STABLE COINS

from electronic money on blockchain
to a cryptocurrency basket

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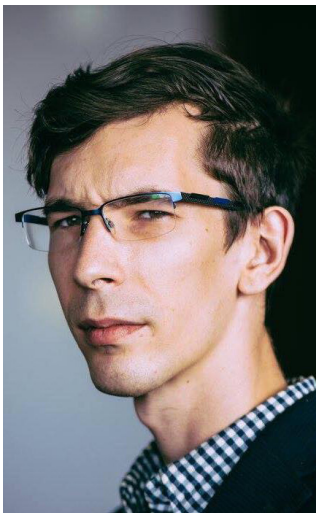


As the digital currency market gets more mature, cryptocurrencies with relatively stable exchange rate have turned into a separate part of the digital tech industry.

Stablecoins are the industry's answer to the problem of extreme volatility. Of course it's arguable that the high volatility is a deteriorating factor as it drove new players to the market, especially in its early days, and helped them accumulate their capital base. This money were later reinvested in the infrastructural development of digital currencies.

Still, the faster the industry grows, the more burning gets the question of intermediary means of exchange and profit taking. At the moment, most market players use fiat currencies for this purpose. This order of things is controversial to some, and instigates the search for a perfect stablecoin.

We were not focused on the difference between the ideologically-driven perception of stablecoins and the search for a perfect digital assets as the notion of stability per se may be quite arbitrary.

The key goal of this research is in analyzing the most important stablecoins that actually exist. After reading this research, you will have a profound insight into this part of the industry. In case a technological and economical breakthrough occurs, it may become the foundation of our civilization's new digital economy.

Toly Kaplan,
CEO

The fundamental theory of money doesn't need the concept of nation state as a prerequesite for describing nature, essence, and functions of money. Yet, the emergence of national and supranational monies is a necessity, not an accident. Cryptocurrencies can be either private, national, and supranational. Open public blockchains became the testing ground for the experiments unaffordable to the conservative national monetary system. The teams and communities behind all stablecoin projects have my gratitude and respect for their courage and persistance in experiments that drive the evolution of money forward.

This research was initially conceived as a small report but as the number of projects grew, so did this work until it turned into a small book. I'm happy that the description of stable cryptocurrencies used here may become partly or completely obsolete by the time this work is published. This would mean that stablecoin evolution never stopped. I hope that in terms of characterizing the main types of stablecoins, their classification, describing their development logic, and the methodology of assessing their successfulness this report remains useful to both theorists and practitioners.

Dmitry Bondar,
Head of Research

Abstract

Volatility of bitcoin and other cryptocurrencies prevents them from being used in the capacity of money. Along with the tools that may mitigate the currency risk of using the existing cryptocurrencies, the industry develops new cryptocurrencies intended and designed to have low volatility against a certain asset, which acts as an anchor. Such cryptocurrencies are generally called stablecoins.

There are different ways of making the exchange rate of a cryptocurrency stable. In the traditional way, the issuer of the stablecoin must exchange it for the anchor asset at a fixed rate. In this case, fiat currencies or precious metals can be said anchor. This is classic e-money placed on blockchain: bills are issued and redeemed in a centralized fashion and require trust to the issuer. In order to reinforce trust, the issuers develop different systems of proving their bills are fully backed by relevant assets.

Smart contracts allow for creating smart trustless banknotes, such as Contracts for Difference (CFD) backed by cryptocurrencies on the same blockchain. Smart banknotes may be pegged to any asset or basket of assets, yet they are redeemed by collateral cryptocurrencies. Both native and non-native tokens may act as a collateral. Unlike traditional e-money on blockchain, smart banknotes can be issued and redeemed in a decentralized fashion, and don't require the trust for the issuer as their collateral is controlled by the smart contract. However, there is a need for the trust for the providers of price feeds that are employed to calculate the extent of backing and the redemption price of said stablecoins, as well as the trust to the users that operate the system.

A stable exchange rate can be attained not through full backing and stable redemption price but also through targeting the market price. Instead of the obligation to redeem the stablecoin at a predetermined rate, the issuer may promise to hold currency interventions and use other monetary policy tools to cause the stablecoin's price to fluctuate within a narrow range against the anchor asset. The counterparty risk related to the need for trust to the monetary authorities that operate the stablecoin may be mitigated via algorithmization of their monetary policy.

Stablecoins with full backing and fiat stablecoins are the two extremities, and stablecoins with partial reserves are somewhere in the middle. The latter don't have a stable redemption price but they have a currency reserve that is used for their repurchasing on the open market. The repurchase may happen only if the market price drops below the target price, or at the price that changes pursuant to a certain algorithm. Managing the off-chain reserve re-

quires one to trust the person who controls it, while the cryptocurrency reserve may be managed by a smart contract.

Stablecoin may not have full backing but have a stable redemption price. Vouchers can act as such as they are the obligations of the issuer to provide certain commodities for a predetermined amount in national currency.

A cryptocurrency basket is popular as an investment item but not as money. So far, there is only one notable project positioning a cryptocurrency basket as a stablecoin. A stablecoin basket allows one to diversify risks related to a certain stablecoin project.

Stablecoins differ not only in their extent of backing but in other criteria as well: the kind of the collateral, its location and way of operation, the pegging object and the way to attain the target exchange rate, the stablecoin's emission channel, and the blockchain where it has its circulation. Just like cryptocurrencies in general, stablecoins tend to be decentralized and trustless. Some projects want to make their stablecoin more in line with the global nature of cryptocurrencies by pegging them to a basket of fiat currencies instead of just one. The evolution of stablecoins generally repeats the evolution of money and the global currency system. Thus, the conceptual focus moves from fully backed stablecoins to fiat stablecoins. The cryptocurrency basket that could be compared to ECU or SDR is yet to be created.

Over their short history, stablecoins have proved that they can play the role of a safe haven for the cryptocurrency market and have a stable exchange rate against their anchor. The data and the methodology used herein allow us to say that e-money on blockchain have the most stable price. However, even some fully backed stablecoins are more volatile than some fiat stablecoins, while some cryptocurrencies positioned as stablecoins are more volatile than bitcoin.

Introduction

General problem statement

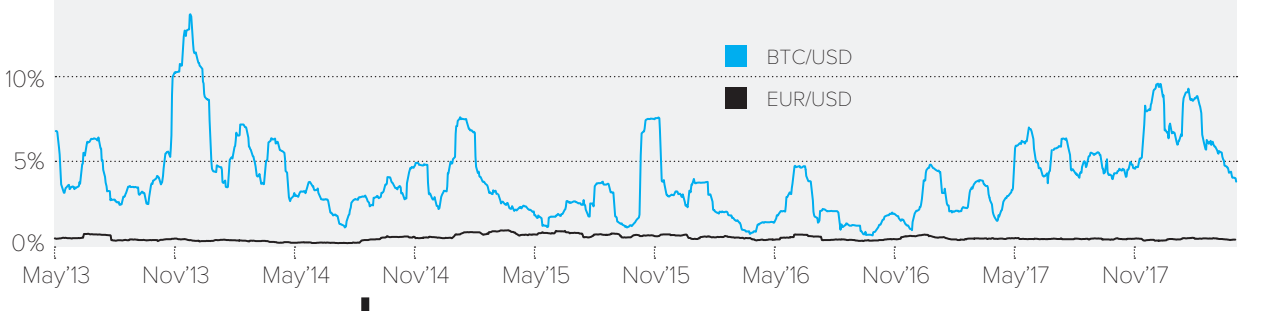
Bitcoin as a p2p electronic cash system has removed the third party risk inherent in centralized digital money systems. However, the users of bitcoin and other cryptocurrencies[1] with non-elastic supply soon had to face the risk that wasn't even mentioned in Bitcoin white paper[2] even though this risk's impact on the use of cryptocurrencies can hardly be overestimated. This is a typical currency risk — the risk of exchange rate fluctuation.

[1] Here and elsewhere, "cryptocurrencies" means private cryptocurrencies, unless specified otherwise.
[2] Nakamoto S. Bitcoin: A Peer-to-Peer Electronic Cash System // https://bitcoin.org/bitcoin.pdf.

The risk of losses due to adverse changes in the exchange rate deteriorates the interest in cryptocurrency for buyers and sellers, as well as for creditors and borrowers. Miners, traders, holders and participants of ICOs, long-term contract counterparties, payment processors, international remittance services, users of decentralised apps and regular bitcoin users that employ it as a store of value, they all bear that risk in some form.

The BTC/USD volatility is still much higher than that of EUR/USD, even though it decreased in 2016.

FIGURE 1.
Volatility of BTC/USD and EUR/USD exchange rates



Sources: https://coinmarketcap.com/currencies/bitcoin/, https://finance.yahoo.com/quote/EURUSD=X?p=EURUSD=X.

Stablecoins' backstory

There are several ways to insure against bitcoin price surges.

The simplest way is to convert your bitcoins into fiat the moment you receive them. This service is the foundation for payment processors: they take the currency risks of merchants that sell goods for BTC. In this case, the merchant never deals with bitcoins: it's the processor who accepts bitcoin payments, sells them for a national currency and then transfers it to the merchant's bank account. If the merchant needs bitcoin later, he or she will have to buy it for fiat.

For those who don't want to use their bank account and buy bitcoins in the future, there are services offering their customers to freeze the bitcoin price on a lock account. Such services, just like payment processors, sell bitcoins frozen on the lock account for a national currency but do not transfer them to the user's bank

account. Instead they store the money on their own account and guarantee that, at the customer's request, they will buy bitcoins for it and transfer them to his or her address. Thus the customer may get bitcoins for a predetermined amount of national currency.

Companies selling bitcoin vouchers allow one to freeze the bitcoin price without the need to have neither a bank account nor a bitcoin wallet. The customer buys a voucher for fiat, and thus purchases the obligation of its issuer to provide him or her with bitcoins for a predetermined amount of national currency. The customer will have to install a wallet only when he or she decide to redeem the voucher.

Those ways of insuring against bitcoin price fluctuations require the user to get rid of BTC, forever or for a while, and to trust a third party service. A futures contract insures from currency risk and allows one to retain control over their BTC. This tool guarantees BTC will be sold in the future at the price determined today. However, if you use a centralized exchange for that purpose, the risks of trusting a third party service remain.

The development of means to insure against currency risk for non-elasctic supply cryptocurrencies isn't the only way. The alternative is to create elastic supply cryptocurrencies intended to have low price volatility.[1] Those cryptocurrencies are called stablecoins.

[1] Buterin V. The Search for a Stable Cryptocurrency // https://blog.ethereum.org/2014/11/11/search-stable-cryptocurrency/; Larimer D. Stable Currencies are Impractical and Undesirable // http://bytemaster.github.io/article/2014/12/31/Stable-Crypto-Currencies-are-Impossible/.

Research objective

Even though stablecoins have been in use for years, there is no comprehensive source of data about them. In order to conceptualize a stablecoin one has to read its white paper and official website, browse through media reports and social network discussions, and read the market data aggregators. There are virtually no researches in this area[2]. The mission of this research is to fill that gap at least partially, and to review the basic types of stablecoins existing today, as well as to assess their ability to attain a stable exchange rate.

[2] In spring 2018 brief reviews of stablecoins were published on Hackermoon and Medium: Qureshi H. Stablecoins: designing a price-stable cryptocurrency // https://goo.gl/yH6BEJ; Glazer P. An Overview of Stablecoins // https://goo.gl/WuL7eT; Schor L. Stablecoins Explained // https://goo.gl/jQ8dqR; Wittayatanaseth N. Stablecoins: De-Risking Non-Collateralized Stablecoins // https://goo.gl/6NJMgs.

Basic criteria of stablecoins classification

This report uses the way of stablecoins backing as the basic criterion for their classification. Any stablecoin is pegged to a certain asset in some way, but not every stablecoin is backed by it.

The very term "backing" is used in different contexts. It may mean the collateral provided by the borrower to the creditor. "Banknote backing" means a reserve that a bank uses to redeem its credit money[3]. In this case, a banknote holder as the bank's creditor doesn't have any collateral. The only thing that could count as a collateral is kept by the borrower. Banknotes can be fully backed by bank reserves, or only partially.

[3] This report uses the traditional understanding of a banknote as a bank promissory note, even though there are other approaches as well. For instance, a banknote can be treated as a warehouse receipt, which is popular amongst the followers of the Austrian school (Rothbard M. State and Money: How State Took Over Society's Monetary System (in Russian), 2008, pp. 52–67)

According to the former head of the Fed Alan Greenspan, bitcoin doesn't have any backing and "there is no fundamental means of 'repaying' it by any means that is universally accepted"[1]. The statements of monetary authorities in post-Soviet countries, like Russia or Ukraine, often imply that bitcoin, unlike national currencies, "doesn't have any backing with real value"[2] and altogether "lacks backing"[3]. Therefore, they imply that national fiat currencies have some backing, even though it can't be a collateral or a reserve.

The issuer of any contemporary national currency doesn't undertake to redeem it with any asset at a fixed or floating rate. In this sense, not only bitcoin but also "U.S. dollar, the euro, and the Swiss franc, have no intrinsic value either"[4]. The only thing guaranteed by the issuer of a national currency is the status of a legal tender, i.e. the principal ability to use it as the means of effecting an official payment. Additionally, the issuer may prohibit the use of any other currency on their territory. Indeed, cryptocurrencies don't have this kind of backing.

However, for the purposes of this research, "backing of stablecoins" doesn't mean the opportunity to exchange the cryptocurrency for goods or other currencies, or the status of a legal tender. We assume that a stablecoin is backed if there is a collateral or a reserve that can redeem it regardless of the way they are stored or redeemed. Stablecoins with a 100% backing (or over 100% backing) are deemed those with full backing, while the rest are considered as ones without full backing.

[1] Greenspan Says Bitcoin a Bubble Without Intrinsic Currency Value // https://www.bloomberg.com/news/articles/2013-12-04/greenspan-says-bitcoin-a-bubble-without-intrinsic-currency-value.
[2] Comments on the legality of using virtual currency/cryptocurrency Bitcoin in Ukraine (in Ukrainian) // http://www.bank.gov.ua/control/uk/publish/article?art_id=11879608.
3 On the usage of virtual currencies, such as Bitcoin, in transactions (in Russian) // http://www.cbr.ru/press/PR.aspx?file=27012014_1825052.htm.
[4] Berentsen A., Schär F. A Short Introduction to the World of Cryptocurrencies, p. 9 // https://files.stlouisfed.org/files/htdocs/publications/review/2018/01/10/a-short-introduction-to-the-world-of-cryptocurrencies.pdf.

Methodology

In order to estimate a stablecoin's ability to ensure a stable exchange rate we use the following criteria:

— arithmetic mean and median values of exchange rate;
— minimum and maximum values and the range of exchange rate;
— standard deviation of exchange rate;
— average 30-day standard deviation of exchange rate;
— exchange rate coefficient of variation;
— average 30-day coefficient of variation of exchange rate;
— density function of exchange rate;
— arithmetic mean and median values of exchange rate's daily change;
— maximum and minimum values of daily exchange rate changes;
— standard deviation of daily exchange rate change;
— average 30-day standard deviation of daily exchange rate changes.

In order to calculate said parameters we used the data from day one of stablecoins to April 30th, 2018. We used the history of exchange rates, daily exchange trading volume and capitalisation as presented on CoinMarketCap.

In order to make the descriptive statistics for BITGOLD, GBG and XAUR exchange rates compatible, they were all pegged to 1 gram of gold for the purposes of this research, though it should be noted that in actuality they are pegged to different amounts of gold. The appendices hereto provide the descriptive statistics for BITGOLD and GBG raw exchange rates, while the XAUR exchange rate was divided by 8,000 for the values before its migration to Ethereum in order to make it comparable to the values after the migration.

In order to build charts for density function, which allows one to estimate deviations of the market exchange rate from their target rate, we used the Scaled Kernel Density Estimation. In order to build charts for density functions of gold-pegged stablecoin exchange rates, we used 1 gram of gold as the target price. In order to express those coins' price in gold equivalent, their USD prices were converted to 1 gram of gold and divided by the price of 1 gram of gold in USD as of the same date.

To compare the rates of increase of gold-pegged stablecoins exchange rates and that of actual gold, the data for the price of gold were given for the same time period as the data for the exchange rate of the stablecoin that was being compared to it.

The daily change of exchange rate is the rate's daily rate of increase in per cent.

While estimating the daily changes of XAUR exchange rate we didn't take into account the price change on August 22nd, 2016 as it was related to the switch for a new scale of prices after migrating to the Ethereum blockchain.

Arithmetic mean and median values for daily rate changes has been calculated from daily rates of price growth in modulus. The resulting value was used to calculate the standard deviation for daily rate fluctuations.

Volatility charts for stablecoins reflect the 30-day standard deviation of daily price changes. The average volatility is the arithmetic mean for 30-day standard deviations of daily price changes.

In order to calculate daily price fluctuations and build volatility charts for stablecoins that have several values per day, we used only the latest value for each day.

The TUSD volatility chart reflects 7-day standard deviation for daily price changes as the market history of TUSD stars only on March 6th, 2018. In the appendices, the columns "Average 30-day standard deviation" and "Average 30-day coefficient of variation" for TUSD and HAV provide 7-day average values instead of 30-day average ones.

We also compared stablecoins in terms of daily exchange turnover using the following criteria:

— arithmetic mean and median values of daily exchange trading volume;
— minimum and maximum values and the range of daily exchange trading volume;
— standard deviation of daily exchange trading volume;
— average 30-day standard deviation of daily exchange trading volume;
— coefficient of variation for daily exchange trading volume;
— average 30-day coefficient of variation for daily exchange trading volume;
— arithmetic mean and median values of daily change of exchange trading volume;
— maximum and minimum values of daily exchange trading volume changes;
— standard deviation for daily change of exchange trading volume;
— average 30-day standard deviation of daily exchange trading volume changes;
— velocity of exchange turnover.

The velocity of exchange turnover is the relation of daily exchange trading volume to the supply of stablecoin on the same day. The supply of stablecoin is the product of the current number of stablecoins by the coin's current USD price. In order to calculate the velocity of exchange turnover for stablecoins whose data contain several values for the same day, we used only the latter value for the day. The

average velocity of exchange turnover for a set of stablecoins (e.g. a set of USD-pegged stablecoins) is the arithmetic mean value for their velocities of exchange turnover.

We used the data for the following cryptocurrencies to build the charts of total daily exchange trading volume of stablecoins: USDT, TUSD, BITUSD, HERO, SBD, DAI, USNBT, MNX, XAUR, BITGOLD, GBG, BITEUR, BITCNY. There are no data on GBG market capitalization on CoinMarketCap or any other public source, so the data for GBG was not accounted for in the total market capitalization and total average velocity of exchange turnover charts.

Dollar stablecoins are cryptocurrencies pegged to USD at a fixed or increasing target rate. We used the data for the following cryptocurrencies to build the charts of exchange trading volume and average velocity of exchange turnover of dollar stablecoins: USDT, TUSD, BITUSD, HERO, SBD, DAI, USNBT, MNX.

Gold stablecoins refer to cryptocurrencies pegged to gold at a fixed or increasing redemption price. We used the data for XAUR, BITGOLD and GBG to build the charts of daily exchange trading volume of gold stablecoins. As there is no data for GBG market capitalization history, only XAUR and BITGOLD data were used to build the charts.

In order to estimate the dependency between stablecoin exchange rates and those of BTC, LTC, ETH, EOS, XMR, DASH, ZEC, XRP, and CRIX index we used the Pearson's correlation coefficient. Historical series were found to be non-stationary pursuant to the augmented Dickey-Fuller test, and transformed into stationary ones via taking first differences. In table F, the correlation coefficient is calculated for the period from December 20th,2017 to April 30th, 2018. In table G, it was calculated for the period of co-existence of each pair of currencies. For DAI and TUSD, the correlation was calculated from the start of their market history, i.e. December 27th, 2017 and March 6th, 2018 respectively.

1 Stablecoins with full backing

1.1. Electronic money on blockchain

1.1.1. Backing by national currencies

The high volatility of cryptocurrency usually implies significant fluctuations of their exchange rates against national currencies in a short span of time. In this case, a zero-volatility cryptocurrency is the one that can be exchanged for the same amount of fiat at any time. E-money on blockchain meet this criterion the best.

According to the European Parliament's definition, electronic money is "monetary value as represented by a claim on the issuer which is: (i) stored on an electronic device; (ii) issued on receipt of funds of an amount not less in value than the monetary value issued; (iii) accepted as means of payment by undertakings other than the issuer"[1].

As the very term of monetary value is not well defined, for the purposes of this research we define e-money on blockchain as a digital claim on the issuer denominated in fiat currency or other asset that exists as a record on blockchain and issued upon the reception of money to the extent of no less than the amount of obligations, and is accepted as a means of payment by someone other than the issuer.

Such stablecoins can be exchanged for a fixed amount of fiat currency at any time because their issuer undertakes to redeem them with national currencies at a fixed rate. For that purpose, the issuer provides them with a 100% reserve in fiat currency that is stored on their bank account.

This kind of stablecoins is represented by ***Tether[2] (USDT)*** and ***TrueUSD[3] (TUSD)*** on the Ethereum blockchain.

The USDT token which is fully backed and redeemed by US dollars at the fixed rate of 1:1 was launched in 2015 on the Bitcoin blockchain. In late 2017 it also entered the Ethereum blockchain.

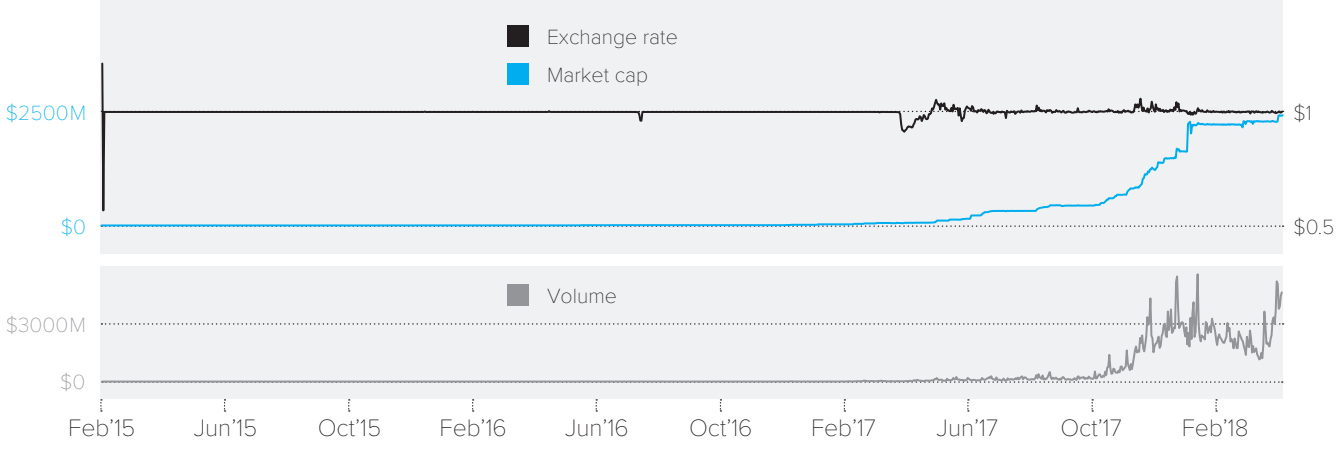
[1] Directive 2000/46/EC of the European Parliament and of the Council of 18 September 2000 on the taking up, pursuit of and prudential supervision of the business of electronic money institutions, p. 40 // http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32000L0046&from=EN.

[2] Tether // https://tether.to/.

[3] TrueUSD // https://www.trusttoken.com/trueusd/.

FIGURE 2.
USDT/USD exchange rate, market cap and daily exchange trading volume of USDT

The project also plans to introduce it to the Litecoin blockchain, and start using Lightning Network[1].



Sources: https://coinmarketcap.com/currencies/tether/.

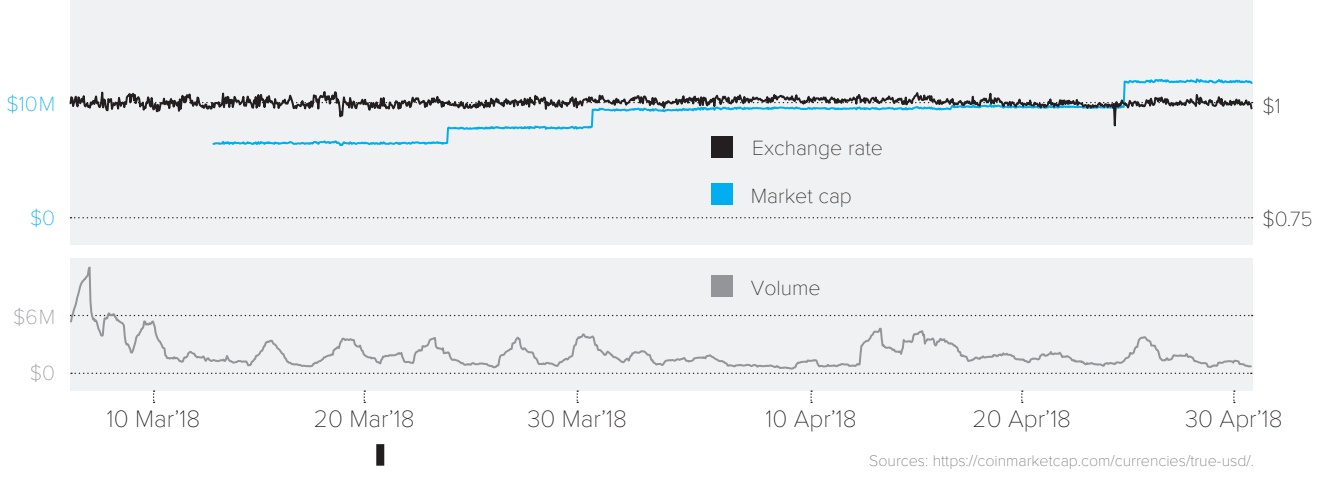
[1] Tether Update // https://tether.to/tether-update/.

[2] Suberg W. Tether's Bank Problems Create Unease As Token Value Slides Below $1 // http://catcut.net/ygNv.

USDT is the most popular stablecoin. Its maximum daily exchange trading volume comprised $5824.15 million, which at the time was 2.59 times more than the amount of USDT in circulation. For two years USDT rate was stable until it faced credibility crisis[2] in late April 2017 which affected its exchange rate. Notably, the crisis didn't led to USDT capitalization decline. After the exchange rate returned to $1, the capitalization began to grow rapidly along with the daily exchange trading volume.

The market history of TUSD starts March 6th, 2018. Still, thanks to four issuances, in less than two months its supply increased to $11.93 million, and maximum daily exchange trading volume comprised $11.13 million, which is 1.7 times more than the number of TUSD actually in circulation at the moment.

FIGURE 3.
TUSD/USD exchange rate, market cap and daily exchange trading volume of TUSD



Sources: https://coinmarketcap.com/currencies/true-usd/.

Table 1 compares the efficiency of USDT and TUSD in attaining a stable exchange rate, as well as the extent of exchange trading with said stablecoins.

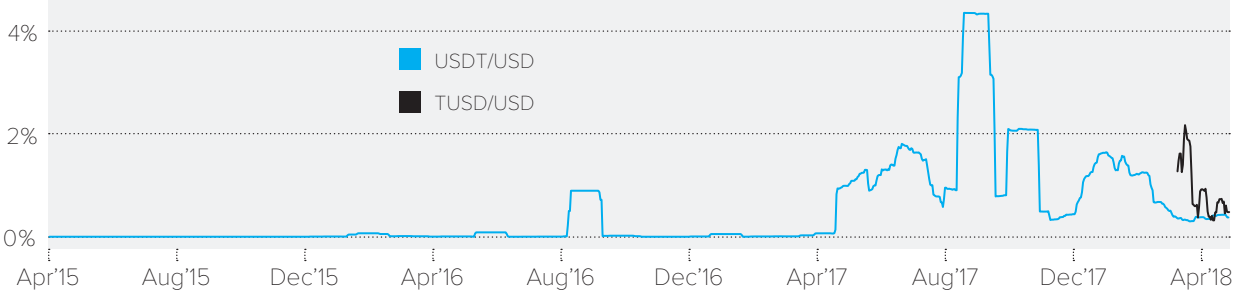
TABLE 1.
Descriptive statistics for price and daily exchange trading volume of USDT and TUSD

	Minimum	Maximum	Range	Mean	Median	Standard Deviation	Average 30-Day Standard Deviation
USDT/USD, $	0.5725	1.2100	0.6375	0.9999	1.0000	0.0175	0.0040
TUSD/USD, $	0.9523	1.0220	0.0697	1.0010	1.0010	0.0069	0.0063
Daily trading volume of USDT, $million	0.0000	5842.1500	5842.1500	376.6531	1.0099	929.1300	130.9133
Daily trading volume of TUSD, $million	0.5266	11.1300	10.6034	2.1010	1.6220	1.4457	1.5631

Sources: https://coinmarketcap.com/currencies/tether/, https://coinmarketcap.com/currencies/true-usd/.

Daily fluctuations of USDT and TUSD prices comprised 0.28 and 0.64 per cent respectively, while the average volatility comprised 0.47 and 0.89 per cent respectively.

FIGURE 4.
Volatility of USDT/USD and TUSD/USD exchange rates



Sources: https://coinmarketcap.com/currencies/tether/, https://coinmarketcap.com/currencies/true-usd/.

Usually the price of e-money redemption is set at 1:1, however, there are fees involved in its purchase, transactions, and redemption. Stablecoins may have the same redemption price, yet the fees associated with their use may differ.

TABLE 2.
Purchase, transaction, and redemption fees of USDT, TUSD and USD.DC

	Purchase/redemption fee, fee currency	Transaction fee, fee currency	Blockchain
Tether (USDT)	Purchase: 0.1% but at least $20. Redemption: at 0.1% but at least $20.	Miner fee (BTC) but transactions from tether.to wallets are free (paid by Tether Limited).	Bitcoin (Omni protocol).
TrueUSD (TUSD)	Purchase: 0.1% but at least $75. Redemption: 0.1% but at least $75.	Miner fee (ETH) + 0.1% in TUSD, the fee is in TUSD will be charged only once TrustToken platform is launched.	Ethereum (ERC20 Token Standard).

Decentralized Capital (USD.DC)	Purchase: miner fee of 0.003 ETH + 0.2% in currency of the payment + Crypto Capital fee of $5. When buying for BTC only the miner fee of 0.003 ETH and the bitcoin transaction fee are charged. Redemption: miner fee of 0.003 ETH + 0.2% in currency of the payment + Crypto Capital fee (starting $10).	Miner fee (ETH) but transactions between USD.DC accounts are free (paid by Decentralized Capital)	Ethereum (ERC20 Token Standard).

Sources: https://tether.to/fees/, https://blog.trusttoken.com/trueusd-faq-18dbc563fb67, https://decentralizedcapital.com/#!/fees, https://cryptocapital.co/fees.html.

E-money is a promissory note of their issuer, and therefore entail a credit risk (the borrower's default risk). Using those stablecoins requires one to trust the ways of proving the presence of a 100% reserve offered by the issuers, as well as the consent to use the service as described in Terms of Service.

TABLE 3
Full backing proofs for USDT, TUSD and USD.DC, their Terms of Service

	Method of proving the presence of a 100% reserve	Features of Terms of Service
Tether (USDT)	The Tether website has a link to issuing addresses and the data on the state of the reserve accounts without any links that would enable one to check them. The project's documentation suggests only that Tether Limited has accounts in Taiwan-based banks Cathay United Bank and Hwatai Bank and works with additional partner banks in other jurisdictions.	"Tethers are not money and are not monetary instruments. They are also not stored value or currency. There is no contractual right or other right or legal claim against us to redeem or exchange your Tethers for money."
TrueUSD (TUSD)	TrueUSD's FAQ gives a link to the issuance smart contract that issues TUSD when USD comes to the escrow deposit, and burns TUSD when USD is withdrawn. The same FAQ reads that, for the sake of greater security, all reserves on escrow accounts are processed by partner trust companies while the TrueUSD team has no way to access the reserves. The website also mentions audits by leading auditor companies on a regular basis, however, there are no links that could confirm it.	"TrueUSDs are not money, legal tender, and are not monetary instruments. They are also not stored value or currency." "You and we agree that any party hereto may bring claims against the other only on an individual basis and not as a plaintiff or class member in any purported class or representative action or proceeding." "We reserve the right to refuse registration to, or to bar transactions from or to, anyone from or in jurisdictions that do not meet international AML–CTF standards as set out by the FATF; to anyone that is a Politically Exposed Person within the meaning of the FATF's 40 Recommendations; or that fails to meet any of our customer due diligence standards, requests, or requirements."

Decentralized Capital (USD.DC)	The DC website provides the issuance addresses and the data on reserve accounts that one can check via the Crypto Capital's API, which services those accounts.	"By using the services you agree with Crypto Capital terms of Service." "If the registered user violates this agreement, Decentralized Capital reserves the right to limit the activity of the account and to confiscate any DC assets they may have."

Sources: https://wallet.tether.to/transparency, https://tether.to/wp-content/uploads/2016/06/TetherWhitePaper.pdf, https://tether.to/legal/, https://blog.trusttoken.com/trueusd-faq-18dbc563fb67, https://blog.trusttoken.com/trueusd-a-usd-backed-stablecoin-you-can-trust-9688796cfd0d, https://www.trusttoken.com/trueusd/, https://truecoin.com/terms-of-use.pdf, https://decentralizedcapital.com/#!/tokens, https://decentralizedcapital.com/#/reserves, https://decentralizedcapital.com/#/legal.

Issuance of e-money backed by national currencies doesn't necessarily use Bitcoin and Ethereum, as exemplified by ***OPEN.USD***, ***OPEN.EUR*** and ***OPEN.CNY*** issued by OpenLedger[1] on BitShares blockchain[2], as well as promissory notes of ***Ripple*** gateways[3] denominated in national currencies[4].

