186549a4ae594fc1f70ba4cfffac714b405be3f9
 0xd273bd546b11bd60214a2f9d71f22a088aaf31b
 0x3052cd6bf951449a984fe4b5a38b46aef9455c8e
 0x2140efd7ba31169c69dff6cdc66c542f0211825
 0xa0ff1e0f30b5dda2dc01e7e828290bc72b71e57d
 0xc1da8f69e4881efe341600620268934ef01a3e63
 0xb4460b75254ce0563bb68ec219208344c7ea838c
 0x15878e87c685f866edfaf454be6dc06fa517b35b
 0x31d03f07178bcd74f9099afebd23b0ae30184ab5
 0xed48dc0628789c2956b1e41726d062a86ec45bff
 0x3fbeb1f8fc5ddb27d428aa60f661eaaab0d2000ce
 0xbb5a0408fa54287b9074a2f47ab54c855e95ef82
 0x5521a68d4f8253fc44bfb1490249369b3e299a4a
 0x8fa8af91c675452200e49b4683a33ca2e1a34e42
 0x3b83cd1a8e516b6eb9f1af992e9354b15a6f9672
 0x00bdb5699745f5b860228c8f939abf1b9ae374ed
 0x1522900b6dafac587d499a862861c0869be6e428
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 0x059799f2261d37b829c2850cee67b5b975432271
 0x4c766def136f59f6494f0969b1355882080cf8e0
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 0x538d72ded42a76a30f730292da939e0577f22f57
 0xfca70e67b3f93f679992cd36323eeb5a5370c8e4
 0x2910543af39aba0cd09dbb2d50200b3e800a63d2
 0x0a869d79a7052c7f1b55a8ebabbea3420f0d1e13
 0xe853c56864a2ebe4576a807d26fdc4a0ada51919

Bitfinex: Contract 2
 Bitfinex: Deployer 1
 Bitfinex: Deployer 2
 Bitfinex: Deployer 3
 Bitfinex: Deployer 4
 Bitfinex: Deployer 5
 Bitfinex: Deployer 6
 Bitfinex: LEO Token
 Bitfinex: MultiSig 1
 Bitfinex: MultiSig 2
 Bitfinex: Old Address 1
 Bitfinex: Old Address 2
 Bitfinex: Old Contract 1
 Bitfinex: Old Contract 2
 Tether EUR
 Tether Gold: XAUt Token
 Tether USD
 OKEEx
 OKEEx 1
 OKEEx 2
 OKEEx 3
 OKEEx: OKB Token
 Bittrex 1
 Bittrex 2
 Bittrex 3
 Bittrex: Controller
 Bithumb 1
 Bithumb 10
 Bithumb 11
 Bithumb 2
 Bithumb 3
 Bithumb 4
 Bithumb 5
 Bithumb 6
 Bithumb 7
 Bithumb 8
 Bithumb 9
 Bithumb: Contract 1
 Bithumb: Old Address 1
 Bithumb: Old Address 2
 Bithumb: Old Address 3
 Bithumb: Old Address 4
 Bitstamp 1
 Bitstamp 2
 Bitstamp 3
 Bitstamp 4
 Bitstamp 5
 Bitstamp 6
 Bitstamp: Deployer
 Bitstamp: Old Address 1
 Kraken 1
 Kraken 2
 Kraken 3

