# What makes private stablecoins stable?

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This draft: October 2020

## Abstract

Stability of crypto assets, in terms of their exchange rate vis-à-vis fiat currency, is an elusive goal. This note argues that for privately issued stablecoins to be successful in terms of delivering stability vis-à-vis current fiat money, they need to "piggy-back" from the credibility of the prevailing fiat money systems. The latter in turn are backed by publicly supported financial safety net. One way to "piggy-back" on the credibility of the latter is for the private issuer to suggest that stablecoins issued are collateralised by existing fiat money. Using data for the prices of 31 different stablecoins and the fiat currency or other assets the former promise to be pegged to, we apply a set of dynamic panel regression in order to investigate what determines relative stability. We find evidence that the design of stablecoin stabilisation mechanisms, and in particular the extent to which fiat money is used as collateral, as well as the presence of external auditors of such backing to enhance the credibility of such backing is crucial for the stability in terms of exchange rate of privately issued stablecoins, controlling for other factors of price developments of stablecoins.

## 1. Introduction

The history of financial innovation is littered with complex terms and acronyms. By contrast, one very recent financial innovation is simply called "stablecoin", and it essentially promises to be stable "digital cash". The term conveys the notion of simplicity, that is, what immediately comes to mind is a coin of stable value that can be exchanged against goods or stored to transfer purchasing power into the future. The impression of simplicity might be deceptive, however, and the present work digs down a bit deeper to clarify what specific design aspects make stablecoins more stable.

There is no generally agreed single definition of stablecoins and the definitions adopted, for example, in the regulatory context are evolving. The present report adopts a somewhat narrow definition focusing on *publicly tradeable* crypto assets only, that is on stablecoins for which daily data from crypto asset exchanges are available. It argues that these stablecoins need to be understood against the background of Bitcoin, which set out to provide an alternative to the money being created by central banks and banking systems. The initial idea of the originator of Bitcoin was to establish a peer-to-peer payments system, which did not involve a traditional commercial bank nor a central bank. Payments would not have to rely on either one of these institutions and in that sense, it would be comparable to how physical cash is currently being used, although this time in digital format. If such a coin was to be widely accepted, it could become a competitor to current money produced by banks and central banks.

Bitcoin has not succeeded in becoming money in particular because of its considerable volatility vis-à-vis with fiat currency. Stablecoins, sometimes referred to as the next-generation cryptocurrencies with bitcoin being the first generation, promise to address that weakness head-on. Since 2015, many stablecoins have been issued and their market capitalization is growing.

[1] Disclaimer: the opinions expressed are those of the authors only and should not be considered as representative of the European institutions or OECD official position. Possible errors and omissions are those of the authors.

Could these crypto assets become currency, just like current fiat money? So far, the international monetary policy and regulatory community avoids referring to these assets as cryptocurrencies. That said, there are suggestions that these private coins could become the fulfilment of the Hayekian notion of currency competition, whereby types of money are being privately created. These developments beg the following question: Should central banks be getting concerned about this private competition for the status of money?

The short answer is no, at least not yet. The relative quantitative importance is still comparatively limited, although it is growing. Also, some new proposals, such as that for project Libra, appear to have accelerated investigations by central banks of the question of considering issuance of central bank digital currencies. Such digital currencies could be construed of as responses to the growing competition from private digital candidates for money. Or, it could be seen simply as a natural evolution in the thinking of central banks about elements to improve the efficiency of the current payment system, which is considered slow, costly and obscure especially when it comes to cross-border transactions. Be that as it may, the example of bitcoin suggests that stability of the value of a digital asset in terms of fiat money price is a crucial determinant of the success of that asset as a means of exchange or unit of account, and bitcoin seems to have so far failed to provide these functions. Rather, it seems to have been considered a speculative investment. A widely held view is that its instability vis-à-vis the US dollar (as well as other fiat currencies) remains a key obstacle to become private money. Stablecoins have been proposed to address this issue, and the present report squarely addresses the question of what makes privately issued stablecoins more stable.

Some terminology is in order. A stablecoin is defined here by three criteria, which are as follows: i) a digital token, which is traded on a crypto asset exchange platform and promises a more or less stable exchange rate in relation to something, which could be fiat currency such as the US dollar, or other another asset. ii) The token aspires to become money, at a minimum to perform its store of value and payments function; if successful in this regard, it would be more similar to digital cash rather than credit money. iii) The token might (or might not) be backed by something.

The third criterion is not restrictive. In fact, it says that the coin might be backed by something. That is, in practise, stablecoins differ depending on their backing mechanism. The key argument advanced in the present paper is that the quality of the backing is a crucial determinant of the stability of the coin in terms of its exchange rate vis-à-vis with current fiat money. In particular, stablecoin tend to be more stable the more fully they are collateralised by fiat money and the more *credible* the collateralisation is. In this context, financial activity regulatory licenses and regular formal audits tend to enhance such credibility.

The paper is organized as follows. Section 2 provides a brief overview of selected aspects of the (publicly traded) stablecoin "landscape", defines the different approaches used to achieve stability, and explains the hypothesis investigated and empirical methodology used here to assess stability performance. Section 3 describes the data used and presents some descriptive statistics. Section 4 presents the results of on empirical analysis of the determinants of price stability of stablecoins. Section 5 concludes.

# 2. Hypothesis investigated and methodology

## 2.1 Hypothesis investigated

Stablecoins promise stability of their value, mostly vis-à-vis the price of fiat currency, but not exclusively. Some stablecoins promise stability of value vis-à-vis commodity or basket of items such as other crypto assets.

The stablecoins considered in the present empirical analysis are issued by private entities. They are being traded on crypto asset exchanges and daily data on their prices is available to us. This

data thus offers the opportunity to explore what determines the stability of potential contenders for Hayekian private money. As a reminder, Hayek (1976) strongly criticized the State monopoly for money issuance, arguing that government control of the supply of money would eventually, and historically consistently did, lead to the debasement of the value of money. He therefore strongly advocated allowing markets to select among contenders for money, so as to decide which (private) money to support and which to allow to fail. He assumed that the decisive criterion in such a competition of private monies would be their "*stability performance*".[2] To facilitate effective competition, Hayek proposed to publish the daily deviations of the various contenders from their announced standards (Hayek, 1976, p. 53).

As to what might make private money stable or not, Hayek provides some guidance [p.31]: "*It is probably impossible for pieces of paper or other tokens of a material itself of no significant market value to come to be gradually accepted and held as money unless they represent a claim on some valuable object. To be accepted as money they must at first derive their value from another source, such as their convertibility into another kind of money*". This assessment inspires our empirical analysis, and we investigate to what extent traded stablecoins derive their stability from different types of backings or collateral, which could include or not fiat currency. We postulate however that stablecoins tend to be more stable the better they can demonstrate that they are fully and credibly backed by existing fiat currency, and that they are closely linked to the current monetary and payment system that requires for its proper functioning a publicly supported financial safety net. Such credible links would allow stablecoins to "piggyback" from the trust generated by the existing payment and monetary system.[3]

## 2.2 Differences in the fundamental design of stablecoins

Broadly, three different approaches to establishing trust in the stability of value of the token could be distinguished. They differ essentially with regard to the redemption promise and the guarantee backing that promise. One way is to promise to redeem the token at par against a unit of fiat currency, say the USD, just as banks promise to return USD in the case of withdrawals from deposit accounts. This type of stablecoin is referred to here as "pseudo-currency-board" stablecoin (*PCurBoard*). Another way is to create a protocol that maintains parity to fiat currency without however promising redemption at par. Under one such approach, individuals obtain new stablecoins by borrowing, that is they receive them in exchange for promises to pay them back in the future. These promises in turn are backed by collateral provided by the borrower. Thus, the approach is similar to a commercial bank creating bank deposits when a customer is taking out a bank loan against the pledge of some collateral. The token is therefore referred to here as "pseudo-commercial-bank" (*PComBank*) stablecoin. Yet another approach consists of a protocol involving stabilizing the price of a stablecoin by buying or selling a second interest-bearing token. This type of stablecoin is referred to here as "pseudo-central-bank" (*PCenBank*) stablecoin. These terms borrow from arrangements in the current monetary system, and they are chosen to highlight some important *economic* aspects of the stabilization approach. They should not be confused with the institutions present in the current monetary system, such as currency boards to defend a currency peg, commercial banks (nor their own internal coins such as e.g. JPMCoin, use of which requires one to be a customer of and have an account with JPMorgan) or central banks nor the digital currencies they might issue. Incidentally, the latter, if issued, might directly inherit the quality as fiat money.

