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Stablecoin Billionaires  
A descriptive analysis of the Ethereum-based  
Stablecoin ecosystem

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Submission Date:  November 25, 2020  
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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 favor of crypto-exchanges and DeFi applications was revealed.
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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 Bellavitd, 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 Repository\(^1\) 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 set\(^2\) 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.

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

\(^2\)Complete data set: tonivahrstaetter.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.to\(^3\), 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

\(^3\)Last accessed 20 Jul 2020
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]

|      | USD | EUR | CNH | XAU | ∑     |
|------|-----|-----|-----|-----|-------|
| 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    |
| ∑       | 10,043 | 50  | 25  | 0.048 | 10,118 |

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 1\(^{st}\) of January 2018, but its tokens have never been distributed, resulting in a total of only 15 token holders.\(^6\) The Renminbi Contract\(^7\) 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-

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\(^4\) Tether Gold: XAUt Token Address: 0x4922a015c4407F87432B179bh209e125432E4a2A  
\(^5\) Tether EUR Address: 0xAbdf147870235FcFC34153828c769A70B3Fa01F  
\(^6\) [see etherscan.io/token/0xAbdf147870235FcFC34153828c769A70B3Fa01F] [Last accessed 1 Jul 2020]  
\(^7\) Tether CNH Address: 0xe6E109E9dD7Fa1a58BC3ef667e8e41fC3cc07A[EF  
\(^8\) [see etherscan.io/token/0xe6E109E9dD7Fa1a58BC3ef667e8e41fC3cc07A[EF] [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...

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. Similar to Tether, Paxos launched a gold-backed asset called Paxos Gold, 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

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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: 0x45804880De22913dAFE909f4980848ECE6EcAbb78
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)\textsuperscript{12} and FDIC-insured banks were selected to hold the fiat funds that are deposited by customers. (Cascarilla, 2018) The tokens represent the 3\textsuperscript{rd} (PAX), 4\textsuperscript{th} (BUSD) and 7\textsuperscript{th} (HUSD) largest Stablecoins by market capitalisation on Ethereum and their contracts can be found at the addresses 0x8E8\ldots\textsuperscript{14} for Paxos, 0x4Fa\ldots\textsuperscript{15} for Binance USD and 0xFD5\ldots\textsuperscript{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 18\textsuperscript{th} of July 2019 and the contract of Binance USD on September 5, 2019.

2.1.4 TrueUSD

TrustToken, the company behind the 5\textsuperscript{th} 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.\textsuperscript{17} The token contract of TrueUSD was originally deployed on 5 March 2018 at the address 0x8dd\ldots\textsuperscript{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 4\textsuperscript{th} of January 2019, when the token contract officially began delegating to the address 0x000\ldots\textsuperscript{376}\textsuperscript{19}. Since

\textsuperscript{12}Paxos Standard Contract Address: 0x8E870D67F660D95d5ce530380D0eC0bd388289E1
\textsuperscript{15}BUSD Contract Address: 0x4Fabb145d64652a9484d72533023f6E7A623C7C53
\textsuperscript{16}HUSD Contract Address: 0xF574c245452fEcb9a59c229253D4111d87e1
\textsuperscript{17}see www.trusttoken.com/currencies [Last accessed 31 Jul 2020]
\textsuperscript{18}TrueUSD Legacy Contract Address: 0x8dd5fbCe2F6a956C3022bA3663759011Dd51e73E
\textsuperscript{19}TrueUSD Address: 0x0000000000085d4780B73119b644AE5ecd223d376
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.\textsuperscript{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 1\textsuperscript{st}, 2020, TrueUSD represents the 5\textsuperscript{th} largest Stablecoin on Ethereum with a market capitalisation of around 140 million dollar.

\subsection{DAI Stablecoin}

\textit{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 \textit{“to safeguard what cannot be technologically decentralized in the Maker Protocol, [...]”} and following the DeFi Leaderboard on etherscan.io\textsuperscript{21}, 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 \textit{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 \textit{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 \textit{Proposal Contract} and additionally, MKR token holders are responsible for decisions about the \textit{DAI Saving Rate (DSR)}, \textit{Oracle Contracts}, \textit{Emergency Shutdown}.

\end{enumerate}

\textsuperscript{20}see blog.trusttoken.com/upgrade-80ba355f8960 [Last accessed 1 Jul 2020]
\textsuperscript{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 dept 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 dept 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 Docs\textsuperscript{22}, 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 dept positions. In November 2019 the protocol then upgraded from Single-Collateral Dai to Multi-Collateral Dai and directly introduced BAT tokens as legitimate security.\textsuperscript{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 \texttt{address(0)}\textsuperscript{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

\textsuperscript{22}see docs.makerdao.com/
\textsuperscript{23}see blog.makerdao.com/say-goodbye-to-cdps-and-hello-to-maker-vaults/
\textsuperscript{24}Address: 0x0000000000000000000000000000000000000000
| Coin             | Symbol | Blockchain | Supply* | Collateralisation and issue policy | Addr. |
|------------------|--------|------------|---------|-----------------------------------|-------|
| Tether           | USDT   | Bitcoin, Ethereum** | 6,037   | Different assets held by Tether Limited 0x0dAC... |       |
| 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 0xFa... |       |
| HUSD             | HUSD   | Ethereum   | 115     | Dollar held by FDIC-insured banks 0xF5... |       |

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

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25[see blog.makerdao.com/a-guide-to-dai-stats/](http://blog.makerdao.com/a-guide-to-dai-stats/)
26DAI 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* 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

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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 | totalSupply() | 18160ddd |
|                | balanceOf(address) | 70a08231 |
|                | transfer(address,uint256) | a9059cbb |
|                | transferFrom(address,address,uint256) | 23b872dd |
|                | approve(address,uint256) | 095ea7b3 |
|                | allowance(address,address) | dd62ed3e |
| ERC20 Event    | Transfer(address,address,uint256) | ddf252ad |
|                | Approval(address,address,uint256) | 8c5be1e5 |
| Optional Method | name() | 06fdde03 |
|                 | symbol() | 95d89b41 |
|                 | decimals() | 313ec567 |