The launch of ***Stably***[5] is planned for several networks at once. "Stably is a reserve-backed stablecoin that is designed to work across multiple blockchain protocols which will initially include Ethereum and Stellar."[6] Launching Stably on several blockchains will enable payments between these blockchains. A cross-chain API will save the user from the need to have wallets for all blockchains involved in his or her payments in Stably. "API will allow the user to seamlessly spend their Stably tokens across these different blockchains apps, with cross-chain atomic swaps implemented in our backend."[7] The token will be pegged to USD and fully backed with USD reserves, however, initially it will be issued for individual customers only in exchange for ETH. The customer will have to send ETH to the smart contract, which then sends ETH to the exchange, where this amount is sold for USD. The dollars then go to the reserve account at a bank, and the smart contract issues the amount of Stably equivalent to the received reserve and sends it to the buyer. In order to redeem Stably, one has to send tokens to the smart contract, and the equivalent amount of USD is sent from the reserve to buy ETH at an exchange, and then the ETH amount goes to the user. The smart contract then burns the tokens in question and sends ETH to the user.

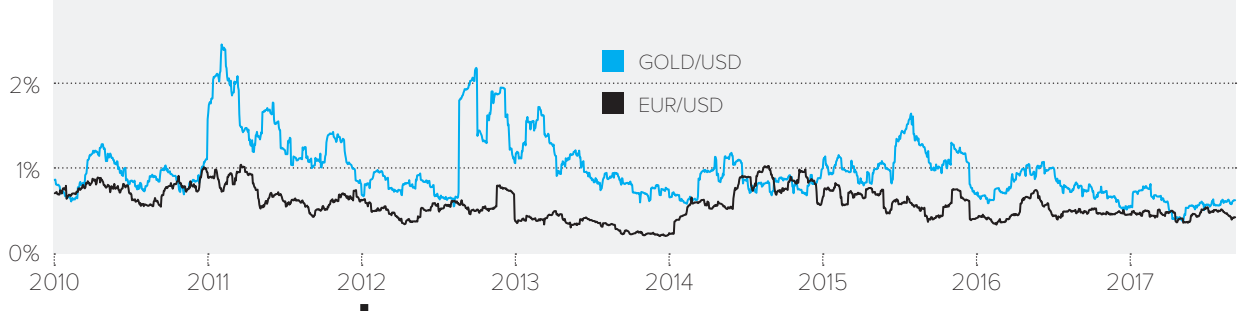
As a part of ***GEO***[8] they develop a decentralized platform enabling one to deploy payment gateways and transact e-money without the involvement of blockchain and the need for network nodes to store the full history of transactions through all nodes.

[1] OpenLedger DC // https://openledger.io/create-account.
[2] OPEN.USD // http://cryptofresh.com/a/OPEN.USD; OPEN.EUR // http://cryptofresh.com/a/OPEN.EUR; OPEN.CNY // http://cryptofresh.com/a/OPEN.CNY.
[3] Ripple Gateway Guide // https://ripple.com/build/gateway-guide/.
[4] XRP Charts // https://xrpcharts.ripple.com/#/trade-volume.
[5] Stably // https://www.stably.io.
[6] Stably: A Transparent Reserve-Backed Stablecoin For Multiple Blockchain Protocols, p. 1 // https://docs.wixstatic.com/ugd/a1dd13_9bf442f027a046df803b62310c0f6e54.pdf.
[7] Ibid., p. 10.
[8] GEO Project // http://geo-project.github.io/.

1.1.2. Backing by precious metals

FIGURE 5.
Volatility of gold price in USD and EUR/USD exchange rate

Gold is the traditional store of value. Even though its price is more volatile than the EUR/USD exchange rate, it is not a promissory note and has value beyond the will of monetary authorities.



Sources: https://www.quandl.com/data/LBMA/GOLD-Gold-Price-London-Fixing, https://finance.yahoo.com/quote/EURUSD=X?p=EURUSD=X&guccounter=1.

As gold is often considered a safe haven, cryptocurrencies fully backed with gold are also considered stablecoins. The first ICO on Ethereum was to launch a gold-backed stablecoin dubbed ***Digix Gold Token (DGX)***, which was created by Digix DAO[1]. One DGX token equals 1 gram of gold, which is stored in the vaults of a Singapore-based company The Safe House[2].

The issuance of DGX is decentralized. It means that anyone can mint DGX out of Digix Gold Asset Cards[3] (DGAC) sold at Digix Marketplace for cryptocurrencies and national currencies.

DGAC is the incarnation of Proof-of-Asset protocol developed by Digix. This digital asset is a set of papers on a particular gold bar bought at Digix Marketplace that is "transparently and permanently uploaded onto IPFS/Ethereum and be kept in your Ethereum Wallet"[4]. The set includes an receipt, electronic digital signatures of the gold bar's supplier, the depository storing said bar, and the auditor checking the vault once every quarter, as well as some other documents[5].

Thus, DGAC is not a promissory note of the issuer who undertakes to provide the client with a certain amount of gold, but a document certifying the property rights for a particular gold bar. "Digix functions as a tradtional bullion reseller and provide custodial services for your gold assets."[6]

Digital Gold Asset Cards are a transferable but non-divisible asset, while DGX can be divided into 1000 parts, so the minimum transaction amount in DGX is equivalent to 0.001 grams of gold.

Redemption of DGX with actual gold takes two phases. The first one is "recasting Digix Gold Tokens into Digix Gold Asset Cards"[7]. As DGAC are property titles for 100 gram gold bars, one can redeem only the amount of DGX proportional to 101. It happens because "recasting" requires one to pay a 1% fee. Phase two is about sending

[1] Digix Global // https://www.dgx.io/.

[2] Where is the Gold bars held? // https://digix.groovehq.com/knowledge_base/topics/where-is-the-gold-bars-held.

[3] Eufemio A. C., Chng K. C., Djie S. Digix's Whitepaper: The Gold Standard in CryptoAssets, p. 5 // https://dgx.io/whitepaper.pdf.

[4] Can I trade Digix tokens or assets at Digix? // https://digix.groovehq.com/knowledge_base/topics/can-i-trade-digix-tokens-or-assets-at-digix.

[5] Eufemio A. C., Chng K. C., Djie S. Digix's Whitepaper: The Gold Standard in CryptoAssets, p. 2 // https://dgx.io/whitepaper.pdf.

[6] Can I trade Digix tokens or assets at Digix? // https://digix.groovehq.com/knowledge_base/topics/can-i-trade-digix-tokens-or-assets-at-digix.

[7] Eufemio A. C., Chng K. C., Djie S. Digix's Whitepaper: The Gold Standard in CryptoAssets, p. 6 // https://dgx.io/whitepaper.pdf.

a request to Digix to provide physical gold, which happens at the custodian's office. At this point, one has to pay a fee for the storage of the bar and the redemption fee for DGAC[1].

In Austrian School banknote is typically considered a warehouse receipt, not as issuer's debt obligation.[2] DGX token is this "Austrian banknote". It's the derivative of DGAC, which is a kind of warehouse receipt, not the issuer's promissory note. As DGX is an "Austrian banknote" storing this stablecoin has additional costs: its holder is charged with demurrage, i.e. the payment for storing the gold with which the token is backed.

Another Ethereum-based stablecoin backed with gold is called ***Xaurum (XAUR)***. "Xaurum is a representative cryptocurrency based on an increasing amount of gold."[3] Unlike DGX, the amount of gold that backs every XAUR unit increases from time to time[4]. Therefore, XAUR doesn't have a fixed price of redemption. This stablecoin is not the issuer's promise to provide a certain amount of gold, but the obligation to provide a share of gold reserves that is equivalent to the share of the redeemed XAUR in the total supply of the token.

According to the creators of Xaurum, backing a cryptocurrency with physical gold requires "centralized control over money creation (coinage) and destruction (melting)"[5]. XAUR issuance and their gold backing are controlled by Auresco Institute[6], which in its turn is controlled by Xaurum Foundation[7]. Two issuance mechanisms of XAUR are called mining and minting, though those terms have an uncommon meaning.

"Xaurum mining is done by mining other cryptocurrencies for value, exchanging their value for gold, and issuing Xaurum."[8] The profits from the special Goldmine multi-pool buy gold, which is then used to back newly minted XAUR paid to miners.

XAUR minting happens in exchange for fiat and cryptocurrencies transferred to Masternodes[9] acting as intermediaries between the buyers of new XAUR and Auresco Institute. The latter uses the resulting money to buy gold, which is then used to back newly minted XAUR subsequently transferred to buyers.

In order for the XAUR redemption price to grow, Auresco Institute's gold reserve has to grow faster than the XAUR supply. There are several mechanisms employed to achieve that.

First, the buyer has to pay so-called Coinage Price[10], which is higher than needed to back newly minted XAUR. This excess, minus miner/minter rewards, is used to buy gold. Therefore, XAUR backing grows faster than its supply. The price of issuing new XAUR is variable, denominated in USD, and set anew during each issuance. New XAUR cannot be issued at a price lower than that of the previous issuance: it can be the same or higher[11]. If the existing market price of XAUR is lower than the production price, miners and minters will have to spend 30% of the amount assigned for the

[1] Ibid.

[2] Rothbard M. State and Money: How State Took Over Society's Monetary System (in Russian), 2008, pp. 52–67

[3] Xaurum Team. A Treatise on Xaurum, p. 13 // http://xaurum.org/TreatiseOnXaurum.pdf.

[4] Growth of Gold per Xaurum // http://www.xaurum.org/groth.html.

[5] Xaurum Team. A Treatise on Xaurum, p. 13 // http://xaurum.org/TreatiseOnXaurum.pdf.

[6] Xaurum // http://www.xaurum.org/#; Auresco Institute // http://auresco.xaurum.org/.

[7] Xaurum Foundation // http://www.xaurumfoundation.com/.

[8] Xaurum Team. A Treatise on Xaurum, p. 16 // http://xaurum.org/TreatiseOnXaurum.pdf.

[9] Xaurum Mints // http://www.xaurum.org/mint.html.

[10] Xaurum Coinage // https://docs.google.com/spreadsheets/d/1Spg-mGTbt5u8-Pl4IfxuZ4gtChNSKvDuN82PBFAyXq8/edit#gid=1340739570; Xaurum Team. A Treatise on Xaurum, p. 18–23 // http://xaurum.org/TreatiseOnXaurum.pdf.

[11] Xaurum Production Price // http://www.xaurum.org/production_price.html.

new issuance to repurchase the existing XAUR in order to drive the token's market price to the price of its production.

Secondly, all XAUR collected as transaction fees are destroyed[1]. This shortage of XAUR supply combined with the unchanging amount of the gold reserve increases the amount of gold backing per single token.

XAUR redemption uses gold bars of 1 gram that can be sent to "the European Union and other countries of the world, except for those countries determined by the Provider or the official authority"[2]. The XAUR redemption price (Xaurum Ratio) is presented in grams of gold and does not depend on the current market prices for XAUR and gold. Just like the production price, XAUR redemption price is re-calculated for each new issuance, and may either stay the same or grow. Unlike Digix DAO, Auresco Institute does not charge the demurrage from XAUR users.

[1] Xaurum Foundation // http://www.xaurumfoundation.com/.

[2] Xaurum Legal // http://www.xaurum.org/legal.html.

TABLE 4
Purchase, transaction/ demurrage, and redemption fees for DGX and XAUR

	Purchase/redemption fee	Transaction/ demurrage fee	Blockchain
Digix (DGX)	Purchase: 2% to 4% when buying the bar (DGAC) in the payment currency + miner fee for transaction to Gold Asset Contract (in ETH). Redemption: miner fee for transaction to Gold Asset Contract (in ETH) + 1% (1 DGX/100-gramm bar) + DGAC redemption fee. Transportation expenses: no delivery of gold at phase one of the project's development. Redemption is possible only at the Safe House office.	Transactions: Miner fee (ETH) + 0.13% per transaction (DGX). Demurrage: 0.6% per year (DGX).	Ethereum (ERC20 Token Standard).
Xaurum (XAUR)	Purchase: no service fees Redemption: miner fee for transaction (ETH), no service fees. Transportantion expenses depend on the amount of gold and the recipient's location.	Transactions: Miner fee (ETH) + 0.5 XAUR. No demurrage (storage and insurance of gold reserves are paid for by Auresco Institute).	Ethereum (ERC20 Token Standard).

Sources: https://digix.groovehq.com/knowledge_base/categories/proof-of-asset, https://www.dgx.io/whitepaper.pdf, http://www.xaurum.org/#.

Stablecoins backed with gold, similar to fiat-backed electronic money on blockchain, require one to trust the methods of proving the availability of 100% reserves, as well as the consent with the Terms of Service.

TABLE 5
Full backing proofs for DGX and XAUR, their Terms of Service

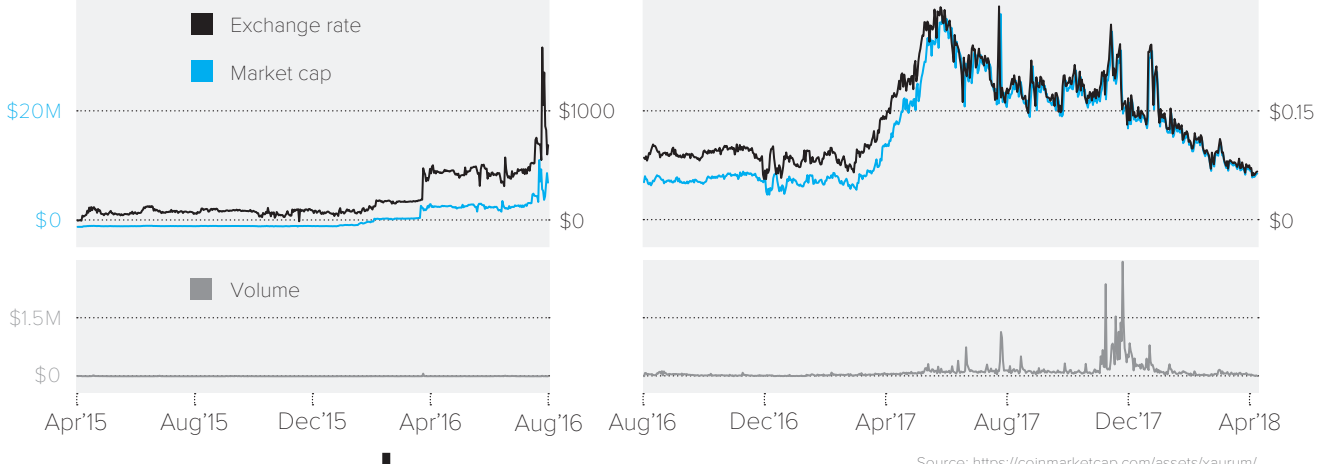
	Method of proving the presence of a 100% reserve	Features of Terms of Service
Digix (DGX)	Proof-of-Asset system. Digix Marketplace website provides data n the gold reserves and their audit, total DGX supply, and the data for individual DGAC.	"You expressly agree that any claim or dispute arising from your use of our website and/or our services will be governed by the laws of Singapore. You further agree that any such claims or disputes shall be resolved in Singapore courts."

		"We may (a) modify or discontinue any portion of the Digix Services, and (b) suspend or terminate your access to the Digix Services, at any time, and from time to time, without notice to you in certain, limited circumstances described herein. You agree that we shall not be liable to you or any third party for any modification or termination of the Digix Services, or suspension or termination of your access to the Digix Services, except to the extent otherwise expressly set forth herein." "Digix reserves the right to reject orders or amend buy/sell prices or to impose conditions for redemption of gold. Digix reserves the right to refuse to process or to cancel any pending blockchain Transaction as required by law or in response to a subpoena, court order, or other binding government order."
Xaurum (XAUR)	Xaurum website offers data on the state of gold reserves and the amount of gold backing a XAUR unit, as well as official Loomis emails on the current state of Auresco Institute's gold reserves.	"The Provider reserves the right to change any clause of the present General Terms and Conditions and/or price list at any time without prior notice." "The Buyer also explicitly and unconditionally states that it is aware of the extreme and high risk of this purchase business, thereby explicitly and unconditionally disclaiming any claims against the Provider, since it is responsible for the risk when buying as well as for its decisions and consequences thereof."

Sources: https://dgx.io/whitepaper.pdf, https://digix.groovehq.com/knowledge_base/categories/proof-of-asset, https://digix.global/app/#/marketplace/dgx, http://www.xaurum.org/commonwealth_audit.html, https://groups.google.com/forum/#!forum/xaurum, http://www.xaurum.org/groth.html, http://www.xaurum.org/legal.html.

DGX was launched on April 8th, and wasn't traded on any exchange but Digix Marketplace as of the time of this report. For that reason, there is no data as to its market history. XAUR history starts April 21st, 2015, and is represented here on two charts of different scale for greater clarity.

FIGURE 6
XAUR/USD exchange rate, market cap, and daily exchange trading volume of XAUR



Source: https://coinmarketcap.com/assets/xaurum/.

Since XAUR migrated to Ethereum blockchain on August 23rd, 2016, and until April 2017 the price of XAUR remained relatively stable, and grew along with the entire market during the cryptocurrency boom. At the redemption price of 983 XAUR for 1 gram

of gold[1], XAUR price of $0.23 and the gold price of $40.3/gram[2], 1 gram of gold in XAUR was 5.6 times more expensive than 1 gram of gold on the gold market.

The descriptive statistics for the price and daily exchange trading volume of XAUR looks as follows:

[1] Xaurum Mint XXVI // https://www.facebook.com/xaurumofficial/photos/a.797370633733102.1073741828.797065590430273/1032400656896764/?type=3&theater.
[2] Gold Price Chart // http://goldprice.org/gold-price-chart.html.

TABLE 6.
Descriptive statistics for price and daily exchange trading volume of XAUR

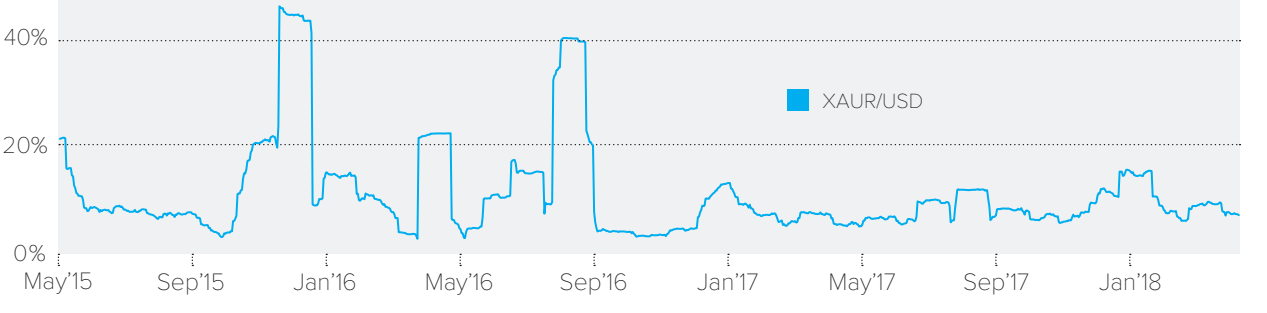
	Minimum	Maximum	Range	Mean	Median	Standard Deviation	Average 30-Day Standard Deviation
XAUR/USD, $	0.0059[3]	0.2857	0.2798	0.0912	0.0842	0.0701	0.0114
Daily trading volume of XAUR, $thousand	0.0000	2915.0000	2915.0000	68.9800	17.9800	176.9457	66.2343

Source: https://coinmarketcap.com/assets/xaurum/.

[3] During the migration to Ethereum blockchain, 1 XAUR converted to 8000 XAUR (https://goo.gl/VKA69w) therefore the price before migration was divided by 8,000 for comparability.

Average daily price change of XAUR comprised 6.73% with average volatility of 10.82%. After the migration to Ethereum, standard deviation of daily price changes nearly halved: before the migration it comprised 19.09%, while afterwards it comprised 9.69%.

FIGURE 7.
Volatility of XAUR/USD exchange rate



Source: https://coinmarketcap.com/assets/xaurum/.

After the migration to Ethereum, the rate of increase of XAUR price was negative. However, since the moment of the stablecoin's launch, it exceeded the rate of increase of gold price nearly by the factor of 100.

TABLE 7.
Gold and XAUR price increase rates

	Price on 21/04/15, $	Price on 23/08/16, $	Price on 30/04/18, $	Price increase rate for 21/04/15 to 30/04/18, %	Price increase rate for 23/08/16 to 30/04/18, %
Gold, 1 gram	38.4298	43.1463	42.2203	9.86	−2.15
XAUR, 1 token	0.0069	0.0883	0.0715	935.54	−19.10

Sources: https://www.quandl.com/data/LBMA/GOLD-Gold-Price-London-Fixing, https://coinmarketcap.com/assets/xaurum/.

1.1.3 Backing by a non-uniform collateral

In order to diversify the risks associated with price fluctuations of the anchor currency or the collateral's price, a stablecoin may be fully backed by a basket of assets rather than one currency or one

precious metal. Stablecoins of this kind are currently at different phases of development, and do not have any market history per se.

Globcoin[1] plans to launch a platform to create tokenized currency baskets on Ethereum. When it's deployed, users will be able to create currency baskets that meet their demands. Still, only two ERC20 tokens will circulate on the platform at phase one: GCP and Globcoin (GLX).

GCP is the access token for Globcoin Crypto Platform. It entitles its holder to issue and exchange GLX (as well as other baskets in the future) with zero fees. This requires one to deposit GCP: the greater the amount of the deal, the bigger the GCP deposit[2]. Additionally, it grants access to trading functionalities at Globcoin Exchange.

GLX is a tokenized GRCI (Global Reserve Currency Index) basket. Five per cent of the basket is gold and the rest is the currencies of 15 world's largest ecomonies, whose weight reflects their issuing countries' share in the global GDP.[3] "Reserve Currency Solutions — RCS SA, a Swiss company created in 2010, will issue fiat IOUs, pegged to the deposits of the currency components and gold of the basket at a prime bank."[4]

Diversification of assets attained thanks to using a basket mitigates the price fluctuations for the included assets against each other. "Even taking Gold or the Swiss Franc as a safe haven example, the basket demonstrates a perfect stability with a tendency to appreciate against major G7 currencies such as US Dollar, Euro or the British Pound."[5] Currency baskets "are a very effective solution to avoid concentrating wealth in a few currencies whose evolution can be very negative"[6].

The Advisory Committee determines, on a monthly basis, the weight of assets in the GLX basket, and checks the included currencies for their compliance with the liquidity requirements. The committee is entitled to remove a currency from the basket on the grounds of liquidity or the issuing country.[7]

GLX is issued when it's bought at Globcoin Crypto Platform for a national currency. In order to back GLX fully, the national currency has to be converted into the GLX basket elements that will directly back the newly minted stablecoins. The project's documentation does not specify the exact way of redeeming GLX. One may assume, however, that GLX will be exchanged for an equivalent of their backing in a national currency, or repurchased at the open market with a discount.

Demurrage for the storage of gold included in GLX backing is not charged, however, the growth of GLX backing by means of currency deposit interest is not on the table.

[1] Globcoin // https://globcoin.io.

[2] Globcoin // https://globcoin.io/index.html.

[3] Bringing stablecoins to the next level // https://medium.com/@globcoin_io/bringing-stablecoins-to-the-next-level-357879430b0f.

[4] Ibid.

[5] Ibid.

[6] Globcoin Crypto Platform, p. 14 // https://globcoin.io/assets/whitepaper-GCP-v2.0.pdf.

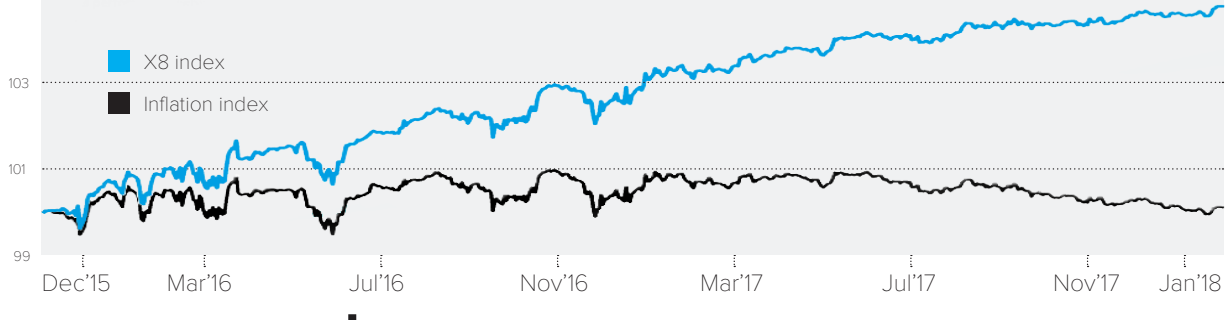
[7] Ibid., p. 11.

X8[1] also develops a stablecoin on Ethereum backed with a basket of national currencies and gold. There are two tokens there: X8X and X8C (X8 currency). X8X allows its holders to issue and redeem X8C with 0% fee, given that corresponding amount of X8X was deposited[2].

X8C will be entirely backed by a basket of assets with flexible stucture. Initially, the reserves behind X8C will be formed out of 8 national currencies: USD, EUR, JPY, AUD, GBP, CAD, CHF, NZD[3]. However, basket composition may change: "Membership in the basket is available for currencies that fulfil the criteria of 100% convertibility: a high transaction rate, consistent electronic liquidity and simple convertibility of meaningful sizes to all other members of the currency basket."[4] X8C is also backed with gold. In the future, the project plans to add some cryptocurrencies having competitive features of money to the extent sufficient for supplementing fiat and gold reserves[5].

The share of each X8C reserve element automatically gets amended by ioNectar's AI in real time on the grounds of "the competitiveness and the individual and the aggregate volatility of each part."[6] Thanks to the automatic reserve management tech (ARM), X8 index tends to grow.

FIGURE 8.
X8 and inflation indices



Source: https://x8currency.com/.

The issuance of X8C happens when the token is sold for national or crypto currencies. The revenue is converted by the ARM and go to the basket with 8 national currencies and gold. Then they are distributed among banks and brokers to diversify the counterparty risks[7].

X8C is redeemed by selling it to the issuer. The redemption price is not fixed: it is calculated from the price of assets that back the token. The issuer sells the share of its reserves that corresponds to the share of the X8C tokens in question for national or crypto currency, and transfers it to the customer.

If the market price of X8C becomes 1% lower than the price of its reserves, the AI automatically repurchases X8C with the reserves. Thus it increases the amount of reserves per X8C unit and drives the market price towards the price of its reserves. If the X8C market price is 1% higher than the nominal price, the X8C supply automatically increases at the expense of a special reserve. This

[1] X8 Currency // https://x8currency.com.

[2] Ibid.

[3] Koželj G. ARM: Automatic Reserve Management AI: The technology behind X8 currency, p. 4 // https://x8currency.com/wp-content/uploads/X8-and-ARM-Technology-whitepaper.pdf.

[4] Ibid.

[5] Ibid, p. 4–5.

[6] Ibid., p. 5.

[7] X8 Project Token Generation Event Whitepaper, p. 4 // https://x8currency.com/wp-content/uploads/X8-Project-TGE-Whitepaper.pdf.

intervention increases the amount of reserves per X8C unit while driving the price down to the nominal.

The X8 team stresses that their cryptocurrency is a shield from inflation: "Regardless of the focus on stability, there will always be a yield. ARM generates risk-free rate yield... ARM is able to earn an additional very safe yield to help neutralize inflation naturally."[1] The redemption price does not grow along a predetermined path as it depends on the ARM's success. The authors note, however, that this growth rate may comprise "1–3% per annum"[2]. No demurrage for the storage of gold is charged. The interest on the backing deposits is not added to the total backing.

ARC Reserve Currency (ARC)[BI] "is an ERC20 compliant token, whose price is related to a pool of underlying assets held by a special purpose vehicle ("the Issuer")"[4]. This stablecoin is expected to be stable in real terms and growing in nominal terms.

"The stability of ARC is enabled by exchange rate controls and investment diversification. The value appreciation of ARC will be supported by a target return, arising from a pool of lending and fixed income assets, diversified across currencies."[5] The target return is the annual ROI from the mentioned assets expected by the Issuer. The ARC reserves will be shared between cash and investment to the ratio of 15:85[6].

ARC basket will include the national currencies whose weight in the global foreign exchange turnover, according to the Bank for International Settlements triennial report, is more than 5.0%.[7] According to the 2016 BIS report[8], the ARC basket will include 6 currencies: USD, EUR, JPY, GBP, AUD, CAD. The reserves will be split across the leading world banks[9].

The target return is set at the higher of two parameters: the first one is the average inflation in G10 countries for the last 10 years plus a premium, which is 3-times the average standard deviation of inflation, or 1% annual interest, whichever is higher; the second one the average central bank rate in the US, Europe, Japan, and UK, over a rolling 5-year period plus a premium of 1.0% per annum[10]. When the net value of assets backing ARC reaches $100 million, the premium will gradually go down until it reaches zero at NAV= $1 billion. Thus, unlike X8C, the ARC price growth is predictable.

Rebalancing of reserves against target weights, recalculation of the target return, and distribution of investments across assets will happen once every three months. ARC/USD exchange rate model for December 2005 to October 2017 show the revenue of 27.5% at the inflation rate of 16.6%.

[1] Koželj G. ARM: Automatic Reserve Management AI: The technology behind X8 currency, p. 10 // https://x8currency.com/wp-content/uploads/X8-and-ARM-Technology-whitepaper.pdf.

[2] X8 Project Token Generation Event Whitepaper, p. 14 // https://x8currency.com/wp-content/uploads/X8-Project-TGE-Whitepaper.pdf.

[3] AAA Reserve // https://www.aaareserve.com.

[4] Findlay S., Hileman G. ARC Primer and Overview, c. 1 // https://www.aaareserve.com/sites/default/files/arc-public-docs/ARC_Primer_and_Overview-vF1.1.pdf.

[5] Ibid., p. 4.

[6] Ibid., p. 10.

[7] Ibid., p. 8.

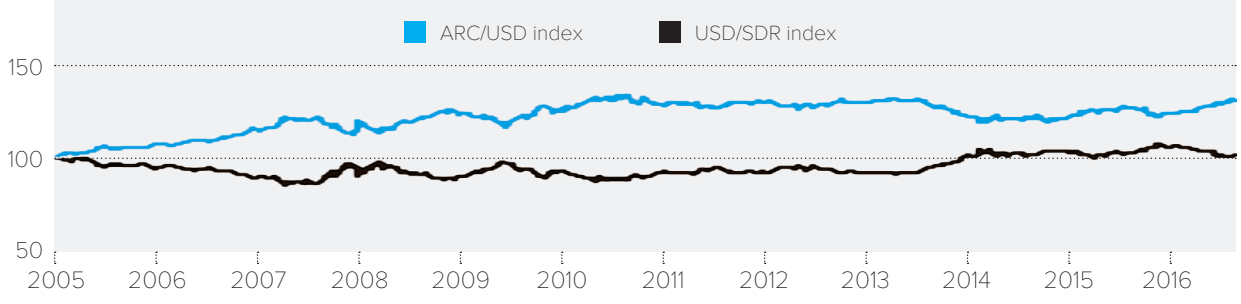
[8] Bank for International Settlements Triennial Central Bank Survey. Foreign exchange turnover in April 2016, p. 5 // https://www.bis.org/publ/rpfx16fx.pdf.

[9] Findlay S., Hileman G. ARC Primer and Overview, c. 13 // https://www.aaareserve.com/sites/default/files/arc-public-docs/ARC_Primer_and_Overview-vF1.1.pdf.

[10] Ibid., p. 10.

FIGURE 9.
ARC/USD and USD/SDR indices

The nominal value growth of ARC over the same period corresponds to the IRR at 2.07% per annum[1].



Source: https://www.aaareserve.com/sites/default/files/arc-public-docs/ARC_Primer_and_Overview-vF1.1.pdf.

In order to maintain the ARC market price within the narrow band against NAV as calculated for an ARC unit, the Issuer will buy ARC at the NAV price with a certain discount using the national currency from their reserves, and sell the newly created ARC at the NAV price[2]. Buying ARC with discount would increase NAV as calculated for the ARC unit.

Initial issuance of ARC will be backed by the assets raised over the project's ICO at the rate of 1 ARC = 1 USD. Afterwards, ARC will be available at the price of NAV as calculated per single unit[3].

There is no redemption of ARC in the traditional sense. The only way for an ARC holder to exchange it for a national currency is to sell it on the market. "It is important to note that the holders of ARC Coin don't have a direct holding the Issuer or right to the underlying assets of the Issuer."[4]

GLX, X8C and ARC have common and distinguishing features.

[1] Ibid., p. 21–22.

[2] Ibid., p. 14.

[3] Ibid., p. 6.

[4] Ibid., p. 14.

TABLE 8.
Comparison of GLX, X8C, and ARC

	Globcoin (GLX)	X8 Project (X8C)	AAA Reserve (ARC)
Backing	Basket of 15 national currencies + gold.	Basket of 8 national currencies + gold.	Basket of 6 national currencies + securities.
Issuance	Selling GLX for the equivalent of its backing.	Selling X8C for the equivalent of its backing.	Selling ARC for the equivalent of its backing.
Redemption	No description in the documentation.	The issuer exchanges X8C for the equivalent of the share of reserves corresponding to the share of redeemed X8C in the total supply of X8C.	The issuer buys ARC on the market at the price below NAV.
Demurrage for storage of gold	Not charged	Not charged	–

Mechanism of redemption price increase	No description in the documentation	Via ARM operation and the purchase of X8C on the market at a price lower than the redemption price, and selling X8C on the market at the price higher than the redemption price. The growth is unpredictable.	Via target return on investment and the purchase of ARC at the price below NAV. The growth is predictable thanks to the target revenue.

Sources: https://globcoin.io/assets/whitepaper-GCP-v2.0.pdf, https://x8currency.com/wp-content/uploads/X8-and-ARM-Technology-whitepaper.pdf, https://www.aaareserve.com/sites/default/files/arc-public-docs/ARC_Primer_and_Overview-vF1.1.pdf.