Conceptually, *PCurBoard* stablecoins involve establishing links to the publicly supported financial safety net. They thus benefit from the trust that comes with it. By contrast, *PCenBank* and

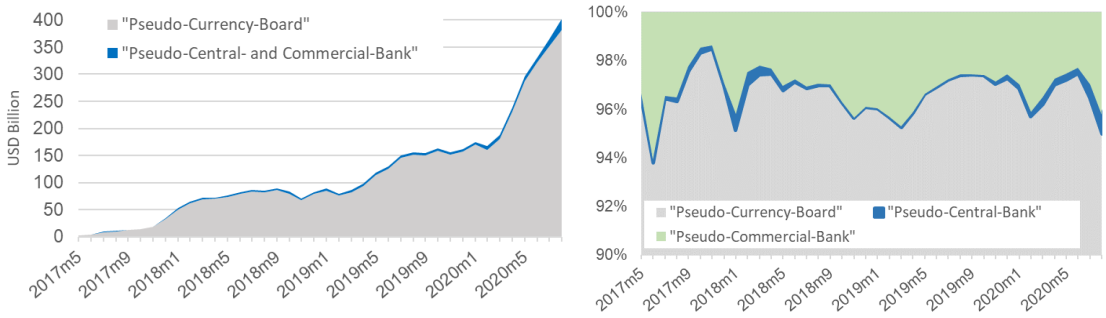
[2] He also acknowledges that the not unrelated aspect of liquidity (or acceptability) might matter in addition to stability, but believes that the former is relevant mainly over the short term.

[3] Thus, we are not investigating what stablecoin might be best suited to perform as a "Hayekian" private money. In fact, we limit our analysis to the question what makes a privately issued stablecoin perform better in fulfilling its own stability promise, which may or may not be stability vis-à-vis the price of fiat currency. In this context, note that Hayek (1976, p.48) suggests *"it would be neither necessary nor desirable that it tie itself legally to a particular standard. Experience of the response of the public to competing offers would gradually show which combination of commodities constituted the most desired standard at any time and place."*

*PComBank* stablecoins come somewhat closer to the idea of Hayek (1976) for types of money being privately created and competing with public money. One fundamental shortcoming of this approach is that they cannot rely however on a publicly (or privately) supported financial safety net to instil trust and prevent a run on the debt being created.

The fundamental assumption made here is that, to be successful in terms of stability vis-à-vis current fiat money, private stablecoins need to piggy-back from the credibility of the prevailing fiat money systems that is in turn backed by the publicly supported financial safety net. One way is for the private issuer to suggest that stablecoins issued are backed by existing fiat money. In this context, we test the hypothesis that "Pseudo-Currency-Board" stablecoins are more stable vis-à-vis fiat currency than are the other two stabilisation approaches. The former stablecoins are typically collateralised by assets in the form of fiat currency, although they might also in some cases be backed by gold or other commodities. Incidentally, while the market capitalisation of stablecoins measured in US dollar has been growing (Figure 1, left panel), the share of these stablecoins in terms of market capitalisation as of all stablecoins has only mildly been increasing over time (Figure 1, right panel).

**Figure 1: Market capitalization of selected stablecoins**

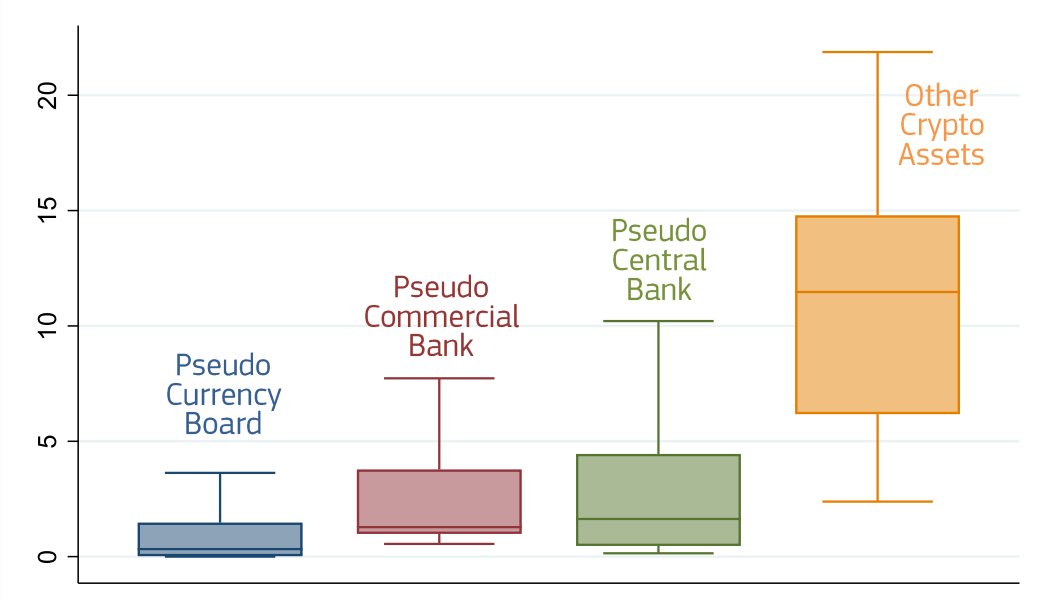



*Note: Market capitalization of selected stablecoins in our sample. Values are In USD Billion (left panel) and percentages (right panel). Source: Estimates based on Coinmarketcap.*

Another way for a private stablecoin issuer to establish or strengthen the link of stablecoins to the prevailing fiat money system is by seeking financial regulatory licenses and regular formal audits of the balance between stablecoins issued and collateral held as backing of such issuances. In this context, we test to what extent the existence of either regulatory licenses or formal audits enhance the stability performance of private stablecoins. In the case of both hypotheses, we control for a number of other potential determinants of stablecoin developments, such as their market capitalisation, historical stability performance and lifetime, as well as broader crypto asset market developments (as proxied by developments in bitcoin which accounts for most of the market in terms of market capitalisation).

All the coins considered in our empirical analysis are tradeable, in principle by anyone, on crypto asset exchanges (and thus does not include stablecoins such as *JPM Coin* nor *Libra* that has been proposed for issuance). A simple measure of volatility of selected examples of stablecoins from each of these three categories of stablecoins is provided on Figure 2, together with Bitcoin for reference. The example, incidentally, is consistent with our first hypothesis.

**Figure 2: Volatility of selected stablecoins**




*Note: Standardised 15-day rolling averages of historical volatility of daily returns in USD, as measured since the beginning of 2016. "Other crypto assets" is the average for a sample of (non-stablecoin) crypto assets that are large by market capitalisation (Bitcoin, Bitcoin Cash, Bitcoin SV, Chainlink, Crypto.com Coin, EOS, Ethereum, Litecoin, TRON, XRP). Outliers are excluded from the plot. Source: estimates based on Coinmarketcap.*

## 2.3 Some related literature

Some related work exists. Lyons and Viswanath-Natraj (2020) find that trades of private market investors as opposed to reserve management on the part of the stablecoin issuer, tend to stabilise stablecoin prices around their pegs. Moreover, they find that arbitraging activity increases as the stablecoins is traded on additional exchanges, thus increasing investor access, and resulting in significantly lower volatility. The authors consider data on prices as well as order flows of stablecoins, focusing however primarily on Tether. Data on five other stablecoins is used to form a control group to assess the relevance of the migration of Tether to an additional exchange and to describe recent developments across stablecoins during the Covid-19 pandemics.

Makarov and Schoar (2020) find that there can be persistent price differences for the same crypto asset across different exchanges, with most but not all likely explained by the existence of national capital controls, as the divergences between different exchanges tend to be larger across rather than within countries. The work is part of a literature on the functioning of trading and arbitrage in crypto assets, and is thus not directly but more loosely related to our work. We might however want to mention the observation that there can be persistent price differences for the same crypto asset across different exchanges.

Bullman et al. (2019) describe different stablecoin approaches and propose a taxonomy of stabilization mechanisms, identifying four types: i) tokenised funds, where the stablecoins are backed by funds that are retained by a custodian; ii) off-chain collateralized stablecoins where the assets are in the possession of the issuer until the user claim the assets back; iii) on-chain collateralized stablecoins, where usually crypto-assets are held on a decentralized ledger: and iv) non-collateral backed tokens, supported only by users' expectations about the future purchasing power of the stablecoin. We consider a broadly similar classification, although we also consider a few additional design aspects and place a sharp focus on the link of the stablecoin initiative to the financial safety net.

Griffin et al. (2020) provide an in-depth analysis of the connections between Bitcoin and Tether, finding evidence of price manipulation in the cryptocurrencies ecosystem. Baur et al. (2020)

analyse six stablecoins to see whether the stablecoins might be a safe haven for Bitcoin investors. They conclude that stablecoins are not consistently stable at all times, especially when the volatility of Bitcoin is high and its price is falling rapidly.

Our work adds to this literature. In particular, we place a sharp focus on design aspects of stablecoins, including in particular their links to the existing publicly supported financial safety net and some governance aspects to address the following question: What aspects of the design of stablecoins tend to make them more stable? Reflecting this focus, we consider a larger number of stablecoins in our empirical analysis than the above-mentioned studies, that is altogether 31 in our analysis. Moreover, we exploit both cross-sectional information on such design elements, as well as developments over time.