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
parameters, an address for the recipient, and an uint256, which is an unsigned 256-bit integer, for the amount to send. Consequently, the Method ID of the transfer function equals the first four bytes of:

\[
\text{Keccak-256}( \text{transfer(address,uint256)} ) \\
= \texttt{a9059cbb2ab09eb219583f4a59a5d0623ade346d962bcd4e46b11da047c9049b}
\]

The Method ID specifies the function a contract should execute. This is done by sending a transaction to the contract with the Method ID included in the first four bytes of the data field. The address and the transfer amount are integrated in the data field too. An example of a data field in a transaction that triggers a token transfer might look like the following:

\[
\text{0xa9059cbb000000000000000000000000} \\
\text{abc3141592653589793238462643383279502884197169399375105820974944} \\
\text{000000000000000000000000000000000000000000000000010}
\]

The first four bytes represent the Method ID, followed by 32 bytes including the recipient-address and finally, 32 bytes containing the amount of tokens in hexadecimal format end the data payload. For a token with zero decimals the above data field would trigger a transfer of 16 tokens to the address 0xabc...01.²⁸

**Events**

According to the ERC-20 Standard by Vogelsteller and Buterin (2015), transfer events should be triggered each time a token is transmitted or when tokens are created in parallel with a contract creation so that third parties can track network activities and thus stay up to date. Event logs contain their contract’s address and are incorporated in the block header of each block, which guarantees that external clients are able to fetch relevant event data, filtered by specific contracts, from the blockchain.²⁹ Besides an address, each event log comprises up to four indexed topics and data. The first one, topic[0], usually represents the Keccak-256 hash of the event’s canonical Solidity implementation, as follows:

\[
\text{Keccak-256}( \text{Transfer(address,address,uint256)} ) \\
= \text{ddf252ad1be2c89b69c2b068fc378daa952ba7f163c4a1162855a4df523b3ef}
\]

In a transfer event, topic[1] and topic[2], both 32 bytes in size, are commonly used.

---

²⁸ [see solidity.readthedocs.io/en/develop/abi-spec.html] (Last accessed 20 Jul 2020)
²⁹ [see ethereum.stackexchange.com/questions/3418/how-does-ethereum-make-use-of-bloom-filters/3426] (Last accessed 20 Jul 2020)
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.\textsuperscript{30} Summarizing, a typical transfer event might take the following form:

\begin{verbatim}
{
    'address': '0xedac17f958d2e5a53a226026994597c13d831e7',
    'topics': ["0xd5252d11e2e89b69c2b6e378daa952ba74f163c4a11628f65a41d523b3ef",
               '0x00000000000000000000000000000000000000001d4ed6a2b4b00875c336b927d57',
               '0x00000000000000000000000000000000000000006c4eb739e2f00954f1570a89a2c1ea828']
    'data': '0x00000000000000000000000000000000000000000000000000000000000000005f5e100',
    'blockNumber': '0x46768',
    'timeStamp': '0x5a1d82e',
    'gasPrice': '0x8e6b2300',
    'gasUsed': '0xd099',
    'logIndex': '0x9',
    'transactionHash': '0x51a2395087450379f38a866662090d656673929d205d5591f5a4f2c46a2ca1',
    'transactionIndex': '0x18'}
\end{verbatim}

### 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.\textsuperscript{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

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

\textsuperscript{31}see solidity.readthedocs.io/en/v0.5.3/types.html [Last accessed 21 Jul 2020]
Transfers need not necessarily be triggered by a transaction to the token contract. Instead, contracts like Multisignature Contracts can lie in between.

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

\(^{32}\)Example Tx: 0xe8230ce593d3bf1f7332acbe8d1a9ee1ee4ee4d65d9797673204720468b488732
\(^{33}\)Tx hash: 0xe49af17de711d7ca1f034f2fb821b082a3a50b53d84a649addbce087d0c36af
\(^{34}\)Bitpie: Batch Sender v2 Address: 0x3b7E71a9f15EEBb541C82f88E020Ae7040484f1
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 \texttt{0xd4d...}, 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: \texttt{Blocktimestamp}, \texttt{blocknumber}, \texttt{transactionindex}, \texttt{transactionhash}, \texttt{transferfrom}, \texttt{transferto}, \texttt{transferamount}, \texttt{gasprice} and \texttt{gasused}.

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-

\footnote{Address: \texttt{0xd4d7B764EC071A0A8a6f9dCe928fa18d7C0E6a6}}
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!', Baumölhl 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 contact.

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 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.io\(^{37}\), which is an alternative to setting up a full-node or using an Infura node\(^{38}\) 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\(_{\text{legacy}}\), 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

\(^{37}\) see etherscan.io/apis [Last accessed 1 Jul 2020]
\(^{38}\) see infura.io/ [Last accessed 1 Jul 2020]
\(^{39}\) Tx hash: 0x2f1c5c2b44f771c942a8506148e256f94f1a464babc938ae0690c6e34cd79190
following attributes were collected: \( \text{Block timestamp} \), \( \text{block number} \), \( \text{transaction index} \), \( \text{transaction hash} \), \( \text{transfer from} \), \( \text{transfer to} \), \( \text{transfer amount} \), \( \text{gas price} \) and \( \text{gas used} \). The same fields apply to all the events that influence the supply of tokens, except that \( \text{transfer from} \) and \( \text{transfer to} \) turn to \( \text{transfer address} \), representing the account where tokens were burned from or issued to. In total, the analysis is based 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 \( \text{Mint} \), \( \text{Burn} \), \( \text{SupplyIncreased} \), \( \text{SupplyDecreased} \), \( \text{Issue} \), \( \text{DestroyedBlackFunds} \) and \( \text{Redeem} \). An overview of all events, their Solidity implementation and their \( \text{topic[0]} \) 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-