The stablecoins above are issued in exchange for the equivalent of their backing. This, however, isn't the only way of issuing stablecoins backed with a non-uniform collateral. Today's commercial banks issue private money via loans[1]. This private money is in fact a monetary obligation redeemed with national currencies. In order to insure itself against the borrower default, the bank loans the money using various property as a collateral. This decentralized issuance scheme underpins the decentralized banking system called ***PHI***[2] developed by String Labs, which they presented at Ethereum DevCon 2[3].

PHI implies the issuance of stablecoins denominated in various national currencies (PHI-USD, PHI-CHF, PHI-HKD)[4]. The developers claim that those stablecoins are a side effect of PHI as a decentralized credit platform.

The PHI issuance model is similar to the money issuance model used by commercial banks. The borrower offers a certain loan collateral estimated by a series of validators. Becoming a validator requires one to make a guarantee deposit in PHI that would limit the maximum amount of the loan a validator can give out. Validators are rewarded for honest operation by a share in the loan interest, as well as the improvement of their reputation. If they fail to act honestly, they pay a penalty charged from their guarantee deposit, and have their reputation deteriorated[5].

Validators make the decision of granting a loan on the grounds of the borrower's creditworthiness and the value of the collateral. For that purpose, a relevant amount of stablecoins, for example PHI-USD, is issued to the borrower. The loan is repayed by the amount of PHI-USD corresponding to the amount of the loan plus interest. The stablecoins are then destroyed, and the interest is distributed among the validators[6]. If the loan is not repaid, its amount is withdrawn from validator deposits, and the validators initiate the legal process of debt collection similar to the one in traditional banking.

Therefore, a PHI holder cannot redeem it at will, and that's what differentiates PHI from traditional e-money on blockchain. Only validators can redeem PHI with a collateral, and only PHI that had been withdrawn from their deposits as a repayment for the loan.

[1] McLeay M., Radia A., Thomas R. Money creation in the modern economy, p. 14 // https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2014/money-creation-in-the-modern-economy.pdf.

[2] PHI: Decentralized commercial banking and stable currency // http://string.technology/pdfs/viewer.html?file=../../library/PHI-DFINITY-Extended-17-12-16.pdf.

[3] Decentralized Commercial Banking // https://www.youtube.com/watch?v=QVWjKX7P2FA.

[4] PHI: Decentralized commercial banking and stable currency, p. 9 // http://string.technology/pdfs/viewer.html?file=../../library/PHI-DFINITY-Extended-17-12-16.pdf.

[5] Ibid., p. 14.

[6] Ibid., p. 17.

The project's presentation does not specify the price of redemption: will it be the nominal price, the market price at the time of the loan, or some other.

PHI market price stability against its target price is attained via automatic market making. "The system will buy PHI at the price below the target one, and sell it at the price higher than it. For that purpose, the Computer will have to be able to accept and hold assets of relatively stable value. The simplest solution would be to accept tokens like Digix, while in practice it will accept a diversified spectrum of assets."[1] It is also assumed that traders will be involved in market making by buying PHI at a lower price than the system, and then selling them to the system at a higher price. On the other hand, they may buy PHI from the system at a lower price and sell it on the market at a higher price[2]. For market making to be possible the system will have to have reserves in PHI and other assets. Even though PHI are issued as loans, the system may issue them for the purposes of market making directly in exchange for said assets[3]. Neither the presentation, nor the comments of String Labs CTO make it clear which sources the system will use to form the reserve for the repurchasing PHI on the open market, aside from selling PHI directly.

The issuance of stablecoins via loaning them against a collateral of assets associated with supply chains is planned for ***Sweetbridge***[4] protocol.

The project seeks to tackle the problem of liquidity gap in supply chain when "for an average invoice, a company must wait 42 days before receiving payment"[5]. The Sweetbridge protocol "allows anyone to borrow money against assets they already own without using the services of a lender. It is designed to dramatically decrease the time required for any entity to convert assets, such as accounts receivable, real estate, inventory, equipment, and commodities into cash"[6]. The types of collateral that may back the loan even includes the "time, including valuable work time pledged by a professional or a team"[7].

The project team plans to standardize the liquidity access for each kind of collateral available digitally on blockchain. "When an asset is onboarded onto Sweetbridge as a digital token, sufficient information becomes available to estimate that asset's risk and volatility parameters."[8] The value of the collateral will be estimated by oracles on the grounds of trusted external data sources, while risk / volatility parameters of each kind of collateral will be initially set up by the project team. The project documentation does not mention any estimation algorithm and the incentives preventing the oracles from abusing their power.

There are two tokens in Sweetbridge: Bridgecoin and Sweetcoin.

Bridgecoin is a stablecoin pegged to a national currency. It is the unit of loans, and functions as the means of exchange within

[1] A critique of Phi, the lending platform and stable currency // https://goo.gl/vVXmcg.

[2] PHI: Decentralized commercial banking and stable currency, p. 19 // https://goo.gl/67MKoQ.i.

[3] A critique of Phi, the lending platform and stable currency // https://goo.gl/LzC6y.

[4] Sweetbridge // https://sweetbridge.com.

[5] Nelson J. S., Henderson D., Jones G., Roon M., Zargham M., Bulkin A., Brukhman J., Rowe K. Sweetbridge: A blockchain-based protocol stack for global commerce and supply chains, p. 8 // https://sweetbridge.com/public/docs/Sweetbridge-Whitepaper.pdf.

[6] Ibid., p. 12.
[7] Ibid., p. 23.

[8] Ibid., p. 21.

supply chains on the Sweetbridge platform. In the future it may become several Bridgecoins pegged to different national currencies or commodities (Bridgecoin-USD, Bridgecoin-EUR, Bridgecoin-Coal, Briedgecoin-Sugar, etc.). "As the pool of collateralized assets used in Sweetbridge grows, a universal Bridgecoin can be tied to the value of the overall collateral basket."[1]

[1] Ibid., p. 22.

Bridgecoin lifecycle looks as follows. The borrower sends the collateral to the smart contract which issues Bridgecoin. The amount of Bridgecoin he or she may receive depends on the kind of the collateral: the more reliable and stable it is, the bigger the percentage of its estimated value the borrower gets. In order to take it back, the borrower redeems the debt, which consists of the loan and a certain interest. The smart contract then burns the Bridgecoins it got from the borrower.

If the current market price of the collateral is dangerously close to the margin level of collateralization called "notice line", the oracle notifies the borrower he or she has to increase the collateral, or repay a part of the debt in order to bring the collateral ratio back to normal. If the borrower fails to do that and the price of the collateral keeps on dropping, the system automatically sells it upon reaching the level called "sell line". It can be sold fully or partially, depending on the need to keep Bridgecoin fully backed.

Sweetcoin allows one to get a discount or, when a sufficient amount is deposited, free access to loans, payments within Sweetbridge, and conversion between Bridgecoin and fiat currencies[2]. Aside from that, it can be used as a collateral, which allows one to get not only a free loan, but a great percentage of the collateral's estimated value.

[2] Ibid., p. 13.

Bridgecoin exchange rate stability will be attained with four mechanisms (as exemplified by Bridgecoin-USD)[3]. First, the collateral is denominated in USD, and Bridgecoin-USD is issued at par with the USD value of the usable portion of the collateral. When Bridgecoin-USD rate drops below the par value it's profitable to repay the loan, which incentivizes the demand, and drives the price upwards. When the rate is above the par value, it's profitable to lend Bridgecoin-USD at the nominal price and sell it on the market, which increases the demand and drives the rate downwards. This system is seen by Sweetbridge authors as the fundamental mechanism of exchange rate stabilization. An additional source of stability is due to the economical incentives for market makers, the first of which will be Sweetbridge. Another source is due to the possibility to provide assets to the system for it to buy Bridgecoin-USD at the par value. Participants providing the assets are rewarded by a share of the fees collected by the system. Aside from that, Sweetbridge authors presume that selling the collaterals at the open market for Bridgecoin-USD at par value will create additional stability.

[3] Ibid., p. 26.

1.2. Smart banknotes

1.2.1. Backing with native tokens

One of the problems with regular e-money on blockchain is the credit risk associated with their use. The backing of such stablecoins is beyond their blockchain, and is controlled by their issuer who can fail to redeem their obligations. Finally, they are not trustless. Tokens that act as warehouse receipts are not promissory notes of their issuer, and therefore have no credit risk. However, even in this case one has to trust the company that stores the backing and delivers it to the owner when necessary.

Smart banknotes can eliminate the credit risk and the storage/delivery risk as their backing is in the same blockchain. Thanks to that, they are trustless: their backing is controlled by the code, and all obligations are redeemed automatically.

The first implementation of smart banknotes is bitUSD on BitShares[1]. This stablecoin is pegged to USD and is backed by bitshares (BTS), the platform's native token. BitSUD is a contract for difference issued in a decentralized fashion. Anyone can create bitUSD by depositing BTS to the amount of at least 175% of the issued bitUSD at current BTS/USD exchange rate (maintenance collateral ratio).

Such stablecoins can be used until their backing can cover BTS/USD price fluctuations. Marginal collateral ratio (maximum short squeeze ratio) set at 110%. When the BTS price drops to said level, the system automatically closes the contract, buys a relevant amount of bitUSD from the market for collateral BTS and burns them. The remaining collateral, if any, is returned to the owner. A bitUSD holder may also initiate its redemption at any time with the native token at the settlement price[2]. Price feeds used for calculation of bitUSD redemption price, as well as the extent of their backing, are supplied by BitShares witnesses[3]. Therefore, the issuer and the holder of bitUSD have to trust they will provide price feeds properly and honestly.

For two years, the appeal of bitUSD issuance was relatively low. However, when BTS price started growing in May 2017, the supply

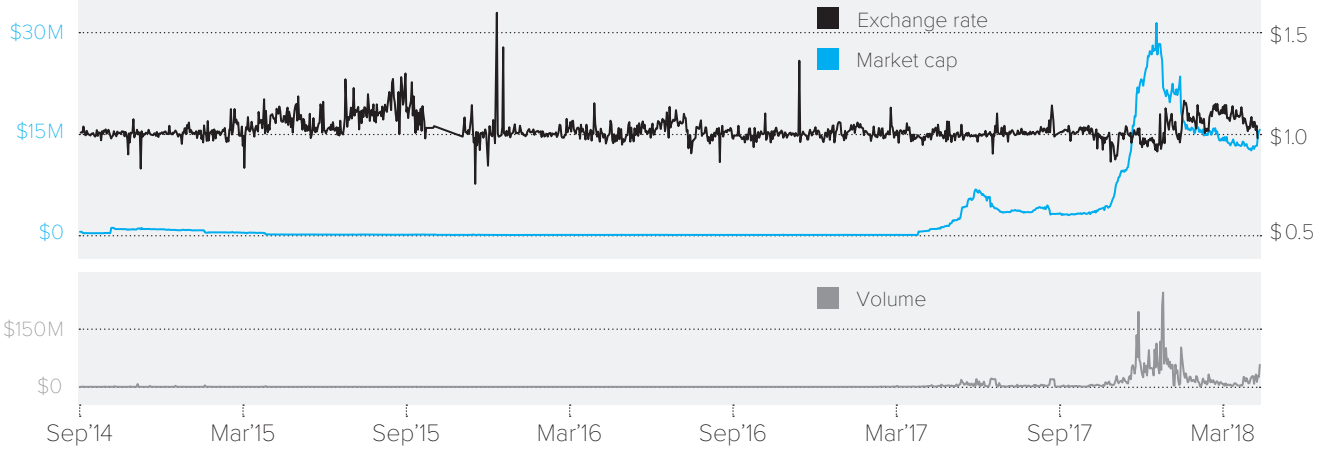
[1] USD SmartCoin // https://cryptofresh.com/a/USD.

[2] BitShares 2.0: Financial Smart Contract Platform, p. 4 // http://docs.bitshares.org/_downloads/bitshares-financial-platform.pdf.

[3] BitShares Witnesses // https://cryptofresh.com/witnesses.

FIGURE 10.
BITUSD/USD exchange rate, market cap, and daily exchange trading volume of bitUSD

of bitUSD increased by an order of magnitude. The first supply upsurge developed from early May to late July, and the second, much more potent, from late November to mid-January 2018.

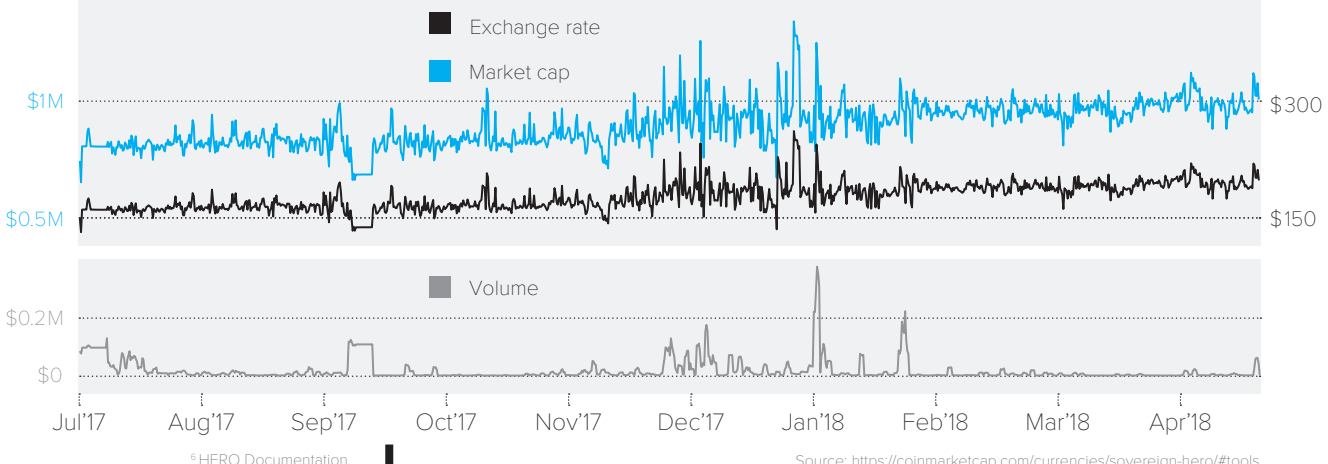


Source: https://coinmarketcap.com/assets/bitusd/.

[1] GOLD SmartCoin // https://cryptofresh.com/a/GOLD.
[2] Price-Stable Cryptocurrencies // https://goo.gl/A5Tve7.
[3] Sovereign HERO // http://www.sovereignhero.com/.
[4] Larimer S. The Hero from BitShares Island... +5% // https://goo.gl/jy42qG.
[5] In compound interest formula, assume $1 is the initial deposit, 0.05 is the interest rate, and 103 years as the period, then $1×(1+0,05)103 = $152,23.

BitShares enables one to issue smart banknotes pegged to any asset, including gold[1]. On BitShares this class of instruments is called SmartCoins[2]. Such smart banknotes may have a more complex logic than simply pegging it to an anchor unit. Thus, HERO[3] is pegged to USD plus 5% per annum as of 1913 when the Fed was established[4]. This approach means that the redemption price of HERO by the moment of its launch in 2017 had to be $152[5]. As of this time, the redemption price, as well as the BTS collateral for HERO has to grow steadily at 5% a year[6]. HERO market price at the start of trading comprised $146, and reached $192.65 in nine and a half months. Therefore, HERO price gained 31.95% over said time. The average daily exchange turnover was minor, and average daily price change comprised 5.57%.

FIGURE 11.
HERO/USD exchange rate, market cap and daily exchange trading volume of HERO



Source: https://coinmarketcap.com/currencies/sovereign-hero/#tools.

[6] HERO Documentation // https://goo.gl/CDWMzp.

Creation of a new SmartCoin that doesn't have a market on BitShares decentralized exchange yet, such as one pegged to a basket of precious metals or fiat currencies, requires additional expenses. These include the fee for creating a new asset[7], and the costs of supplying the relevant price feeds to the market.

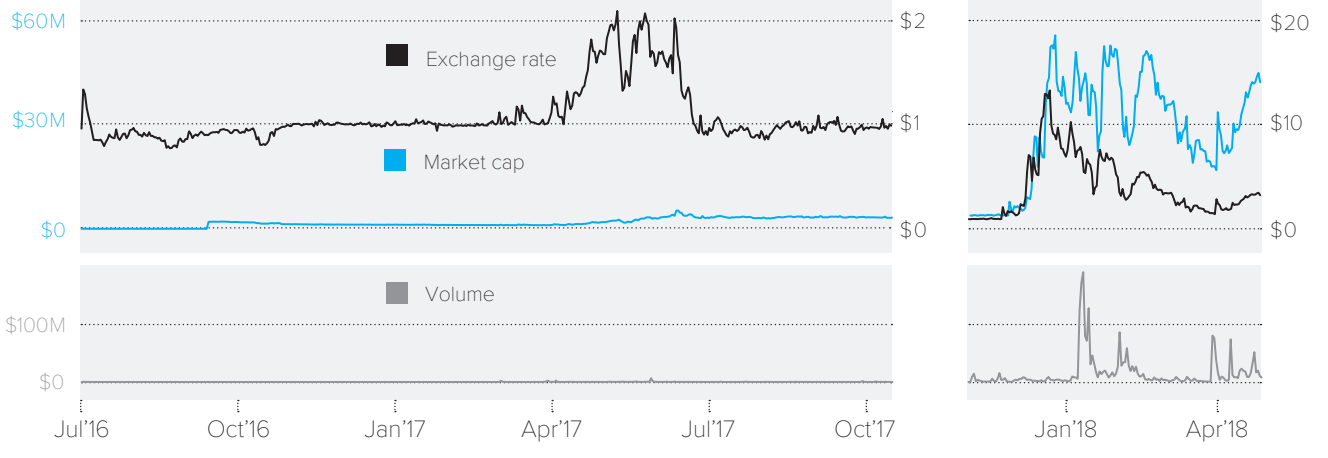
[7] BitShares Fee Schedule // https://cryptofresh.com/fees.

Smart banknotes redeemed by the native token are also issued on Steem[1] and Golos[2] blockchains. Golos is a Russian-language fork of Steem. Steem uses ***Steem Dollar (SBD)*** pegged to USD, while Golos uses ***Golos Gold (GBG)*** pegged to 1 mg of gold.

[1] Trending posts — Steemit // https://steemit.com/.
[2] GOLOS.io Блоги // https://golos.io/.

Up until late November 2017, SBD price was relatively steady, but within the period from late November to late December 2017 it experienced a massive upsurge almost reaching $14 at its peak. Since then, the price was going down, though it never reached $1.

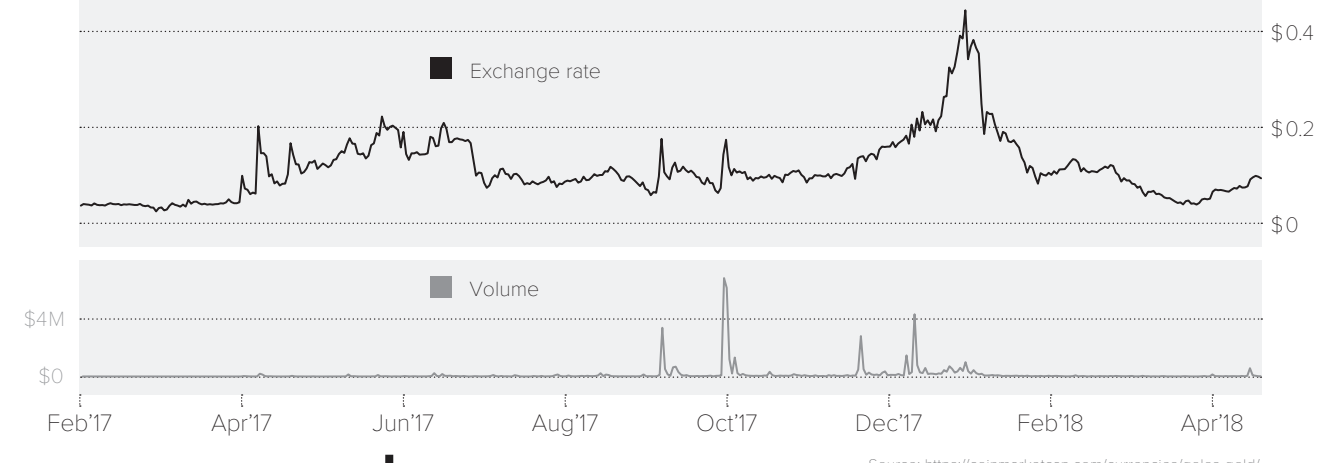
FIGURE 12.
SBD/USD exchange rate, market cap, and daily exchange trading volume of SBD



Source: https://coinmarketcap.com/currencies/steem-dollars/#charts.

GBG price, on the other hand, was steady only until mid-April 2016, until the trading volume was well within a few hundred US dollars a day. After that, it showed massive fluctuations.

FIGURE 13.
GBG/USD exchange rate, and daily exchange trading volume of GBG



Source: https://coinmarketcap.com/currencies/golos-gold/.

Unlike bitUSD, smart banknotes on Steem and Golos are issued by the system as a reward for content creation, not by the users for a collateral of a native token. The issuance of those two assets is algorithmically limited: the system controls debt-to-ownership ratio[3]. Similarly, SBD and GBG are redeemed by the system, not the users. These smart banknotes don't have any collateral as their backing: when the holder wishes to redeem them, the system specifically issues the required amount of native tokens. Another distinctive

[3] Larimer D., Scott N., Zavgorodnev V., Johnson B., Calfee J., Vandeberg M. Steem: An incentivized, blockchain-based social media platform, p. 12–13 // https://steem.io/SteemWhitePaper.pdf.

feature of those smart banknotes is that they ensure APR for their holders. Its amount, as well as the redemption price, is set up by witnesses[1].

[1] Steem Witnesses // https://steemdb.com/witnesses; Golos Witnesses // https://golosdb.com/witnesses.

The descriptive statistics for price and daily exchange turnover of the smart banknotes in question is viewed against their pegging elements: USD and gold. The first pair is bitUSD and SBD.

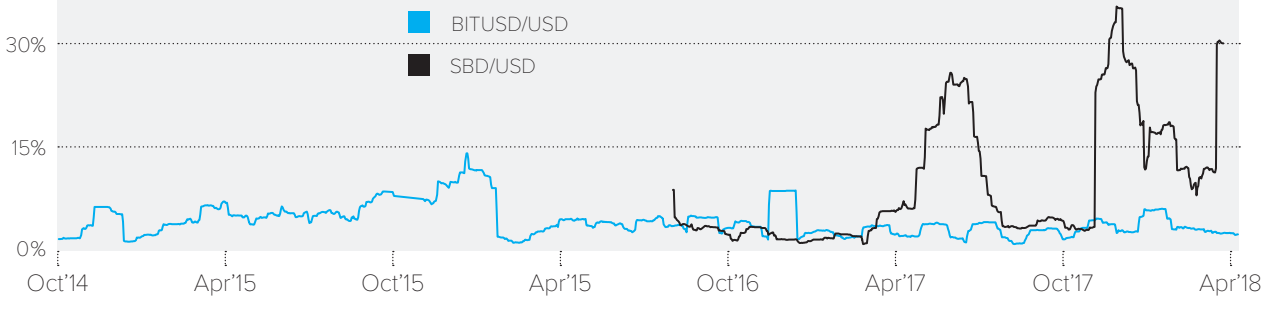
TABLE 9.
Descriptive statistics for price and daily exchange trading volume of BITUSD and SBD

	Minimum	Maximum	Range	Mean	Median	Standard Deviation	Average 30-day Standard Deviation
BITUSD/ USD, $	0.7552	1.6000	0.8448	1.0250	1.0110	0.0571	0.0362
SBD/USD, $	0.7682	13.8100	13.0418	1.9480	1.0060	2.1100	0.5989
Daily exchange trading volume of BITUSD, $thousand	0.0000	23790.0000	23790.0000	464.1000	5.6110	1634.8030	371.2344
Daily exchange trading volume of SBD, $thousand	1.3340	192500.0000	192498.6660	3879.0000	89.3800	15541.9930	4749.4652

Sources: https://coinmarketcap.com/currencies/bitusd/, https://coinmarketcap.com/currencies/steem-dollars/.

The average volatility of bitUSD price, as well as its average daily change, is almost twice as little as that of SBD: 4.29% vs 9.24% and 2.99% vs 6.29% respectively. Up until June 2017, SBD volatility was lower than that of bitUSD, but the situation changed dramatically in early May 2017.

FIGURE 14.
Volatility of BITUSD/USD and SBD/USD exchange rates



Source: https://coinmarketcap.com/assets/bitusd/, https://coinmarketcap.com/currencies/steem-dollars/#charts.

The second pair of smart banknotes is bitGOLD and GBG.

TABLE 10.
Descriptive statistics for price and daily exchange trading volume of BITGOLD and GBG

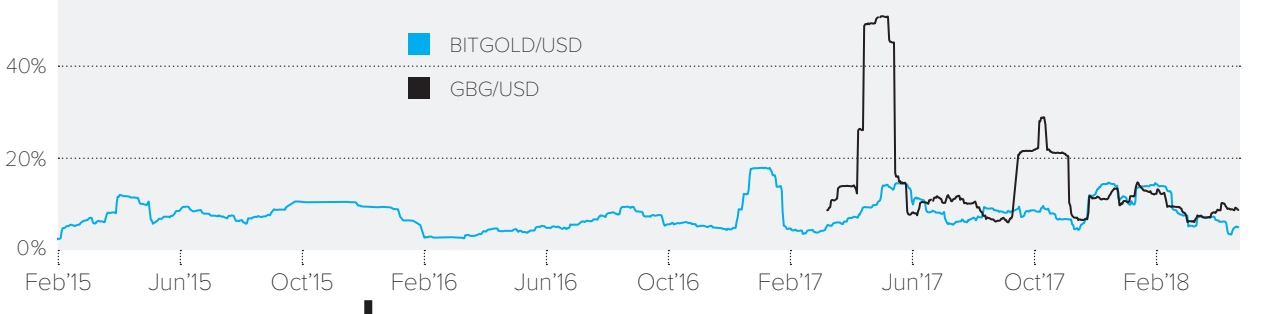
	Minimum	Maximum	Range	Mean	Median	Standard Deviation	Average 30-day Standard Deviation
BITGOLD/USD, $	35.7498	74.1639	38.4141	48.3619	47.9077	5.4935	2.9135
GBG/USD, $	24.6579	446.8640	422.2061	113.3968	101.0040	64.8785	26.7673

Daily exchange trading volume of BITGOLD, $thousand	0.0000	121.4000	121.4000	1.8970	0.2465	7.5906	3.0402
Daily exchange trading volume of GBG, $thousand	0.0450	6876.0000	6875.9550	124.4000	20.9500	546.1190	249.2042

Sources: https://coinmarketcap.com/currencies/bitgold/, https://coinmarketcap.com/currencies/golos-gold/.

Average volatility of bitGOLD price is twice as low compared to that of GBG: 7.86% vs 14.66%. Average daily change of bitGOLD and GBG prices comprised 5.74% and 9% respectively.

FIGURE 15.
Volatility of BITGOLD/USD and GBG/USD exchange rates



Source: https://coinmarketcap.com/currencies/bitgold/, https://coinmarketcap.com/currencies/golos-gold/.

Unlike BitShares, there are no fees in Steem and Golos[1]:

TABLE 11.
Fees for purchase, transactions, and redemption of BITUSD, SBD and GBG

	Purchase/redemption fee, fee currency	Transaction fee, fee currency
BitShares (BITUSD)	*Issuance.* Basic: 0.104 BTS. For lifetime members: 0.021 BTS. *Redemption.* Basic: 0.29 BTS. For lifetime members: 0.058 BTS.	Basic: 0.104 BTS. For lifetime members: 0.021 BTS
Steem (SBD)	0	0
Golos (GBG)	0	0

Sources: https://steem.io/SteemWhitePaper.pdf, https://wiki.golos.io/1-introduction/golos_whitepaper.html, https://cryptofresh.com/fees.

[1] The zero fees are justified in a separate section of Larimer D., Scott N., Zavgorodnev V., Johnson B., Calfee J., Vandeberg M. Steem: An incentivized, blockchain-based social media platform, p. 24–33 // https://steem.io/SteemWhitePaper.pdf.

There are smart banknotes on Ethereum as well: thus, ***StabL***[2] aims to create stablecoins based on futures/CFD redeemed with ETH.

1.2.2. Backing with non-native tokens

[2] StabL Bringing Stable Tokens and Derivative Products to the Ethereum Blockchain // https://goo.gl/vhNjv5.

Not only the respective native tokens circulate in public permissionless blockchains. In Bitcoin, Ethereum, BitShares and some others there are lots of tokens issued for different purposes by projects that don't need their own proprietary blockchain, or regular users.

Those tokens can also be used as an onchain collateral to issue stable cryptocurrencies.

Maker DAO that created ***DAI***, a stable cryptocurrency, was the first project on Ethereum to aim at creating a smart banknote backed by non-native tokens.

Like smart banknotes on BitShares, DAI are issued in a decentralized fashion with a collateral controlled by a smart contract. DAI, however, has several notable differences from smart banknotes described above.

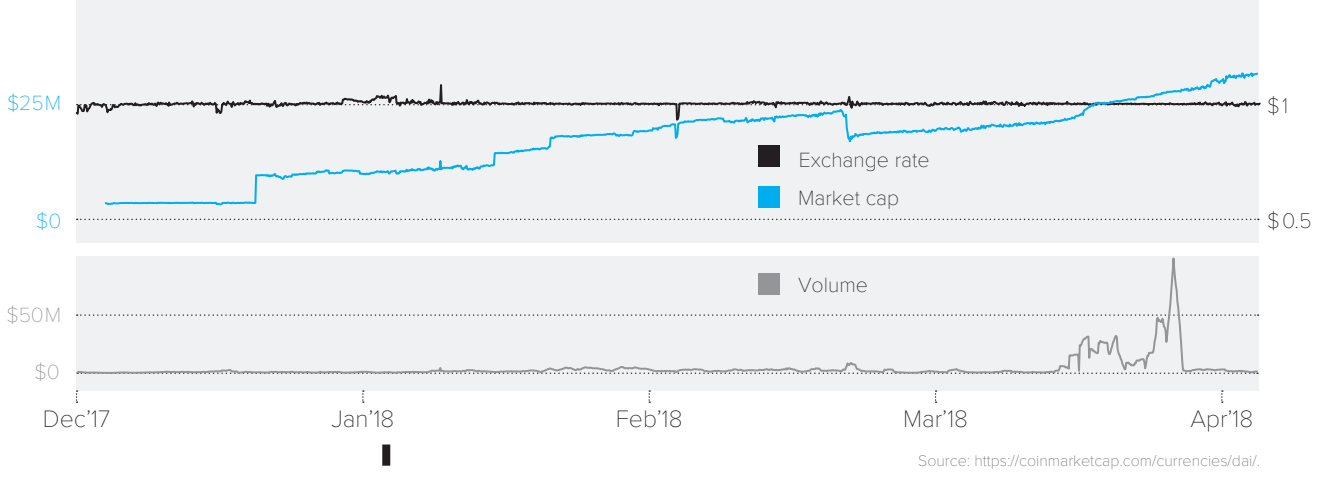
BitUSD has two collateral ratios: maintenance collateral ratio to issue bitUSD, and maximum short squeeze ratio at which the system automatically closes the contract. DAI only has liquidation ratio, i.e. maximum short squeeze ratio, while the maintenance collateral ratio is not determined. Users can control the current level of collateralization for their collaterals and the collateral of the entire system, the current supply of DAI, and other stats on the project website[1].

[1] Dai explorer // https://dai.makerdao.com.

DAI is pegged to USD, yet its stability is not understood as a fixed redemption price but as low volatility of its market price against the target price, which was set at $1. Even though DAI is fully backed, it is not redeemed in the traditional sense of the word. The only way to "redeem" DAI is to sell it on the market. Therefore, their market price is the redemption price. The data on market prices are supplied by oracles.

DAI started trading on December 27th, 2017. The coin's short market history has been successful so far: the price was steady, while supply and trading volume grew, with the turnover almost reaching $100 million.

FIGURE 16.
DAI/USD exchange rate, market cap, and daily exchange trading volume of DAI



Source: https://coinmarketcap.com/currencies/dai/.

Table 12 shows the descriptive statistics for the price and daily exchange trading volume of DAI.

TABLE 12.
Descriptive statistics for price and daily exchange trading volume of DAI

	Minimum	Maximum	Range	Mean	Median	Standard Deviation	Average 30-day Standard Deviation
DAI/USD, $	0.8555	1.1710	0.3155	1.0010	1.0010	0.0164	0.0116
Daily exchange trading volume of DAI, $million	0.0641	98.7700	98.7059	3.9290	1.4640	9.1634	3.9520

Source: https://coinmarketcap.com/currencies/dai/.

DAI is actually redeemed only in case of so-called global settlement[1]. System participants selected by the holders of Maker DAO governance tokens (MKR) may initiate a global settlement, i.e. closure of all collateral contracts (collateralized debt positions, CDPs), and redemption of all DAI. Global settlement is initiated if the system is attacked, oracles or MKR holders abuse their power, or if there are technical problems. In this case DAI is redeemed at the target price of DAI and the market price of the collateral. The remainder goes to the owners of the collaterals.

[1] Maker Team. The Dai Stablecoin System, p. 7–8 // https://makerdao.com/whitepaper/DaiDec17WP.pdf.

Target price[2] is the price of DAI in USD at which the extent of its backing is calculated. For example, current target price of DAI is $1, and the issuer deposits $150 in order to issue 100 DAI. While in bitUSD the collateral may devalue down to the minimum backing level only when it devalues against USD, in DAI it may also happen when the DAI target price grows. Assume that in the given example DAI's liquidation ratio is 110%. Then, if DAI target price reaches $1.37, the collateral for $150 will comprise the limit value of 110%, and the system will automatically put it up for auction in order to close the CDP.

[2] Ibid., p. 5.