The first stablecoin was issued on an open decentralised ledger already in the mid-2010s, but it was the announcement of the Libra project by Facebook in 2019, which now is referred to as a global stablecoin, that produced an unprecedented response from regulators both at the individual and globally coordinated level. The first globally coordinated response in 2019 by the G7 Working Group on Stablecoins focused on the various potential risks of global stablecoins, including in particular for the effective transmission of monetary policy.[4] The Financial Stability Board issued a report to address the regulatory issues raised by global stablecoins in 2020, , considering the differences in contexts for emerging and mature market economies.[5] At the European level, the European Commission and the Council[6] released a joint statement, affirming "no global "stablecoin" arrangement should begin operation in the European Union until the legal, regulatory and oversight challenges and risks have been adequately identified and addressed."[7] The statement emphasises the need to have a coordinated EU legislative response to crypto-assets, including stablecoins. Also, the European Central Bank Crypto-Assets Task Force (ECB, 2020) published its analysis of so-called global stablecoins, highlighting the risk of a potential liquidity run on the stablecoin, whereby users might lose confidence in the stability of the instrument and massively seek redemption. This possibility is linked to the quality of collateral for the stablecoins, which is also the focus of the empirical work in the present work.

## 2.4 Methodology

The following section describes our econometric methodology. We consider four types of measures of price stability: (1) the simple monthly standard deviation of returns: (2) a moving-average-15-days-standard deviation of returns; (3) the deviation of the price in levels from the peg; and (4) the half-life of persistence of such deviations. The simple monthly standard deviation is calculated from the daily returns of stablecoins prices for an interval of one month. The moving-average-15-days-standard deviation is calculated using daily returns over a window of 15 days, which are then averaged across the month. The deviation from the peg is simply the closing price minus one, expressed in basis point; it can be positive or negative. A positive deviation indicates that the stablecoin is trading at premium, while a negative deviation indicates that the stablecoin is trading at discount. We consider however absolute values as part of our regressions, meaning that higher absolute values of deviations are considered less stable. The half-life, in number of days, is the speed of mean reversion, that is the number of days that it takes for the price to halve its distance from the peg after a deviation from the latter. In other words, it represents the time where a shock will dissolve by 50%. It is calculated running an autoregressive process of order 1, or AR(1) on the deviation from the peg, applying the following formula:

[4] See G7 Working Group on Stablecoins (2019).
[5] See FSB (2020)
[6] See Council of the European Union (2019)
[7] That principle has been confirmed at the global level more recently by the G7 working group on stablecoins, which says: "The G7 continues to maintain that no global stablecoin project should begin operation until it adequately addresses relevant legal, regulatory, and oversight requirements through appropriate design and by adhering to applicable standards". See https://www.reuters.com/article/g7-stablecoin/facebooks-libra-must-not-start-until-properly-regulated-g7-draft-idUSKBN26X26B.

$$Half\ life = \frac{\log 0.5}{\log |\emptyset_1|}$$

where $\emptyset_1$is the coefficient in the equation $dev_t = \alpha + \emptyset_1 dev_{t-1} + \varepsilon_t$, with $|\emptyset_1| < 1$. The half-life is calculated considering a time frame equal to three months, in order to have at least around 75 observations to estimate the AR coefficient. The value is calculated daily and then averaged across the month. The units are number of days.

Let $i=1,...,N$ be the index for the stablecoins in the sample, and $t=1,...,T$ the time series dimension of the panel (in months), we consider three different specifications of our dynamic panel regression.

The first basic specification considers the type of stablecoins, which could be *PCurBoard*, *PCenBank*, or *PComBank* Formally:

$$Y_{i,t} = \alpha + \gamma Y_{i,t-1} + \beta_1 CUB_{i,t} + \beta_2 CB_{i,t} + \beta_3 Volume_{i,t} + \beta_4 Lenght_i + \\ + \beta_5 BitRet_t + \beta_6 BitVol_t + \phi_t + \varepsilon_{i,t}$$

where $Y_{i,t}$ represents either one of the four measures of price stability considered, for coin *i* and month *t*; $Y_{i,t-1}$ refers to the one-period lagged value of the dependent variable $Y_{i,t}$; $CUB_{i,t}$ and $CB_{i,t}$ each represent a dummy variable that assumes the value of 1 if the coin is of type *PCurBoard* or *PCenBank*, respectively. Thus, *PComBank-type* stablecoins serve as the reference in this panel regression. Length represents the length of time, in number of days, that the stablecoin has existed (as judged by availability of data in our database); $BitRet_t$ is the average daily return of bitcoin for month t; $BitVol_t$ is the average change (delta) trading volume from the previous to the actual month for the bitcoin. We decide to include the bitcoin return and trading volume given the strong connections between the trading activity of these two cryptocurrencies (see Griffin et al., 2020). Finally, $\phi_t$ represents a month fixed effect.

The second basic specification focuses on the type of collateral used, that is either fiat money, gold, crypto-assets, or no collateral. In the latter case, and algorithm attempts to influence demand or supply of stablecoins; we refer to this approach as "algorithmic collateral". Formally

$$Y_{i,t} = \alpha + \gamma Y_{i,t-1} + \beta_1 Fiat_{i,t} + \beta_2 Com_{i,t} + \beta_3 Algo_{i,t} + \beta_4 Volume_{i,t} + \beta_5 Lenght_i + \\ + \beta_6 BitRet_t + \beta_7 BitVol_t + \phi_t + \varepsilon_{i,t}$$

where $Y_{i,t}$ represents the four measures of price stability considered, for coin *i* and month *t*; $Y_{i,t-1}$ refers to the one-period lagged value of the dependent variable $Y_{i,t}$; $Fiat_{i,t}$ and $Com_{i,t}$ represents a dummy variable that assume the value of 1 if the collateral is fiat money or gold. *Algo* refers to algorithmic collateral. Thus, collateral in form of crypto-assets serves as the reference. The other control variables are the same as in the first basic specification.

The third basic specifications includes a dummy variable each to indicate the presence of a financial service license or external regular audit of the availability of the collateral. Formally:

$$Y_{i,t} = \alpha + \gamma Y_{i,t-1} + \beta_1 X_{i,t} + \beta_3 Volume_{i,t} + \beta_4 Lenght_i + \beta_5 BitRet_t + \beta_6 BitVol_t + \phi_t + \varepsilon_{i,t}$$

where $Y_{i,t}$ represents one of the four measures of price stability considered, for coin *i* and month *t*; $Y_{i,t-1}$ refers to the one-period lagged value of the dependent variable $Y_{i,t}$; $X_{i,t}$ a dummy variable that assumes the value of 1 if the issuer has a license, or the collateral is audited. The other control variables are the same as in the other basic specifications.

In addition to the three basic specifications mentioned above, we estimate two models that include some interaction terms. The first, estimated only for the two variables related to the price volatility (the monthly standard deviation of returns and the moving-average-15-days-standard deviation of returns) include interactions between the variables *PCurBoard* or *PComBank*, and the presence of fiat collateral and/or a license or external audit. The second specification, estimated only for the absolute deviation of the price from the peg and the half-life, includes interaction

terms between the variable *PCenBank* and the algorithmic collateral dummy, and the interaction between the *PComBank* variable and the crypto collateral dummy. The choice of set of interactions is justified by the results obtained with the basic specifications, and will be explained in detail in Section 4.

## 3. Data and descriptive statistics

Our empirical analysis relies on data obtained from Coinmarketcap, which is a crypto asset market information service providing daily data on prices and market capitalization in US dollars of more than 2000 crypto assets, as well as various of their design features. Unfortunately, the database does not directly identify stablecoins, as defined for the purposes of the present study, nor does it provide a systematic and complete description of all features of crypto assets that are considered in our study in the analysis of stablecoin features. We thus use some judgement in i) identifying stablecoins from the large list of crypto assets and ii) in identifying their stabilization approach, type of collateral used (if any), licenses, and presence of a formal audit. In doing so, we tend to rely however as much as possible on the existing literature: Coinmarketcap explicitly identifies some crypto assets as stablecoins[8] and there are additional lists of stablecoins from specialized websites.[9]

Our dataset consists of 31 stablecoins. 14 are *PCurBoard* stablecoins, another 10 are *PComBank* and yet another seven *PCenBank* stablecoins. In terms of collateral used, 23 stablecoins have at least some forms of collateral, either in form of fiat money (12 stablecoins), gold (2 stablecoins), or a combination of fiat money and crypto assets (9 stablecoins). Eight stablecoins have no collateral. 11 stablecoins report to have at least one regulatory license and 12 stablecoins report that they are being formally audited, although in the case of two of them it is hard to verify whether their activity is in fact audited or not. 18 stablecoins promise to be stable vis-à-vis the USD, and the others are pegged to the price of different currencies or commodities. The complete list of stablecoins with their features are presented in Table 1.