| Token | .sol Implementation of Event | Event ID |
|-------|-----------------------------|---------|
| USDT  | Issue(uint256)              | 0xcb8241...176a |
|       | DestroyedBlackFunds(address,uint256) | 0x61e666...98c6 |
|       | Redeem(uint256)             | 0x0702d59...9a44 |
| USDC  | Mint(address,address,uint256) | 0xab530...c908 |
|       | Burn(address,uint256)       | 0xcc1055...7ca5 |
| PAX   | SupplyIncreased(address,uint256) | 0x5c174...8797 |
|       | SupplyDecreased(address,uint256) | 0x1b7e18...8a63 |
| BUSD  | SupplyIncreased(address,uint256) | 0x05c174...8797 |
|       | SupplyDecreased(address,uint256) | 0x1b7e18...8a63 |
| TUSD  | Mint(address,uint256)       | 0xf6798a...6885 |
|       | Burn(address,uint256)       | 0xcc1055...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 \( \text{Event ID (topic[0])} \), which is the keccak-256 hash of the canonical Solidity expression.
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 1\(^{st}\), 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/0x0000000000000000000000000000000000000000 [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.

41 see bittrex.zendesk.com/kc/en-us/articles/360031291791, binance.com/en/support/articles/360030263911 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]
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’ platforms\(^{42}\) 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.

\(^{42}\)see Market Pairs at [coinmarketcap.com/currencies/binance-usd/markets/](https://coinmarketcap.com/currencies/binance-usd/markets/) and [coinmarketcap.com/currencies/husd/markets/](https://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 website\(^{43}\), however, MMM BSC with the address \(0x8a9\ldots\)\(^{44}\) accounts for 650,256 transfers of PAX token, representing 25.2 % of the total number of PAX transfers. Additionally, the account\(^{45}\) with the 3\textsuperscript{rd} 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

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\(^{43}\)see [paxos.com/what-is-mmm-is-it-affiliated-with-paxos/][Last accessed 19 Jul 2020]

\(^{44}\)MMM BSC Address: 0x8a91c9a16cd62693649d80afa85a09dbgbchb8508

\(^{45}\)Address: 0xC88F7666330b4b511358b7742dc2a3234710c7B1

\(^{46}\)see [etherscan.io/address/0xc88f7666330b4b511358b7742dc2a3234710c7B1][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 Twitter:47:

“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-

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47 see twitter.com/jerallaire/status/1238604280036278227 [Last accessed 21 Jul 2020]
nance. The crypto-exchange shifted 549,037,905 tokens from one of their wallets\textsuperscript{48} into another one\textsuperscript{49} and paid fees of around 0.00058 Ether (some 0.12 \$ with 1 Ether = 200 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 6\textsuperscript{th} largest coin regarding market capitalisation and is the youngest of the contracts analysed, it has the 3\textsuperscript{rd} 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.\textsuperscript{50} It can be observed that trans-

\begin{table}
\centering
\begin{tabular}{|l|c|c|c|c|c|c|}
\hline
 & Total & Mean & Std Dev & Q\textsubscript{0.25} & Q\textsubscript{0.50} & Q\textsubscript{0.75} & Max* \\
 & Transfers* & & & & & & \\
\hline
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 \\
\hline
\end{tabular}
\caption{Transfer-Volume Descriptive Statistics of the Transfer-Volume of the largest Stablecoins on Ethereum as of July 1\textsuperscript{st}, 2020. The numbers are rounded and represent tokens. *in Mio.}
\end{table}

\textsuperscript{48}Binance
\textsuperscript{6} Address: 0xE9cc36E442e55EcD9025B9a6E0fD88485d628A67
\textsuperscript{49}Binance
\textsuperscript{7} Address: 0xBE0eB53F46cd790Cd13851d5EF43D12404633E8
\textsuperscript{50}see etherscan.io/chart/gasprice [Last accessed 25 Jul 2020]
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 Ether = 200 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\textsuperscript{51},

\textsuperscript{51}Proxy Actions DSR Address: 0x07ee93aEEa0a36FfF2A9B95d422Bd6049EE54f26
Maker: MCD Join DAI\textsuperscript{52}, Maker: MCD Pot\textsuperscript{53}, Maker: MCD Vat\textsuperscript{54}, DAI Stablecoin\textsuperscript{55} and a DS Proxy\textsuperscript{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 Contracts\textsuperscript{57} 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

\textsuperscript{52} Maker: MCD Join DAI Address: 0x9759A6Ac90977b93B58547b4A71c78317f391A28
\textsuperscript{53} Maker: MCD Pot Address: 0x197E90F9FAD81970B7A7976633C3bD77088E5D7c7
\textsuperscript{54} Maker: MCD Vat Address: 0x35D1b3F3D7966A1DfC207aa454C1C2a259A0492B
\textsuperscript{55} DAI Stablecoin Address 0x6B175474E89094C44Da988C955434C1E6eAC495271d0F
\textsuperscript{56} see docs.makerdao.com/dai.js/advanced-configuration/using-ds-proxy [Last accessed 9 Sep 2020]
\textsuperscript{57} OasisDEX, 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

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\(^{58}\) *NEST Protocol: Oracle Address: 0x43D99D54F14c64994FD9666BEAB6023b0069De20*

\(^{59}\) *Tx hash: 0x2baf54b20e026b1efacf307feb5d46dd4574355c61cc3f2c6522ef27d8ac4*
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.

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.