The forced closure of the CDP involves two processes. First, the system buys enough DAI to close the CDP and take control over the collateral for the minimum possible amount of MKR specifically issued for that purpose. Second, the collateral is then used to repurchase an equivalent amount of MKR in order to exclude their dilution. The system also makes its best to use as little of the collateral as possible. The remaining part of the collateral minus the liquidation penalty will be returned to its owner.

Unlike bitUSD, DAI has a mechanism of adjusting the market price to the target one, which minimizes the volatility of the former against the latter.

The target price is continuously corrected accordingly with the current target rate[3]. Target rate determines the change of the target price over time. For example, if the target rate is 2% per annum, the target price will continuously grow by 2% a year, while if the target rate is −2% per annum, the target price will decrease by the same amount over a year.

[3] Ibid., p. 6.

When the market price of DAI is equal to the target price, the target rate is zero. If the market price diverges from the target one, the target rate automatically adjusts. The extent of the adjustment depends on the divergence and sensitivity parameter[1], which is controlled by MKR holders.

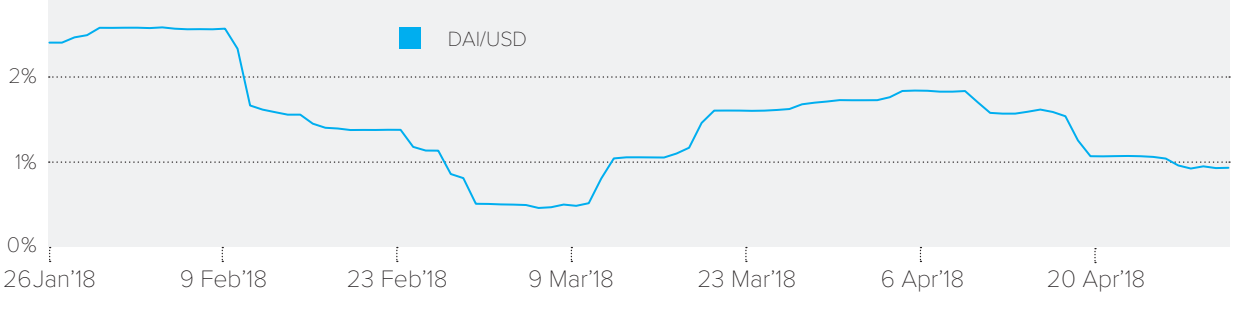
[1] Ibid., c. 7.

If DAI market price is below the target, the target rate goes up, which causes the target price to grow. It makes the issuance of new DAI more expensive and increases the amount of the collateral required for normal operation of the existing DAI. This, in turn, has to result in the closure of certain CDPs and, subsequently, the contraction of DAI supply. On the other hand, the target rate growth means that in the future, one will be able to sell DAI at a higher price, provided that the adjustment mechanism works as intended. Therefore, the contraction of supply and the growth of demand must result in the growth of DAI market price.

If DAI market price exceeds the target one, the reverse incentive mechanism is activated: the target rate and the price decrease, which increases the supply and decreases the demand, thus lowering the market price.

The average daily change of DAI market price never exceeded 0.5% while the average volatility comprised 1.48%.

FIGURE 17.
Volatility of DAI/USD exchange rate



Source: https://coinmarketcap.com/currencies/dai/.

Another important feature of DAI is the transferable collateral. In Digix system the ownership over DGX is inseparable from the ownership over DGAC which collateralize DGX. Meanwhile, in Maker system the ownership over a collateral and the ownership over the DAI backed by it are separated. This allows the DAI issuer to pass the title to their collateral, regardless of who owns the DAI backed by it. The issuers of smart banknotes on BitShares don't have such option.

During phase one of the project, only ETH can be used to back DAI, though not directly: all ETH are stored together in the same liquidity pool and create the backing token called PETH (pooled ETH)[2]. PETH are claims on ETH deposited in a smart contract that acts as the liquidity pool.

[2] Ibid., p. 5.

Anyone can issue PETH by placing the relevant amount of ETH on the smart contract. The conversion rate starts with 1:1 and fluc-

tuates along with the total PETH supply. The conversion rate may drop beyond 1:1 if the ETH price suddenly drops, which can make the backing less than 100%. Here, in order to buy the DAI from the market the system issues non-backed PETH, thus diluting the supply. The PETH holder may redeem them with ETH at any time: he or she gets the share of ETH deposited in the smart contract that corresponds to the share of redeemed PETH in the total supply of PETH.

On the second stage of the project's development, there will be an option to use non-native Ethereum-based tokens for the collateral, while PETH will be cancelled, and the system will use MKR to repurchase DAI on the market. The selection of tokens that can be used as a collateral, the liquidation ratio for each collateral type, and the maximum amount of DAI that can be issued for that collateral, will be set by MKR holders.

The execution of smart contracts that service the circulation of DAI requires a higher fee than transactions in native Ethereum tokens and tokens based on simpler smart contracts. Issuing DAI requires four transactions, and three to retrieve the collateral[1]. In order to release the collateral, one has to return the DAI issued for said collateral, and pay a stabilisation fee of 0.5 per cent a year, which is payable in MKR[2]. The fee amount is set up by the MKR holders and may vary due to changes in the market.

Augmint[3] also develops a stablecoin pegged to national currency that can be backed by non-native tokens. As more assets get tokenized, the project will use gold, shares, bonds, and real estate along with cryptocurrency as a collateral[4], however, the only available collateral at the first development phase will be ETH. Augmint Crypto Euro (A-EUR) will be the first stablecoin of this project.[5]

"Augmint tokens are only issued when a new, collateral backed loan is issued. Augmint tokens are automatically destroyed (burnt) on loan repayment. In case of loan default the collateral goes to Augmint stability reserves, managed by smart contracts"[6]. The system features two kinds of loans: flexible and fixed. For flexible loans there is a marginal collateral ratio. Upon reaching this ratio the collateral is automatically transferred to Augmint reserves. For fixed loans there is no such ratio. The collateral is transferred to Augmint only if the borrower is unable to repay the loan timely. After getting control over the loan, the smart contract takes the fee for not repaying a loan and the sum equivalent to the borrower's debt. Then the smart contract gives back the rest of the collateral, if any, to the borrower.[7]

Augmint reserves are replenished both with the collaterals for unpaid loans and A-EUR transaction fees.

The stability of A-EUR exchange rate is attained thanks to the interest rate on loans and depoists, as well as market interventions[8].

[1] Ibid., p. 3–4.

[2] Dai Public Announcement // https://dai.makerdao.com.

[3] Augmint // https://www.augmint.cc.

[4] Augmint Whitepaper, c. 4 // https://goo.gl/KtLgDz.

[5] Ibid.

[6] Ibid., p. 12–13.

[7] Ibid., p. 11–12.

[8] Ibid., p.5–6.

When the A-EUR market price drops below the target level, the interest rate on loan grows, which makes the issuance of A-EUR more expensive and slows down the supply growth. The interest rate on deposits also grows, which incentivizes the demand for A-EUR. Here the deposits are simply freezed, unlike bank deposits that are typically lent. The interest on deposits is paid from Augmint's reserves. If the A-EUR market price exceeds the target price, the interest rates on loans and deposits drop, thus stimulating the growth of supply and the decrease of demand. Market interventions can be used to promptly impact the market price of A-EUR: the system may buy and sell A-EUR at a price close to the par value using its own reserves. As the means of intervention the system can issue A-EUR: in this case, the issuance of A-EUR uses the assets exchanged on the market for the newly minted A-EUR[1] instead of the borrower's collateral. Additionally, the system may use the updates in the conditions for new loans, like repayment term, collateral type, collateral ratio, and the type of the loan[2].

The decisions on the monetary policy are made by Augmint Stability Board, which is elected by the holders of Augmint Treasury Coin (ATC) and Governance Deposit Coin (GDC), the governance tokens in Augmint[3].

A-EUR that remain in circulation due to the borrower's default are not removed automatically. Unlike Maker, Augmint does not provide for automatic buyback of non-returned A-EUR. The decision about buying A-EUR back from the market is made by the smart contract using oracle data on the current A-EUR market price. "As long as the A-EUR/EUR rate does not deviate downwards from par no intervention happening."[4]

Another approach towards backing a stablecoin with a non-native token is developed by ***Havven***[5]. In this case, a stablecoin dubbed nomin (nUSD) pegged to USD is backed by the project's own token, havven (HAV).

HAV tokens, as long as they are deposited in the system, entitle their holders to receive fees for nUSD transactions. "Those who use the stablecoin pay fees to those who collateralise the network, compensating them for the risks of providing collateral and stability. Collateral providers control the money supply, and fees are distributed in proportion with each individual's stabilisation performance."[6] Thus, the price of HAV depends on the amount of nUSD fees receivable by those using HAV as a collateral to issue nUSD. The more the amount of nUSD transactions, the greater the fee that has to be distributed among the holders of HAV collaterals.

The HAV ownership title gives one the right to issue an amount of nUSD proportional to the value of the deposited HAV in USD equivalent. When nUSD is created, the system places a limit sell order with a price of $1 on a decentralised exchange: the cryptocurrency received from selling the newly minted nUSD goes to the issuer.

[1] Ibid., p. 14.

[2] Ibid., p. 16.

[3] Ibid., p. 6–7.

[4] Ibid., p. 12.

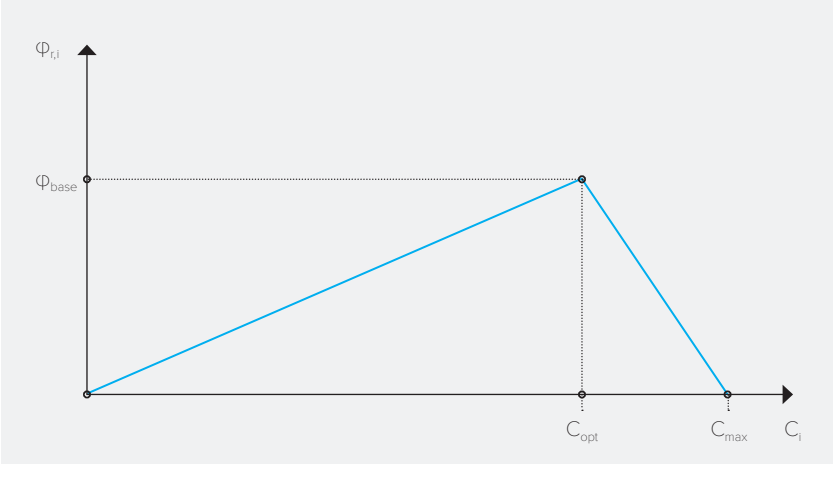
[5] Havven // https://havven.io.

[6] Brooks S., Jurisevic A., Spain M., Warwick K. Havven: A Decentralised Payment Network And Stablecoin, p. 5 // https://goo.gl/8SNdsd.

If the user wishes to release the deposited HAV, he or she has to provide the system with the amount of nomins he or she issued for said deposit. When the issuer initiates the return of their HAV from the collateral, the system places a limit buy order on a decentralised exchange, up to a maximum price of $1, on behalf of the issuer.[1] The system then burns the purchased nUSD and returns the collateral to the issuer. The developers of Havven stress that the nUSD stability starts with the sufficient level of backing that can ensure that "nomins can be redeemed for their face value"[2]. Still, the project's papers do not cover the question of whether the nUSD holder, as opposed to their issuer, is able to redeem them at face value at any time.

The market prices for nUSD and HAV are provided by the oracles[3]. Initially, the system will use 7-day moving averages to calculate the collateral ratios. However, in order to avoid the effect of speculation, the price of HAV is planned to be calculated depending on the expected rewards the token would bring[4].

The nUSD market price stability around the target price of $1 is attained through manipulating the nUSD supply. "The system monitors the nomin price, and responds by adjusting its targeted global supply, which individual issuers are incentivised to move towards."[5] For that purpose the system calculates the optimal collateralisation ratio (Copt) of nUSD. The issuers using this coefficient maximize their revenues from nUSD transaction fees. The individual issuer collateralization ratio (Ci) is calculated as the relation of market price of the nUSD they issued to the market price of HAV they deposited. The lower one's Ci is, the more their nUSD are collateralized. Copt is calculated from the current collateralization ratio for all circulating nUSD, as well as the price sensitivity and flattening parameters[6]. The project's documents omit the way those parameters are established.



Source: https://havven.io/uploads/havven_whitepaper.pdf.

As Ci increases and approaches Copt, the issuer's reward grows and reaches its maximum at Copt, then abruptly drops and reaches

[1] Ibid., p. 9.

[2] Ibid., p. 6.

[3] Havven Analytics // http://alchemy.havven.io.

[4] Brooks S., Jurisevic A., Spain M., Warwick K. Havven: A Decentralised Payment Network And Stablecoin, p. 14 // https://goo.gl/8SNdsd.

[5] Ibid., p. 6.

[6] Ibid., p. 12.

FIGURE 18.
The dependence of the issuer's reward (Φr) on the collateralization ratio (Ci)

zero at the maximum admissible coefficient (Cmax) which cannot be more than 1 under normal conditions[1]. If Ci<Copt, the maximization of the reward requires the issuer to issue additional nUSD backed with their collateral, thus increasing the supply of nUSD and decreasing their backing. If Ci>Copt, the issuer has to reduce the number of issued nUSD by repurchasing and burning them. This results in the shrinkage of the nUSD supply and the increase of their backing.

Aside from the aforementioned incentives, Havven Foundation takes a role of the buyer of last resort who "will have capital reserves with which to intervene in the market to stabilise nomin prices in extreme situations"[2].

[1] Ibid., p. 10.

[2] Ibid., p. 21.

2 Stablecoins without full backing

2.1. Fiat stablecoins

Stablecoins described in the previous chapter have two prices: a floating market price and a fixed price the issuer is obliged to redeem the stablecoin at. Most cryptocurrencies, however, have only the former. The issuers of these cryptocurrencies aren't obliged to redeem them with commodities or money at a fixed or even at a floating rate. Such cryptocurrencies can be seen as the next generation of fiat money[1] or, under certain circumstances[2], as a digital commodity. In both cases full backing isn't implied.

Today's national currencies are fiat monies that have only the floating market price, though the monetary authorities can maintain their price at a certain target level[3] using various monetary instruments like open market operations, interest rates, and currency interventions. Such tools are equally applicable in stabilizing the exchange rate of private fiat currencies and cryptocurrencies among them. This kind of cryptocurrency is the practical implementation of von Hayek's concept of private money. He suggested that full backing and the issuer's obligation to redeem their money at a fixed price are not prerequisites for the stability of freely competitive private monies[4].

Some argue that this kind of stablecoins originates from ***Seigniorage Shares***[5], a project dating back to October 24th, 2014 that never saw practical realization. However, ***NuBits (USNBT)***[6] had been presented a month before that[7]. USNBT is the first fiat stablecoin to be implemented and it exists to this day.

Unlike most stablecoins, USNBT has its own blockchain[8]. It is the cryptocurrency of Nu network, which is a DAO controlled by the NuShares (NSR) holders: "Nu is controlled by shareholders who own NuShares and mint blocks with them using proof of stake"[9]. The block reward comprises 40 NSR, with the average block time around 1 minute. The holders of Nu governance tokens have to implement the monetary policy aimed at minimizing USNBT market price fluctuations from the target price of 1 USNBT = 1 USD. For those purposes, the NSR holders vote to regulate the USNBT issuance, interventions on the cryptocurrency market, and interest rates on USNBT parking, as well as the fees and the issuance of NSR.

USNBT is not issued as a block reward, and their issuance does not have a predetermined and unchangeable algorithm. Those stablecoins can be created at any time and in any quantity as long as NuShares holders vote for it.

[1] Bondar D. Why Bitcoin Is not Gold 2.0 (in Russian) // http://forklog.com/pochemu-bitkoin-ne-zoloto-2-0/.

[2] Bondar D. Not All Tokens Have the Same Utility (in Russian) // https://forklog.com/ne-vse-tokeny-odinakovo-polezny/.

[3] Classification of Exchange Rate Arrangements and Monetary Policy Frameworks // https://www.imf.org/external/np/mfd/er/2004/eng/0604.htm.

[4] Dowd K. Hayek-Style Cybercurrency // https://www.alt-m.org/2015/05/06/hayek-style-cybercurrency/.

[5] Sams R. A Note on Cryptocurrency Stabilisation: Seigniorage Shares // https://goo.gl/SjQjvM.

[6] NuBits // https://nubits.com/.

[8] Nu Explorer // https://explorer.nubits.com/.

[9] Lee J. Nu, p. 2 // https://nubits.com/NuWhitepaper.pdf.

If the USNBT demand starts growing, the NSR holders vote for additional issuance of USNBT. This additional issuance goes to exchanges and makes up the USNBT sell order wall at the target price. "NuBits created and sold are network revenues that can be used ... for Nu operating expenses and dividends"[1].

[1] Ibid., p. 3.

The NSR holders can also vote for the issuance of USNBT in order to reward the liquidity providers who maintain the USNBT buy order wall at the target price. "In the same way that anyone can contribute hashing power to help maintain the Bitcoin network, anyone can contribute liquidity to help support the NuBits $1 peg. People who provide liquidty to support the peg can earn interest back for helping to maintain it."[2]

[2] Liquidity Pools // https://docs.nubits.com/liquidity-pools/.

The decision on issuance can be made for different reasons, for instance, to fund the development of a protocol or other software. USNBT issued after the voting are then sent to the custodian, a network participant entrusted by NSR holders to perform the task for which USNBT had been issued. The custodian sells the newly acquired USNBT on an exchange at the target price.

If the demand for USNBT goes down, the NSR holders vote for the increase of the interest rate payable for USNBT parking. There are actually several interest rates which vary depending on the duration of the parking. The parking procedure itself is the freezing of USNBT for a certain time, during which the owner cannot use these tokens. The growth of the interest yield for parking stimulates the demand for USNBT on the part of investors. This growth simultaneously decreases USNBT supply, since the incentive to freeze USNBT and thus temporarily remove the tokens from circulation grows. The issuance of USNBT for the repayment of the interest rate for parking is automatic and requires no voting.

The absolute values of the parking fee and transaction fees in NuBits are set up by NuShares holders and depend on the market conditions[3]. This instrument can be used as a means to reduce the supply of USNBT as the fees are not distributed among NSR owners but are destroyed instead.

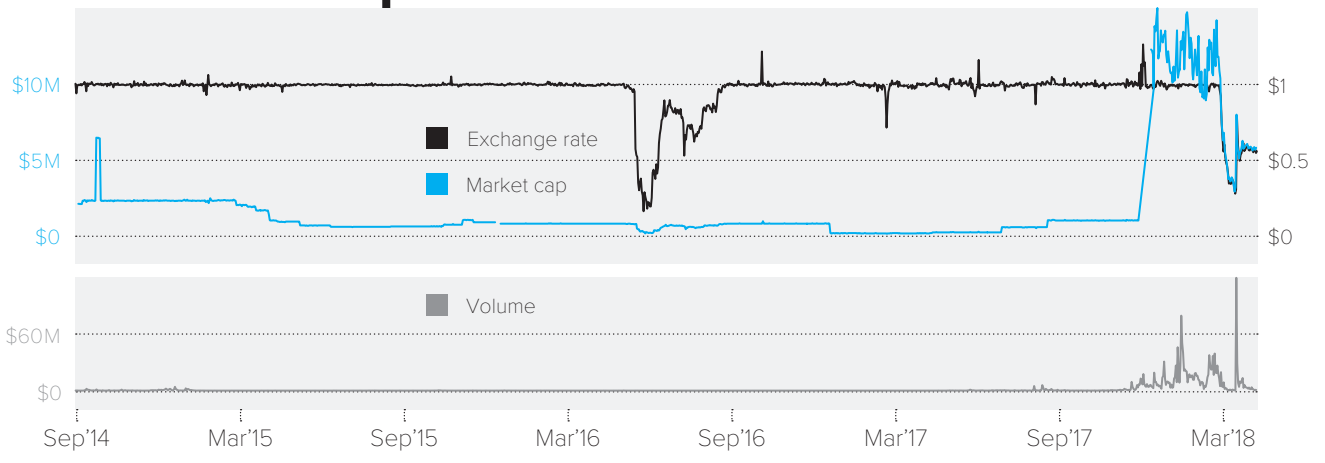
[3] NuBits Exchange Listing // https://nubits.com/list-nubits.

USNBT can also be burned as a result of their repurchasing with NSR. The holders of the governance tokens can vote for additional issuance of NSR subject to auctioning. The proceeds from that auction go to buy USNBT on an open market, which are then burned. In this case, the stability of the USNBT exchange rate is attained via the dilution of the governance tokens.

Even though USNBT is not fully backed and cannot be redeemed at a fixed price, its exchange rate against USD has been relatively steady with significant exchange trading volume range. USNBT exchange rate stabilty has been compromised twice: in one instance the rate plummeted and went for a subsequent three-

FIGURE 19.
USNBT/USD exchange rate, market cap, and daily exchange trading volume of USNBT

month long recovery, in the other the price drop occured over the rapid surge in USNBT supply.



Source: https://coinmarketcap.com/currencies/nubits/.

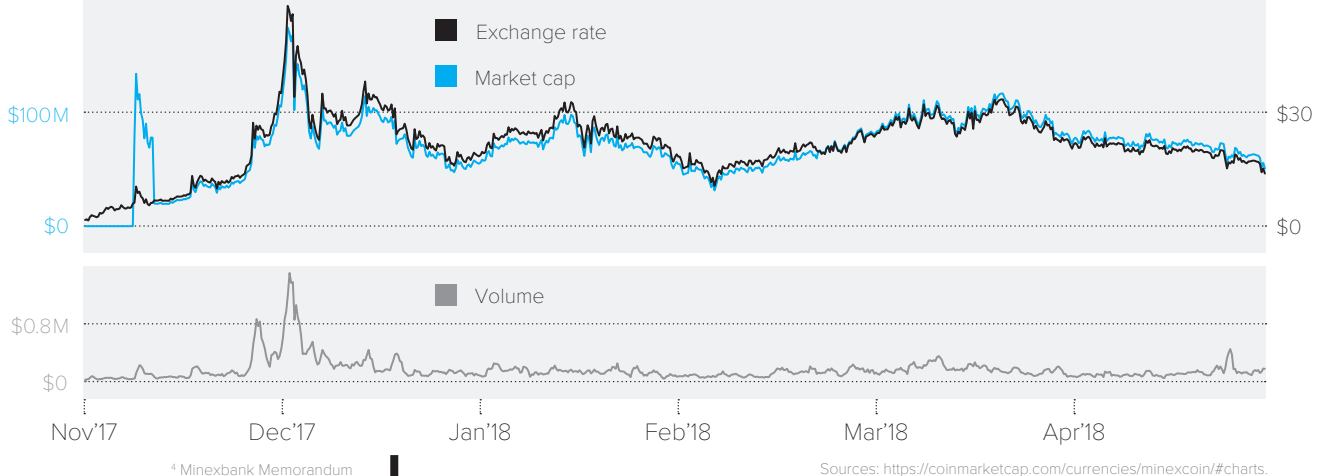
For a long time, USNBT remained the only fiat stablecoin on the market. In 2017, another similar coin dubbed ***Minexcoin (MNX)***[1] was launched. This stablecoin also uses a proprietary blockchain[2], and uses parking and interventions to stabilize its market price, but it also has certain substantial differences from NuBits.

The first fundamental difference is that MNX doesn't have a fixed target price. Its price is intended to grow by 33.6% per annum: "Predictable and controllable annual growth of the coin's price which correlates with average annual price growth calculated for a portfolio of most popular altcoins (around 33.6%)"[3].

As of the start of MNX's market history, its price has grown by 853% in less than a year. If MNX price had grown linearly for 33.6% per annum, the growth for this period would have comprised 16.47%. The project's second Memorandum increased the target rate to 88.4% per annum[4].

[1] Minexcoin // https://minexcoin.com/?r=site/index.
[2] MinexExplorer // https://minexplorer.com/.
[3] Minexcoin Low Volatility Asset, p. 4 // https://goo.gl/N6shW6.

FIGURE 20.
MNX/USD exchange rate, market cap, and daily exchange trading volume of MNX



Sources: https://coinmarketcap.com/currencies/minexcoin/#charts.

[4] Minexbank Memorandum // https://minexbank.com/memorandum.

In order to stabilize the MNX price, the project uses the autonomous intelligent algorithm dubbed MinexBank, which is a closed

app some of whose functions can be accessed through the official website[1]. "The main purpose of MinexBank is to stabilize the exchange rate within the range of no more than 5% of the previous day's close price… Upon reaching the limits of the 5% band, MinexBank would either change the interest rates for 'parking,' or go for an intervention to keep the price within the intended range."[2]

In order to make decisions on using the monetary policy instruments, MinexBank calculates two parameters: the weighted average cross rate of MNX/USD and the estimated value of MNX.

The weighted average cross rate of MNX/USD is calculated from the current MNX/BTC rate and the exchange rates of top 10 most capitalized cryptocurrencies weighted by their share in the market's total cap[3]. The exchange rates of other cryptocurrencies are involved in calculation of MNX/USD weighted average cross rate in order to peg it to these top 10 cryptocurrencies[4].

The current estimated value of MNX is the MNX target price at the given moment calculated from the MNX target growth rate and its initial price.[5] The initial price is the MNX price calculated upon the end of the second round of the company's ICO, which ended on June 13th, 2017[6]. In other words, the estimated value of MNX shows what would the MNX price have been had it been growing by 33.6% a year (or another rate) since June 13th, 2017.

If the MNX weighted average cross rate diverges from the MNX estimated value, MinexBank adjusts the parking rate. If the cross rate is lower than the estimated value, the parking rate goes up in order to stimulate the demand for MNX and reduce the supply, and therefore drive the price up. If the target price is lower than the weighted average cross rate, the parking rate goes down to increase the supply and reduce the demand. Unlike USNBT, the reward for MNX parking is paid from the MinexBank reserve and does not require a new issuance.

Strictly speaking, MNX parking is not freezing per se. A user can always use their coins: "If a user withdraws all money from their wallet, MinexBank does not award interest regardless of how much time there is until parking ends"[7].

If the adjustment of parking rates is not enough to impact the market price of MNX, MinexBank can undertake an intervention: it sells MNX to lower the market price, and buys them to increase it. "While assessing market conditions, MinexBank will use the asset price at the base exchange, which is the exchange where MinexBank stores, buys and sells its assets."[8]

MinexBank has 1,500,000 MNX premined for the purpose of interventions.[9] This reserve will be replenished by the deductions from miner revenues, both from block rewards and transaction fees. Once MNX issuance ends, the reserve will be replenished only at

[1] Minexcoin Low Volatility Asset, p. 5 // https://minexcoin.com/html/download/wprus.pdf.

[2] Ibid., p. 9.

[3] Ibid., p. 5–6.

[4] Ibid., p. 6–7.

[5] Ibid., p. 7.

[6] Ibid., p. 18.

[7] Ibid., p. 10.

[8] Ibid., p. 8.

[9] Ibid., p. 10.

the expense of transaction fees, with miners getting 30% of them, and MinexBank getting 70%[1]. MinexBank's publicly available documents don't describe the sources of the initial reserve for MNX repurchasing from the market and the ways of it's further replenishment.

[1] Ibid., p. 11.

Issuance via mining is another fundamental difference between MNX and USNBT. The miner reward comprises 2.5 MNX with the maximum supply of 19,000,000 MNX and average block time of 3 minutes[2]. The total premine distributed between the ICO participants, MinexBank reserve, and the project's developers and advisors, as well as bounty program participants, comprises 5,500,000 MNX or 28.94% of the max supply.

[2] Ibid., p. 16.

"At early phases of the system's operation, the team reserves the right to introduce adjustments to the algorithm's parameters in order to promptly prevent emerging risks and guarantee steady work of the system."[3]

[3] Ibid., p. 8.

The descriptive statistics for the price and daily exchange turnover of USNBT and MNX looks as follows.

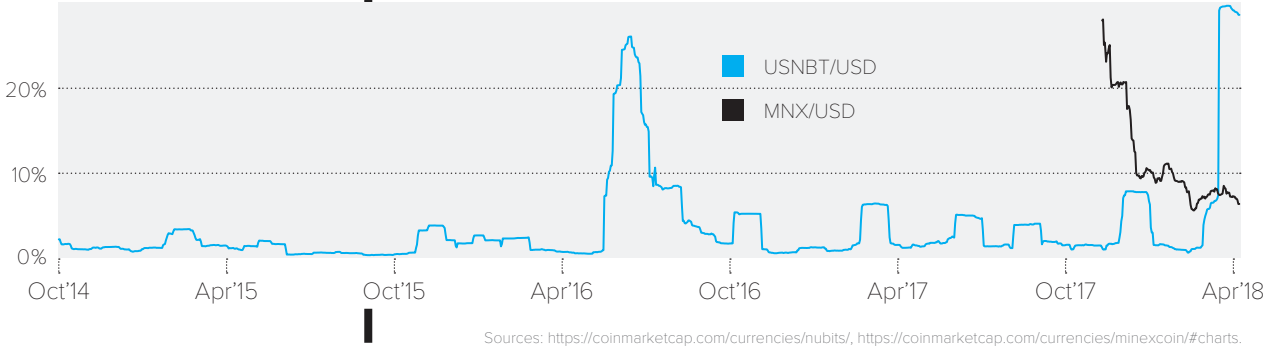
TABLE 13.
Descriptive statistics for price and daily exchange trading volume of USNBT and MNX

	Minimum	Maximum	Range	Mean	Median	Standard Deviation	Average 30-day Standard Deviation
USNBT/USD, $	0.1666	1.2641	1.0975	0.9598	0.9976	0.1339	0.0317
MNX/USD, $	1.2970	57.9600	56.6630	21.4500	21.5500	7.9691	5.3936
Daily turnover of USNBT, $thousand	0.0010	116754.0000	116753.9990	1318.5270	19.5170	5844.3480	1482.2438
Daily turnover of MNX, $thousand	16.4600	1491.0000	1474.5400	154.2000	120.4000	150.7808	106.0129

Source: https://coinmarketcap.com/currencies/nubits/, https://coinmarketcap.com/currencies/minexcoin/#charts.

FIGURE 21.
Volatility of USNBT/USD and MNX/USD exchange rates

The MNX average daily price change is almost 3.5 times as high as that of USNBT: 7.59% vs 2.19% respectively.



Sources: https://coinmarketcap.com/currencies/nubits/, https://coinmarketcap.com/currencies/minexcoin/#charts.

There are at least three more fiat stablecoin projects being in development: Basis, Carbon, and Kowala.

Basis project developing Basis cryptocurrency is positioned as an algorithmic central bank[1]. The system is intended to have three types of tokens: Basis, Bond tokens, and Share tokens[2].

[1] Basis // https://www.basis.io

[2] Al-Naji N., Chen J., Diao L. Basis: A Price-Stable Cryptocurrency with an Algorithmic Central Bank, p. 13 // https://www.basis.io/basis_whitepaper_en.pdf.

Basis is a fiat cryptocurrency whose price will be maintained stable against the target price. The algorithm will manipulate the supply of Basis, reducing it when the market price is below the target level, and increasing it when the market price is above the target level.

The project's creators consider three alternative approaches to feeding the current Basis market price: centralized based on a single trusted source; partially decentralized based on several oracles elected by Basis; and a fully decentralized one, which uses Schelling points scheme[3]. Generally, they prefer the latter option, however, the rules of this game for Basis are not fully developed yet, and therefore there's not much certainty in this regard: "Either way, all of these implementations are valid alternatives for providing the Basis blockchain with a feed of Basis-USD prices."[4]

[3] Ibid., p. 11–12.

[4] Ibid., p. 12.

Bond token is a kind of a promissory note redeemed with Basis. The system redeems it at the par value, which is 1 Basis.

When the system needs to reduce the supply of Basis, it sells the bonds at an auction below the par value[5] for the amount of Basis that has to be removed from the circulation. The auction participants place their bids to buy some bonds at a certain price. The system ranges their bids from the worst to the best and sells the bonds until it has the necessary amount of Basis, which is then destroyed. If the system needs to remove, for example, 100 Basis from circulation and there are two bids (100 bonds for 0.8 Basis and 100 bonds for 0.4 Basis), it will take the first bid entirely for 80 Basis and sell 50 bonds to the second bidder for the 20 Basis that's left to get.[6]

[5] Ibid., p. 13.

[6] Ibid., p. 15–16.

When the system needs to increase the supply of Basis, it redeems the bonds for the amount it needs to put into circulation. The bonds are redeemed in the order of their issuance, from the first to the last. For example, if it needs to add 100 Basis, it redeems 100 of the oldest bonds issued less than 5 years ago as 5 years is the bond's validity term. If no one has redeemed it within said period, its holder cannot redeem it anymore[7]. Thus, bonds are not fungible as each of them has its own place in the redemption queue.

[7] Ibid., p. 14.

Share token is the system stock of a kind. Unlike Basis and bonds, their supply is fixed. These shares provide an auxiliary channel for getting new Basis into circulation. If the system needs to increase the supply of Basis but all bonds have been redeemed, it redistributes all newly created Basis amongst the shareholders accordingly with their share in the total supply of the shares[8].

[8] Ibid.

In the future, if the role of Basis in international circulation will be comparable to USD and commodities will be priced in Basis, the pegging mechanism may be changed. Instead of pegging it to USD, the system may control the supply of Basis using the target inflation rate similarly to the Fed using the Consumer Price Index[1]. The system, just like the Fed, may ensure the stability of prices and tackle unemployment. As the decrease of salaries is related to unemployment, the system may include the hourly wages in the target inflation index[2] to be used later.

"In the long run, it may be favorable to create a separate instance of Basis for each regional economy, with each stabilizing against a CPI computed for that particular region."[3]

Carbon[4] uses two tokens: Carbon (CUSD) and Carbon Credits. The former is a USD-pegged stablecoin, the latter is a security whose holder can receive revenues in CUSD under certain circumstances. Just like Basis bonds, Carbon Credits are used to reduce the CUSD supply if the market price drops below the target level, and to increase the CUSD supply if its market price exceeds $1.