**Table 1: Characteristics of the stablecoins in the sample**

| Name | Symbol | Collateral | Aims to be stable vis-à-vis... | Audited | License | Date of Introduction |
|---|---|---|---|---|---|---|
| Tether | USDT | Fiat money | USD | Yes | Yes | 25-Feb-2015 |
| TrueUSD | TUSD | Fiat money | USD | Yes | Yes | 6-Mar-2018 |
| STASIS EURO | EURS | Fiat money | EUR | Yes | Yes | 30-Jul-2018 |
| Paxos Standard | PAX | Fiat money | USD | Yes | Yes | 27-Sep-2018 |
| Gemini Dollar | GUSD | Fiat money | USD | Yes | Yes | 6-Oct-2018 |
| USD Coin | USDC | Fiat money | USD | Yes | Yes | 8-Oct-2018 |
| StableUSD | USDS | Fiat money | USD | No | No | 6-Feb-2019 |
| CryptoFranc | XCHF | Fiat money | CHF | Yes | Yes | 2-Jul-2019 |
| Binance GBP Stable Coin | BGBP | Fiat money | GBP | No | No | 29-Jul-2019 |
| USDK | USDK | Fiat money | USD | Yes | No | 29-Jul-2019 |
| xEURO | XEUR | Fiat money | EUR | No | Yes | 16-Aug-2019 |
| Binance USD | BUSD | Fiat money | USD | Yes | Yes | 20-Sep-2019 |
| PAX Gold | PAXG | Commodities | GOLD | Yes | Yes | 26-Sep-2019 |
| Tether Gold | XAUT | Commodities | GOLD | Yes | Yes | 7-Feb-2020 |
| bitCNY | BITCNY | Crypto assets | CNY | No | No | 23-Sep-2014 |
| Single Collateral DAI | SAI | Crypto assets | USD | No | No | 27-Dec-2017 |
| EOSDT | EOSDT | Crypto assets | USD | No | No | 17-Jun-2019 |
| USDQ | USDQ | Crypto assets | USD | No | No | 18-Jun-2019 |
| HUSD | HUSD | Crypto assets | USD | Yes | No | 15-Oct-2019 |
| EURBASE | EBASE | Crypto assets | EUR | No | No | 21-Oct-2019 |
| Dai | DAI | Crypto assets | USD | No | No | 22-Nov-2019 |

[8] Coinmarketcap.com includes tags in the cryptocurrencies details that allows identifying the stablecoins. For example, some of them are "stablecoin", "stablecoin-asset-backed", "stablecoin-algorithmically-stabilized".

[9] https://cryptoslate.com/cryptos/stablecoin/ provides a list of 46 stablecoins, but not all of them are present also in coinmarketcap.com. Some additional insights comes from https://blog.idex.io/all-posts/updated-list-of-stablecoins?rq=stablecoins and https://download.blockdata.tech/blockdata-stablecoin-report-blockchain-technology.pdf

| Name | Symbol | Collateral | Aims to be stable vis-à-vis… | Audited | License | Date of Introduction |
|---|---|---|---|---|---|---|
| QCash | QC | Crypto assets | CNY | No | No | 12-Dec-2019 |
| USDx stablecoin* | USDX | Crypto assets | Basket of Stablecoins | No | No | 30-Dec-2019 |
| NuBits | USNBT | Algorithmic | USD | No | No | 24-Sep-2014 |
| Brazilian Digital Token | BRZ | Algorithmic | REAL | No | No | 19-Jul-2019 |
| Neutral Dollar | NUSD | Algorithmic | USD | No | No | 19-Sep-2019 |
| Rupiah Token | IDRT | Algorithmic | IDR | No | No | 24-Sep-2019 |
| Anchor* | ANCT | Algorithmic | USD | No | No | 9-Nov-2019 |
| TerraKRW | KRT | Algorithmic | WON | No | No | 15-Jan-2020 |
| Neutrino USD | USDN | Algorithmic | USD | No | No | 30-Jan-2020 |
| USDJ | USDJ | Algorithmic | USD | No | No | 14-Apr-2020 |

*Note: stablecoins in the sample, sorted by the type of collateral and the date of introduction in the Coinmarketcap database. *Eurbase is (not fully) collateralized by crypto assets and fiat currency. Anchor declare to be stable to the USD deflated by US price index since introduction of Anchor). USDx aims to be stable vis-à-vis with a fixed portfolio consisting of USDC, PAX and TUSD. More details on the auditing and the license are presented in Appendix. Source: Coinmarketcap and respective websites or white papers of single stablecoins.*

Table 2 reports some descriptive statistics for the stablecoins in our sample. As mentioned, most stablecoins are pegged to the USD, although some are pegged to other currencies or even gold or a basket of other crypto assets. The data provided by Coinmarketcap are in USD. Thus to make the series comparable, we convert the reported USD price into the specific currency values or prices to which the stablecoin is pegged.[10]

Table 2 shows that the vast majority of stablecoins in our sample have an average closing price around one with some notable exceptions, especially in the case of *PCenBank* stablecoins. The simple standard deviation of the closing price reveals a large heterogeneity among stablecoins: Some stablecoins are quite successful in maintaining their price close to the peg, with a minimum average deviation of six basis point for Binance GBP Coin. The half-life, expressed in days, illustrate that some coins recover fast after a shock. By contrast, NuBits is characterised by a very high half-life statistics (an average value of 393 days), This observation is due to the fact that this coin, among the ones with longest history in our sample, lost parity with the USD on March 2018 and never returned to parity.[11]

We note that there is no single definition of what measure to use to assess the stability of a stablecoin in the empirical literature on the performance of stablecoins. Two measures that have been used in previous studies are considered in Figure 3. It shows the (dynamic) stability performance, as measured by the average monthly standard deviation of the returns and the average monthly half-life of days of deviation of stablecoins.[12]Distinguishing by stablecoin approaches, *PCurBoard* stablecoins appear relatively stable in both dimensions. By contrast, *PComBank* stablecoins tend to be more volatile in terms of average daily deviations from parity while *PCenBank* stablecoins tend to be more volatile as judged by the time it takes to ultimately returning to parity. The figure also shows that the most frequently traded stablecoin, Tether, has lowest daily average deviation, but performs less well when considering average half-life, deviations from its are relatively persistent, with a half-life of close to 4 days, while most other stablecoins have an average half-life of around one day.

[10] Exchange rates with respect to the USD are retrieved from FRED, Federal Reserve Bank of St. Louis, except for the exchange rate of the Rupiah, which comes from the Central Bank of Indonesia. Cryptocurrencies prices comes from Coinmarketcap.

[11] See Bullman et al (2019) for more details on NuBits.

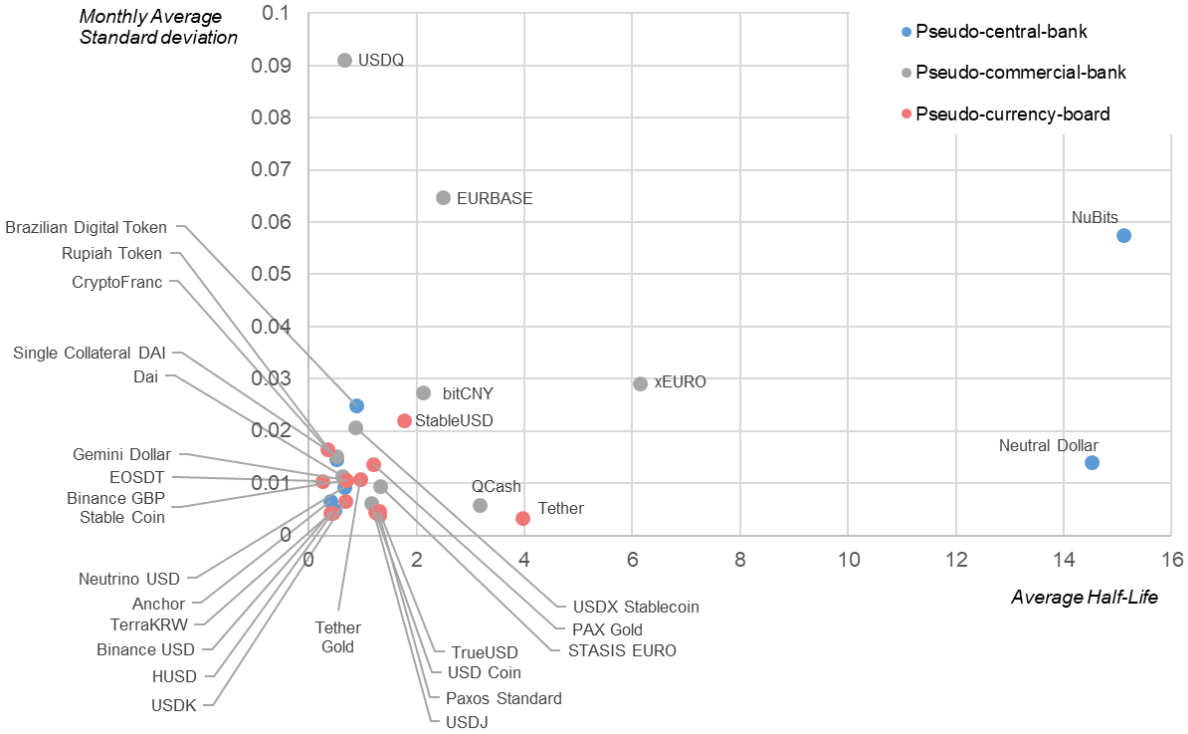
[12] Our subsequent econometric analysis is carried out with two volatility measures estimated using the log returns of the stablecoins prices (monthly standard deviation and 15-days rolling window standard deviation), and two measures related to the deviation from the peg (the deviation itself, and the half-life). Descriptive statistics of the returns are presented in the Appendix, Table 10