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* |
|---------|-------------|-------------|------------|------------|-----------|-----------|
| USD     | 74          | 49          | 81,623     | 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: 0xC6CDE7C39eB20F0005F41570a89eFC2C1Ea828
⁶¹ Bitfinex: Deployer 5 Address: 0x36928500Bc1dCd7affa2B4008875CC3361927D57
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.
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 Vault62, which is a contract within the MakerDAO ecosystem that facilitates the generation of DAI in exchange for a security deposit. This process is designed

62Maker: 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...* 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. 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-
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 function 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),

**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]

65Address: 0x64a84e558192dd025f3a96775f6e8fb530f27177
66Address: 0x55fe002aef77364de339a129292a15844b8
67Address: 0x28c5b0445d0728be25f143f8eb5c5539fae151a
68Address: 0x895f07957b863f4ab6086035a4990d8366bc3266
69Address: 0xce7ab0d2a069fa115c0d7878af6fd95ba0f9100a
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.

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70 Address: 0x24BDd8771b08C2EA6FE0e898126e65BD49021BE3
71 Address: 0xd4C1315948125Cd20C11C5E9565a3632C1710055
72 MasterMinter Address: 0xE982615d461DD5cD06575BbeA87624fda4e3de17
73 Blacklister Address: 0x5dB0115f3B72d19cEa34dD697cf412F864c7E1b
74 USDC Owner Address: 0xFcb19e6a322b27c06842A7e8c725399f049AE3a
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 \texttt{0xA0b...} points to another account that is located at address \texttt{0x088...} \textsuperscript{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 1\textsuperscript{st}, the contract has never been upgraded and basically only the account privileged with the \textit{Admin} role inside the proxy contract would be able to do so. By July ’20, the EOA acting as the \textit{Admin} can be found at address \texttt{0x807...} \textsuperscript{76}

Continuing with the token contract of \textit{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 \textit{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 \textit{owner} of the contract, which is the contract at address \texttt{0x000...cc9} \textsuperscript{77}, publicly known as \textit{TrueUSD: Token Controller}. In addition, the \textit{owner} is entitled to blacklist accounts and burn tokens from third party addresses. This was implemented with a function named \textit{wipeBlacklistedAccount}, which sets the balance of a blacklisted address to zero. The said indicates that power is very centrally distributed within the \textit{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 \textit{TrustToken} distributes freshly embossed tokens directly(!) to customer accounts whenever fiat money is deposited into an escrow account. Similar to the USDC contract, \textit{TrueUSD} was implemented via a proxy contract that retrieves its functions from the contract at address \texttt{0x205...} \textsuperscript{78}, but unlike USDC, TUSD has already been upgraded 13 times.\textsuperscript{79}

\textsuperscript{75}Address: 0x0882477e7895bdC5cea7cB1552ed914aB157Fe56
\textsuperscript{76}TrueUSD: Token Controller Address: 0x000000000000000075FBeE23fe2de1bd0b7690883cc9
\textsuperscript{77}Address: 0x20594f0B1F549D19B5DD81990d93Bd131c657e01
\textsuperscript{78}see Appendix 3 for the transactions hashes of the upgrades

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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 \(0x519\ldots\)\(^{80}\) was mainly used to distribute freshly minted tokens. With one exception in October 2018, when address \(0xcba\ldots\)\(^{81}\) became the new distribution channel, address \(0x519\ldots\) always acted as the supply-controlling account. The *Binance USD* tokens were minted to the account at address \(0x519\ldots\) 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 \(0x519\ldots\), 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 1\(^{st}\), this role is granted to the account at address \(0x519\ldots\) 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 \(0x87f\ldots\)\(^{82}\) and for BUSD, it is the account at address \(0xb87\ldots\)\(^{83}\). 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

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\(^{80}\)Address: 0x5195427ca88DF768c298721dA791B93AD11ECa65
\(^{81}\)Address: 0xcba1766e19f32d79E3BA7A276f404a7042324F0A
\(^{82}\)AssetProtectionRole Address: 0x87f1aA3037AE65E141cd895dCa066d5fB872d94e95
\(^{83}\)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 0xC1A...85 and 0xC2F...86, are privileged to issue and redeem tokens.

84HUSD owner Address: 0x2Bd9caa19a724608BeF32dD3C10c0fd1f70B309D
85CoinFactoryAdmin Address: 0xC1A3054592CFef49Cf345800ad2763d276879919691e
86CoinFactoryAdmin Address: 0xC2FbF9b9084e92F9649C4CeCC9043DaAc9092539
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 |
|----------------|------------|------------|-----------------------|----------------|
| USD$T$         | owner      | owner      | owner                 | ✓              |
| US$DC$         | minters    | minters    | Blacklister           | ✓              |
| DAI            | anyone     | anyone     | -                     | ✓              |
| PAX            | SupplyController | SupplyController | AssetProtectionRole | X              |
| TUSD           | owner      | anyone     | owner                 | ✓              |
| BUSD           | SupplyController | SupplyController | AssetProtectionRole | ✓              |
| HUSD           | CoinFactoryAdmin | CoinFactoryAdmin | CoinFactoryAdmin | X              |

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\textsuperscript{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 1\textsuperscript{st}, 1,842,166 (some 22 \%) of them have a positive balance, which means that they own at least 1/10\textsuperscript{18} of an US-Dollar in Stablecoins. The mean balance of the positive addresses is 4,235 dollars in Stablecoins with a standard deviation

\textsuperscript{87}see 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 (Q₃), 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 $4 \times 10^{26}$ 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.\textsuperscript{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  | 0.03| 10  | 75  | 400 |
| USDC  | 779          | 177             | 41            | 5,552| 529  | 0.05| 1   | 9   | 204 |
| PAX   | 1,030        | 86              | 33            | 2,804| 363  | 0.13| 5   | 45  | 104 |
| TUSD  | 145          | 30              | 12            | 4,735| 133  | 0.05| 3   | 100 | 16  |
| DAI   | 250          | 100             | 35            | 1,064| 38   | 0.08| 2   | 40  | 5   |
| BUSD  | 10           | 5               | 2             | 33,796| 1,174| 1.00| 1   | 100 | 73  |
| HUSD  | 4            | 1               | .8            | 81,003| 2,938| 3.58| 13  | 56  | 111 |