The provision of data on the current CUSD market price, which is required for the decision making on the change of supply, uses the Schelling points scheme. Once every 24 hours, the Carbon holders will vote on the current CUSD market price. The weight of their votes depends on the amount of the CUSD they have deposited as a collateral. The system calculates the weighted average price of CUSD, and rewards those whose votes were between 25 and 75 percentiles with the collateral of those whose votes were outside of that interval. The system uses normal distribution to determine the amount of the reward: it normally declines both sides of the 50 percentile value[5]. The project notes that "liquid decentralized exchanges will offer a new set of options to the oracle problem as price data will be encoded in the network itself"[6].

The market price of CUSD is controlled as follows. If it drops below the target price, the system starts selling Carbon Credits via Dutch auction[7]. Aside from the contraction of CUSD supply via burning the revenues from Carbon Credits sales, the auction also stimulates the demand for CUSD as there is an opportunity to use them for buying Carbon Credits below the market price. If the CUSD market price exceeds the target price, the system starts issuing new CUSD and distribute them among Carbon Credit holders proportionally to their share in the total supply of Carbon Credits[8].

Unlike Basis bonds, Carbon Credits are fungible and are not destroyed after its holder gets CUSD. Like Basis shares, they stay in circulation forever. Still, unlike Basis shares, their supply is not fixed: they are diluted every time the system reduces the CUSD supply.

Unlike most stablecoin projects without their own blockchain, Carbon developers have chosen Hashgraph, not Ethereum[9].

[1] Ibid., p. 18.

[2] Ibid., p. 19.

[3] Ibid., p. 20.

[4] Carbon // https://www.carbon.money.

[5] Lin C., Mai G., Albert M., Trautwein S. Carbon: A Price-Stable Cryptocurrency for Next-Generation Payments, p. 8 // https://goo.gl/82kL1Z.

[6] Ibid., p. 14.

[7] Ibid., p. 9.

[8] Ibid.

[9] Ibid., p. 12.

Kowala[1] will enable one to create fiat stablecoins pegged to different assets. It "defines a method for constructing a family of distributed, self-regulating, asset-tracking cryptocurrencies called kCoins"[2]. Depending on the anchor, such cryptocurrencies are called kUSD, kEUR, etc.

Kowala protocol is based on Ethereum code, however, "because every kCoin needs a robust exchange market to function properly, each kCoin is implemented as a distinct, independent blockchain with its own tokens, smart contracts, mining community, etc"[3]. Each kCoin is mined separately by the holders of relevant mining tokens called mTokens. For instance, kUSD can be mined only by the holders of mUSD, and kEUR by the holders of mEUR. The Kowala protocol distributes block rewards through a mechanism called proof-of-control[4], rather than PoW or PoS.

"kCoins constantly gather market information from endorsed sources and regulate their value through three core mechanisms: variable block rewards, variable fees, and an active and well-informed trading market."[5]

The reward for genesis block will be 42 kUSD. Starting from block 2, the system continuously estimates the current market price of kUSD and changes the block reward accordingly. If the market price of kUSD for two previous blocks was above $1 and keeps on growing or remains stable, the block reward gains 1%. If the market price for the two previous blocks was under $1 and keeps on dropping or remains stable, the reward decreases. The reward for the current block is then calculated by dividing the previous block reward by 1.01. The minimum reward is 0.0001 kUSD[6]. If the market price of kUSD is $1 or closer to that value than in the previous block, the reward does not change.

The reward shortage from 1 kUSD to 0.0001 kUSD takes 3.9 hours considering each new block is generated every 15 seconds.

However, the reduction of the reward to the value close to zero could be insufficient in order to increase the market price of kUSD. In addition to said mechanism, there is a stabilisation fee that allows not only to reduce the speed of kUSD supply growth, but to decrease its supply. Each sender has to pay a 0.001% to 2% stabilisation fee in addition to the regular transaction fee (gas fee). The stabilisation fee goes to a dead-end address that can only accept transactions, so it is equivalent to burning the coins. Under normal circumstances, stabilisation fee is under 0.1%, however, when kUSD price keeps on dropping, it can increase up to the maximum level and goes back to minimum when the market price returns to the target price[7].

As the efficiency of said mechanisms gains market recognition, the target price of kUSD becomes a focal point (a Schelling point). "The absence of perfect communication and trust among disparate human market participants along with the status of the parity price

[1] Kowala // https://www.kowala.tech.

[2] Glover E., Reitano J.W. The Kowala Protocol: A Family of Distributed, Self-Regulating, Asset-Tracking Cryptocurrencies, p. 3 // https://goo.gl/HJk1Va.

[3] Ibid.

[4] Ibid., p. 9.

[5] Ibid., p. 3.

[6] Ibid., p. 5.

[7] Ibid., p. 6–7.

as a focal point increase the likelihood that the price of kUSD will return to parity."[1]

[1] Ibid., p. 7.

The arbitrageurs who believe that the market price of kUSD will return to the parity level will be able to profit from buying kUSD at a price below the par value and selling it at a price higher than that. "Although arbitrageurs may exploit these profit opportunities purely for self-interest, their trading activity should have the positive effect of accelerating the return to parity."[2] As this trading activity is advantageous for the stabilization of kUSD, Kowala plans to participate in independent, open-market, profit-seeking trading activities based on the same information publicly available to all[3].

[2] Ibid., p. 7–8.

[3] Ibid., p. 8.

The data on the current market price of kUSD are supplied by miners who use so-called price-determining transactions[4]. For that purpose, they use the data on the current deals where kUSD is bought for BTC or USD. As the protocol supports the pegging of kUSD to USD, miners have to provide BTC/USD exchange rate along with kUSD/BTC exchange rate.

[4] Ibid.

In order to service the Kowala protocol, an eponymous organization managed by the board of directors will be established[5]. In particular, Kowala will provide two kinds of API for the miners to use in order to obtain the data on kUSD market price: Exchange Endorsement API and BTC Price Endorsement API. This APIs will show mining clients from which exchanges they should get the data about kUSD and BTC prices in order to calculate block rewards and fees.[6] The project team also weighs on using Schelling points scheme for decentralized asset price data feeding[7].

[5] Ibid., p. 4.

[6] Ibid., p. 9.

[7] Ibid., p. 12.

TABLE 14.
Basis, Carbon, and Kowala comparison

	Basis	Carbon	Kowala
Increase of stablecoins supply	Redemption of bonds and distribution of newly created stablecoins among shareholders	Distribution of newly created stablecoins among shareholders	Block reward increase
Decrease of stablecoins supply	Selling bonds for stablecoins	Selling shares for stablecoins	Increasing stabilization fee
Method of feeding data on stablecoin market price	Not developed	Schelling points scheme	Oracle miners provide data from pre-approved exchanges
Blockchain	Basis	Hashgraph	Kowala

Sources: https://www.basis.io/basis_whitepaper_en.pdf, https://www.carbon.money/whitepaper.pdf, https://cdn2.hubspot.net/hubfs/3919777/pdf/kowala-protocol-whitepaper-v1.0.pdf?t=1525290814171.

Unlike stablecoins reviewed above, four out of five fiat stablecoins reviewed herein use or plan to use their own blockchain; two use or plan to use the issuance through the miner rewards; and one uses a growing target price instead of a fixed one.

2.2. Stablecoins with fractional reserves

Stablecoins with full backing and fiat stablecoins whose issuers do not undertake to redeem them at a fixed or floating price, are the extreme versions of stablecoins. Between them, there are stablecoins whose issuers do undertake to redeem them, but this kind of redemption requires only fractional reserves.

Modern-day commercial banks manage to function normally using only fractional reserves. The history of gold-backed banknotes that played the role of national currencies saw full backing as an exception more often than as a rule. Unlike modern commercial banks' and classic bankote issuers' fixed obligations, stablecoins with fractional reserves described below don't have a constant redemption price.

Saga (SGA)[1] is a cryptocurrency on Ethereum blockchain that is developed by Saga — non-profit foundation incorporated in Switzerland.

[1] Saga Foundation // https://www.saga.org..

Saga is positioned as a complementary global currency pegged to special drawing rights (SDR). "Saga tokens are backed by a reserve held in a regulated banking institution on behalf of Saga customers... The reserve comprises liquid low-risk assets in a mixture of fiat currencies, whose composition replicates the International Monetary Fund's SDR."[2]

[2] Saga Whitepaper, p. 8 // https://www.saga.org/files/saga-whitepaper.pdf

SGA is issued by a smart contract in exchange for ETH. Those willing to buy SGA send ETH to the smart contract and obtain the respective amount of newly created SGA. "Most ETH received by the contract is converted into fiat currencies according to the SDR makeup, while some is maintained as an ETH liquidity buffer."[3] Those willing to sell SGA send them to the smart contract which pays the amount of ETH corresponding to the current price of SGA from the liquidity buffer, and burns the received SGA.

[3] Ibid.

The Saga smart contract acts as a market maker for SGA. It buys SGA at a price below the target price (bid) and sells it at a price above targer price (ask). The market price of SGA may freely fluctuate within this price band. It is irrational to sell SGA at a price lower than that offered by the smart contract, and to buy at a price higher than that.

The target price of SGA is not fixed. The pricing model used by the smart contract is the evolution of the automatic price discovery model developed by the Bancor team[4]. The key variable here is the reserve ratio reflecting the share of SGA market cap backed with reserves. As long as it is 100%, the target price of SGA used by the smart contract for bid/ask prices calculation remains the same. As the project develops, the reserve ratio will start to decline, and the target price will grow as a result[5].

[4] Ibid., p. 11.

[5] Ibid., p. 15.

There are three stages in Saga's development in terms of the changes in the reserve ratio[6].

[6] Ibid., p. 13.

At stage one, when the Saga ecosystem is small and fragile, the reserve ratio will be 100%. “SGA price is fixed, and does not reflect changes in market trust. SGA at a reserve ratio of 100% is no more than a digital SDR currency board.”[1] This would exclude any bank run, and ensure equal conditions for all early investors. This will remain the basic regime until the SGA supply reaches 20 million SDR.

[1] Saga Whitepaper, p. 9 // https://www.saga.org/files/saga-whitepaper.pdf.

At stage two, as the Saga ecosystem grows, the reserve ratio will decrease linearly and reach 10% when the SGA supply reaches 3 trillion SDR.

At stage three, the SGA model will change. “The reserve-ratio-based Price Discovery Model is abandoned and replaced by a new system, to be determined as needed.”[2]

[2] Ibid., p. 13.

As the reserve ratio decreases, the price band set up by the smart contract will increase. “The band’s maximum width of 15% is reached when the reserve ratio hits its 10% minimum. However, until a secondary market is well established, the width of the price band remains fixed at 0.15%, covering only direct transaction costs.”[3]

[3] Ibid.

The direct expenses on market making are transaction fees in Ethereum and bank fees. The profits from market making after that is deposited in the reserve thus increasing the backing of SGA and its target price. The difference between SGA and other stablecoins is that the growth source of its backing and target price are not only the profits from market making, but also the interest yield from storing the reserve in a bank. “The price increase is done continuously, in order to prevent manipulations — namely someone buying SGA just before a price increase and then immediately selling at a profit. This mechanism ensures Saga holders receive their fair value while reducing opportunities for arbitrage.”[4]

[4] Ibid., p. 10.

“Saga implements a KYC (Know Your Customer) that deploys a multi-signature on-chain solution. Three signatures are issued: one to the participant; the second to their jurisdiction; the third remains in the hands of Saga. Two out of three signatures are required to reveal the identity of a participant.”[5]

[5] Ibid., p. 5.

In order to fund the development, Saga offers its investors Saga Genesis tokens (SGN), which are actually vouchers converted into SGA. The SGN to SGA conversion rate increases as the SGA supply grows: “Whenever Saga’s economy reaches a new Genesis Minting Point, SGA tokens are minted, to be allocated to SGN holders upon conversion to SGA”[6]. There are three Genesis Minting Points for rewarding SGN holders. The first issuance occurs when the SGA supply reaches 25 million SDR; the second, when it reaches 610 million SDR; the third, when it reaches 1.5 trillion SDR. The conversion rate is calculated from a predetermined formula[7] and reaches its maximum of 15 SGA in the third point. Thus, the reserve ratio for SGA will decrease not only due to the programmed linear decrease, but also due to the issuances of SGA for the SGN holders.

[6] Ibid., p. 10.

[7] Ibid., p. 12.

Another Ethereum-based project developing a stablecoin with fractional reserve is called ***Fragments***[1]. "The Fragments protocol is an algorithmic monetary supply policy and reserve."[2] Thanks to that protocol, one can create various low-volatility cryptocurrencies, with the first of them being USD Fragment (USDF) pegged to USD.

The stability of USDF market pricewill be achieved via two mechanisms: a network of market makers mitigating minor fluctuations, and the USDF supply manipulation focused on more significant deviations.

Arbitrageurs who believe the system can bring the USDF market price back to the target price will buy it when it costs less than $1, and sell when it's over $1. As the resources of the market makers are limited, the USDF supply will have to be contracted or expanded at some moment.

The USDF supply can be manipulated as follows. When the USDF exchange rate drops below $1, the system starts an auction where it accepts bids to buy USD Fragment Bonds worth 1 USDF that will later be redeemed at their par value. For instance, the system places 80 bonds for bidding, and there are two bids: one for 20 bonds $0.80 each, and the other for 80 bonds $0.75 each. As a result, the system will fill the first bid entirely, and sell 60 bonds to the second bidder. Unlike the projects reviewed above, "the Fragments reserve acts as the primary participant in this auction"[3]. The system does its best to reduce the supply using the internal reserve rather than external borrowing. The system's reserve is formed during the expansion.

When USDF is traded at prices over $1, its supply is increased during the issuance. The stablecoins enter the circulation in the following order. First, all bonds are redeemed. If it's not enough to increase the supply, the stablecoins are distributed among all USDF wallets proportionally to their balance, as well as between Fragments Foundation and the Fragments reserve. The issued USDF are not sent to all the wallets automatically: each user has to personally send the transaction to the smart contract and pay a miner fee to receive his or her own USDF. If the user fails to request his or here USDF over the specified period, they lose their title to them. Those tokens cannot enter the circulation, and the system does not account for them in its further calculations.

At initial phases, Fragments will use ETH as a reserve, so the newly created USDF issued for the reserve are automatically sold for ETH. When the system needs to reduce the supply of USDF it uses those ETH to buy USDF, which are then used in the auction of bonds.

The share of USDF sent to the reserve after each issuance determines the degree of USDF's backing with the native Ethereum token. This share varies depending on how massive the increase of USDF supply is after the given issuance. When the USDF supply

[1] Fragments // https://www.fragments.org.

[2] Fragments Protocol // https://www.fragments.org/protocol/.

[3] Ibid.

increases abruptly, most issued tokens remaining after the redemption of bonds go to the reserve — and the Fragments Foundation and USDF holders get a much smaller share. When the supply of USDF grows relatively insignificantly, most of the issued tokens are distributed amongst the USDF holders, and a much smaller share goes to the reserve and the Fragments Foundation.

The exact percentage of newly created USDF sent to the reserve depends on the target buffer ratio (TBR). The extent of its conservatism is set by the sensitivity parameter, which defines the extent of USDF supply increase that is seen by the system as abrupt and therefore requiring the maximum TBR. For instance, if the sensitivity parameter equals 1, the maximum reserve ratio will be applicable when the USDF supply increases by more than 100%. If the sensitivity parameter equals 1×10^{-8}, the maximum reserve ratio will be applicable to any increase of supply over one millionth of one per cent. The description of the Fragments protocol notes that the sensitivity parameter may be fixed or floating, however, the latter option is only possible if it provides greater reliability as it requires additional expenses.

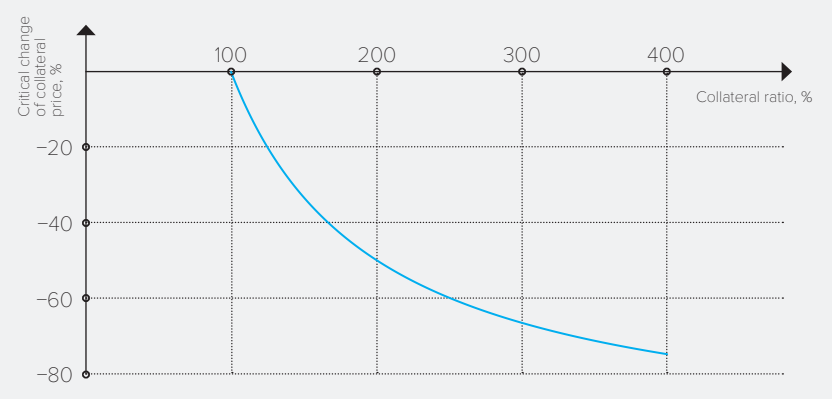
Aside from ensuring USDF stability, the team seeks to maximize the sensitivity parameter which would allow the system to distribute the majority of newly issued USDF among the USDF holders rather than to the Fragments reserve, while minimizing the sales of bonds to external buyers. The reliable network of market makers is an important prerequisite for increasing the sensitivity parameter safely. The project's documentation claims that "the Fragments Foundation will participate as a market maker alongside others"[1].

[1] Ibid.

Even though at the maximum reserve ratio some of the issued USDF don't get to the reserve, it can still be sufficient to repurchase all the USDF in circulation, since the repurchasing occurs only at prices lower than $1. The mitigation of currency risk associated with using ETH as the only reserve is possible via diversification. For example, the reserve may contain a portfolio of non-native tokens alongside with the native Ethereum token.

The stablecoins with full backing discussed in part one of this report can also become partially backed under certain circumstances. The issuer of e-money may violate the rules and issue tokens without replenishing the reserves, or spend the reserves that should have been the collateral for the existing tokens. If an anchor asset of e-money is different from a collateral asset, there is a risk of the collateral devaluation against the anchor. Smart banknotes' collateral can devalue abruptly enough to make it impossible for their holder to redeem them at the target price. The threshold values for negative changes of the collateral price that turn a fully-backed stablecoin into a partially-backed one are shown on the chart below.

FIGURE 22.
Critical change of the collateral price depending on the collateral ratio



Source: calculated by the author.

Maximum daily decrease of ETH price, which is used as a collateral in DAI, is 25.48%; the price of BTS, which is a collateral for bitUSD, once dropped by 43.31% in one day. The normal functioning of smart banknotes implies a trade-off between the consumers and the manufacturers: the increase of the collateral ratio enhances the smart banknote's reliability while decreasing the incentive for its issuance as it requires the issuer to freeze a greater amount of their assets as collateral.

HAV tokens that were supposed to back nUSD once cheapened by 20.27% in one day. The current Havven system, unlike BitAssets or Maker, doesn't include the automatic forced sellout of the collateral if its price drops to the limit. Havven is supposed to return to the full-backing state exclusively via the distribution of nUSD transaction fees. The reward of those issuers whose nUSD aren't fully backed drops to the zero, while the issuers who maintain the optimal collateral ratio for their nUSD get the maximum reward. It is also possible in Havven that the requirements for the collateral needed to issue nUSD drop to the level of fractional reserve: "it should be noted that Cmax > 1 corresponds to a fractional reserve monetary system, where a greater value of nomins can be issued against each havven. In Havven, this situation is unsustainable because it would cause simultaneous appreciation of havvens (up to at least the value of nomins issuable against a havven) and depreciation of nomins, immediately diminishing C, Copt and Cmax, bringing them back under 1"[1].

[1] Brooks S., Jurisevic A., Spain M., Warwick K. Havven: A Decentralised Payment Network And Stablecoin, p. 13 // https://havven.io/uploads/havven_whitepaper.pdf.

2.3. Vouchers

Aside from banknotes and warehouse receipts, there is one more instrument that can be transferred onto blockchain and used as a stablecoin: voucher. Lock account allowing one to freeze the price of BTC is the provider's obligation to provide the customer with the cryptocurrency for a fixed amount of fiat. A bitcoin voucher (just like a voucher for any other crytocurrency) is a similar obligation, but unlike a Lock account it is more suitable as a means of exchange. If it's, for instance, a voucher in the form of a scratch card, it can be used for offline exchange. Exchange with such voucher,

unlike that with smart banknotes, doesn't even require one to have a cryptocurrency wallet. However, vouchers are not trustless and may lack full backing.

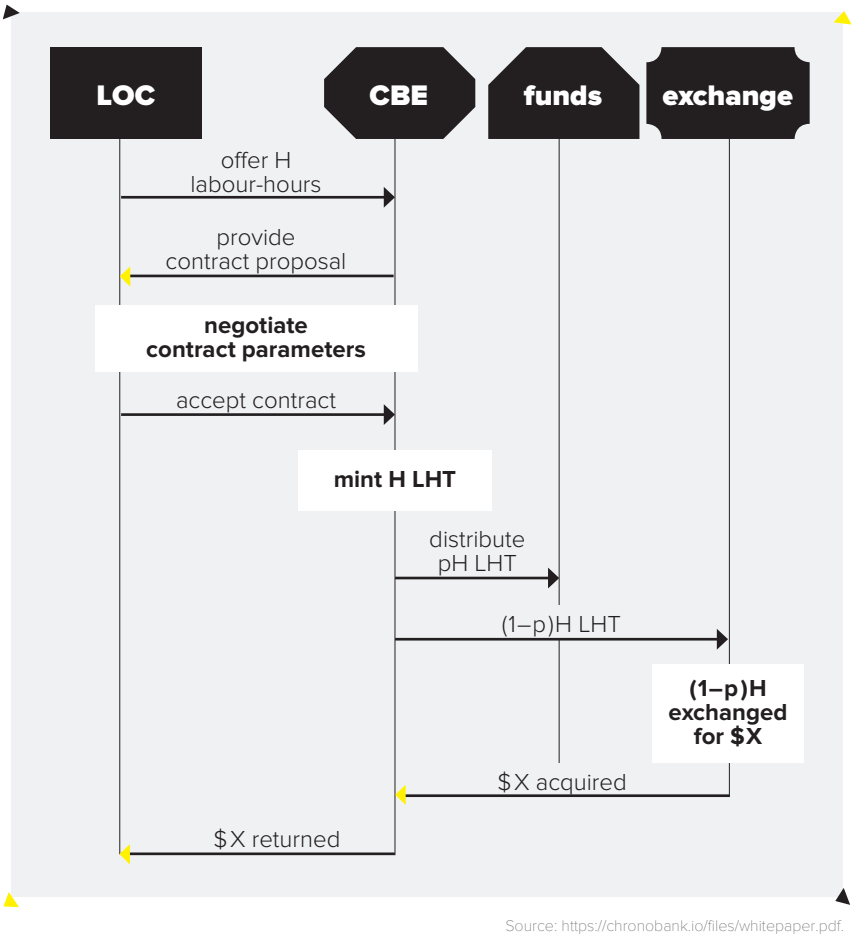
The team of ***ChronoBank***[1] develops a stablecoin as a voucher denominated in fiat and redeemed with a commodity, not cryptocurrency. It's called Labor-hour token (LHT) pegged to the hourly wage calculated as the average hourly wage in the givern country. ChronoBank plans to issue four national LHTs: LHAU, LHUS, LHEU, and LHGB[2].

[1] Chronobank.io // https://chronobank.io/.

[2] Chronobank.io Development Plan // https://chronobank.io/files/dev_plan.pdf.

LHT is issued as a result of Chronobank Entity (CBE) and a labour offering company (LOC) signing a contract that obliges the LOC to redeem a certain amount of LHT with workforce, or repurchase LHT for national currency when the contract expires. After that, the CBE issues the relevant amount of LHT, sells it at an exchange, and transfers the proceeds to the LOC.

FIGURE 23.
Issuance of LHT

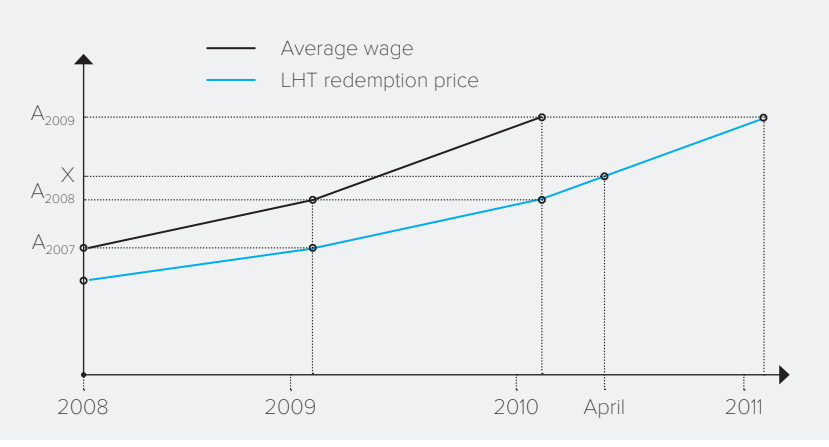


Source: https://chronobank.io/files/whitepaper.pdf.

The LOC undertakes to redeem LHT with workforce to the amount equivalent to the price of LHT redemption as of the time of redemption. If the average wage grows, the redemption price will grow along with it. The official data on average wages are published only once a year. This is why the redemption price of LHT grows linearly over a year from one point to another: from the value

published last year to the value for the current year. Therefore, the LHT price calculation lag is one year against the newest set of stats.

FIGURE 24.
Change of LHT redemption price along with average wage



Source: https://chronobank.io/files/whitepaper.pdf.

As LHT is a promissory note, it entails the risk of default. The borrower is a LOC and not the CBE: it's the LOC undertakes to buy the workforce to redeem LHT or repurchase LHT for money. The CBE controls the LOCs' compliance with their legal obligations and manages the Liquidity Reserve (LR) and the Security Guarantee Fund (SGF). The former is used for interventions for the purpose of maintaining the stable market price of LHT, while the latter is needed for the insurance against the default on the part of the LOC.

Thus, LHT are pegged to the workforce price and can be redeemed by it, however, they are backed by national currency on the LOC's accounts and the reserves formed by the CBE.

According to the developers, the LHT pegged to the Australian labor market (LHAU) will be the first to be issued. There are no data on the fees charged from Chronobank users so far, however, the documentation suggests there will be issuance and transaction fees[1]. The issuance will be paid for by the LOC and the transactions by the stablecoin users, who will pay not only fees in LHT, but also the Ethereum mining fees. The CBE also reserves the right to charge a fee of 0 to 1 per cent from LHT deposited for redemption[2]. The amount of fees upon the project's launch will be set up by the Chronobank team, however the CBE can hold polls on the Ethereum blockchain to elicit the opinion of TIME token holders. TIME tokens are not governance tokens, however, they entitle their holders to get revenues from LHT issuance and transaction fees[3]. The results of the surveys "will be incorporated into decisions made by the CBE concerning the financial or technical direction and/or implementation of the CBE system."[4]

After LHT is launched on Ethereum blockchain, Chronobank is going to issue this stablecoin on other blockchains, including Waves and NEM.[5]

[1] The Chronobank Team. Chronobank — Phase 1: A Non-Volatile Digital Token Backed By Labour-Hours, p. 2–3 // https://chronobank.io/files/whitepaper.pdf.
[2] Ibid., p. 5.

[3] Ibid., p. 2–4.
[4] Ibid., p. 3–4.
[5] Chronobank partners with WAVES to create ChronoWAVES wallet // https://blog.chronobank.io/chronobank-partners-with-waves-to-create-chronowaves-wallet-c6e24be533a4; Chronobank partners with NEM to create ChronoNEM wallet // https://blog.chronobank.io/chronobank-partners-with-nem-to-create-chrononem-wallet-eebdc176351d.

3 Cryptocurrency basket as a stablecoin

3.1. Pegging to a basket of cryptocurrencies

Any stablecoin is stable only in relative terms. A cryptocurrency may remain steady against an anchor asset but dramatically fluctuate against other assets. The decrease of currency risks associated with pegging a stablecoin to one national currency is therefore possible by pegging it to a basket of national currencies. Divergent price fluctuations of different currencies within the basket cancel each other out thus making the basket's price more steady than those of the currencies it includes.

Saga uses the SDR basket as the anchor for their stablecoin. SDR is a supranational currency pegged to the basket of freely usable currencies[1]. SDR was designed during the final days of the Bretton-Woods system as a new global money capable of overcoming the natural limitations of gold and the national limitations of USD. The IMF revises the SDR basket composition once every five years. As of October 1st, 2016 it includes USD (41.73%), EUR (30.93%), CNY (10.92%), JPY (8.33%) and GBP (8.09%)[2]. Since CNY was added, the volatility of SDR against the currencies included in the basket became lower than that of USD.

[1] As defined in: International Monetary Fund. Articles of Agreement // https://www.imf.org/external/pubs/ft/aa/pdf/aa.pdf.

[2] Review of the Special Drawing Right (SDR) Currency Basket // https://www.imf.org/en/About/Factsheets/Sheets/2016/08/02/19/35/Review-of-the-Special-Drawing-Right-SDR-Currency-Basket.

TABLE 15.
Coefficient of variation for SDR and USD exchange rates against currencies included in SDR basket

Currency pair	Coefficient of variation, %	Coefficient of variation, %	Currency pair
SDR/CNY	1.0058	3.1560	USD/CNY
SDR/EUR	3.1022	5.5902	USD/EUR
SDR/JPY	2.8000	2.9562	USD/JPY
SDR/GBP	2.3038	4.4846	USD/GBP

Source: http://www.imf.org/external/np/fin/ert/GUI/Pages/CountryDataBase.aspx.

In stablecoins, a cryptocurrency basket can be used in different ways and for different purposes.

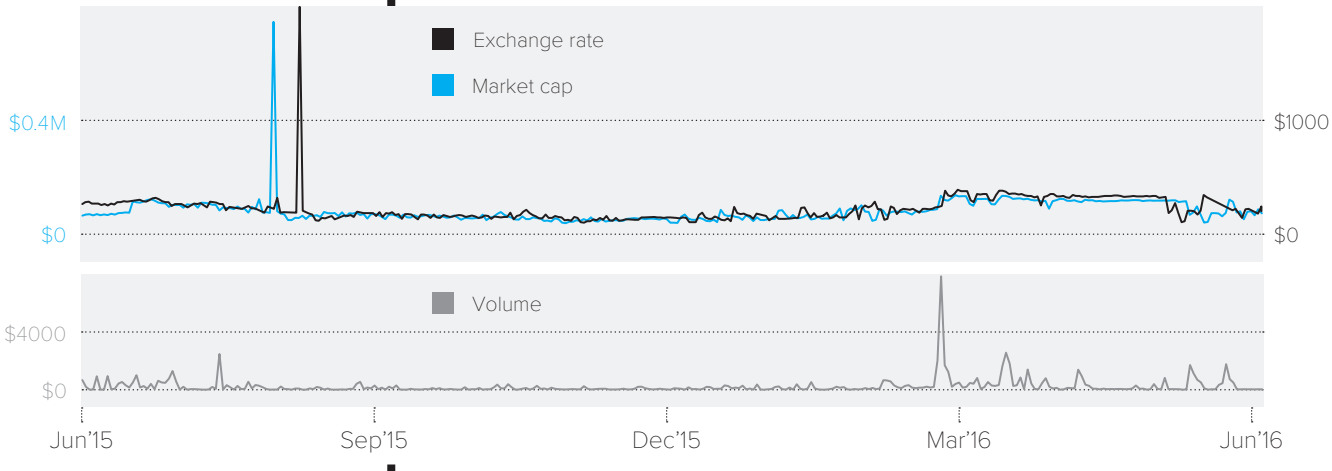
A cryptocurrency bakset can act as an anchor, in which case the stablecoin's purpose would be to remain stable against the cryptocurrency market in general or in part. At the moment of writing, there are no tokens positioned as a stablecoin pegged to the cryptocurrency market, however, there are tokens pegged to cryptocurrency indices.

The first instrument pegged to a basket of cryptocurrencies is probably ***Coinoindex (INDEX)***[3], created on Nxt. It was pegged to

[3] Coinoindex: Dow Jones for Cryptocurrencies (in Russian) // http://forklog.com/coinoindex-indeksdou-dzhons-dlya-kriptovalyut/.

the index of a 20-currency basket calculated with a method developed by Coinoindex team. It was the issuer's obligation to provide the token holder with an amount equivalent to the current price of the basket. INDEX required one to have profound trust in the issuer who didn't provide any information on any backing for the token.

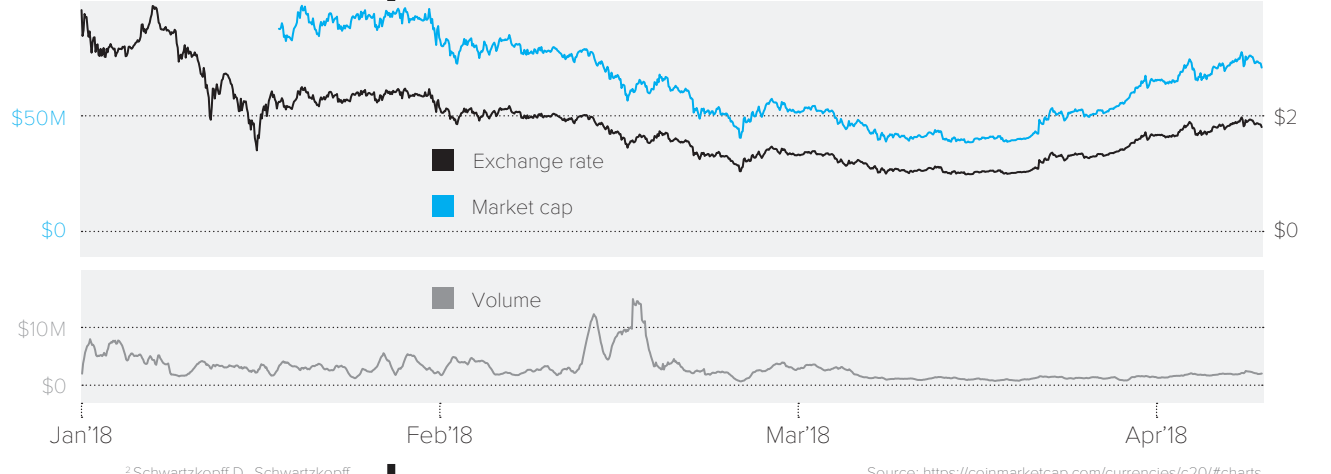
FIGURE 25.
INDEX/USD exchange rate, market cap, and daily exchange trading volume of INDEX



Source: https://coinmarketcap.com/assets/coinoindex/.