**Table 2: Descriptive statistics of sample stablecoins**

| *Name* | *Obs.* | *Average close price* | *Standard deviation of close price* | *Average deviation from peg (bps)* | *Half-life (days)* |
|---|---|---|---|---|---|
| **"Pseudo-currency-board" stablecoins (PCurBoard)** | | | | | |
| Binance GBP Stable Coin | 400 | 1.0006 | 0.0109 | 6.1550 | 0.7230 |
| Binance USD | 347 | 1.0020 | 0.0051 | 19.6263 | 0.4463 |
| CryptoFranc | 427 | 1.0030 | 0.0131 | 30.2137 | 0.2715 |
| EOSDT | 442 | 0.9981 | 0.0084 | -18.5140 | 0.3135 |
| Gemini Dollar | 696 | 1.0024 | 0.0124 | 24.4142 | 0.4429 |
| HUSD | 322 | 1.0020 | 0.0052 | 19.9588 | 0.4854 |
| PAX Gold | 341 | 1.0093 | 0.0171 | 92.7511 | 1.2282 |
| Paxos Standard | 705 | 1.0040 | 0.0061 | 39.7829 | 1.5633 |
| StableUSD | 573 | 0.9954 | 0.0426 | -46.2740 | 1.1143 |
| Tether | 2,010 | 1.0008 | 0.0167 | 7.9404 | 7.8150 |
| Tether Gold | 207 | 1.0021 | 0.0127 | 20.9434 | 0.9678 |
| TrueUSD | 910 | 1.0045 | 0.0075 | 44.6601 | 1.4229 |
| USD Coin | 694 | 1.0053 | 0.0077 | 53.1892 | 2.3345 |
| USDK | 400 | 0.9967 | 0.0101 | -32.9927 | 1.0470 |
| **"Pseudo-commercial-bank" (PComBank)** | | | | | |
| Dai | 284 | 1.0064 | 63.6961 | 63.6961 | 0.5435 |
| EURBASE | 316 | 1.0039 | 38.9097 | 38.9097 | 0.2717 |
| QCash | 264 | 0.9955 | -44.5311 | -44.5311 | 4.0980 |
| STASIS EURO | 764 | 0.9956 | -44.2976 | -44.2976 | 1.3080 |
| Single Collateral DAI | 896 | 1.0044 | 44.3141 | 44.3141 | 1.1516 |
| USDJ | 140 | 1.0004 | 3.8927 | 3.8927 | 1.2982 |
| USDQ | 441 | 0.9764 | -235.773 | -235.773 | 0.7086 |
| bitCNY | 2,150 | 1.0119 | 119.488 | 119.488 | 0.5206 |
| USDx stablecoin | 246 | 1.0002 | 1.5740 | 1.5740 | 0.4720 |
| xEURO | 382 | 1.0011 | 11.3955 | 11.3955 | 1.2685 |
| **"Pseudo-central-bank" (PCenBank)** | | | | | |
| Anchor | 297 | 0.7912 | 0.0049 | -2087.7940 | 0.3642 |
| Brazilian Digital Token | 410 | 0.9936 | 0.0386 | -63.5929 | 1.1968 |
| Neutral Dollar | 348 | 0.8872 | 0.1430 | -1127.5020 | 31.6383 |
| Neutrino USD | 215 | 0.9975 | 0.0110 | -24.5216 | 0.9804 |
| NuBits | 2,169 | 0.6231 | 0.4348 | -3769.2720 | 393.5443 |
| Rupiah Token | 343 | 1.0089 | 0.1538 | 89.2214 | 0.0867 |

*Note: descriptive statistics of the stablecoins in the sample. The average deviation from peg is expressed in basis points (bps) and it is calculated after converting every stablecoins into their reference currency, commodity price, or stablecoin basket.* Source: *authors' estimation on data from Coinmarketcap*

**Figure 3: Scatterplot of Half-Life vs Standard Deviation**

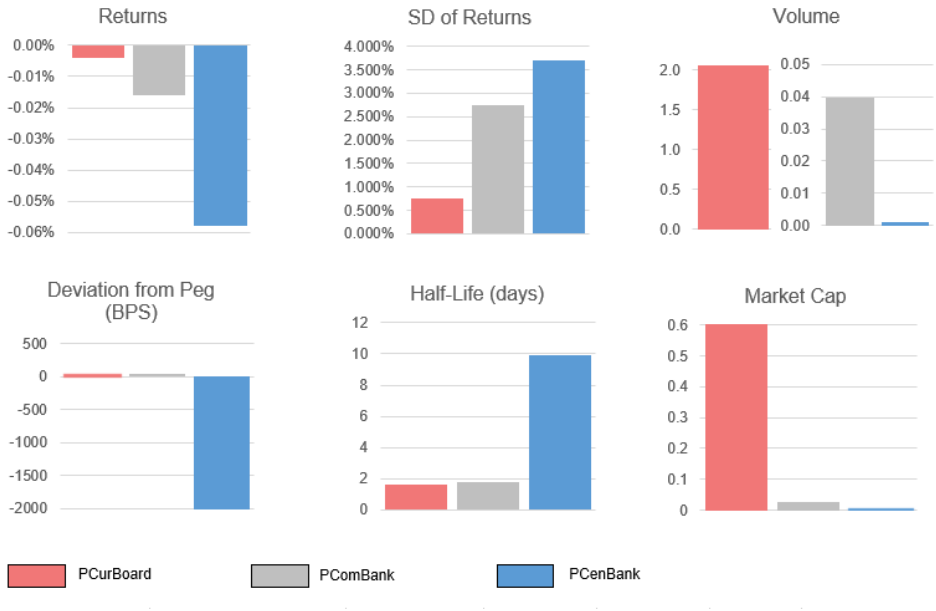



*Note: scatterplot of average half life (x-axis) versus monthly average standard deviation of price returns (y-axis). The average half-life is calculated using a rolling window of three months of data in order to estimate the AR(1) coefficient (see Section 2.4). The average monthly standard deviation of returns is obtained using daily return and then calculating the simple standard deviation of returns for each month. A graphical representation of the ranking for these two measures is presented in Appendix. Source: authors' estimation on data from Coinmarketcap.*

Figure 4 to Figure 6 provide average performances along these dimensions for groups of stablecoins (e.g. according to the type of stabilization approach used, type of collateral used, and presence or not of licenses). Figure 4 shows "pseudo-currency-board" stablecoins tend not to provide positive return, while displaying the lowest volatility, as measured by average deviation from peg and half-life. As an aside, they are by far the most traded and with the highest market capitalization in the sample. *PComBank* stablecoins provide a small positive return, while they have the highest average standard deviation and highest deviations from the peg among the three different types of stablecoins considered here. The former stablecoins' half-life is somewhat similar to that of *PCurBoard* stablecoins. In terms of volume traded and market capitalization, *PCurBoard* stablecoins are in a different order of magnitude compared to the other two categories.[13]

[13] For reasons of comparability, we report two different scale in the plots when the difference between the groups is extremely high.

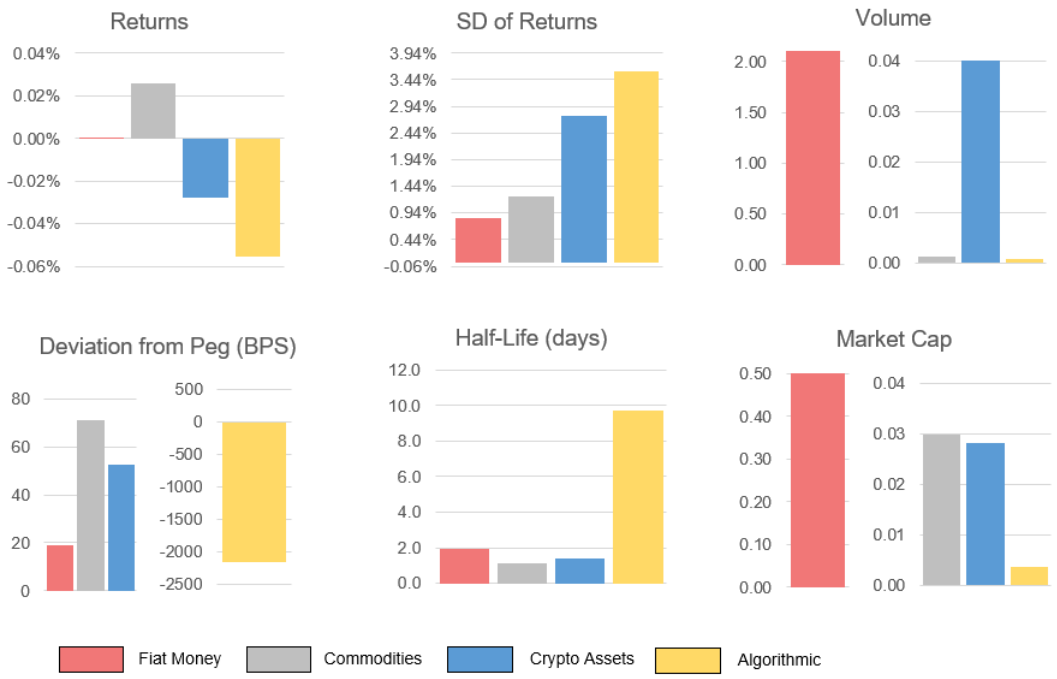
**Figure 4: Monthly average statistics by type of stablecoins**




*Note: average monthly statistics are obtained using daily data and calculating the measure for each month. The half-life is calculated using a rolling window of three months of data in order to estimate the AR(1) coefficient. Volume traded and Market capitalization are in USD billion. Source: authors' estimation on data from Coinmarketcap .*

Concerning the type of collateral used by the issuers of stablecoins, we note that Fiat money and gold (Commodities) as a collateral display a very similar pattern in most measures, with the exception of the deviation from the peg, where the value is lower for the gold-pegged stablecoins (see Figure 5). In general, being collateralized by Fiat money or commodities reduces the instability of the price for the stablecoins in the sample. The algorithmic collateral seems to perform well in terms of reduction of the deviation from the peg, albeit in case of shocks the half-life is five times larger, on average, compared to the other types of collateral. In terms of market capitalization and volume traded, most of the trading activity involves the Fiat Money collateralized stablecoins. Figure 6 shows that the presence of a license reduces dramatically the volatility of the price, reduces the averages deviations from the peg, and display a lower half-life time in days. The market seems to believe more in issuers that have some forms of licensing in place, as testify by the trading volume and the market capitalization.