Table 9: Accounts Analysis

Descriptive Statistics of the largest Ethereum-based Stablecoins and their token holders as of July 1\textsuperscript{st}. 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 posses 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

\textsuperscript{88}see 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... and has a balance of around 400 million dollars. Although this account is not

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89 Huobi Address: 0x7b8c69a0f60cD43ef67f948976daaE77BC6A019B
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 List91, 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-

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90Huobi 2 Address: 0x6748F50686fbcA6Fe8adam62b22228b87F31ff2b
91see wallet.tether.to/richlist [Last accessed 19 Jul 2020]
trated in Figure 11. Moreover, the addresses \textit{0x674...} and \textit{0xfdb...}\textsuperscript{92}, which are labeled with \textit{Huobi 2} and \textit{Huobi 3}, represent the 4\textsuperscript{th} and 5\textsuperscript{th} wealthiest identities within the Stablecoin ecosystem and the 3\textsuperscript{rd} and 4\textsuperscript{th} largest token holders amidst the USDT community. Finally, the account with the 6\textsuperscript{th} largest Stablecoin balance, located at address \textit{0x106...}\textsuperscript{93} and labeled as \textit{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 \textit{0x674...}, \textit{0xfdb...}, \textit{0x106...} count about one million in- and outgoing transfers and are in 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} 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 accounts\textsuperscript{94} on the Omni Layer protocol, which have been published on \texttt{wallet.tether.to/richlist}, as of July 1\textsuperscript{st}, 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 10\textsuperscript{th} Stablecoin is owned by Huobi, underpinning the company’s supremacy.

The 2\textsuperscript{nd} largest account identified in the Ethereum-based Stablecoin ecosystem can be found at address \textit{0xBE0...}\textsuperscript{95}, is labeled as \textit{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

\textsuperscript{92}Huobi 3 Address: 0xfdb16996831753d5331fF813e29a93c76834A0AD
\textsuperscript{93}Huobi 9 Address: 0x1062a747393198f70F71ec65A582423Dba7E5Ab3
\textsuperscript{94}see \texttt{omniexplorer.info/search/35hK24tcLcwcgN44xprbbKKeA4C0QqQPeP} and \texttt{omniexplorer.info/search/1HckjUpR6GcrrR8tFaaCABdGJsPz9eYnLs2} [Last accessed 1 Jul 2020]
\textsuperscript{95}Binance 7 Address: 0xBE0eB53F46cd790Cid3851d5EF43D12404d33E8
| Entity | USDT  | USDC  | DAI   | PAX   | BUSD  | TUSD  | HUSD  | ∑      |
|--------|-------|-------|-------|-------|-------|-------|-------|--------|
| 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| -     | -     | -     | -     | -     | 198.92 |
| 0xfdb  | Huobi | 152.46| -     | -     | -     | -     | -     | 152.46 |
| 0x575  | -     | 139.29| -     | -     | -     | -     | -     | 139.29 |
| 0x106  | Huobi | 1.85  | -     | -     | -     | -     | -     | 110.48 |
| 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  |
| 0x3d0  | -     | 45.75 | 0.27  | -     | 0.04  | -     | 0.14  | 46.19  |
| 0x92d  | -     | -     | 43.19 | -     | -     | -     | -     | 43.19  |
| 0x778  | -     | 40.20 | -     | -     | -     | -     | -     | 40.20  |
| 0xe8c  | -     | -     | 40.00 | -     | -     | -     | -     | 40.00  |
| 0x570  | -     | 34.65 | -     | -     | -     | -     | -     | 34.65  |
| ∑      |       | 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 provided by Etherscan, except for 0x7b8..., were wallet.tether.to/richlist was used as source.

the 8th richest account identified in the data set, located at address **0x3f5...**

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.

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96 Binance Address: 0x3f5CE5FBEc3E9af3971dD833D266A9b5C936f0bE
belonging to Binance. Adding the Omni Layer Tether funds, which account for 98,413,357 dollars, the exchange’s balance equals 755,037,861 dollars. As of July 1st, only by adding Binance’s Tether balance issued on Tron 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 Tron 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... 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... refers to the label Compound USD Coin and represents the USDC treasury of the DeFi provider Compound Labs, Inc. It has a wealth of 204,069,453 dollars in the form

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98 see omniexplorer.info/search/1FoWyxwPjxj6C6abqwhjDwz604PZgYRJA [Last accessed 1 Jul 2020]
99 see wallet.tether.to/richlist [Last accessed 19 Jul 2020]
100 see tronscan.org/#/address/TWd4WrZ9wn84f5x1hZhL4DHvk738ns5jwb [Last accessed 1 Jul 2020]
101 Binance 8 Address: 0xF977814e90dA44bFA03b6295A0616a897441aceC
102 Compound USD Coin Address: 0x39A39c021dfbaE8faC545936693aC917d5E7563
103 see compound.finance/ [Last accessed 19 Jul 2020]
of USDC tokens and holds the largest share of these tokens within the entire ecosystem. In total, \textit{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 \textit{0x7b8...} and \textit{0xBE0...}: Compound’s account at address \textit{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 2\textsuperscript{nd} richest account that belongs to Compound can be found at address \textit{0xf65...}

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 \textit{dYdX} \textsuperscript{105}, \textit{Curve.fi} \textsuperscript{106} and \textit{Uniswap} \textsuperscript{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 \textit{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

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\textsuperscript{104} Compound Tether Address: 0x650C3d88D12dBB855b8bf7D11Be6C55A4e67dCC9  
\textsuperscript{105} dYdX: Solo Margin Address: 0xe0447b19bb6ecfdae1e4ae1694b0c3659614e4e  
\textsuperscript{106} Curve.fi: sUSD v2 Swap Address: 0xa5407eae9ba41422680c2e00537571bc53efb6d  
\textsuperscript{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 5\textsuperscript{th} 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.