C20, the token of cryptocurrency index fund ***CRYPTO20***[1] launched on Ethereum "is representative of a portion of the total value of the CRYPTO20 cryptocurrecy index."[2] The C20 portfolio includes 20 top cryptocurrencies in terms of their market cap. It is rebalanced on a weekly basis, and no cryptocurrency can account for more than 10% of the portfolio[3].

FIGURE 26.
C20/USD exchange rate, market cap, and daily exchange trading volume of C20



Source: https://coinmarketcap.com/currencies/c20/#charts.

The C20 supply is not elastic: all tokens were issued over an ICO in exchange for ETH, and will not be issued in the future. Most proceeds from the ICO (98% of all raised ETH) were used to buy cryptocurrencies stored on cold wallets. A minor share of the portfolio is kept in ETH on a smart contract in order to enable C20 holders to liquidate their tokens.

"Tokens can be liquidated through the C20 smart contract for their share of the porfolio's net asset value (NAV)."[4] The smart con-

[1] Crypto20 // https://crypto20.com/ru/.

[2] Schwartzkopff D., Schwartzkopff L., Botha R., Finlayson M., Cronje F. CRYPTO20: The First Tokenized Cryptocurrency Index Fund, p. 2 // https://goo.gl/ocVwcK.

[3] Ibid., p. 10.

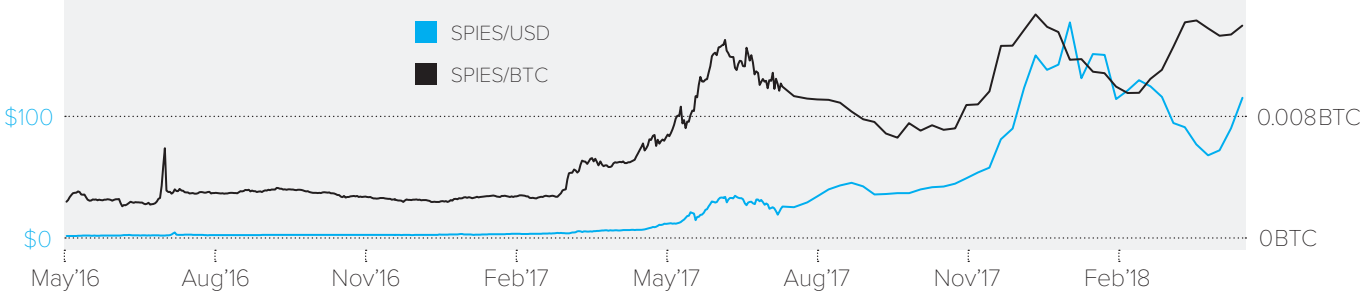
[4] Ibid., p. 4.

tract calculates the amount of ETH to be paid in exchange for the liquidated C20 using the current prices of the included assets[1]. The redemption price of C20 is the lower limit of its market price as it is irrationally to sell a token on the market at a price lower than the redemption price. The smart contract does not destroy the obtained tokens but sends them to the fund's managers who sell them at an exchange in order to replenish the fund's assets[2].

Satoshi Pie (SPIES) issued by Satoshi Fund[3] works on BitShares blockchain, and is 100% backed by a portfolio of tokens[4] managed by the fund managers. The SPIES holder has to trust the issuer who controls the backing and redeems the tokens[5], however, the information on the backing of SPIES is open for external audit[6]. SPIES is issued in exchange for BTC: when the buyer sends BTC to the Satoshi Pie address and gets the equivalent amount of SPIES calculated from the current BTC/SPIES exchange rate[7]. The tokens are also redeemed by BTC at the current rate[8], not by the basket of tokens that backs them.

[1] Ibid., p. 6.
[2] Ibid., p. 7.
[3] Satoshi Fund // https://satoshi.fund.
[4] Satoshi Fund Portfolio // https://satoshi.fund/#portfolio.
[5] In late July 2017, Satoshi Fund published a statement on the liquidation of SPIES on jan 31, 2019. Prior to that, they plan to release a next-generation investment product that does not require trust for the fund as the holder of private keys: Satoshi•Pie Evolution (in Russian) // https://golos.io/bitcoin/@satoshifund/evolyuciya-satoshi-pie).
[6] Satoshi•Pie Public // https://goo.gl/sa5Q98.
[7] Starodubcev D., Lomashuk K., Lvov V. satoshi•Pie: Blockchain Traded Fund, p. 4 // https://goo.gl/2UP3Us.
[8] Ibidem; I want to redeem my SPIES to BTC, can you describe withdrawal process in details? // https://goo.gl/cEFzgU.

FIGURE 27.
SPIES/BTC and SPIES/USD exchange rates.



Source: https://goo.gl/LN56rj.

Even though SPIES is fully backed by a portfolio of tokens, the exact composition of this portfolio is not fixed. SPIES is not pegged to a basket of cryptocurrencies, and its management strategy is focused on "the right profit/risk ratio betting on the growth of the whole blockchain economy, not particular assets",[9] not on pegging it to a certain anchor.

In terms of daily price changes, INDEX, C20 and SPIES proved to be more volatile than CRIX[10], and index reflecting the dynamics of the cryptocurrency market as a whole.

[9] Starodubcev D., Lomashuk K., Lvov V. satoshi•Pie: Blockchain Traded Fund, p. 2 // https://goo.gl/ykv32h.
[10] Trimborn S., Härdle W. K. CRIX or evaluating blockchain based currencies // https://goo.gl/Q5C8d9.

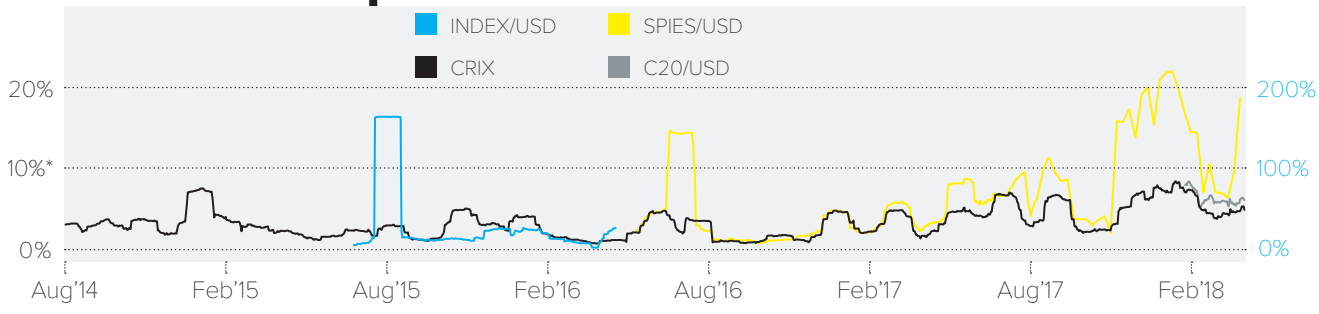
TABLE 16.
Descriptive statistics for daily changes of INDEX/USD, C20/USD, and SPIES/USD prices, and CRIX

	Minimum, %	Maximum, %	Mean, %	Median, %	Standard Deviation, %	Average 30-day Standard Deviation, %
CRYPTO20	−13.53	16.84	4.94	3.51	8.33	6.37
Coinoindex	−89.02	881.17	13.83	5.17	54.95	29.70
Satoshi Pie	−48.07	42.32	3.96	1.80	7.67	4.86
CRIX	−22.38	21.96	2.49	1.39	4.43	3.37

Sources: https://coinmarketcap.com/assets/coinoindex/, https://coinmarketcap.com/currencies/c20/#charts, https://goo.gl/CRN1yf, http://crix.hu-berlin.de/.

FIGURE 28.
Volatility of INDEX/USD, C20/USD, SPIES/USD and CRIX

Figure 28 shows the charts for 30-day standard deviation of daily price changes of INDEX, C20 and SPIES, as well as CRIX.



* A scale for C20/USD, SPIES/USD and CRIX

Sources: https://coinmarketcap.com/assets/coinoindex/, https://coinmarketcap.com/currencies/c20/#charts, https://goo.gl/G37YuC, http://crix.hu-berlin.de/.

[1] The Coinmetrics Team. Our guide to the cryptoasset research universe: Indices // https://coinmetrics.io/cryptoasset-indices-compared/; Digital Assets Indices // https://www.mvis-indices.com/indices/digital-assets; Daily Crypto Basket // https://dailycryptobasket.com.

[2] Trinkler R., Mona El Isa. Melon Protocol: A Blockchain Protocol For Digital Asset Management, p.1 // https://github.com/melonproject/greenpaper/blob/master/melonprotocol.pdf.

[3] Ibid.

The spectrum of cryptoruccrency indices and ways to build cryptocurrency baskets is expanding[1], which makes it possible to expand the spectrum of tokens pegged to the market or its individual segments.

Melon protocol is a blockchain protocol for digital asset management on the Ethereum platform that enables its participants to "set up, manage and invest in digital asset management strategies in an open, competitive and decentralised manner"[2]. The protocol is set to overcome the limitations and risks of traditional hedge fund investment focused on digital assets[3].

Melon enables one to create tokens backed by a share in a portfolio of digital assets. Unlike C20 and SPIES, those portfolios may include only assets created on Ethereum. On the other hand, the solution is decentralized and protected against possible abuse by portfolio managers by smart contracts. Aside from that, it stimulates competition, as Melon offers relatively low costs of entering the portfolio manager market the comparison of strategies, and possible change of strategies and managers.

3.2. Backing by a basket of cryptocurrencies

A stablecoin can be pegged to a national currency or any other asset while being backed by a cryptocurrency basket. In this case, the stablecoin's purpose is to attain stability against its anchor by using a diversified on-chain collateral whose structure may change following the market situation.

Xronos (XPO) — is a stablecoin on Xronos blockchain[4]. The target price of XPO is the global average wage (GAW) calculated from the data published annually by the OECD, and denominated in SDR[5]. The functioning of this stablecoin is serviced by three bots: analytic, issuing, and guaranteeing.

[4] Xronos // http://www.xronos.space.

[5] Xronos Rate Stabilization System // http://stats.xronos.space/#gaw.

XPO is backed by a cryptocurrency basket, which includes cryptocurrencies whose market cap comprises 95% of the total cryptocurrency market cap. The analytic bot uses the market dynamics

data to determine the list of cryptocurrencies to be included in the basket and calculates their weight therein on a daily basis. Then it compares the result with the existing XPO basket, and, if necessary, commands the guaranteeing bot to change its structure. The guaranteeing bot, which controls the XPO collateral, performs the necessary transactions and buys/sells cryptocurrencies in order to bring the XPO basket in line with the new data.

The issuance and the redemption of XPO occur at the exchange. The issuance of XPO is the responsibility of the issuing bot which places a wall of XPO selling orders at the price of GAW+1%. At the initial stage, proceeds from the newly minted XPO sales are distributed between project development fund and guaranteeing bot in a 20%/80% ratio. In future this ratio will reach 2%/98% in favor of guaranteeing bot.[1]

The redemption of XPO is the responsibility of the guaranteeing bot. For that purpose, it places a wall of XPO buy orders at the price of GAW-1%. XPO is not redeemed directly with the basket it is backed by. XPO can be redeemed by selling it at an exchange for the cryptocurrency to the guaranteeing bot at a guaranteed price[2]. "10% of the available reserves instantly turn into a wall of XPO buy orders (demission)... Along with that, the impossibility to withdraw more than 10% of the available amount of money from the system within 24 hours protects XPO from speculative attacks."[3] The guaranteeing bot repurchases XPO for cryptocurrencies for which it is traded at an exchange, and then restores the structure of the collateral basket in line with the current data from the analytic bot.

The initial distribution of XPO that had formed its collateral basket was happening at a price much lower than GAW[4]. For that reason, the project's initial phase don't use GAW-1% as the XPO redemption price. Instead, it is calculated by the analytic bot once every few minutes by dividing the market price of XPO collateral by the amount of XPO in circulation (XPO Guaranteed Value)[5]. The current redemption price is fed to the guaranteeing bot which then adjusts the price of the wall of XPO buy orders at the exchange. The current revision of the project's documentation does not mention the way to increase the XPO redemption price to GAW-1%.

Xronos is different from other stablecoin projects in its intended use: it will be used as a means of payment in Globula[6], a game developed by the project's team. Therefore, the source of demand for XPO comes both from the demand for a stablecoin and the demand for products and services within Globula that can be bought exclusively for XPO. Another distinctive feature of XPO is that it's focused on enhanced privacy of transactions via using ring signatures and zero-knowledge proof.[7]

There are certain troubles in using a basket of cryptocurrencies as a collateral of a stablecoin pegged to a national currency when said basket's price reflects the dynamics of the entire cryptocurren-

[1] Xronos Whitepaper, p. 10 // http://www.xronos.space/docs/ru/Xronos_White_Paper.pdf.

[2] OPEN.XPO/OPEN.BTC Market // https://openledger.io/market/OPEN.XPO_OPEN.BTC.

[3] Xronos Whitepaper, p. 11 // http://www.xronos.space/docs/ru/Xronos_White_Paper.pdf.

[4] Ibid., p. 24.

[5] Xronos Rate Stabilization System // http://stats.xronos.space.

[6] Natural Synthetics Whitebook, p. 26–30 // http://www.xronos.space/docs/ru/Xronos_White_Book.pdf.

[7] Xronos Whitepaper, p. 18 // http://www.xronos.space/docs/ru/Xronos_White_Paper.pdf.

cy market. Today there is a high positive correlation of main cryptocurrencies prices[1]. This correlation makes it more difficult to create a basket of cryptocurrencies that could have a steady exchange rate against national currency thanks to the divergent price fluctuations of cryptocurrencies within the basket. Still, the diversification of the token portfolio backing the stablecoin allows one to reduce its dependence on the success or failure of a certain project. The devaluation of a certain token may be caused not by the fall of the entire market, but by the emergence of a signigicant competitor, or the team's refusal to keep on working on the project. In this case, the chances for a stablecoin with a diversified collateral to fail are less than those of a stablecoin backed only by the token in question.

Smart banknotes can be backed by things other than native tokens. For instance, an issuer of DAI will have an option to collateralize their newly minted DAI by ETH or by a certain non-native Ethereum token. Therefore, each DAI unit will be issued against the collateral of a particular token, while all DAI together will be backed by a portfolio of tokens. The maximum share of a token in this aggregate collateral portfolio will be set by MKR holders. However, the actual proportions within these limitations will be set continuously by the DAI issuers as an unintended consequence of the decentralized issuance, thus reflecting the actual market conditions.

Using a portfolio of tokens from the same blockchain as a collateral, one cannot reduce the dependence on the success of a certain project as the dependence on the single blockchain retains.

Internet of Coins is a meta-protocol connecting blockchains for cross-chain transactions and facilitating cryptocurrency exchange which still typically involves a trusted third party. The project's team argues that "what is needed is a hybrid asset and transfer system utilizing a modular and standardized peer-to-peer platform to replace the trust model"[2].

The hybrid asset is defined as a "blockchain-agnostic set of tokens allocated on multiple digital value exchanges or multiple blockchains"[3]. The node daemon of the Internet of Coins dubbed hybridd "glues" different cryptocurrencies from different blockchains together using data arrays stored in the decentralized storage named weavechain. This storage contains the identification information on each individual blockchain asset and the rulesets that govern their relationship in order to form a hybrid asset. Such assets have the "flexibility to pass their value from blockchain to blockchain"[4]. In other words, it's an asset that can circulate in several blockchains at once, and move from one blockchain to another. The creators of the Internet of Coins argue that "smaller, declining cryptocurrencies can be bound together in hybrid assets giving survivability and exchange flexibility to these coins"[5]. However, they do not consider the question about "gluing" several cryptocurrencies for using such a basket in the capacity of a stablecoin.

[1] Cryptocurrency Correlation Matrix // https://www.sifrdata.com/cryptocurrency-correlation-matrix/.

[2] Koning J. de. Internet of Coins: Hybrid Assets for Peer-to-Peer Intersystemic Value Transfer, p. 2 // https://internetofcoins.org/whitepaper_ioc.pdf.

[3] Ibid.

[4] Hybrid Asset // https://internetofcoins.org/en/wiki/hybrid-asset.

[5] Koning J. de. Internet of Coins: Hybrid Assets for Peer-to-Peer Intersystemic Value Transfer, p. 5 // https://internetofcoins.org/whitepaper_ioc.pdf.

3.3. Basket of stablecoins

In order for the stablecoins to be used as a safe haven for the times of market unrest, their price has to avoid any significant correlation with the prices of individual cryptocurrencies and the crypto market dynamics. Table F[1] in the Appendices shows the correlation matrix for the exchange rate of stablecoins, some crytocurrencies, and the CRIX index for the period of December 20th, 2017 when BTC price started plummeting, to April 30th, 2018. The exchange rates of most stablecoins don't have a pronounced correlation with the prices of individual cryptocurrencies and the market as a whole, which provides the reason to claim that such stablecoins can act as a safe haven.

[1] See Appendices.

The safe haven status doesn't relieve stablecoins from risks associated with tehcnological, economic, or legal factors. The diversification of risks of individual stablecoins can be attained through using a basket of stablecoins with the same or even different anchors.

Today, there are virtually no mentions of stablecoin baskets in project papers. One of such mentions is the basket of national LH tokens by ChronoBank. Their Chronobank Business Outline claims that after the successful launch of four national LH tokens "it will be possible to issue 'global' LH tokens that will essentially comprise a basket of national LH tokens – similar to the SDR currency basket used by the International Monetary Fund"[2]. The global LH token is a stablecoin basket, however, it's the basket of tokens issued by ChronoBank itself, not a basket of independent stablecoins.

[2] ChronoBank Business Outline, p. 9 // https://chronobank.io/files/business_outline.pdf.

The creators of Basis note: "While it might seem attractive to have a single global currency, the reality is that regional economies often benefit from having their own currencies that can respond independently to local demand shocks."[3] Even though the team doesn't weigh on creating a basket of stablecoins, regional Basis can be brought together in a basket. Again, it will be a basket of the same project's tokens, not independent ones.

[3] Al-Naji N., Chen J., Diao L. Basis: A Price-Stable Cryptocurrency with an Algorithmic Central Bank, p. 19 // https://www.basis.io/basis_whitepaper_en.pdf.

Another mention of a basket of tokens that can be viewed as stablecoins is in the roadmap of Fragments. At phase one of the platform's development, the team plans to launch USDF, and at phase two, to develop the stabilisation service that would enable any blockchain developer to create utility tokens of stable price. Once the service in question is deployed, the team intends to create a super-stable basket of currencies pegged to consumer tokens, not fiat currencies[4].

[4] Fragments Roadmap // https://www.fragments.org/map/.

One possible way to create a basket of stablecoins whose use entails a counterparty risk (or, in other words, a basket of e-money on blockchain) was proposed by Vitalik Buterin[5]. A similar amount of stablecoins from different issuers (M tokens from N issuers) pegged to the same anchor (say, $1) are deposited in a DAO. The DAO then issues N tokens backed with those stablecoins, and calls them slice 1, slice 2, and so forth up until slice N.

[5] Buterin V. Collateralized Debt Obligations for Issuer-Backed Tokens // https://ethresear.ch/t/collateralized-debt-obligations-for-issuer-backed-tokens/525.

Those tokens won't be fungible as they have different degree of risk. The buyers of slice 1 have the priority right to redeem it with any stablecoin from the collateral pool. Therefore, if at least one of N issuers is solvent, they will be able to redeem their slice with USD. Once a certain period for slice 1 redemption has elapsed, it's slice 2 buyers' turn. They can redeem their slice with any stablecoin remaining in the pool after the redemption of slice 1. If at least two issuers are solvent by the time of slice 2 redemption, the holders of slice 2 will be able to redeem it with USD. The same progression goes on until it's the turn of the slice N holders which can be redeemed only if all N issuers are solvent.

"To compensate those who are willing to bear risk (or those with insider knowledge that allows them to trust the issuers more than the general public does), the holders of slices closer to N would be paid interest rates, which would come out of the pockets of the holders of slices closer to 1."[1]

[1] Ibid.

A basket of stablecoins backing the slices will be formed via an auction. Those willing to buy slice i of N makes a bid: "I want to buy a unit of slice i, and I am willing to pay x / N units of every coin in the basket to purchase it".[2] After the auction, the DAO ranges the bids for each slice and makes sure the top bids for each slice make up at least 1 together. If so, the bids are accepted, if not, they are declined. Then, all participants who made a bid on slice i pay the lowest of the bids accepted by the system. "This mechanism ensures that, for every set of bids the system accepts, the system issues one coin for each slice and receives at least one coin from each issuer as backing, so it will be able to meet all obligations."[3]

[2] Ibid.

[3] Ibid.

Slices are not perpetual, and have to have a certain redemption date in order to ensure the priority of their redemption. "To create an infinite-duration coin on top of this, one can simply imagine a DAO that creates rounds of this game with duration 2D every D (i.e. there are always two overlapping games) and another DAO which buys tokens of some specific slice on the open market a quarter of the way through their period and sells them three quarters of the way through to buy the coins from the next game."[4]

[4] Ibid.

The creators of Bancor[5] stress that their project is named after bancor, a project of supranational currency developed by J. Keynes to reform the international currency system after World War II[6]. In part, this project was implemented as SDR.

[5] Bancor Network // https://about.bancor.network/.
[6] Hertzog E., Benartzi G., Benartzi G. Bancor Protocol: Continuous Liquidity and Asynchronous Price Discovery for Tokens through their Smart Contracts; aka "Smart Tokens", p. 2 // https://goo.gl/fcSfoV.

The Bancor protocol aims to enable one to create smart tokens on Ethereum backed by a reserve of different assets on Ethereum blockchain. "A smart token holds a balance of least one other reserve token, which (currently) can be a different smart token, any ERC20 standard token or Ether."[7] This reserve is controlled by a smart contract, therefore the issuance, circulation, and redemption of smart tokens can be performed in a decentralized and trustless fashion. The creators of Bancor name the creation of decentralized baskets of tokens as one of the ways to use smart tokens[8].

[7] Ibid., p. 3.

[8] Ibid., p. 5.

Set[1] allows one to create tokens backed with a basket of ERC20 tokens on Ethereum. However, Set Protocol "is designed to eventually support many blockchains and interoperate across blockchains"[2]. Tokens named {Set} are issued by a smart contract: the user sends a basket of tokens to the contract and gets {Set} backed with the basket in question in return[3]. There is an option to back {Set} by a basket of other {Set}, so, theoretically speaking, it is possible to create a basket including all tokens in existence.[4] {Set} is redeemed when it's sent to the smart contract, which then burns it and sends the respective basket of tokens to the user[5].

Stablecoins can be classified by different criteria, and the methods of stablecoin basket creation can be equally different. The competitive issuance of tokens backed by different stablecoin baskets is technically possible today. Thus, TokenSets[6] has several {Set} tokens backed by different baskets of tokens, including ***StableSet***, a basket of stablecoins including USDT (50.16%) and DAI (49.84%).

Tokens like StableSet have fundamental differences from slices as proposed by Vitalik Buterin. They are perpetual and can be issued at any time by anyone without any auctions. They are fungible and don't imply charging and paying out any interest as the risks associated with a certain stablecoin included in their backing basket are distributed among all tokens uniformly.

[1] Set Protocol // https://setprotocol.com.

[2] Feng F. {Set} Protocol: A Specification for Token Abstraction, p. 5 // https://setprotocol.com/pdf/set_protocol_whitepaper.pdf.

[3] Ibid., p. 10–11.

[4] Ibid., p. 11.

[5] Ibid., p. 14–15.

[6] TokenSets // https://www.tokensets.com.

Conclusions and prospects for future research

This report uses the type of backing for classification of stablecoins, but this is not the only possible criterion for their classification. Stablecoins are distinguishable by a series of properties, and the only two things in common for them are the fact that they are pegged to something, and the fact that their supply is elastic. Some of the possible criteria of classification are available in the table "Classification of stablecoins" in Appendices.

Stablecoins as an individual kind of cryptocurrencies began relatively recently, and the projects existing today haven't yet exhausted all the possible combinations of stablecoin properties. It is difficult to find an ideal combination of those properties because stablecoins, just like cryptocurrencies in general, can be used for different purposes. Different purposes may require different combinations of features that eventually determine the unique set of advantages and shortcomings of each particular stablecoin. In this context, the research of substitution and complementarity of stablecoins with different configuration looks promising.

Bitcoin has become the first digital cash to be issued and circulate in a decentralized and, in some sense[1], trustless fashion. The short history of stablecoins also features their inclination towards decentralization and trustlessness.

Alongside with e-money on blockchain that are issued and redeemed in a centralized way, there are smart banknotes with decentralized issuance and redemption, as well as stablecoins without full backing which are issued via redeeming bonds, rewarding stakeholders or rewarding miners. Smart banknotes' collateral is stored on a blockchain of a decentralized cryptocurrency network, not on the issuer's offchain account which is the single point of failure.

The minimization of trust to an issuer of electronic money on blockchain relies on the systems proving full backing. The issuance of smart banknotes is carried out by a smart contract that issues them only in exchange for sufficient collateral and manages that collateral. It enables to eliminate the risks of issuer's abuse associated with traditional e-money. Fiat stablecoins are positioned as stable cryptocurrencies that need no backing, and therefore, no trust to the holder of the collateral.

[1] Bondar D. Can Bitcoin Exist Without Trust (in Russian) // https://forklog.com/mozhet-li-bitkoin-sushhestvovat-bez-doveriya/.

The evolution of stablecoins follows the evolution of national currencies and goes further than that. The stability of the market price of e-money on blockchain and smart banknotes is maintained automatically by a mechanism similar to 'gold points' that automatically maintained the market price of banknotes with fixed price of redemption with gold. As those stablecoins are fully backed, they can be removed from circulation entirely at any time via redemption at a fixed price. As they are fully backed, the increase of their supply is possible only through depositing a collateral with the collateral ratio of 100% and higher. It means that their supply is limited by the supply of the collateral.

The crisis of Bretton-Woods system comes from the limitations imposed by full backing on the increase of the supply of world money. Those limitations can be mitigated by fractional reserving and, afterwards, by a system of fiat currencies that can be issued without any backing. Those currencies cannot be removed from circulation by redeeming them at a fixed price with a certain asset. However, their supply may be temporarily reduced by using different monetary instruments.

National monetary authorities are extremely experienced in stabilizing the market price of fiat currencies with instruments like open market operations, interest rates, reserve requirements, and currency interventions. Such instruments are also used to stabilize the market price of stablecoins (both fully backed and without full backing).

In order to manipulate the supply of fiat stablecoins, they buy and sell bonds, which can be compared to open market operations, even though they have major differences. The supply of fiat stablecoins temporarily shrinks thanks to the growth of the interest rate paid for their parking. Smart banknotes can differ in their requirements for the collateral ratio that is similar to the reserve requirements; or the interest rate charged from the owner of the collateral that backs the smart banknotes in question. Buying or selling a stablecoin on the market in order to maintain its price within a chosen range is similar to currency interventions by central banks who use their own currency reserves for that purpose.

The applicability of this experience of national monetary authorities to private cryptocurrencies, and the role of a central bank in competitive circulation of stablecoins with or without full backing is also a prospective line of research. The scenario analysis for speculative attacks on stablecoins without full backing, and "bank runs" that can happen to stablecoins with fractional reserves are of particular interest here.

Unlike commercial banks, stablecoins don't have a lender of last resort represented by a central bank. Some stablecoins, however, provide for something one might call a "lending of last resort". In Maker, when DAI collateral ratio drops below 100%, the system starts diluting the governance tokens. The issuance of MKR is used to repurchase DAI that had lost their full backing.

In fiat stablecoin systems, the collateral cannot devalue by definition. However, even those systems make use of the dilution of governance tokens to repurchase the stablecoins from the market when other instruments are inefficient. Unlike the board of the governors of a central bank, the revenue of the governance token holders directly relies on the success of their stablecoin and the share each of the stakeholders has in the total supply of the governance tokens.

The use of stablecoins whose steady price is attained via different monetary policy instruments requires one to trust the monetary authorities who use said instruments. In Steem and Golos, the monetary authority functions are carried out by the witnesses; in Maker, by MKR holders; in Nu, by NSR holders.

Nu is the only such project to implement the mechanism of rewarding the liquidity providers who ensure the liquidity of USNBT at exchanges. However, the creators of many different stablecoins (those fiat, fully backed, or with fractional reserves) consider the actions of arbitragers who buy and sell stablecoins at the prices close to their target prices to be important for stabilizing the market price of the coin in question. This mechanism of stablecoin exchange rate stabilization is based on the faith of the arbitragers in the monetary authorities' capability to bring back the market price of the stablecoin to its target level.

In Steem and Golos, the witnesses are elected and re-elected by the native token holders (for that purpose token holders need to turn their native tokens into Steem Power and Golos Power, respectively). The holders of Steem Power and Golos Power can replace witnesses by taking votes from some and giving them to others. In Maker, there are participants that can initiate a global settlement in case MKR holders abuse their power, but it is the MKR holders who elect such participants. Basis has become the first project seeking to minimize the trust to monetary authorities through full algorithmization of cryptocurrency supply manipulation. Issuance and distribution of fiat stablecoins decided upon the governance token holders is replaced by issance and distribution governed by an algorithm. This brings up the question of the automatization limits for monetary policies, as well as requires the analysis of risks associated with different governance models for stablecoins.

Even within the conditions of fully algorithmized and automatized monetary policy, there is a need to trust the price feed providers (one of them, a group of them that is elected somehow, or all holders of stablecoins that participate in providing price feeds under the Schelling points scheme). The search for possible solutions to minimize the trust to price feed providers is still on, and the study of risks, advantages, and limitations of different price feed provision and utilization models for proper functioning of stablecoins is still important.

The data on the market prices of stablecoins used herein prop up the claim that cryptocurrencies with low volatility against their anchor assets exist. The most stable exchange rate is seen in e-money on blockchain. The market price of some stablecoins with full backing is less steady than the price of fiat stablecoins, while certain cryptorrencies marketed as stable are in fact less stable than bitcoin[1].

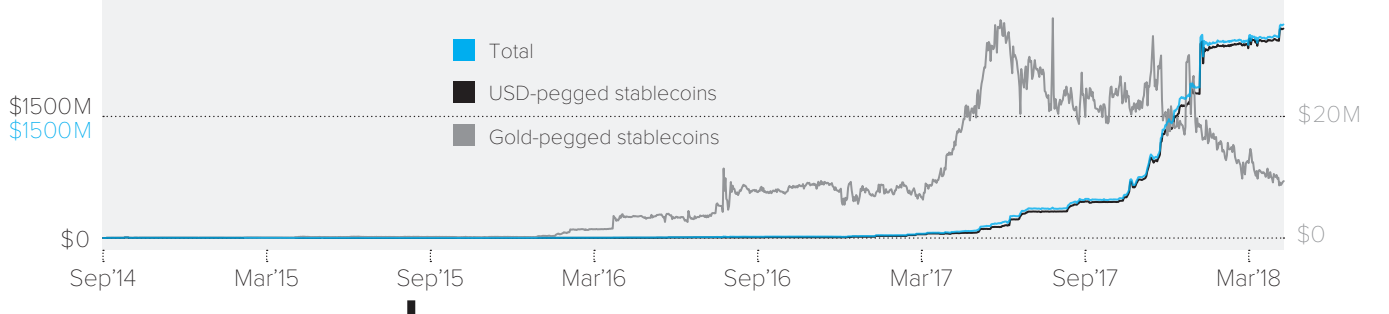
[1] See tables B and C in the Appendices.

The low correlation of stablecoin prices with the prices of main cryptocurrencies and the cryptocurrency market as a whole allows stablecoins to aim for the role of a safe haven in this market.[2]

[2] See table F in the Appendices.

Technically speaking, a stablecoin may be pegged to any asset. Among the projects reviewed herein, there are some who have launched or plan to launch a stablecoin pegged to gold, a regional currency, a currency basket, or other basket of assets. Still, USD remains the most popular anchor asset these days. The market cap of USD-pegged stablecoins has increased 4573 times over 44 months: from $0.566 million to $2.588 billion. The market cap of gold-pegged stablecoins has increased 809 times over 40 months: from $0.011 million to $9.401 million.

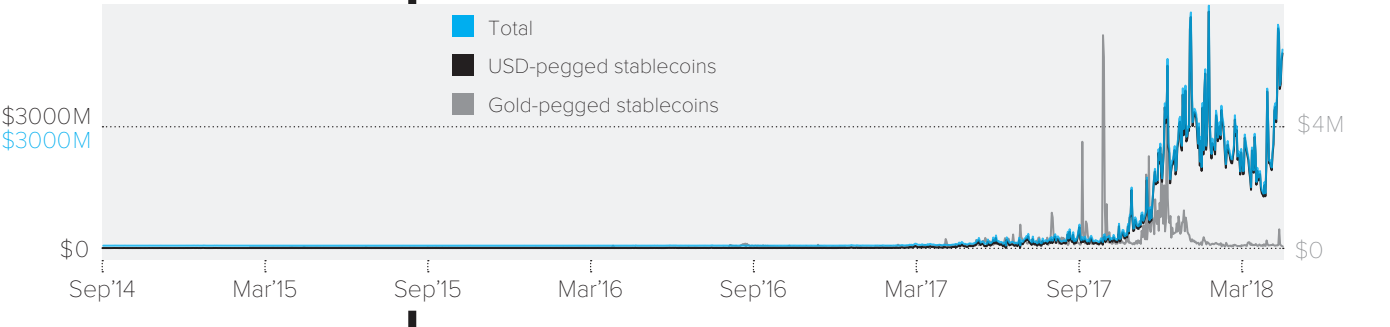
FIGURE 29.
Market cap of USD-pegged stablecoins, gold-pegged stablecoins, and total stablecoin market cap



Source: https://coinmarketcap.com/.