**Figure 5: Monthly average statistics by collateral**




*Note: average monthly statistics are obtained using daily data and calculating the measure for each month. The half-life is calculated using a rolling window of three months of data in order to estimate the AR(1) coefficient. Volume traded and Market capitalization are in USD billion. Source: authors' estimation on data from Coinmarketcap.*

**Figure 6: Monthly average statistics by presence of license/audit**


*Note: average monthly statistics are obtained using daily data and calculating the measure for each month. The half-life is calculated using a rolling window of three months of data in order to estimate the AR(1) coefficient. Volume traded and Market capitalization are in USD billion.Source: authors' estimation on data from Coinmarketcap .*

# 4. Empirical Results

In the following section, we analyse the empirical results of the regression based on our four measures of stability, which includes the monthly standard deviation, the fifteen days rolling window average standard deviation, the deviation from the peg, and the half-life. The results are presented in the following subsections.

## 4.1 Type of stablecoin

As we have seen from the descriptive figures presented in the previous section, *PCurBoard* stablecoins display, on aggregate, better performance in terms of price stability. Given the considerable cross-sectional differences in terms of return volatility even among the same type of stablecoins (see Appendix 2), we want to assess whether this supposed stability is statistically significant and common to the group of stablecoins controlling also for other factors. We estimate a dynamic panel regression on a set of dummy variables, to discern differences among groups of stablecoins. We include the lagged value of the dependent variable to control for autoregressive components, as well as Bitcoin return and volume traded to take into account the trading pattern with the pair Bitcoin/stablecoins. We expect that *PCurBoard* stablecoins display a negative coefficient, which can be interpreted as a measure of higher efficiency in terms of price stability.

Column (1) and (2) of Table 3 includes two standard volatility measures as a dependent variable. The coefficient of the *PCurBoard* dummy is in this case negative and significant, also including monthly fixed effect, indicating a negative relationship between return volatility and *PCurBoard* stablecoins. We observe also that in three out of four models, the $\Delta$ Bitcoin volume traded is positive and statistically significant, indicating that an increase in the trading activity of bitcoin have a detrimental effect in the volatility of the stablecoins. Other control variables are not significant, as well as the *PCenBank* dummy.

Column (3) of Table 3 shows the model estimated using the absolute value of the deviation from the peg as a dependent variable. We recall that we use the absolute value of the deviation in the panel regressions since we are interested in assessing the magnitude of the movements, rather than the fact that the cryptocurrency is traded at premium or at discount. Ideally, on the one hand we expect that the group of more stable cryptocurrencies have a lower deviation, and should not appear as significant. On the other hand, a higher persistent deviation from the peg indicates that the mechanisms of price stabilization is not very efficient, and does not prevent to have large and significant differences from the parity. Indeed, we can see that the coefficient of *PCurBoard* is not significant, and instead the dummy *PCenBank* is positive and significant at the 5% level. The $\Delta$ Bitcoin volume traded in this case is negative and statistically significant in the specification without monthly fixed effect, which indicate that the higher the trading activity in the bitcoin market, the lower is the deviation from the peg. This is potentially a liquidity effect in the market, where an increase in the trading activity in cryptocurrencies helps to close the gap between the traded price of stablecoins and the peg.

Column (4) of Table 3 displays the results of the model estimated on the half-life of deviation. In this case, *PCenBank* stablecoins display a positive relationship with the half-life. In other words, their speed of mean reversion is lower, thus they ability to recover from a shock is worse compared to the other type of stablecoins. *PCurBoard* stablecoins does not perform statistically differently from the *PComBank* stablecoins. The lagged Y variables are positive and significant in all specifications.

**Table 3: Stability and type of stablecoin**

| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| | Average Monthly SD of returns (Y) | | Average Rolling 15 days SD of returns (Y) | | Average Monthly ABS Deviation from PEG(Y) | | Average Monthly Half-Life (Y) | |
| Lag (1) Y | 0.8287*** | 0.8382*** | 0.9178*** | 0.9201*** | 0.9728*** | 0.9689*** | 0.0524*** | 0.0508*** |
| | (0.093) | (0.099) | (0.084) | (0.092) | (0.014) | (0.006) | (0.006) | (0.010) |
| *PCurBoard* | -0.0045** | -0.0039* | -0.0503* | -0.0434 | -0.2056 | -0.0035 | 0.7209 | 0.3373 |
| | (0.002) | (0.002) | (0.026) | (0.027) | (0.218) | (0.226) | (1.034) | (1.355) |
| *PCenBank* | 0.0010 | 0.0003 | 0.0024 | -0.0056 | 0.9687** | 1.1367** | 7.2351*** | 7.6968*** |
| | (0.004) | (0.004) | (0.052) | (0.057) | (0.470) | (0.550) | (2.469) | (2.964) |
| Bitcoin average monthly return | -0.0141*** | -0.0425 | -0.1513** | -6.1425* | -1.9041* | 7.3930 | -3.2438 | -17.5820*** |
| | (0.005) | (0.035) | (0.065) | (3.460) | (1.075) | (7.576) | (3.553) | (2.990) |
| Δ Bitcoin volume traded | 0.0115*** | 0.0100 | 0.1752*** | 0.9993* | 0.8749 | -12.6721 | 7.0941 | 1.4013 |
| | (0.004) | (0.027) | (0.044) | (0.513) | (0.964) | (9.083) | (5.985) | (3.234) |
| Length | 0.0000 | 0.0000 | -0.0000 | 0.0000 | 0.0002* | 0.0008 | 0.0025*** | 0.0028*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.001) | (0.001) |
| Average Monthly Volume traded | -0.0000 | -0.0002 | 0.0001 | -0.0015 | -0.0065 | -0.0341 | -0.0998** | -0.0933 |
| | (0.000) | (0.000) | (0.001) | (0.003) | (0.008) | (0.025) | (0.041) | (0.058) |
| Constant | 0.0058** | 0.0176 | 0.0662** | -0.3276 | -0.0655 | 9.3793 | -1.9650* | -2.9244 |
| | (0.002) | (0.039) | (0.032) | (0.447) | (0.219) | (10.521) | (1.155) | (5.288) |
| Observations | 580 | 580 | 565 | 565 | 584 | 584 | 509 | 509 |
| Number of stablecoins | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 |
| Month FE | NO | YES | NO | YES | NO | YES | NO | YES |
| Overall R2 | 0.647 | 0.691 | 0.754 | 0.783 | 0.952 | 0.965 | 0.0405 | 0.325 |

*Note: the table report the panel regression estimation for which the dependent variable is one of the four measures of price stability introduced in the methodology section. The explanatory variables are a set of dummy variables that identify PCurBoard and PCenBank stablecoins. PComBank stablecoins dummy is excluded and serves as a baseline. The control variable includes the bitcoin average monthly return and the average change (delta) trading volume from the previous to the actual month for the bitcoin, the length in days since the introduction of the stablecoin, and the average monthly volume traded for each stablecoins. Robust standard error in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

## 4.2 Collateral used

Stablecoin designs also differ by the extent and type of collateral they use, although such choices are not fully independent of the fundamental stablecoin type discussed before. In particular, *PCurBoard* and *PComBank* tend to rely on offchain (fiat currency or gold) and onchain (crypto assets) collateral, *PCenBank* stablecoins rely on an algorithmic mechanism rather than any collateral. The volume traded for this last category is far lower compared to the other two (see Figure 4). We expect in this analysis that fiat money and gold collateralized stablecoins performs better in terms of price stability in our sample. We estimate a dynamic panel regression including three types of collateral-related dummy, namely the Fiat Collateral, the Gold collateral, and the Algorithmic collateral. We use as a baseline the crypto-assets collateral group, since it appears to display the worse performance on average among the group (see Figure 4).