0x267be1c1d684f78cb4f6a176c4911b741e4ffdc0	Kraken 4
0xfa52274dd61e1643d2205169732f29114bc240b3	Kraken 5
0x53d284357ec70ce289d6d64134dfac8e511c8a3d	Kraken 6
0x2e7542ec36df6429d8c397f88c4cf0c925948f44	Kraken: Deployer
0x3fda67f7583380e67ef93072294a7fac882fd7e7	Compound
0xb3319f5d18bc0d84dd1b4825dcde5d5f7266d407	Compound 0x
0x158079ee67fce2f58472a96584a73c7ab9ac95c1	Compound Augur
0x6c8c6b02e7b2be14d4fa6022dfd6d75921d90e4e	Compound Basic Attention Token
0x5d3a536e4d6dbd6114cc1ead35777bab948e3643	Compound Dai
0x4ddc2d193948926d02f9b1fe9e1daa0718270ed5	Compound Ether
0xf5dce57282a584d2746faf1593d3121fcac444dc	Compound Sai
0xf650c3d88d12db855b8bf7d11be6c55a4e07dcc9	Compound Tether
0x39aa39c021dfbae8fac545936693ac917d5e7563	Compound USD Coin
0xc11b1268c1a384e55c48c2391d8d480264a3a7f4	Compound Wrapped BTC
0xc00e94cb662c3520282e6f5717214004a7f26888	Compound: COMP Token
0x3d9819210a31b4961b30ef54be2aed79b9c9cd3b	Compound: Comptroller
0xf859a1ad94bcf445a406b892ef0d3082f4174088	Compound: Contract 1
0xa7ff0d561cd15ed525e31bbe0af3fe34ac2059f6	Compound: Deployer 1
0x1449e0687810bddd356ae6dd87789244a46d9adb	Compound: Deployer 2
0xcec237e83a080f3225ab1562605ee6dedf5644cc	Compound: Deployer 3
0xfe83af639f769ead20bad76067abc120245a06a9	Compound: Deployer 4
0xc0da01a04c3f3e0be433606045bb7017a7323e38	Compound: Governor Alpha
0x1055be4bf7338c7606d9efdcf80593f180ba043e	Compound: Liquidator
0x02557a5e05defeffd4cae6d83ea3d173b272c904	Compound: Oracle
0x9e77ad51e5c0825d6e440f49e49ef1a1bca37b5d	Compound: Oracle 2
0xe7664229833ae4abf4e269b8f23a86b657e2338d	Compound: Oracle v2
0xddc46a3b076aec7ab3fc37420a8edd2959764ec4	Compound: Price Oracle Proxy
0xd25c029a607ee888bdbdbe054515e25ec6f3fff9	Compound: Rate Model
0x0a97f822272519d5296e21de278a86cd3ce3c96a	Compound: Rate Model 2
0x16c2a19edbc68780dfc03708bc9021ef34db2e33	Compound: Rate Model 3
0xcdaf8cb1839952cbe6d98d248e593b782a2419c7	Compound: Rate Model 4
0xd928c8ead620bb316d2cefe3caf81dc2dec6ff63	Compound: Rate Model 5
0x8ac03df808efae9397a9d95888230ee022b997f4	Compound: Stablecoin Rate Model
0x6b175474e89094c44da98b954eedeac495271d0f	Dai Stablecoin
0x39755357759ce0d7f32dc8dc45414cca409ae24e	Eth2Dai: Old Contract
0x9f8f72aa9304c8b593d555f12ef6589cc3a579a2	Maker Token
0x5ef30b9986345249bc32d8928b7ee64de9435e39	Maker: CDP Manager
0x448a5065aebb8e423f0896e6c5d525c040f59af3	Maker: Contract 1
0xbda109309f9fafa6dd6a9cb9f1df4085b27ee8ef	Maker: Contract 2
0x9b0f70df76165442ca6092939132bbaea77f2d7a	Maker: Contract 3
0x9b0ccf7c8994e19f39b2b4cf708e0a7df65fa8a3	Maker: Contract 4
0xf2c5369cffb8ea6284452b0326e326dbfdbc867c	Maker: Contract 5
0x315cbb88168396d12e1a255f9cb935408fe80710	Maker: Contract 6
0x79f6d0f646706e1261acf0b93dcb864f357d4680	Maker: Contract 7
0x8e2a84d6ade1e7fffee039a35ef5f19f13057152	Maker: Contract 8
0x69076e44a9c70a67d5b79d95795aba299083c275	Maker: Contract 9
0x4f26ffbe5f04ed43630fdc30a87638d53d0b0876	Maker: Deployer 1
0xdb33dfd3d61308c33c63209845dad3e6bfb2c674	Maker: Deployer 2
0x00daa9a2d88bed5a29a6ca93e0b7d860cd1d403f	Maker: Deployer 3
0xddb108893104de4e1c6d0e47c42237db4e617acc	Maker: Deployer 4
0xa26e15c895efc0616177b7c1e7270a4c7d51c997	Maker: DS Proxy Factory
0x36a724bd100c39f0ea4d3a20f7097ee01a8ff573	Maker: Get CDPS
0x9ef05f7f6deb616fd37ac3c959a2ddd25a54e4f5	Maker: Governance Contract