FIGURE 30.
Daily exchange trading volume of USD-pegged stablecoins, gold-pegged stablecoins, and total daily exchange trading volume of stablecoins

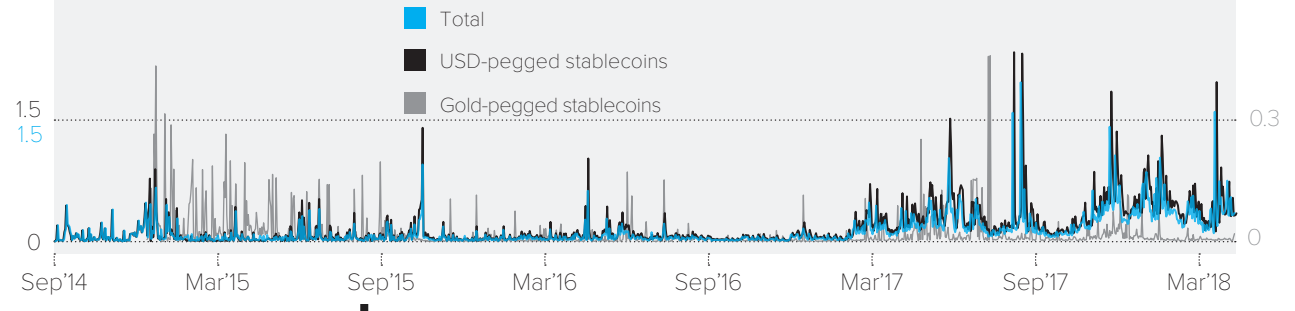
The daily exchange trading volume of USD-pegged stablecoins has increased 9.3 million times, from $521 to $4.872 billion, while that of gold-pegged stablecoins has increased 481 times, from $71 to $34.195 thousand.



Source: https://coinmarketcap.com/.

FIGURE 31.
Average velocity of exchange turnover of USD-pegged stablecoins, gold-pegged stablecoins and total average velocity of exchange turnover of stablecoins

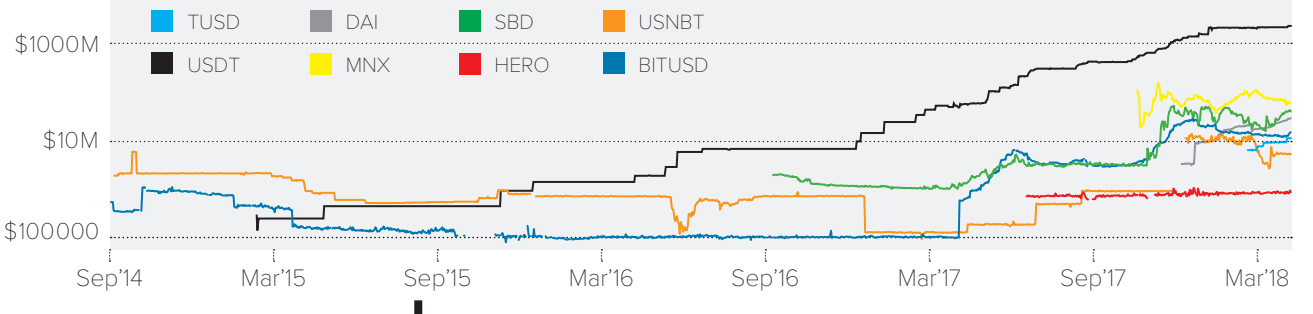
The average velocity of exchange turnover of USD-pegged stablecoins has increased 392 times, from 0.0009 to 0.3531, and gold-pegged stablecoins 4 times, from 0.0047 to 0.0194.



Source: https://coinmarketcap.com/.

FIGURE 32.
Market cap of USD-pegged stablecoins

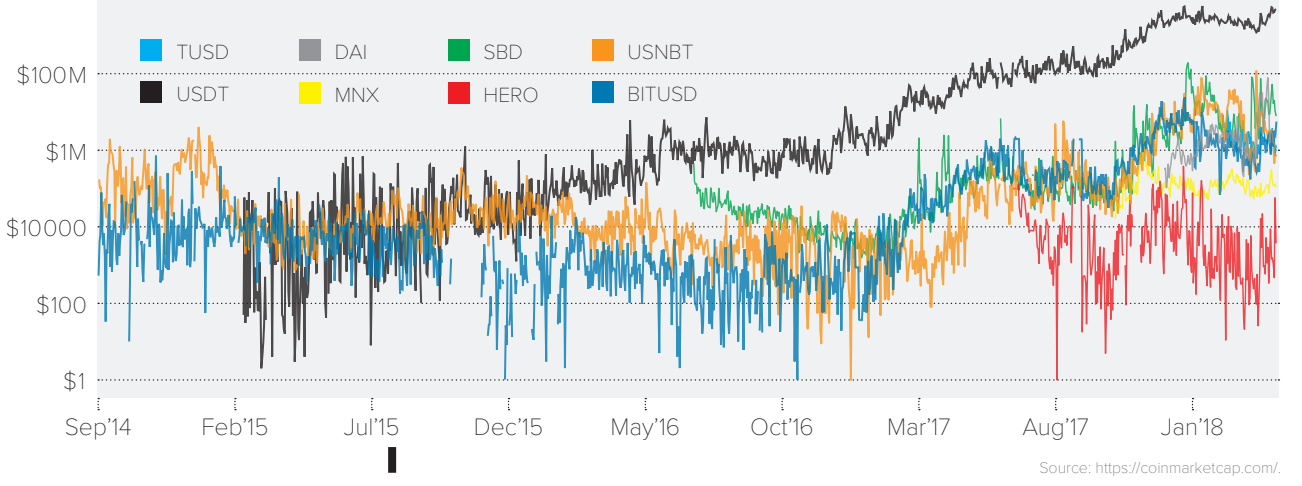
USDT accounts for the lion's share of the market cap of USD-pegged stablecoins and all stablecoins altogether. Its market cap has increased 7592 times, from $304.476 thousand to $2.421 billion, and as of April 30th, 2018 accounts for 93.55% of the total market cap of USD-pegged stablecoins.



Source: https://coinmarketcap.com/.

FIGURE 33.
Daily exchange trading volume of USD-pegged stablecoins

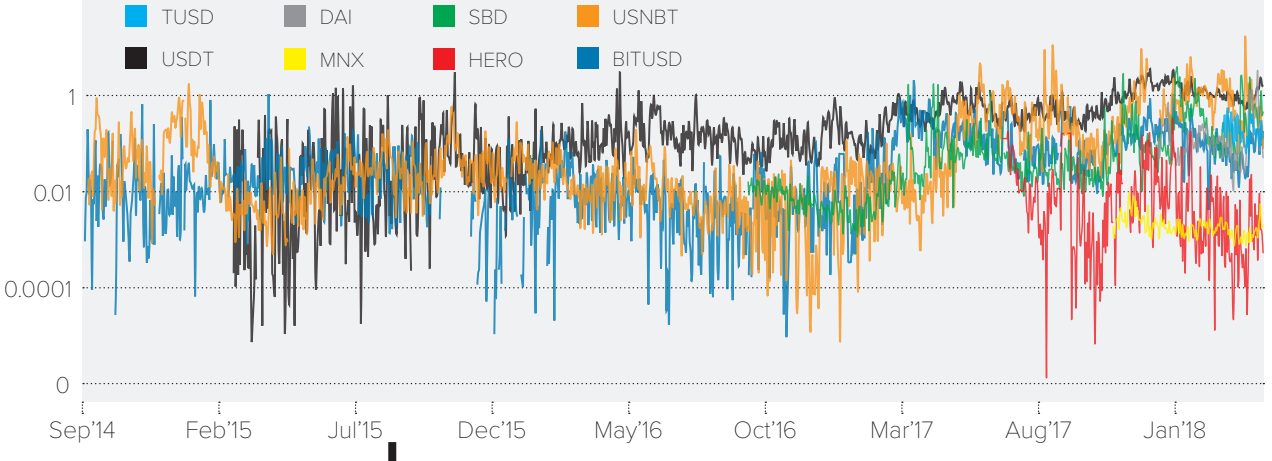
USDT also dominates the trading volume of USD-pegged stablecoins: its daily exchange trading volume has increased from $50 to $4.855 billion, and reached 99.65% of the total daily exchange trading volume of USD-pegged stablecoins.



Source: https://coinmarketcap.com/.

FIGURE 34.
Velocity of exchange turnover of USD-pegged stablecoins

The highest velocity of exchange turnover amongst USD-pegged stablecoins is seen in USNBT. However, generally USDT is the leader here, too.



Source: https://coinmarketcap.com/.

TABLE 17.
Descriptive statistics for USD-pegged stablecoin prices

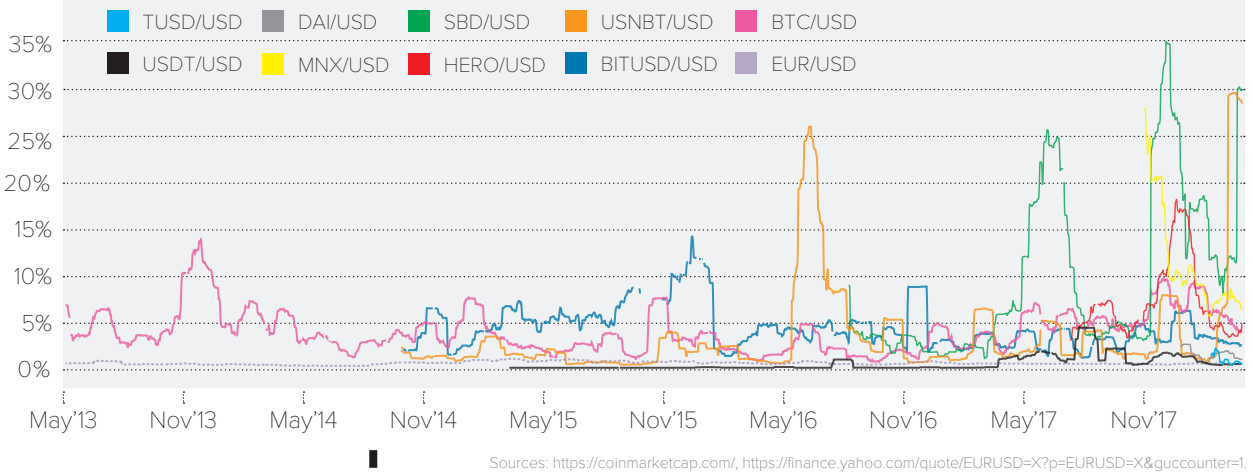
The descriptive statistics for USD-pegged stablecoin prices is set forth in table 17.

Name	Range, $	Mean, $	Median, $	Mode, $	Standard Deviation, $	Average 30-day Standard Deviation, $
TrueUSD	0.0697	1.0010	1.0010	1.0070	0.0069	0.0063
Dai	0.3155	1.0010	1.0010	1.0022	0.0164	0.0116
Tether	0.6375	0.9999	1.0000	1.0000	0.0175	0.0040
BitUSD	0.8448	1.0250	1.0110	1.0022	0.0571	0.0362
NuBits	1.0975	0.9598	0.9976	1.0007	0.1339	0.0317
Steem Dollar	13.0418	1.9480	1.0060	1.0093	2.1100	0.5989

Source: https://coinmarketcap.com/.

FIGURE 35.
Volatility of USD-pegged stablecoins, BTC/USD and EUR/USD

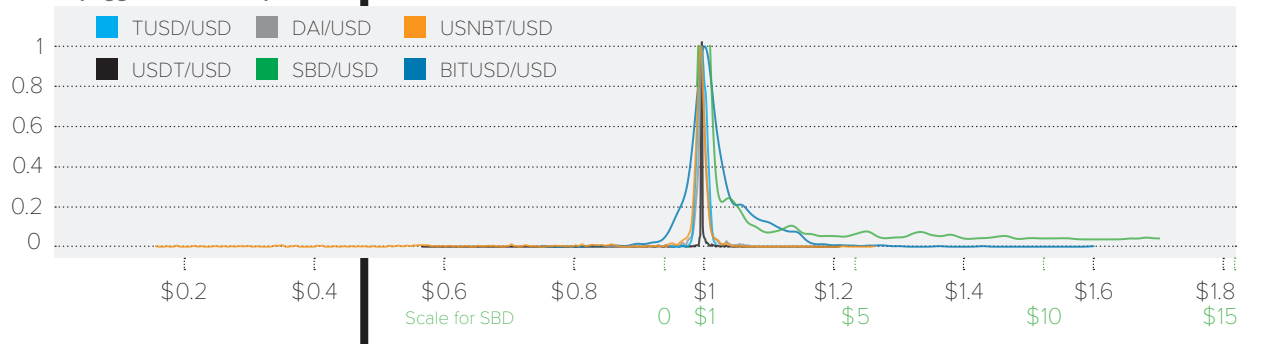
Figure 34 compares the dynamics of 30-day standard deviation of daily price changes of USD-pegged stablecoins, BTC, and EUR.



Sources: https://coinmarketcap.com/, https://finance.yahoo.com/quote/EURUSD=X?p=EURUSD=X&guccounter=1.

FIGURE 36.
Density function of USD-pegged stablecoin prices

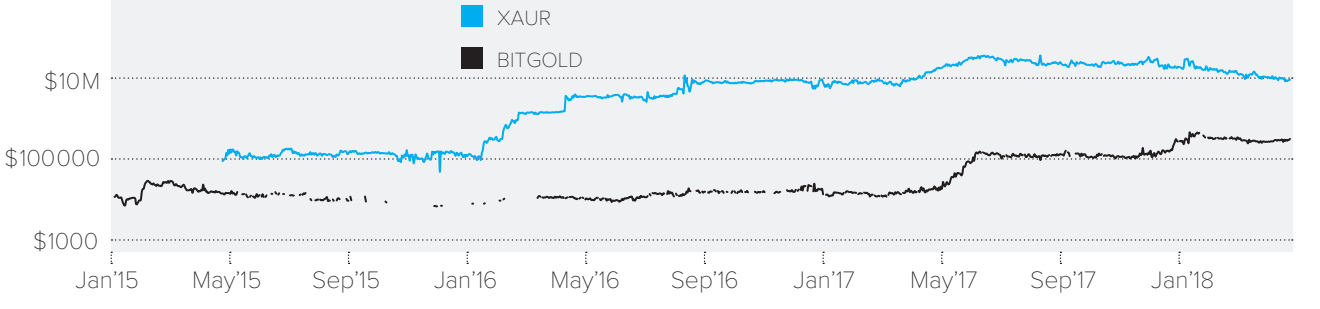
USDT was the closest to the $1 mark:



Source: https://coinmarketcap.com/.

The market cap of gold-pegged stablecoins wasn't growing as fast as the market cap of USD-pegged stablecoins. XAUR market cap has increased 106 times, from $88.646 thousand to $9.083 million, while bitGOLD experienced a 27-fold growth, from $11.611 thousand to $317.220 thousand.

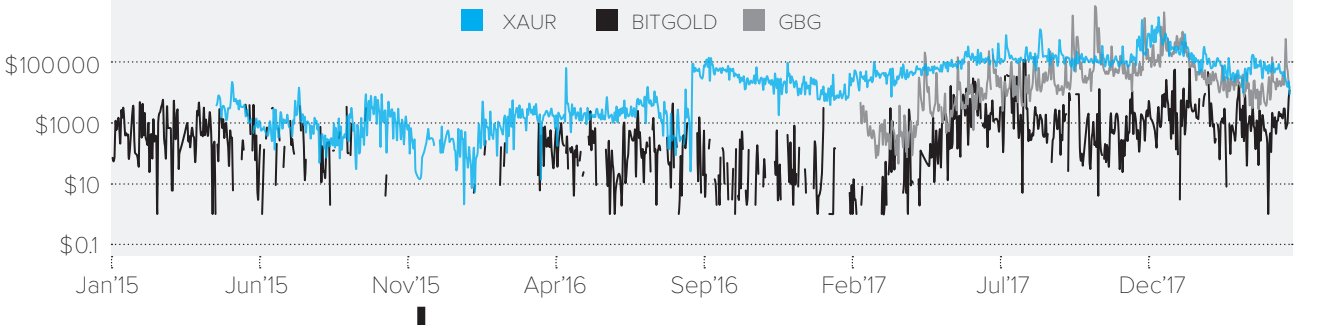
FIGURE 37.
Market cap of gold-pegged stablecoins



Source: https://coinmarketcap.com/.

Up until April 2017, XAUR was the leading gold-pegged stablecoin in terms of exchange trading volume. After that, the shares of bitGOLD, XAUR and GBG started converging. As of April 30th, 2018, the share of bitGOLD in the daily exchange trading volume of gold-pegged stablecoins comprised 35.09%, while XAUR accounted for 24.27%, and GBG for 40.64%. The daily exchange trading volume of bitGOLD increased from $71 to $11.998 thousand, XAUR from $3.596 thousand to $8.300 thousand, and GBG from $4.563 thousand to $13.897 thousand.

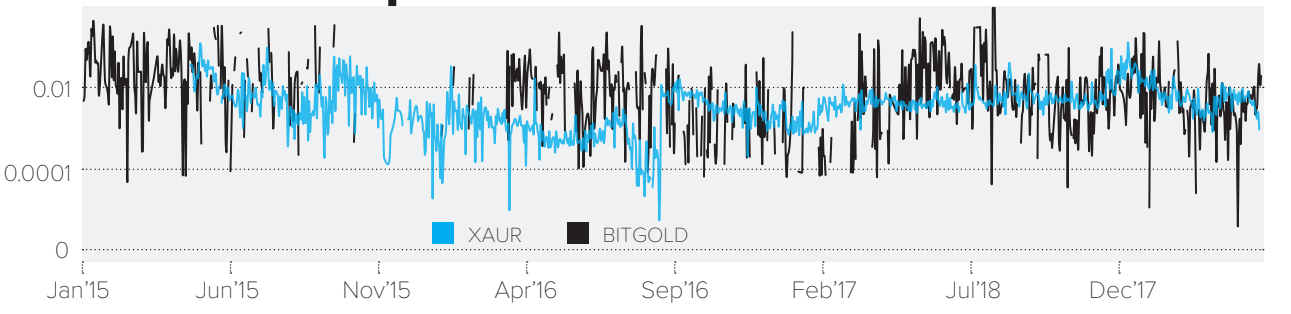
FIGURE 38.
Daily exchange trading volume of gold-pegged stablecoins



Source: https://coinmarketcap.com/.

FIGURE 39.
Velocity of exchange turnover of gold-pegged stablecoins

The velocity of exchange turnover of XAUR was more stable than that of bitGOLD after XAUR migrated to Ethereum.



Source: https://coinmarketcap.com/.

TABLE 18.
Descriptive statistics for gold-pegged stablecoin prices

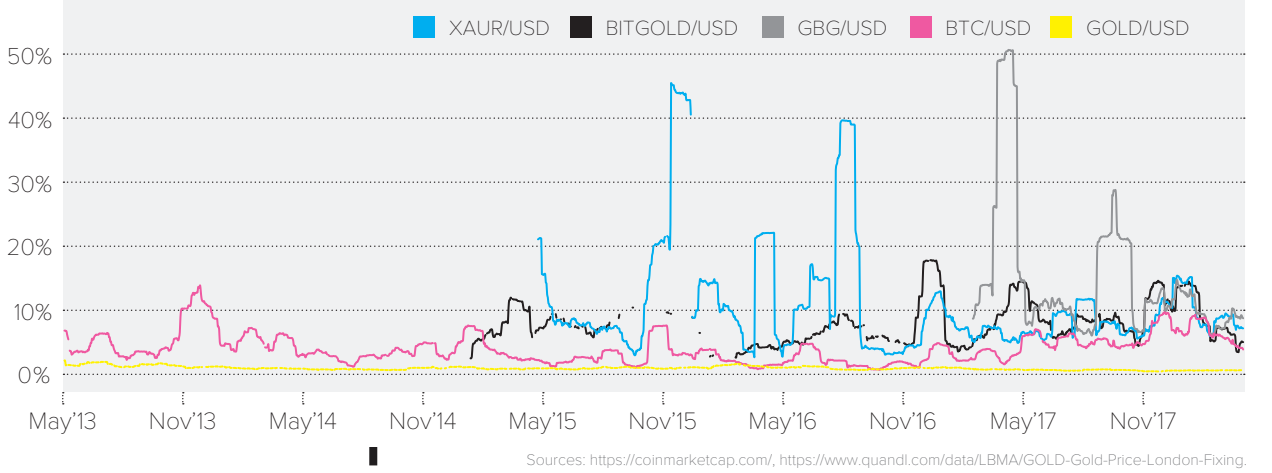
Table 18 shows the descriptive statistics for gold-pegged stablecoin prices.

Name	Range, $	Mean, $	Median, $	Mode, $	Standard Deviation, $	Average 30-day Standard Deviation, $
BitGOLD	38.4100	48.3600	47.9100	45.8100	5.4935	2.9135
Xaurum	449.9700	166.0300	169.8400	107.9041	58.3412	2.7367
Golos Gold	422.2000	113.4000	101.0000	109.0000	64.8785	26.7673

Source: https://coinmarketcap.com/.

FIGURE 40.
Volatility of gold-pegged stablecoins, BTC/USD and GOLD/USD

Figure 39 shows the volatility of gold-pegged stablecoins, bitcoin, and gold prices.



Sources: https://coinmarketcap.com/, https://www.quandl.com/data/LBMA/GOLD-Gold-Price-London-Fixing.

Gold-pegged stablecoins have greater volatility than gold, as well as greater price increase rates.

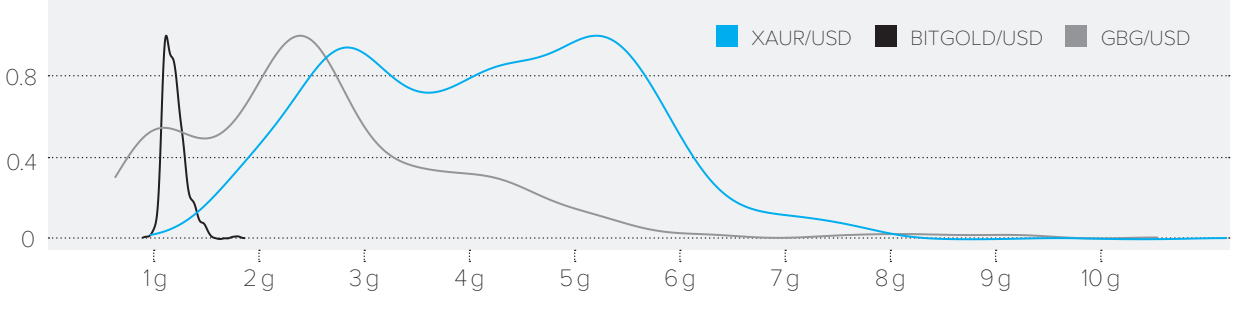
TABLE 19.
Price increase rates for gold and gold-pegged stablecoins

	Starting price, $	Price on 30/04/18, $	Price increase rate, %
XAUR	XAUR: 0.0069 GOLD: 38.4298	XAUR: 0.0715 GOLD: 42.2203	XAUR: 935.54 GOLD: 9.86
BITGOLD	BITGOLD: 1195.79 GOLD: 38.5809	BITGOLD: 1674.12 GOLD: 42.2203	BITGOLD: 40.00 GOLD: 9.43
GBG	GBG: 0.0368 GOLD: 39.2962	GBG: 0.0942 GOLD: 42.2203	GBG: 155.87 GOLD: 7.44

Sources: https://coinmarketcap.com/, https://www.quandl.com/data/LBMA/GOLD-Gold-Price-London-Fixing.

The downside of this high price increase rate was the fact that the price of one gram of gold as calculated from the market price of gold-pegged stablecoins, is usually much higher than the price of one gram of gold on the gold market.

FIGURE 41.
Density function of gold-pegged stablecoin prices



Source: https://coinmarketcap.com/, https://www.quandl.com/data/LBMA/GOLD-Gold-Price-London-Fixing.

Pegging a stablecoin to gold instead of national currency makes said coin's exchange rate against national currency less stable. This, in turn, makes it less convenient to use it as money, first of all as a measure of value and a medium of exchange, as prices of goods are denominated in national currencies. On the other hand, such stablecoin is more attractive as a store of value than fiat-pegged stablecoins.

The price of gold-pegged stablecoins is more volatile in terms of daily price changes than the price of USD-pegged stablecoins and native tokens of public permissionless blockchains like BTC and ETH. In this sense, BTC and ETH are more reliable collateral for the smart banknotes pegged to national currencies than gold-pegged stablecoins.

Stablecoins that are not just pegged to gold but are fully backed by it, are similar to classical banknotes backed by gold. They have a built-in mechanism of limiting market price fluctuations within "golden points." As the costs of redemption of such stablecoins go down, the range of "golden points" will get narrower, and the market price of such stablecoins will get more steady. Stability of the exchange

rate comparable to the stability of the price of gold, combined with transparency and reliability, can make such stablecoins more attractive as a collateral for fiat-pegged smart banknotes, than BTC and ETH.

Stablecoins can have a stable exchange rate against national currency or a precious metal, but are not limited to that. The stability may also be understood as the stability of purchasing power. From this standpoint, stablecoins can be classified not only by their target exchange rate (fixed or increasing), but also by their purchasing power (decreasing, stable, or increasing). Stablecoins with decreasing purchasing power are those that have a fixed exchange rate against an inflating national currency. Stablecoins with stable purchasing power are those whose exchange rate index is equal to the inflation index. Finally, stablecoins with increasing purchasing power have the exchange rate index higher than the inflation index.

Stablecoins with increasing target price include not only XAUR, HERO, and MNX, but also SBD and GBG, as the latter two allow their holders to earn interest. Today's stablecoins with increasing target price have not been really sucsessful in attaining low volatility of exchange rate. Using an asset whose price is increasing (especially if it's increasing unpredictably) complicates its assessment. Therefore, using it as a measure of value and medium of exchange also gets complicated. Since such stablecoins have a growing redepmtion/target price, or a built-in interest, they can be valuated via discounted cash flow method.

The "deflationary" cryptocurrencies are better as the store of value, and, according to the Gresham's law, will be superseded from circulation by stablecoins that don't have a built-in mechanism of price growth. If the exchange rate of such "deflationary" cryptocurrencies will not only grow in the long run, but will also have low volatility in the short run, they may become a popular collateral for smart banknotes.

The development of asset tokenization make it possible to use much more than national currencies and precious metals to back stablecoins. First of all, it may be bonds that are mostly used today by central banks as a "collateral" when issuing national currencies.

This report uses the simplest metrics to assess stablecoins. Further researches shall focus on the development of a method that would allow one to assess the quality of stablecoins in a more comprehensive fashion.

Ethereum remains the most popular blockchain for stablecoins, both existing and planned[1]. Own blockchains are popular among fiat stablecoin projects. Only three projects are using or planning to use several third-party blockchains. The circulation of e-money issued by GEO gateways does not get reflected on the blockchain.

[1] See table H in the Appendices.

Using a third-party blockchain reduces the team's expenses on the development, launching, and servicing their stablecoin. On the other hand, the use of most stablecoins without their own blockchain implies a miner fee paid with the native token of the blockchain, as well as an additional fee paid with the stablecoin itself. In some cases, those fees can be seen as a necessary payment to cover the stablecoin servicing expenses, while in others it's just a reward for the project's investors.

Regardless of the mechanisms for the additional fee distribution, there is an option to evade it. One can create so-called wrapped stablecoins for that purpose: a stablecoin goes to a smart contract that issues a token fully backed by the stablecoin in question. Such a token can be redeemed by the stablecoin at a fixed rate, and its use does not require any additional fees as the stablecoin itself does not move at all. It poses a risk for projects that need an additional fee to cover the expenses on servicing the stablecoin, or, as in Havven, to maintain the exchange rate stabilization mechanism.

The increase in exchange trading volume of stablecoins with additional fee on centralised exchanges will not result in proportional growth of additional payable fees as transactions on such exchanges do not get reflected on the blockchain.

The prospective areas of further research regarding the introduction of an additional fee are: analysis of the consequences of evading an additional fee under different models of its distribution and use; prevention of such evasion under the models where such fee is required for normal stablecoin operation; and assessment of long-term prospects for different models of stablecoin with an additional fee.

Stablecoins circulating on several blockchains simultaneously have different circulation conditions, such as the amount of fees, the transaction speed, privacy degree, hash rate, and other security aspects. Aside of these, different force majeure can affect some of the networks involved. Those differences can result in loss of fungibility: the same stablecoin will have different price depending on the blockchain it's circulating on.

A basket of stablecoins allows one to diversify the risks by reducing the dependence of its holder on an individual project's successes and failures. As opposed to the exchange rates of main cryptocurrencies, the prices of main stablecoins show a low degree of correlation[1]. A stablecoin basket allows one to transfer several stablecoins at once while paying a fee for just one token without paying the additional fees for the use of the stablecoins in the basket. The first such basket, StableSet on TokenSets platform, has already been implemented. The further development of this kind of assets is related with the development of stablecoin basket building methodology, as well as the study of substitution and complementarity of stablecoin baskets with a different composition.

[1] See table G in the Appendices.

The necessity and the possibility of utilizing a cryptocurrency basket as the money of a global public permissionless blockchain economy, as well as the use of national monetary authorities' experience in using a currency basket, like ECU, also deserves a separate research. Today, the only project to position a basket of cryptocurrencies as a stablecoin rather than an investment is Xronos. Still, XPO is pegged to the average global wage, not an anchor linked to the global economy of public permissionless blockchains.

Today, there are no projects of stablecoins with decentralized issuance that use a basket of tokens as a collateral, however, there are upcoming stablecoins with full backing that can be issued for the collateral of native and non-native tokens. Each unit of such a stablecoin will be backed by a particular token, while all units will be together backed by a basket of tokens. Launching such a stablecoin requires one to answer the question of the principles used to form such a basket.

Most DApp tokens are private fiat money with floating exchange rate[1]. Daily use of many apps all having their own means of payment with floating exchange rate entails cognitive trouble and currency risks. Those risks can be mitigated by monetary policy instruments that could maintain a stable price of the app token[1], thus making that appcoin a stablecoin. Low volatility of the app token price could be attained via the fixed redemption price denominated in the units of products or services offered by the app. In this case, the token price, similarly to the e-money on blockchain price, will have "golden points" that limit its fluctuations.

Another way to avoid currency risks associated with use of app tokens is not to save them. Instead, the user may save stablecoins and buy the necessary app tokens immediately before using the application of interest. This approach frees the user from the need to manage a portfolio of app tokens, however, it requires additional costs related to the conversion of the stablecoins into the tokens of interest. Applications that use stablecoins as the direct means of payment can eliminate such costs.

[1] Bondar D. Not All Tokens Have the Same Utility — Part 2 (in Russian) // https://forklog.com/ne-vse-tokeny-odinakovo-polezny-chast-vtoraya/.

[1] Aragon Network // https://github.com/aragon/whitepaper#4-aragon-network-token.

Glossary

Cryptocurrency — digital money relying on cryptography, such as cryptographic hash functions and digital signatures. Cryptocurrency may be private, national, or supranational.

Native token — the initial token of a blockchain, a base unit of account, and the means of payment for the use of blockchain. On Bitcoin blockchain, BTC is the native token; On Ethereum blockchain, ETH; on BitShares blockchain, BTS.

Backing — the collateral deposited upon the issuance of a stablecoin and also used to redeem it. The backing may be controlled by the issuer, a trusted third party, or a smart contract.

Pegging — fixation of the target price of a stablecoin against a certain asset (so-called anchor). The pegging may be attained by fixating the redemption price or the target market price.

Means of redemption — an asset the stablecoin's issuer undertakes to use for redemption of said stablecoin. It may be an asset to which the stablecoin is pegged, or a different asset.

Token — general designation of any blockchain asset unit. Tokens are: cryptocurrencies, shares, bonds, vouchers, or other securities functioning on a blockchain. A token may be native or non-native.

Redemption price — the exchange rate against the anchor asset at which the issuer undertakes to redeem its stablecoin. The redemption may be conducted at a fixed or a floating price.

References

1. A critique of Phi, the lending platform and stable currency // https://www.reddit.com/r/ethereum/comments/5fjncm/a_critique_of_phi_the_lending_platform_and_stable/dalltg6/.
2. AAA Reserve // https://www.aaareserve.com.
3. Al-Naji N., Chen J., Diao L. Basis: A Price-Stable Cryptocurrency with an Algorithmic Central Bank // https://www.basis.io/basis_whitepaper_en.pdf.
4. Aragon Network // https://github.com/aragon/whitepaper#4-aragon-network-token.
5. Augmint // https://www.augmint.cc.
6. Augmint Whitepaper // https://docs.google.com/document/d/1lQwGEsImpAv2Nlz5IgU_iC-JkEqlM2VUHf5SFkcvb80A/edit#.
7. Auresco Institute // http://auresco.xaurum.org/.
8. Bancor Network // https://about.bancor.network/.
9. Bank for International Settlements Triennial Central Bank Survey. Foreign exchange turnover in April 2016 // https://www.bis.org/publ/rpfx16fx.pdf.
10. Basis // https://www.basis.io.
11. Berentsen A., Schär F. A Short Introduction to the World of Cryptocurrencies // https://files.stlouisfed.org/files/htdocs/publications/review/2018/01/10/a-short-introduction-to-the-world-of-cryptocurrencies.pdf.
12. Bitcoin Charts // https://coinmarketcap.com/currencies/bitcoin/.
13. BitGold Charts // https://coinmarketcap.com/currencies/bitgold/.
14. BitShares 2.0: Financial Smart Contract Platform // http://docs.bitshares.org/_downloads/bitshares-financial-platform.pdf.
15. BitShares Fee Schedule // https://cryptofresh.com/fees.
16. BitShares Witnesses // https://cryptofresh.com/witnesses.
17. BitUSD Charts // https://coinmarketcap.com/assets/bitusd/.
18. Bringing stablecoins to the next level // https://medium.com/@globcoin_io/bringing-stablecoins-to-the-next-level-357879430b0f.
19. Brooks S., Jurisevic A., Spain M., Warwick K. Havven: A Decentralised Payment Network And Stablecoin // https://havven.io/uploads/havven_whitepaper.pdf.
20. Buterin V. Collateralized Debt Obligations for Issuer-Backed Tokens // https://ethresear.ch/t/collateralized-debt-obligations-for-issuer-backed-tokens/525.
21. Buterin V. The Search for a Stable Cryptocurrency // https://blog.ethereum.org/2014/11/11/search-stable-cryptocurrency/.
22. Can I trade Digix tokens or assets at Digix? // https://digix.groovehq.com/knowledge_base/topics/can-i-trade-digix-tokens-or-assets-at-digix.
23. Carbon // https://www.carbon.money.
24. ChronoBank // https://chronobank.io/.