Column (1) and (2) of Table 4 shows the results of the panel regression with the two measures of return volatility used in the analysis. The coefficient related to Fiat Money collateral is negative and significant in both models, thus stablecoins with this type of collateral experienced less return volatility in our sample. The results for Gold collateral is not significant, albeit the sign is negative for all models. The coefficient of the Bitcoin return is negative and significant in three out of four

specification, which testify the close link between the two types of cryptocurrencies. When the bitcoin has positive returns, the volatility of the stablecoin is lower, and vice versa. To complement this result, the coefficient of Δ Bitcoin volume traded is positive and statistically significant in three out of four models: the volatility of stablecoins could be affected by an intensification of trading in bitcoins.

**Table 4: Stability and collateral**

| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| | Average Monthly SD of returns (Y) | | Average Rolling 15 days SD of returns (Y) | | Average Monthly ABS Deviation from PEG(Y) | | Average Monthly Half-Life (Y) | |
| Lag (1) Y | 0.8290*** | 0.8395*** | 0.9172*** | 0.9210*** | 0.9728*** | 0.9688*** | 0.0523*** | 0.0505*** |
| | (0.092) | (0.099) | (0.083) | (0.091) | (0.014) | (0.007) | (0.006) | (0.010) |
| Fiat Collateral | -0.0053** | -0.0044* | -0.0650** | -0.0519* | -0.2065 | 0.0375 | 0.6605 | -0.0283 |
| | (0.002) | (0.002) | (0.030) | (0.029) | (0.224) | (0.252) | (1.087) | (1.474) |
| Gold Collateral | -0.0033 | -0.0036 | -0.0450 | -0.0531 | 0.0443 | 0.1726 | 2.9980** | 2.6775** |
| | (0.003) | (0.004) | (0.041) | (0.048) | (0.257) | (0.348) | (1.374) | (1.223) |
| Algorithmic Collateral | 0.0004 | -0.0001 | -0.0076 | -0.0143 | 0.9529** | 1.1502** | 7.1849*** | 7.5199*** |
| | (0.004) | (0.004) | (0.054) | (0.060) | (0.468) | (0.540) | (2.411) | (2.847) |
| Bitcoin average monthly return | -0.0144*** | -0.0398 | -0.1550** | -6.1177* | -1.9569* | 7.4990 | -3.3827 | -17.4448*** |
| | (0.005) | (0.035) | (0.066) | (3.316) | (1.078) | (7.755) | (3.590) | (3.032) |
| Δ Bitcoin volume traded | 0.0118*** | 0.0126 | 0.1790*** | 1.0718** | 0.9073 | -12.7266 | 7.1374 | 1.2698 |
| | (0.004) | (0.027) | (0.045) | (0.457) | (0.964) | (9.178) | (6.016) | (3.260) |
| Length | 0.0000 | 0.0000 | -0.0000 | 0.0000 | 0.0003** | 0.0009 | 0.0026*** | 0.0029*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.001) | (0.001) |
| Average Monthly Volume traded | -0.0000 | -0.0001 | 0.0003 | -0.0014 | -0.0069 | -0.0355 | -0.099*** | -0.0874 |
| | (0.000) | (0.000) | (0.001) | (0.003) | (0.008) | (0.024) | (0.038) | (0.060) |
| Constant | 0.0062** | 0.0135 | 0.0762** | -0.2945 | -0.0963 | 9.3142 | -2.1632* | -10.556*** |
| | (0.003) | (0.039) | (0.034) | (0.428) | (0.227) | (10.571) | (1.173) | (3.632) |
| Observations | 580 | 580 | 565 | 565 | 584 | 584 | 509 | 509 |
| Number of stablecoins | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 |
| Month FE | NO | YES | NO | YES | NO | YES | NO | YES |
| Overall R2 | 0.648 | 0.691 | 0.755 | 0.783 | 0.952 | 0.965 | 0.0407 | 0.325 |

*Note: the table report the panel regression estimation for which the dependent variable is one of the four measures of price stability introduced in the methodology section. The explanatory variables are a set of dummy variables that identify the collateral for each stablecoin. Crypto-assets collateral dummy is excluded and serves as a baseline. The control variable includes the bitcoin average monthly return and the average change (delta) trading volume from the previous to the actual month for the bitcoin, the length in days since the introduction of the stablecoin, and the average monthly volume traded for each stablecoins. Robust standard error in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Column (3) of Table 4 confirm and supplements the results shown in the previous analysis, where we underline that the algorithmic-stabilization mechanism is related with larger price deviation from the peg. Column (4) of Table 4 presents the results using the half-life as a dependent variable. In this case, we do find that also gold-related stablecoins might take more time to recover after a shock, as well as algorithmic collateralized stablecoins. In addition, we find that the Length variable is positive and statistically significant: a longer presence in the stablecoin market does not guarantee to be able to respond quickly to a shock, as demonstrated graphically in Figure 3, recalling that the first three stablecoins issued in the market were NuBits (Algorithmic collateral), bitCNY (crypto-assets collateral), and Tether (Fiat Collateral).

## 4.3 Licenses and audits

Finally, we analyse the results of the panel regression where we include the dummies for License and Audit together with the set of control variables. Given that the market of stablecoins is to date not regulated, we would expect that some forms of reassurances, like a public authority issuing a license for these type of activities, or an external auditor that certify the actual availability of the collateral in exchange of the stablecoin, provides a "premium" in terms of price stability, reduced deviation from the peg, and a reduced half-life. Thus, we expect that all our dummy variables that identify the presence of a license or the availability of an external auditor, have a negative sign. We recall that almost all stablecoins that have a license are also audited, then these two characteristics goes together in our framework.

**Table 5: Stability and presence of license/external audit**

| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| | Average Monthly SD of returns (Y) | | Average Rolling 15 days SD of returns (Y) | | Average Monthly ABS Deviation from PEG(Y) | | Average Monthly Half-Life (Y) | |
| Lag (1) Y | 0.8270*** | 0.8368*** | 0.9142*** | 0.9173*** | 0.978*** | 0.982*** | 0.0653*** | 0.0699*** |
| | (0.087) | (0.094) | (0.079) | (0.087) | (0.013) | (0.010) | (0.011) | (0.008) |
| License/Audit | -0.0058*** | -0.0047*** | -0.0670*** | -0.0519** | 0.2077 | 0.2412 | -2.0533 | -2.7616 |
| | (0.002) | (0.002) | (0.024) | (0.021) | (0.221) | (0.316) | (1.690) | (2.396) |
| Bitcoin average monthly return | -0.0145*** | -0.0369 | -0.1555** | -5.8608* | 1.4682 | 15.5239 | -2.8030 | -10.0299* |
| | (0.005) | (0.032) | (0.066) | (3.286) | (1.649) | (10.682) | (3.396) | (5.276) |
| Δ Bitcoin volume traded | 0.0117*** | 0.0092 | 0.1779*** | 0.9996** | -1.6569* | -17.1687 | 7.0479 | -7.2544 |
| | (0.004) | (0.027) | (0.045) | (0.498) | (0.866) | (10.756) | (6.015) | (5.456) |
| Length | 0.0000 | 0.0000 | -0.0000 | 0.0000 | -0.0004* | -0.0004 | 0.0029 | 0.0033** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.002) | (0.002) |
| Average Monthly Volume traded | -0.0000 | -0.0001 | 0.0004 | -0.0013 | 0.0151** | 0.0194 | -0.1105 | -0.1050* |
| | (0.000) | (0.000) | (0.001) | (0.003) | (0.006) | (0.018) | (0.071) | (0.056) |
| Constant | 0.0064*** | 0.0163 | 0.0739*** | 1.5054 | 0.0996 | 15.6678 | 0.3201 | 6.9532*** |
| | (0.002) | (0.039) | (0.024) | (1.366) | (0.160) | (10.402) | (0.821) | (2.145) |
| Observations | 580 | 580 | 565 | 565 | 584 | 584 | 509 | 509 |
| Number of stablecoins | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 |
| Month FE | NO | YES | NO | YES | NO | YES | NO | YES |
| Overall R2 | 0.648 | 0.692 | 0.756 | 0.784 | 0.946 | 0.960 | 0.0285 | 0.312 |

*Note: the table report the panel regression estimation for which the dependent variable is one of the four measures of price stability introduced in the methodology section. Our main variable of interest is a dummy that is equal to one if the issuer of the stablecoin is audited. The control variables include the bitcoin average monthly return and the average change (delta) trading volume from the previous to the actual month for the bitcoin, the length in days since the introduction of the stablecoin, and the average monthly volume traded for each stablecoins. Robust standard error in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Column (1) and (2) of Table 5 displays the results of the panel regression related to the volatility of the returns. As expected, the signs of the coefficients are negative and highly significant, confirming that the presence of some external validator is negatively related to high volatility phenomenon. These characteristics does not affect the deviation from the peg, which appears to be not significant (column (3) of Table 5 and the half-life. For the control variables, the considerations done in the previous analysis are still valid.

## 4.4 Price stability regression

Having established that being part of the *PCurBoard* stablecoins, using Fiat Collateral and having a License/Audit in place is individually beneficial for the price stability, as measured with the standard deviation of returns and the moving average standard deviation, we want to make an overall assessment of these three characteristics together.