0x78f2c2af65126834c51822f56be0d7469d7a523e
0xbaa65281c2fa2baacb2cb550ba051525a480d3f4
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0x2fa2bc2ce6a4f92952921a4caa46b3727d24a1ec

Maker: MCD Cat
Maker: MCD Deploy
Maker: MCD End
Maker: MCD ESM
Maker: MCD Flap
Maker: MCD Flip BAT A
Maker: MCD Flip ETH A
Maker: MCD Flip SAI
Maker: MCD Flop
Maker: MCD Gov Actions
Maker: MCD Join BAT A
Maker: MCD Join DAI
Maker: MCD Join ETH A
Maker: MCD Join SAI
Maker: MCD Jug
Maker: MCD Pause
Maker: MCD Pause Proxy
Maker: MCD Pot
Maker: MCD Spot
Maker: MCD Vat
Maker: MCD Vow
Maker: Medianizer 1
Maker: Medianizer 2
Maker: Migration
Maker: Migration Proxy Actions
Maker: Multicall
Maker: MultiSig
Maker: Oasis Proxy
Maker: Old Token
Maker: PIP BAT
Maker: PIP ETH
Maker: PIP SAI
Maker: Proxy Actions
Maker: Proxy Actions DSR
Maker: Proxy Actions End
Maker: Proxy Deployer
Maker: Proxy Pause Actions
Maker: Proxy Registry
Maker: Sai Proxy 1
Maker: Sai Proxy 2
Maker: WBTC
OasisDEX
OasisDex: Old Contract 1
OasisDex: Old Contract 2
Pooled Ether
ProtoSAI Token
Sai Stablecoin
Poloniex
Poloniex 2
Poloniex 3
Poloniex 4
Poloniex: BAT
Poloniex: BNT

0x31a2feb9b5d3b5f4e76c71d6c92fc46ebb3cb1c1
0x6b71834d65c5c4d8ed158d54b47e6ea4ff4e5437
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Poloniex: CVC
Poloniex: FOAM
Poloniex: GNO
Poloniex: GNT
Poloniex: KNC
Poloniex: LOOM
Poloniex: MANA
Poloniex: NXC
Poloniex: OMG
Poloniex: REP
Poloniex: SENT
Poloniex: STORJ
Poloniex: USDC
Poloniex: ZRX
dYdX: Admin Impl
dYdX: Auction Proxy
dYdX: Bucket Lender Factory
dYdX: Dai Price Oracle
dYdX: Deployer
dYdX: Dutch Auction Closer
dYdX: Erc20 Long Factory
dYdX: ERC20 Long Factory 2
dYdX: ERC20 Position Withdrawer
dYdX: ERC20 Position Withdrawer V2
dYdX: Erc20 Short Factory
dYdX: ERC20 Short Factory 2
dYdX: Erc721 Margin Position
dYdX: Eth Wrapper Bucket Lender
dYdX: Expiry
dYdX: Margin
dYdX: Oasis V1 Simple Exchange Wrapper
dYdX: Oasis V2 Simple Exchange Wrapper
dYdX: Oasis V3 Simple Exchange Wrapper
dYdX: Open Directly Exchange Wrapper
dYdX: Operation Impl
dYdX: Payable Proxy For Solo Margin
dYdX: Polynomial Interest Setter
dYdX: Solo Margin
dYdX: Token Proxy
dYdX: Usdc Price Oracle
dYdX: Vault
dYdX: Weth Payout Recipient
dYdX: Weth Price Oracle
dYdX: ZeroEx V1 Exchange Wrapper
dYdX: ZeroEx V2 Exchange Wrapper
Dydx Expo