25. ChronoBank Business Outline // https://chronobank.io/files/business_outline.pdf.
26. ChronoBank Development Plan // https://chronobank.io/files/dev_plan.pdf.
27. Chronobank partners with NEM to create ChronoNEM wallet // https://blog.chronobank.io/ chronobank-partners-with-nem-to-create-chrononem-wallet-eebdc176351d.
28. Chronobank partners with WAVES to create ChronoWAVES wallet // https://blog.chronobank.io/ chronobank-partners-with-waves-to-create-chronowaves-wallet c6e24be533a4.
29. Classification of Exchange Rate Arrangements and Monetary Policy Frameworks // https://www.imf.org/external/np/mfd/er/2004/eng/0604.htm.
30. Coinoindex Charts // https://coinmarketcap.com/assets/coinoindex/.
31. CRIX — CRyptoIndeX // http://crix.hu-berlin.de/.
32. Crypto Capital Fees // https://cryptocapital.co/fees.html.
33. Crypto20 // https://crypto20.com/ru/.
34. Crypto20 Charts // https://coinmarketcap.com/currencies/c20/#charts.
35. Cryptocurrency Correlation Matrix // https://www.sifrdata.com/cryptocurrency-correlation-matrix/.
36. Dai Charts // https://coinmarketcap.com/currencies/dai/.
37. Dai Explorer // https://dai.makerdao.com.
38. Dai Public Announcement // https://dai.makerdao.com.
39. Daily Crypto Basket // https://dailycryptobasket.com.
40. Decentralized Capital Fees // https://decentralizedcapital.com/#!/fees.
41. Decentralized Capital Legal // https://decentralizedcapital.com/#/legal.
42. Decentralized Capital Reserves // https://decentralizedcapital.com/#/reserves.
43. Decentralized Capital Tokens // https://decentralizedcapital.com/#!/tokens.
44. Decentralized Commercial Banking // https://www.youtube.com/watch?v=QVWjKX7P2FA.
45. Digital Assets Indices // https://www.mvis-indices.com/indices/digital-assets.
46. Digix Global // https://www.dgx.io/.
47. Digix Marketplace // https://digix.global/app/#/marketplace/dgx.
48. Digix Proof of Asset // https://digix.groovehq.com/knowledge_base/categories/proof-of-asset.
49. Directive 2000/46/EC of the European Parliament and of the Council of 18 September 2000 on the taking up, pursuit of and prudential supervision of the business of electronic money institutions, // http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32000L0046&from=EN.
50. Dowd K. Hayek-Style Cybercurrency // https://www.alt-m.org/2015/05/06/hayek-style-cybercurrency/.
51. Eufemio A. C., Chng K. C., Djie S. Digix's Whitepaper: The Gold Standard in CryptoAssets // https://dgx.io/whitepaper.pdf.
52. EUR/USD Charts // https://finance.yahoo.com/quote/EURUSD=X?p=EURUSD=X.

53. Feng F. {Set} Protocol: A Specification for Token Abstraction // https://setprotocol.com/pdf/set_protocol_whitepaper.pdf.
54. Findlay S., Hileman G. ARC Primer and Overview // https://www.aaareserve.com/sites/default/files/arc-public-docs/ARC_Primer_and_Overview-vF1.1.pdf.
55. Fragments // https://www.fragments.org.
56. Fragments Protocol // https://www.fragments.org/protocol/.
57. Fragments Roadmap // https://www.fragments.org/map/.
58. GEO Project // http://geo-project.github.io/.
59. Glazer P. An Overview of Stablecoins // https://hackernoon.com/an-overview-of-stablecoins-cf3fac75dcf7.
60. Globcoin // https://globcoin.io.
61. Globcoin Crypto Platform // https://globcoin.io/assets/whitepaper-GCP-v2.0.pdf.
62. Glover E., Reitano J.W. The Kowala Protocol: A Family of Distributed, Self-Regulating, Asset-Tracking Cryptocurrencies // https://cdn2.hubspot.net/hubfs/3919777/pdf/kowala-protocol-whitepaper-v1.0.pdf?t=1525290814171.
63. Gold Charts // https://www.quandl.com/data/LBMA/GOLD-Gold-Price-London-Fixing.
64. Gold Price Chart // http://goldprice.org/gold-price-chart.html.
65. GOLD SmartCoin // https://cryptofresh.com/a/GOLD.
66. Golos Gold Charts // https://coinmarketcap.com/currencies/golos-gold/.
67. GOLOS.io Блоги // https://golos.io/.
68. Golos Witnesses // https://golosdb.com/witnesses.
69. Greenspan Says Bitcoin a Bubble Without Intrinsic Currency Value //https://www.bloomberg.com/news/articles/2013-12-04/greenspan-says-bitcoin-a-bubble-without-intrinsic-currency-value.
70. Growth of Gold per Xaurum // http://www.xaurum.org/groth.html.
71. Havven // https://havven.io.
72. Havven Analytics // http://alchemy.havven.io.
73. HERO Documentation // http://docs.hero.global/en/master/index.html.
74. Hertzog E., Benartzi G., Benartzi G. Bancor Protocol: Continuous Liquidity and Asynchronous Price Discovery for Tokens through their Smart Contracts; aka “Smart Tokens” // https://bravenewcoin.com/assets/Whitepapers/Bancor-Protocol-Whitepaper-en.pdf.
75. Hybrid Asset // https://internetofcoins.org/en/wiki/hybrid-asset.
76. I want to redeem my SPIES to BTC, can you describe withdrawal process in details? // https://intercom.help/satoshifund/faq-satoshi-fund/payments-and-balance/i-want-to-redeem-my-spiesto-btc-can-you-describe-withdrawalprocess-in-details.
77. IMF Exchange Rates // http://www.imf.org/external/np/fin/ert/GUI/PagesCountryDataBase.aspx.
78. International Monetary Fund. Articles of Agreement // https://www.imf.org/external/pubs/ft/aa/pdf/aa.pdf.
79. Koning J. de. Internet of Coins: Hybrid Assets for Peer-to-Peer Intersystemic Value Transfer // https://internetofcoins.org/whitepaper_ioc.pdf.

80. Kowala // https://www.kowala.tech.
81. Koželj G. ARM: Automatic Reserve Management AI: The technology behind X8 currency // https://x8currency.com/wp-content/uploads/X8-and-ARM-Technology-whitepaper.pdf.
82. Larimer D., Scott N., Zavgorodnev V., Johnson B., Calfee J., Vandeberg M. Steem: An incentivized, blockchain-based social media platform // https://steem.io/SteemWhitePaper.pdf.
83. Larimer D. Stable Currencies are Impractical and Undesirable // http://bytemaster.github.io/article/2014/12/31/Stable-Crypto-Currencies-are-Impossible/.
84. Larimer S. The Hero from BitShares Island... +5 % // https://steemit.com/bitshares/@stan/the-hero-from-bitshares-island-5.
85. Lee J. Nu // https://nubits.com/NuWhitepaper.pdf.
86. Lin C., Mai G., Albert M., Trautwein S. Carbon: A Price-Stable Cryptocurrency for Next-Generation Payments // https://www.carbon.money/whitepaper.pdf.
87. Liquidity Pools // https://docs.nubits.com/liquidity-pools/.
88. Maker Team. The Dai Stablecoin System // https://makerdao.com/whitepaper/DaiDec17WP.pdf.
89. McLeay M., Radia A., Thomas R. Money creation in the modern economy // https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2014/money-creation-in-the-modern-economy.pdf.
90. Minexbank Memorandum // https://minexbank.com/memorandum.
91. Minexcoin // https://minexcoin.com/?r=site/index.
92. Minexcoin Charts // https://coinmarketcap.com/currencies/minexcoin/#charts.
93. Minexcoin Low Volatility Asset // https://minexcoin.com/html/download/wprus.pdf.
94. MinexExplorer // https://minexexplorer.com/.
95. Nakamoto S. Bitcoin: A Peer-to-Peer Electronic Cash System // https://bitcoin.org/bitcoin.pdf.
96. Natural Synthetics Whitebook // http://www.xronos.space/docs/ru/Xronos_White_Book.pdf.
97. Nelson J. S., Henderson D., Jones G., Roon M., Zargham M., Bulkin A., Brukhman J., Rowe K. Sweetbridge: A blockchain-based protocol stack for global commerce and supply chains // https://sweetbridge.com/public/docs/Sweetbridge-Whitepaper.pdf.
98. Nu Explorer // https://explorer.nubits.com/.
99. NuBits // https://nubits.com/.
100. Nubits Charts // https://coinmarketcap.com/currencies/nubits/.
101. NuBits Exchange Listing // https://nubits.com/list-nubits
102. OPEN.USD // http://cryptofresh.com/a/OPEN.USD; OPEN.EUR // http://cryptofresh.com/a/OPEN.EUR; OPEN.CNY // http://cryptofresh.com/a/OPEN.CNY.
103. OPEN.XPO/OPEN.BTC Market // https://openledger.io/market/OPEN.XPO_OPEN.BTC.
104. OpenLedger DC // https://openledger.io/create-account.
105. PHI: Decentralized commercial banking and stable currency // http://string.technology/pdfs/viewer.html?file=../.library/PHI-DFINITY-Extended-17-12-16.pdf.
106. Price-Stable Cryptocurrencies // https://bitshares.org/technology/price-stable-cryptocurrencies/.

107. Qureshi H. Stablecoins: designing a price-stable cryptocurrency // https://hackernoon.com/stablecoins-designing-a-price-stable-cryptocurrency-6bf24e2689e5.
108. Review of the Special Drawing Right (SDR) Currency Basket // https://www.imf.org/en/About/Factsheets/Sheets/2016/08/02/19/35/Review-of-the-Special-Drawing-Right-SDR-Currency-Basket.
109. Ripple Gateway Guide // https://ripple.com/build/gateway-guide/.
110. Saga Foundation // https://www.saga.org.
111. Saga Whitepaper // https://www.saga.org/files/saga-whitepaper.pdf.
112. Sams R. A Note on Cryptocurrency Stabilisation: Seigniorage Shares // https://bravenewcoin.com/assets/Whitepapers/A-Note-on-Cryptocurrency-Stabilisation-Seigniorage-Shares.pdf.
113. Satoshi Fund // https://satoshi.fund.
114. Satoshi Fund Portfolio // https://satoshi.fund/#portfolio.
115. Satoshi•Pie Public // https://docs.google.com/spreadsheets/d/1CMoQEXTPK-jay9SgiNyvjsAkQAGD2wNYfN7pYfI2FEro/edit#gid=490366967.
116. Schor L. Stablecoins Explained // https://medium.com/@argongroup/stablecoins-explained-206466da5e61.
117. Schwartzkopff D., Schwartzkopff L., Botha R., Finlayson M., Cronje F. CRYPTO20: The First Tokenized Cryptocurrency Index Fund // https://cdn.crypto20.com/pdf/c20-whitepaper-ru.pdf?_ga=2.96117084.1109891693.1528896490-1627073525.1525087995.
118. Set Protocol // https://setprotocol.com.
119. Sovereign HERO // http://www.sovereignhero.com/.
120. Sovereign Hero Charts // https://coinmarketcap.com/currencies/sovereign-hero/#tools.
121. StabL Bringing Stable Tokens and Derivative Products to the Ethereum Blockchain // https://blog.variabl.io/stabl-bringing-stable-tokens-and-derivative-products-to-the-ethereum-blockchain-df4d5eba89d9.
122. Stably // https://www.stably.io.
123. Stably: A Transparent Reserve-Backed Stablecoin For Multiple Blockchain Protocols // https://docs.wixstatic.com/ugd/a1dd13_9bf442f027a046df803b-62310c0f6e54.pdf.
124. Starodubcev D., Lomashuk K., Lvov V. satoshi•Pie: Blockchain Traded Fund // https://docs.google.com/document/d/1QbzZyAgev5On7hrBFCq1t-4TAsfFoDeSRjBf-gZpzWVE/edit.
125. STASIS // https://stasis.net.
126. Steem Dollar Charts // https://coinmarketcap.com/currencies/steem-dollars/#charts.
127. Steem Witnesses // https://steemdb.com/witnesses.
128. Suberg W. Tether's Bank Problems Create Unease As Token Value Slides Below $1 // https://cointelegraph.com/news/tethers-bank-problems-create-unease-as-token-value-slides-below-1.
129. Sweetbridge // https://sweetbridge.com.
130. Tether // https://tether.to/.

131. Tether Charts // https://coinmarketcap.com/currencies/tether/.
132. Tether Fees // https://tether.to/fees/.
133. Tether Legal // https://tether.to/legal/.
134. Tether Transparency // https://wallet.tether.to/transparency.
135. Tether: Fiat currencies on the Bitcoin blockchain // https://tether.to/wp-content/uploads/2016/06/TetherWhitePaper.pdf.
136. The Chronobank Team. Chronobank — Phase 1: A Non-Volatile Digital Token Backed By Labour-Hours // https://chronobank.io/files/whitepaper.pdf.
137. The Coinmetrics Team. Our guide to the cryptoasset research universe: Indices // https://coinmetrics.io/cryptoasset-indices-compared/.
138. TokenSets // https://www.tokensets.com.
139. Trending posts — Steemit // https://steemit.com/.
140. Trimborn S., Härdle W. K. CRIX or evaluating blockchain based currencies // http://crix.hu-berlin.de/data/CRIXDiscussionPaper.pdf.
141. Trinkler R., Mona El Isa. Melon Protocol: A Blockchain Protocol For Digital Asset Management // https://github.com/melonproject/greenpaper/blob/master/melon-protocol.pdf.
142. TrueUSD // https://www.trusttoken.com/trueusd/.
143. TrueUSD Charts // https://coinmarketcap.com/currencies/true-usd/.
144. TrueUSD Fees // https://blog.trusttoken.com/trueusd-faq-18dbc563fb67.
145. TrueUSD Terms of Use // https://truecoin.com/terms-of-use.pdf.
146. TrueUSD: A Stablecoin That You Can Redeem 1-for-1 for US Dollars // https://blog.trusttoken.com/trueusd-a-usd-backed-stablecoin-you-can-trust-9688796cfd0d.
147. USD SmartCoin // https://cryptofresh.com/a/USD.
148. Where is the Gold bars held? // https://digix.groovehq.com/knowledge_base/topics/where-is-the-gold-bars-held.
149. Wittayatanaseth N. Stablecoins: De-Risking Non-Collateralized Stablecoins //https://medium.com/@natwittayatanaseth/https-medium-com-fintech-kellogg-de-risking-non-collateralized-stablecoins-40e832562090.
150. X8 Project Token Generation Event Whitepaper // https://x8currency.com/wp-content/uploads/X8-Project-TGE-Whitepaper.pdf.
151. X8: The ultimate safe haven for crypto investors // https://x8currency.com/
152. Xaurum // http://www.xaurum.org/#.
153. Xaurum Charts // https://coinmarketcap.com/assets/xaurum/.
154. Xaurum Coinage // https://docs.google.com/spreadsheets/d/1Spg-mGTbt5u8-PI4Ifx-uZ4gtChNSKvDuN82PBFAyXq8/edit#gid=1340739570.
155. Xaurum Commonwealth Audit // http://www.xaurum.org/commonwealth_audit.html.
156. Xaurum Foundation // http://www.xaurumfoundation.com/.
157. Xaurum Gold Verification // https://groups.google.com/forum/#!forum/xaurum.
158. Xaurum Legal // http://www.xaurum.org/legal.html.

159. Xaurum Mint XXVI
// https://www.facebook.com/xaurumofficial/photos/a.797370633733102.1073741828.797065590430273/1032400656896764/?type=3&theater.
160. Xaurum Mints // http://www.xaurum.org/mint.html.
161. Xaurum Production Price
// http://www.xaurum.org/production_price.html.
162. Xaurum Spike Explained
// https://medium.com/@xaurumofficial/xaurum-spike-explained-530fbde96c8a.
163. Xaurum Team. A Treatise on Xaurum
// http://xaurum.org/TreatiseOnXaurum.pdf.
164. Xronos // http://www.xronos.space.
165. Xronos Rate Stabilization System // http://stats.xronos.space.
166. Xronos Whitepaper
// http://www.xronos.space/docs/ru/Xronos_White_Paper.pdf.
167. XRP Charts // https://xrpcharts.ripple.com/#/trade-volume.
168. Bondar D. Can Bitcoin Exist Without Trust (in Russian)
// https://forklog.com/mozhet-li-bitkoin-sushhestvovat-bez-doveriya/.
169. Bondar D. Not All Tokens Have the Same Utility (in Russian)
// https://forklog.com/ne-vse-tokeny-odinakovo-polezny/.
170. Bondar D. Not All Tokens Have the Same Utility — Part Two (in Russian)
// https://forklog.com/ne-vse-tokeny-odinakovo-polezny-chast-vtoraya/.
171. Bondar D. Why Bitcoin Is not Gold 2.0 (in Russian)
// http://forklog.com/ pochemu-bitkoin-ne-zoloto-2-0/.
172. Coinoindex — Dow Jones Index for Cryptocurrencies (in Russian)
// http://forklog.com/coinoindex-indeksdou-dzhons-dlya-kriptovalyut/.
173. Golos: Russian-Language Social Media Blockchain Platform (in Russian)
// https://wiki.golos.io/1-introduction/golos_whitepaper.html.
174. On the usage of virtual currencies, such as Bitcoin, in transactions (in Russian)
// http://www.cbr.ru/press/PR.aspx?file=27012014_1825052.html.
175. Comments on the legality of using virtual currency/cryptocurrency Bitcoin in Ukraine (in Ukrainian)
// http://www.bank.gov.ua/control/uk/publish/article?art_id=11879608.
176. Rothbard M. State and Money: How State Took Over Society's Monetary System (in Russian), 2008.
177. Satoshi•Pie Evolution (in Russian)
// https://golos.io/bitcoin/@satoshifund/evolyuciya-satoshi-pie.

Appendices

TABLE A. **Classification of stablecoins**

Classification criterion	Types of stablecoins
Collateral amount	Fully backed Partially backed Non-backed
Collateral type	Backed by national currency Backed by precious metals Backed by cryptocurrency Backed by a non-uniform collateral
Collateral location	Offchain backing Onchain backing Mixed backing
Collateral control	Collateral controlled by the issuer Collateral controlled by a third party Collateral controlled by a smart contract
Anchor	Pegged to a national currency Pegged to a precious metal Pegged to a basket of national currencies and/or precious metals Pegged to a cryptocurrency basket
Target price	With stable target price With increasing target price
Method of attaining price stability	Redemption at a fixed price Market price targeting Redemption at a price below par and market price targeting
Issuance & redemption	Issued and redeemed in centralized fashion Issued and redeemed in decentralized fashion
Method of delivering the stablecoins to the circulation	Issued in exchange for an equivalent Issued as a loan Issued as a reward for content creation Issued as a mining reward Issued as a means to retire bonds and reward stakeholders
Blockchain	Own blockchain Third-party blockchain Single-blockchain Multi-blockchain

TABLE B. **Descriptive statistics for prices of stablecoins**

Name	Minimum, $	Maximum, $	Range, $	Mean, $	Median, $	Mode, $	Standard deviation, $	Average 30-day standard deviation, $	Coefficient of variation,%	Average 30-day coefficient of variation, %
TrueUSD	0.9523	1.0220	0.0697	1.0010	1.0010	1.0070	0.0069	0.0063	0.69	0.63
Dai	0.8555	1.1710	0.3155	1.0010	1.0010	1.0022	0.0164	0.0116	1.64	1.15
Tether	0.5725	1.2100	0.6375	0.9999	1.0000	1.0000	0.0175	0.0040	1.75	0.40
BitUSD	0.7552	1.6000	0.8448	1.0250	1.0110	1.0022	0.0571	0.0362	5.57	3.51
NuBits	0.1666	1.2641	1.0975	0.9598	0.9976	1.0007	0.1339	0.0317	13.95	4.34
Steem Dollar	0.7682	13.8100	13.0418	1.9480	1.0060	1.0093	2.1100	0.5989	108.31	20.42
Sovereign Hero	130.8000	250.1000	119.3000	172.6000	170.6000	160.7530	15.9134	10.3422	9.22	5.97
Minexcoin	1.2970	57.9600	56.6630	21.4500	21.5500	21.0000	7.9691	5.3936	37.15	24.41
BitGOLD	1013.0000	2103.0000	1090.0000	1358.0000	1371.0000	1298.1000	156.4076	96.1796	11.52	6.97
Golos Gold	0.0246	0.4469	0.4223	0.1134	0.1010	0.1092	0.0649	0.0268	57.21	21.85
Xaurum	0.0059	0.2857	0.2798	0.0912	0.0842	0.0980	0.0701	0.0114	76.90	15.40
BitEUR	0.8508	1.7270	0.8762	1.1610	1.1350	1.1356	0.0986	0.0527	8.49	4.51
BitCNY	0.0360	0.4919	0.4559	0.1539	0.1524	0.1633	0.0177	0.0086	11.50	5.45
Crypto20	0.9759	3.8810	2.9051	1.8210	1.6590	1.3850	0.6968	0.2964	38.27	17.73
Coinoindex	117.8000	2018.0000	1900.2000	241.9000	212.4000	163.1000	126.2383	61.6627	52.19	24.53
CRIX	342.1000	62900.0000	62557.9000	6474.0000	1086.0000	424.0000	11586.2900	878.2137	178.97	8.13
Satoshi Pie	1.0160	177.4000	176.3840	12.4500	2.1700	1.8096	25.8730	1.7438	207.82	11.76
Havven	0.3047	0.6946	0.3899	0.4637	0.4623	0.5420	0.0903	0.0396	19.47	9.30
Ethereum	0.4225	1389.1800	1388.7575	179.0033	12.7364	0.9000	283.5483	28.6005	158.40	16.11
Bitcoin	67.8100	19535.7000	19467.8900	1761.6100	520.6800	135.3000	3217.3520	247.0963	182.64	8.08
BitShares	0.0030	0.8746	0.8716	0.0592	0.0064	0.0049	0.1204	0.0164	203.51	82.17

TABLE C. **Descriptive statistics for daily price changes of stablecoins**

Name	Minimum, %	Maximum, %	Mean, %	Median, %	Standard deviation, %	Average 30-day standard deviation, %
Tether	-11.00	12.12	0.28	0.00	1.00	0.48
TrueUSD	-3.15	2.63	0.65	0.46	1.16	0.90
Dai	-4.77	3.83	0.42	0.42	1.49	1.48
BitUSD	-29.73	37.76	2.99	1.87	5.56	4.30
NuBits	-39.72	150.88	2.19	0.65	6.85	3.38
Steem Dollar	-42.15	146.24	6.29	2.52	14.90	9.24
MinexCoin	-31.03	45.13	7.60	5.56	7.62	11.32
Sovereign Hero	-22.05	46.08	5.58	3.56	9.77	7.19
BitGOLD	-34.37	54.71	5.74	3.79	10.00	7.86
Xaurum	-68.74	216.80	6.74	4.05	14.83	10.82
Golos Gold	-39.58	228.80	9.00	5.17	19.64	14.67
BitEUR	-37.33	65.46	3.98	2.35	7.48	5.75
BitCNY	-76.87	190.11	3.85	1.74	15.80	7.41
CRIX	-22.38	21.96	2.49	1.39	4.43	3.37
Satoshi Pie	-48.07	42.32	3.96	1.80	7.67	4.86
Crypto20	-13.53	16.84	4.94	3.51	8.33	6.37
Coinoindex	-89.02	881.17	13.83	5.17	54.95	29.70
Bitcoin	-28.47	28.55	2.93	1.69	5.29	3.97
Ethereum	-25.48	46.63	4.88	3.06	8.36	6.74
Havven	-20.27	17.69	6.25	5.51	9.87	8.72
BitShares	-43.32	156.84	5.43	3.20	10.70	7.64

TABLE D. **Descriptive statistics for daily exchange trading volume of stablecoins**

Name	Minimum, $	Maximum, $	Range, $	Mean, $	Median, $	Standard deviation, $	Average 30-day standard deviation, $	Coefficient of variation, %	Average 30-day coefficient of variation, %
TrueUSD	526600	11130000	10603400	2101000	1622000	1445721	1563058	68.81	67.34
Dai	64080	98770000	98705920	3929000	1464000	9163411	3951998	233.23	76.31
Tether	0	5842150000	5842150000	376653107	1009940	929130006	130913280	246.68	100.34
BitUSD	0	23790000	23790000	464100	5611	1634803	371234	352.25	128.45
Steem Dollar	1334	192500000	192498666	3879000	89380	15541993	4749465	400.67	106.45
NuBits	1	116754000	116753999	1318527	19517	5844348	148224	443.25	111.87
MinexCoin	16460	1491000	1474540	154200	120400	150781	106012	97.78	64.48
Sovereign Hero	0	379722	379722	17697	3352	36628	26345	206.97	162.56
Xaurum	0	2915000	2915000	68980	17980	176946	66234	256.52	82.76
BitGOLD	0	121400	121400	1897	247	7591	3040	400.14	127.43
Golos Gold	45	6876000	6875955	124400	20950	546119	249204	439.00	160.45
BitEUR	0	145500	145500	6640	317	16753	5579	252.31	141.53
BitCNY	0	100400000	100400000	3792000	6200	12003646	1717214	316.55	120.43
Crypto20	708000	14060000	13352000	2876000	2410000	2169788	1568611	75.44	46.44
Coinoindex	0	7901	7901	235	67	565	334	240.56	142.71
Havven	56914	1252620	1195706	520985	664724	322520	308912	61.91	58.23
Ethereum	90621	9674000000	9673909379	637178530	27693200	1246433756	273363023	195.62	61.61
Bitcoin	178002	23430800000	23430621998	1235972374	58377650	3133619709	378133544	253.53	45.13
BitShares	9083	574732000	574722917	10239630	197360	31182143	7713456	304.52	83.03

TABLE E. **Descriptive statistics for stablecoins' daily exchange trading volume changes**

Name	Minimum, %	Maximum, %	Mean, %	Median, %	Standard deviation, %	Average 30-day standard deviation, %
TrueUSD	–64.40	393.90	59.10	38.31	99.06	86.15
Dai	–93.03	525.90	61.93	38.90	103.71	87.35
Steem Dollar	–93.49	12910.00	129.12	42.51	711.30	378.49
NuBits	–99.56	64500.00	338.47	58.65	2580.55	1040.46
BitUSD	–100.00	5927.00	486.99	63.67	3316.49	1732.91
Tether	–100.00	537000.00	1417.89	44.22	21737.21	5571.98
MinexCoin	–62.13	189.90	33.43	27.76	52.45	55.07
Sovereign Hero	–100.00	606800.00	3320.28	87.09	38628.24	16109.12
Golos Gold	–95.35	8626.00	201.48	54.52	790.34	572.81
Xaurum	–100.00	2190.00	179.35	39.83	1745.02	597.33
BitGOLD	–100.00	2363000.00	4990.38	95.65	81022.60	24937.40
BitCNY	–100.00	185100.00	859.32	57.92	7742.45	3623.20
BitEUR	–100.00	1421000.00	2462.11	85.90	51718.56	11884.09
Crypto20	–58.81	264.30	26.60	15.01	53.82	53.41
Coinoindex	–100.00	3620.00	604.34	80.92	2646.52	2026.15
Ethereum	–72.76	402.60	42.40	27.79	71.88	63.63
Havven	–85.82	405.80	51.19	28.42	92.77	81.78
BitShares	–90.37	4074.00	62.60	36.50	163.18	117.47
Bitcoin	–98.47	6904.00	38.17	23.16	184.85	71.53

TABLE F. **Correlation of prices of stablecoins, some cryptocurrencies, and CRIX index**

	Bitcoin	Litecoin	Ethereum	EOS	Monero	Dash	Zcash	Ripple	CRIX
Tether	–0.2333	–0.1526	–0.0918	–0.0068	–0.1779	–0.0490	–0.0831	0.1536	–0.0207
Dai	0.0034	0.0958	0.0724	0.0140	0.0265	0.0642	0.0289	–0.0951	0.0278
BitUSD	0.0762	0.0864	–0.1185	0.0884	–0.0343	0.1010	–0.0066	0.0350	0.0473
NuBits	–0.0355	0.0033	–0.0150	–0.0884	0.0099	–0.0043	–0.0460	0.0019	–0.0303
Steem Dollar	0.5873	0.5208	0.4617	0.2957	0.6219	0.4399	0.4241	0.1719	0.4856
TrueUSD	–0.0792	–0.0098	–0.0481	–0.0308	–0.1093	–0.0824	–0.0818	0.1244	–0.0423
MinexCoin	0.5580	0.4275	0.4480	0.0708	0.3916	0.1684	0.3236	0.1824	0.2647
BitGOLD	0.0667	0.0389	–0.0475	–0.0375	0.1269	0.0745	–0.0516	0.0792	0.0305
Golos Gold	0.3058	0.3146	0.2959	0.4011	0.3760	0.4251	0.1563	0.2776	0.5082
Xaurum	0.2826	0.2698	–0.0405	0.3541	0.2349	0.4980	0.0123	0.1985	0.4037
BitEUR	–0.2819	–0.2188	–0.3787	–0.0359	–0.2622	–0.1044	–0.2297	–0.0926	–0.1965
BitCNY	0.0775	0.0624	–0.1897	0.0476	–0.0343	0.1196	–0.0642	–0.0496	0.0146

- Non-stationary time series
- p-value > 0,05
- 0 < correlation < 0,2
- 0,2 < correlation < 0,5
- 0,5 < correlation

TABLE G. **Correlation of prices of stablecoins**

	Tether	Dai	BitUSD	NuBits	Steem Dollar	TrueUSD	MinexCoin	Sovereign Hero	BitGOLD	Golos Gold	Xaurum	BitEUR	BitCNY
Tether	/	0.1417	–0.0033	0.0101	0.0761	–0.0308	–0.0747	0.1338	0.0550	0.0692	–0.0743	0.0024	–0.0011
Dai	0.1417	/	0.1292	–0.0045	0.2028	–0.0502	–0.0630	–0.0020	0.1249	–0.1188	0.0016	0.0756	0.2221
BitUSD	–0.0033	0.1292	/	0.4861	0.0324	–0.2646	0.2365	0.2889	–0.0311	–0.2841	0.0016	–0.0044	0.0396
NuBits	0.0101	–0.0045	0.4861	/	0.0020	0.1117	0.0171	–0.3766	–0.1815	0.2847	–0.3588	–0.0352	–0.0669
Steem Dollar	0.0761	0.2028	0.0324	0.0020	/	–0.0648	0.1104	0.0650	0.0946	0.1285	–0.0391	–0.0050	0.0601
TrueUSD	–0.0308	–0.0502	–0.2646	0.1117	–0.0648	/	–0.3036	0.1141	0.0963	0.1349	–0.2609	–0.0743	–0.3637
MinexCoin	–0.0747	–0.0630	0.2365	0.0171	0.1104	–0.3036	/	0.2101	0.3749	0.2093	0.0494	0.1426	0.1533
Sovereign Hero	0.0134	–0.0020	0.2889	–0.3766	0.0650	0.1141	0.2101	/	0.4656	0.2319	–0.5303	0.0971	0.4167
BitGOLD	0.0550	0.1249	–0.0311	–0.1815	0.0946	0.0963	0.3749	0.4656	/	0.1299	–0.1122	0.0962	–0.0232
Golos Gold	0.0692	–0.1188	–0.2841	0.2847	0.1285	0.1349	0.2093	0.2319	0.1299	/	0.4856	–0.0064	–0.2758
Xaurum	–0.0743	0.0016	0.0016	–0.3588	–0.0391	–0.2609	0.0494	–0.5303	–0.1122	0.4856	/	–0.0525	0.0918
BitEUR	0.0024	0.0756	–0.0044	–0.0352	–0.0050	–0.0743	0.1426	0.0971	0.0962	–0.0064	–0.0525	/	0.1100
BitCNY	–0.0011	0.2221	0.0396	–0.0669	0.0601	–0.3637	0.1533	0.4167	–0.0232	–0.2758	0.0918	0.1100	/

Non-stationary time series
p-value > 0,05
0 < correlation < 0,2
0,2 < correlation < 0,5
0,5 < correlation

TABLE H. **Stablecoins in terms of using an own or third-party blockchain**

Own blockchain	Third-party blockchain			
	Single-blockchain		Multi-blockchain	
	Stablecoin	Blockchain	Stablecoin	Blockchain
Steem Dollar	TrueUSD	Ethereum	Tether	Bitcoin, Ethreum
Golos Gold	OPEN.USD	BitShares	Stably	Ethereum, Stellar
NuBits	IOUs issued by Ripple gateways	Ripple	Labor-Hour Tokens	Ethereum, Waves, NEM
Minexcoin	Digix Gold Token	Ethereum		
Basis	Xaurum	Ethereum		
Kowala	Globcoin	Ethereum		
Xronos	X8X	Ethereum		
	ARC Reserve Currency	Ethereum		
	PHI	Ehtereum		
	Sweetbridge	Ethereum		
	SmartCoins (bitUSD, bitGOLD и др.)	BitShares		
	Stabl	Ethereum		
	Dai	Ethereum		
	Augmint	Ethereum		
	Havven	Ethereum		
	Carbon	Hashgraph		
	Saga	Ethereum		
	Fragments	Ethereum		

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