0x9AD17F958DF225323335A5D07E7597B6e2C0E68A6 | Tether USD
0xA0b86991c621b36c1d9D4a2e9Ebe0cE3606eB48 | USDC
0xB7547Al609094C44Da8b954De0AC495271d0F | Dai Stablecoin
0x000000000000085d4780B73119b644AE5ecd22b376 | TrueUSD
0xF4bb145d66452a948d725350336f67A623C7C53 | Binance USD
0xFD57e24545E5F0Ecb9a656e29253D4111d87e1 | HUSD
0xC6DE7C39e2B00F0005F157D0fa89eFC2C1Eaa828 | Bitfinex: MultiSig 2
0x0882477e7895bC5ca7eB152ed914aB150eb56 | Proxy for USDC
0x205940BF1F49D1985DD81590d93Bd131c657e01 | Proxy for TUSD
0x8d5fb2eCf6a95623C022A63667950111D51e73E | TrueUSD: Legacy Contract
0x2Bdc9a19a724508BeF3d3C1c0f1f70B309D | HUSD Multisignature
0x0759A67e9077b9375347b4A71c7831E91A28 | Maker: MCD Join DAI
0x197E099FAD81970bA7976f3C8bD7708E5D7cf7 | Maker: MCD Pot
0x35D1b3F3D7966A1DFe207aa5414C12a259A0492B | 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.

0x0000000000000000000000000000000000000000 | DSR
0x794e6e91555438a3e3a9c5076a74ff42133d08d | OasisDEX
0xa1530c4c41b0b0b2bb646cb5ebb67b7158667 | Uniswap: DAI
0x65bf64ff5f512727f1bacad7af53c0776fcd86cd | Kyber: Contract
0x397553577590e7d532d8c45f14ca0a9ae2ae | Eth2Dai: Old Contract
0x5d3a536e4d6dbd114ec1ead35777bab948e3643 | Compound DAI
0x111111254369792b2ca50d8ab5e397e8a8f48b | 1inch.exchange
0xb040b4954593347a162c210ce72931452150 | Disperse.app
0x31e085a98af1d65c1e193153d625f80f514e7f | Kyber: Reserve Uniswap
0x97dec8720136b5f843761090a9d31542878126 | Uniswap: USDC
0x39aa39e021dbae8fac545396939ae917de57563 | Compound USD Coin
0x9a9c40d7f96e4b864e004f686ac829d4a095 | Kyber: Old Contract
0x0404602754f1f39edf65b2a78edba0b8f4514 | BlockFi
0x65b008ee4947ed2a500d7d4ed03d7757c79de0 | Nexo: Wallet
0x32a325b6a1b5badd4a6d280a32d3340d4b5a5e7f | Celsius Network: Contract
0xaf38668f4719ec9452dce030be386e8 proceedings.1
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 \textit{TrueUSD}_\textit{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.

| Transaction Hash | Nametag |
|------------------|---------|
| 0x1b947f74158a8b6e13985620e979b706108d699f959b0f047700acde9f84a383f | - |
| 0x10c46913e9da21b7b6c6ce6f6f7a717db5f6a316392433428bec4ed0a29fe9ba | - |
| 0x695a17a59aad7cc334f24bb2411579c909e66f4b025ec82ede5f3be654f8b5b | - |
| 0xf2a616e8364b06e50ce47da0f81adb07852e5c7f01657dcd32326034a5741 | - |
| 0x963292c3d4c045fcc5092b5175a61773dc76d2de3190f8569777c91df412d | - |
| 0x182a5608c3bcd25215c75aa8906419058e072109bf49a4e60b3226a55b2377 | - |
| 0x0ce49183d32da325c641512844572e60932ab33a2ff1e105821fbbda6cf | - |
| 0x2f05475a016a0f910dab95304968d8c4e8283ddc2f7bbc73ed864b69cdac8 | - |
| 0xce09df3f4689324c343a723d013a5f030a92a117a3a3add89da88de31688 | - |
| 0xb99ffe7797bc01e24f003b44e7b83162c3393ed9da66c0622b735cad4c136d | - |
| 0x2f46b24a0a5a5489dcd2581af0a00820472be107bf60bcbf7058b31a421a2 | - |
| 0xa01f46f693518ada560b08c38b5073cf7ef60895fa1e9e4114c275db7c24827 | - |
| 0xbe0e01abf79ce4f4f106c1924b1541d279501ada82a35db4d8ba885b246279a | - |

4. Addresses that own every Stablecoins analyzed

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

| Address | Nametag |
|---------|---------|
| 0x395e0bd2e6f95c66ba427306c9d5774f4b752aeca | - |
| 0x8d12a197cba0d4747af196e0339095ce2a5ce6819 | EtherDelta 2 |
| 0x3c02e02e04069df790d4f4e63fd297bada1e58f1f | BitFracatic |
| 0x7cd6b0672a477ee0312c6d4e6992e51235ca5f2d | - |
| 0xd77459d138f27a20f2f2e1132c48d6dbd9d8de8 | - |
| 0x41f8d14f947544430a80431e68cf24dec9a8369a | - |
| 0xfa543a0c2ba3e4aebbadab9a8e25b15af5e59d | - |
| 0x81f7f7586c7eda8f8b0b940323a6206ac21f644 | - |
| 0x09d7c893aa8c4b040606a3a244b066a07583542 | dForce: Swap |
| 0x67b9796e085fd47a48c951be533ff104f4f1 | - |
| 0x03ce37856bd08eb47e2de7aeb4add2e19b60f2 | - |
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 |
|----------------------------------------------|-------------|
| 0xc180dafe23a8bf22178babebe7147d21a36b601755654024c92f012ae845dd3e | 1           |
| 0x40b6917430426221587ba17d9a7427d9042d6ed7da9ce8f8b2a766ce9717246891 | 24,999,999  |
| 0x9b279ba338b05f7b2b8e605b5b22b088a327f62907977de2c64375e5fc8f46ce | 25,000,000  |
| 0xf466d5f3abfb512aa4919cedf480f21a093bce8b83bbade59821cf36767e0a0 | 25,000,000  |
| 0x2b2843581cd840763f317982123bd87eced96e88fa78a164774a874ecbbedda | 25,000,000  |
| 0x31bc32a8575f8554d10b6d66a4918a0ff80c5953ebe4f8cd6002889226b8d3 | 1           |
| 0x2b26d1fd199f278a3a83bddd47606f6e6e91f28951a67b26d5b05f52062f244c | 24,999,999  |
| 0x55439eeced3549adcedf6b3d5e2ba34b56e8f0e1928e8a2879f4a5e6c622857 | 25,000,000  |
| 0xa8cfbfe92e95bf69f8f9f673ecfe444e130b1b63e1693369201df3a983b | 25,000,000  |
| 0xa61b1d9e14e57e3958a041b3ea5d701b0f6b19970be5d639055be1ca55bc3e | 25,000,000  |
| 0xc6dab180b4b2e1b37660666775997a0236c7922641ed666d393fece065681a06c6 | 1           |
| 0x50e0af964666a6ae19f1923a155f9056e68ce249b1fd9d3ad5d5017a60efec2c | 24,999,999  |
| 0x1f177a5349ecf26c6147211207ed3da9a570a63d39f881ed9bedf1078b32613 | 25,000,000  |
| 0x0a1776e06347044a34aaffaca2fa5b1e06e4eae9e468f0f2a04dd91caabe3 | 25,000,000  |
| 0xb415f2ef767092a6e3b80207a6f14b80185bff3f53881d7f13f7dd7dc3550e | 25,000,000  |
| 0xb44d2a0659df2cfa21e67736947f9db5e8870f916e8f8915d587f5a5c10787d | 1           |
| 0x969eb3f1e69a4b5e3dc21b27becc352076b6e2e24f362aa7bd43e6ceebec04578 | 24,999,999  |
| 0x12a10529a9d5e3c4713bf318ace7a07f4c29ebdbba26faddef99e7e2572f0f4 | 25,000,000  |
| 0x944a54b16adaa5d443769f7f7962bd8e4a0fc6e768fd50ec95b9acc8d644add77 | 25,000,000  |
| 0x742ca7d841ac5454bd294e4b16da3ae9b043da91a492e8c3d7ad02ea036e6f9 | 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         |
| 0xfa4b5be32f28456703e3d5eb2124274e495a2c58 | Huobi 11         |
| 0x46705df2ff2456421a05d056c29e81bdc09723b8 | Huobi 12         |
| 0x32598293906b5b17c27d657db3ad2e9b33e4265 | Huobi 13         |
| 0x5861b8446a2f6e19a067874c1330f4578928727 | Huobi 14         |
| 0x926f56767fac6ae2d08e2d4734c134a743988 | Huobi 15         |
| 0xeece606a66dcb6f497662ea31b5eb1610da87ab5f | Huobi 16         |
| 0x7ef35bb398ec0416b81b019eaa395219b65c52164 | Huobi 17         |
| 0x229bc50c79f9b53009ca1321ad2034d4b3d95070f6 | Huobi 18         |
| 0xd8a83b72377476d0a66683cedca08aadd0b628713 | Huobi 19         |
| 0x674850f66f6bc6a6fe8db2228b8731f2f2b | Huobi 2          |
| 0x90ede9d9d85d4e43763d0fcf856f97594dea7325 | Huobi 20         |
| 0x189161da9233cb349145a12384075a6e8eb6630cb | Huobi 21         |
| 0x6f48a3e70f9251e83a98962aa2281a6d5380 | Huobi 22         |
| 0xf05f435ba0c4ced2f1b17c3766549f404b94 | Huobi 23         |
| 0x137ad9e4777e1d36e4b605e7458f37b2b62e9c5 | Huobi 24         |
| 0x5401db7da53ec19dbf48ed3e69505815f25f6e6 | Huobi 25         |
| 0x03f854b44d28ec26386c1bc37f9f206c6380b0d | Huobi 26         |
| 0x0577a79ec63bcb0df58383f4e4a3bf2905b404 | Huobi 27         |
| 0xe0ec634cdd915845376fb5407e80951969dd4e8cc | Huobi 28         |
| 0x794d28ac31bcb136294761a556b6862d234094153 | Huobi 29         |
| 0xfd1b16696831753d5331f813c29a93c76834a0bad | Huobi 3          |
| 0xd54078badd565371726c3370a1b27351aaf26 | Huobi 30         |
| 0xb4dcd386ed2db86630c1a11c2b8c4f1851cded9 | Huobi 31         |
| 0xd77a1144dc74f26385b969391a6d33e403d0990 | Huobi 32         |
| 0x28ffe357f8f8df065aace2634778b0ae4c193ad | Huobi 33         |
| 0x0a3c725bce4f1147f8ecbdf744a73a1ca463c3fc | Huobi 34         |
| 0x7358fc2e74302e2be2eda152a326655ace0f2d241b | Huobi 35         |
| 0xeeee28d48028d41a82d01e21d12e278d69920da | Huobi 4          |
| 0x5c985ec89dfe42e6f9eaf19505d1c49ebf73829b | Huobi 5          |
| 0xdc76cd25977e0a5ace7155770273ad58648900d3 | Huobi 6          |
| 0xad2b2b2f6bd965c62409b9ace8681dce4166f94 | Huobi 7          |
| 0xae866e0f8d6578f657b72c081128ae0f735e | Huobi 8          |
| 0x1062a747931987f70f71ce65a582423dabb7e5ab3 | Huobi 9          |
| 0x96d492ed500da5b33ec195a5d610a73360fcaaa0 | Huobi Mining Pool |
| 0xa66daa57432024023db65477ba87d7e75f95213 | Huobi Pool Token |
| 0x6f259637dec74c767781e37bc6133ced6a8fa161 | Huobi Token      |
| 0x03f31eb71485b0a1410307b65a021042c36350 | Huobi: HBTC Token|
| 0x1d1e10e8c66667692f4c002c0eb334c5d485e41 | Huobi: Old Address 1 |
| Address                                      | Huobi: Old Address 10 | Huobi: Old Address 11 | Huobi: Old Address 12 | Huobi: Old Address 13 | Huobi: Old Address 14 | Huobi: Old Address 15 | Huobi: Old Address 16 | Huobi: Old Address 17 | Huobi: Old Address 18 | Huobi: Old Address 19 | Huobi: Old Address 20 | Huobi: Old Address 21 | Huobi: Old Address 22 | Huobi: Old Address 23 | Huobi: Old Address 24 | Huobi: Old Address 25 | Huobi: Old Address 26 | Huobi: Old Address 27 | Huobi: Old Address 28 | Huobi: Old Address 29 | Huobi: Old Address 30 | Huobi: Old Address 31 | Huobi: Old Address 32 | Huobi: Old Address 33 | Huobi: Old Address 34 | Binance: Old Address 1 | Binance: Old Address 2 | Binance: Old Address 3 | Binance: Old Address 4 | Binance: Old Address 5 | Binance: Old Address 6 | Binance: Old Address 7 | Binance: Old Address 8 | Binance: Old Address 9 | Binance Charity | Binance JEX | Binance Token | Binance USD | Binance: BGBP Token | Binance: Contract | Bitfinex | Bitfinex 1 | Bitfinex 2 | Bitfinex 3 | Binance: Contract 1 |
0x31a2feb9b5d3b5f4e76c71d6cf926e46eb3ceb1c1
0x6b71834d65c5c4d8c158f4b47e6e4af4e5437
0x48d466f7c0d32b61e8a82c2d2e0f607c3f966df
0x0536806d512d6cdee13e9f5988686f5b1d3462
0x8d4f5e8557a9c7a7d7f8e8a8c4000d25cb
0xbd2ee7c608a6bfe975bdca79e84d6d34ee21
0xc00e030823e6e828d8f8c9f2636a347e51520ecb
0x65f9b2e4d7a0e40f88e86f544d5a7d257e0
0x36b01066f7a40f8be2968ea0256e48e9135674
0xab11204e2eac24f6a3d2f3a2e0a9bdf0a0d5
0x6795c8e8b25585eac356a32ac6641016550f2
0xfb21731547f25713bc2e0504404efbe021eeae
0x6f803466ecc17f440a198755fc7599a6b4f3825
0xeadd6be34c31594026519f25d81603f69a5cd
0x8a6629e8a41960ea61b8e8c49d095e525b0e55
0x57b989a88b69e6269519d53f6edcb0d176ac
0xf6bc08a66f8b939d2142f69251029f41c04
0x787f5552bdc17332e9aa36074884513e3ce401a
0xa2f71941743e9100ed6d2f77a54825f197148
0x686f7d069b867b0a8ce1d6ae13bb8813552f3
0x2657eca107d7ac2b72c7a07c8e8ef8632c22507
0xd5e3e6f3f6e677bdc31e1757ba453b90d9825
0x5be497a1293268ed9a0ed994398d3067ca
0xf57263953ddd02707cc26b6d920802cd310a01d
0xc7278ad11be5f5326299409d5fe69120563ab
0x4cfc98e1793e4f5a2ce9c622d871e63d61cecb28
0x1098898efacad1e1824ed16052d0f6890bedc87a
0x61fa5d7c04f0d6f853740330b62e3cad34f8bc04
0x0e0e22f4e224d40446c6a94a142dc41fa7672f2
0x36bf21e8c661b21e6166e435f5749116c0ca
0xdf72136e6da6ae959b5960c2046f8b260087bca
0x8f85acce3e76d46a4918fe46503bb51539d554
0x89f5925aa301b2e651c9e2834058ac9b6830835
0x2c71e996928a8e49d5e70176945c56670e798ed
0x56e74d55b2afecf10b38368b900723d9bdc21e1
0x8a38b9999e2c246d893c1013b8edc15506e9a76
0xad91a04df799176a08a7a32a6df33d28479918
0x1e0447b19b66c6d3a1e41e1694006359614e4
0xe0f3d355e072689579226ee7a3b49065a277f7d
0x52f1c952a48a5889aee159d38cfd4bdf30366e60
0x5199071825e1d6cd019b07d74e2b081066f516d
0x84188bb7253b3ac5e58ff3791dd8b4e0480cc2a2
0xf61a3c28463c997c755e70545cd613e1cfd6b9
0x5dd44d695274f72d7d4308597d0ca9b597b094cf
0xa26d16a21805b14a2977555f1e34e56e43b7a
0x059550a1ca3e46a2adb803e9ea3ea4585a34f04a
Poloniex: CVC
Poloniex: FOAM
Poloniex: GNO
Poloniex: KNC
Poloniex: LOOM
Poloniex: MANA
Poloniex: NXC
Poloniex: OMG
Poloniex: REP
Poloniex: SNT
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 Withdrawal

dYdX: ERC20 Position Withdrawal 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

Payable Proxy For Solo Margin

dYdX: Polynomial Interest Setter

Solo Margin

dYdX: Token Proxy

dYdX: Usdc Price Oracle
dYdX: Vault

dYdX: Weth Payout Recipient
dYdX: Weth Price Oracle
ZeroEx V1 Exchange Wrapper
ZeroEx V2 Exchange Wrapper
DydX Expo