**Table 6: Volatility models**

| | (1) | | | | (2) | | | |
|---|---|---|---|---|---|---|---|---|
| | Average Monthly SD of returns (Y) | | | | Average Rolling 15 days SD of returns (Y) | | | |
| Lag (1) Y | 0.8309*** | 0.8307*** | 0.8510*** | 0.8286*** | 0.9186*** | 0.9186*** | 0.9335*** | 0.9166*** |
| | (0.090) | (0.090) | (0.084) | (0.090) | (0.082) | (0.081) | (0.076) | (0.081) |
| PcurBoard# FiatCollateral# License/Audit | -0.0049** | -0.0050** | | -0.0057*** | -0.0515** | -0.0516** | | -0.0615** |
| | (0.002) | (0.002) | | (0.002) | (0.025) | (0.025) | | (0.026) |
| PcurBoard# Fiat Collateral# NO License/Audit | | -0.0005 | | -0.0013 | | -0.0007 | | -0.0125 |
| | | (0.002) | | (0.003) | | (0.030) | | (0.032) |
| PComBank# Fiat Collateral# License/Audit | | | -0.0039** | -0.0061*** | | | -0.0638* | -0.0870** |
| | | | (0.002) | (0.002) | | | (0.034) | (0.036) |
| Bitcoin average monthly return | -0.0144*** | -0.0144*** | -0.0146*** | -0.0147*** | -0.1540** | -0.1540** | -0.1569** | -0.1588** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.065) | (0.066) | (0.064) | (0.066) |
| Δ Bitcoin volume traded | 0.0116*** | 0.0116*** | 0.0117*** | 0.0119*** | 0.1766*** | 0.1766*** | 0.1787*** | 0.1806*** |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.045) | (0.045) | (0.045) | (0.045) |
| Length | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -0.0000 | -0.0000 | -0.0000 | -0.0000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Average Monthly Volume traded | -0.0000 | -0.0000 | -0.0001 | -0.0000 | 0.0002 | 0.0002 | -0.0009 | 0.0003 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.001) | (0.001) | (0.001) |
| Constant | 0.0048*** | 0.0048*** | 0.0032** | 0.0058*** | 0.0528*** | 0.0529** | 0.0389** | 0.0674*** |
| | (0.001) | (0.002) | (0.001) | (0.002) | (0.019) | (0.022) | (0.017) | (0.024) |
| Observations | 580 | 580 | 580 | 580 | 565 | 565 | 565 | 565 |
| Number of stablecoins | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 |
| Overall R2 | 0.647 | 0.647 | 0.644 | 0.648 | 0.754 | 0.754 | 0.753 | 0.755 |

*Note: the table report the panel regression estimation for which the dependent variable are the average monthly standard deviation of return and the average rolling window standard deviation of returns. The control variables include the bitcoin average monthly return and the average change (delta) trading volume from the previous to the actual month for the bitcoin, the length in days since the introduction of the stablecoin, and the average monthly volume traded for each stablecoins. Robust standard error in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

To do so, we define three interaction terms: the first *PcurBoard#FiatCollateral#License/Audit* is a dummy equal to one when all these three characteristics are present. The second, *PcurBoard#FiatCollateral#NO License/Audit* defines the same set that includes both PCurBoard and Fiat Collateral, but without a license. In this case, we aim to disentangle if the presence of Audit/License is *ceteris paribus* beneficial. The third dummy, PComBank# Fiat Collateral# License/Audit defines the group of PComBank that has Fiat Collateral and have Audit/License. None of the *PCenBank* stablecoins in our sample use Fiat Collateral (they all have Algorithmic

collateral) and Audit/License, thus they serve as a baseline. The results presented in Table 6 shows unambiguously that the presence of these three characteristics together contributes strongly to the stability, in terms of lower standard deviation of the price. The estimation also shows that it is relevant to have all the three characteristics together to be statistically more stable compared to the other stablecoins, as testify by the coefficient of *PcurBoard#FiatCollateral#NO License/Audit*, which is not statistically different from zero.

## 4.5 Deviation from PEG and Half-Life Regression

The results in the previous sections with the basic regression have identify a different reaction for two measures considered in our work, namely the absolute deviation from peg and the half-life. In the estimation that follows we use a different specification strategy, adopting as a baseline initially all the other groups excluding *PCenBank* using Algorithmic collateral, and then adding interaction terms to keep as a baseline *PCurBoard* with Fiat Collateral and with a License/Audit, for both the measures indicated above. The results are presented in Table 7,

The first column of model (1) shows, as expected, that the group of *PCenBank* using Algorithmic collateral[14] perform worse in terms of keeping the price close to the peg. In fact, the coefficient is positive and significant. Adding the interaction terms for all the other groups reveals another interesting result. In fact, the only group statistically significant and positive is the *PCurBoard* without a license (*PcurBoard#No License*) This group identify a subset of the *PCurBoard* that, even if they have Fiat Collateral, they are not efficient enough to keep a low and stable deviation from the peg. For what concerns the Half-Life, Table 7 model (2), the results for PCenBank using Algorithmic collateral mirror in terms of sign and significance the one presented for the deviation. Adding the interaction terms for the other groups reveals that, having as a baseline the *PCurBoard* with Fiat Collateral and with a License/Audit, the other group that is less able to absorb the shocks is the PcurBoardPCurBoard#Gold Collateral, albeit the coefficient is less than one half compared to the PCenBank#Algorithmic collateral.

[14] We indicate in the regression the interaction term *PCenBank#Algorithmic collateral* to indicate this group, albeit only the group *PCenBank* uses algorithmic collateral, thus the interaction term identifies only the group of *PCenBank*.

**Table 7: Deviation from PEG and Half-Life models**

| | (1) | | (2) | |
|---|---|---|---|---|
| | Average Monthly ABS Deviation from PEG(Y) | | Average Monthly Half-Life (Y) | |
| Lag (1) Y | 0.9689*** | 0.9683*** | 0.0508*** | 0.0493*** |
| | (0.007) | (0.006) | (0.010) | (0.010) |
| PCenBank# Algorithmic collateral | 1.1386** | 1.2035** | 7.5383** | 7.8719** |
| | (0.498) | (0.487) | (3.040) | (3.393) |
| PCurBoard# Gold Collateral | | 0.2177 | | 3.0939** |
| | | (0.312) | | (1.345) |
| PCurBoard# Crypto collateral | | -0.0332 | | 0.7920 |
| | | (0.232) | | (1.159) |
| PCurBoard# No License | | 0.4319** | | 2.0993 |
| | | (0.196) | | (1.331) |
| PComBank# Fiat Collateral | | 0.2584 | | 0.6419 |
| | | (0.232) | | (1.050) |
| PComBank# Crypto collateral | | 0.0028 | | 0.0295 |
| | | (0.284) | | (1.745) |
| Bitcoin average monthly return | 7.3940 | 7.7588 | -17.1311*** | -18.3440*** |
| | (7.565) | (7.715) | (2.246) | (3.689) |
| Δ Bitcoin volume traded | -12.6751 | -12.7903 | 0.9256 | 2.2601 |
| | (9.013) | (9.191) | (2.522) | (3.941) |
| Length | 0.0008 | 0.0009 | 0.0027*** | 0.0030*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Average Monthly Volume traded | -0.0342 | -0.0335 | -0.0863* | -0.0801 |
| | (0.026) | (0.024) | (0.048) | (0.067) |
| Constant | 9.3792 | -6.7052*** | -10.3679*** | -4.1582 |
| | (10.513) | (2.446) | (3.747) | (5.765) |
| Observations | 584 | 584 | 509 | 509 |
| Number of stablecoins | 31 | 31 | 31 | 31 |
| Month FE | YES | YES | YES | YES |
| Overall R2 | 0.965 | 0.965 | 0.325 | 0.326 |

*Note: the table report the panel regression estimation for which the dependent variable are the average monthly absolute deviation from peg and the average monthly Half-Life. The control variables include the bitcoin average monthly return and the average change (delta) trading volume from the previous to the actual month for the bitcoin, the length in days since the introduction of the stablecoin, and the average monthly volume traded for each stablecoins. Robust standard error in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

## 5. Conclusion

Design features of private stablecoins matter for their performance in terms of stability. Our paper digs deeper into the issue of volatility and addresses the question what makes private stablecoins stable, where stability is assessed in terms of deviations of the price of stablecoins from their respective peg, which could be parity vis-à-vis fiat currency (mostly the US dollar), the price of gold or that of a basket of crypto assets. We consider a variety of volatility measures and find strong evidence that *PCurBoard* stablecoins enhance the stability of stablecoins, after controlling for various other factors. Perhaps reflecting this observation, *PCurBoard* stablecoins are growing fastest among the stablecoins considered in our sample.

Conceptually, these "currency-board-like" stablecoins involve establishing links to the publicly supported financial safety net, mostly by effectively "tokenising" fiat currency. They thus benefit

from the trust that comes with the financial safety net that backs current bank deposits. If these types of private digital assets were the ones to become more widely used among private crypto assets, central banks need not be overly concerned about any undesired fundamental changes to the current monetary system. Such stablecoins, might compete with fiat currency in some dimension, e.g. in onchain payments, but they also rely on fiat currency to establish trust. Consequently, considerations regarding a reduction in monetary policy efficiency would tend to be more limited and somewhat similar conceptually to those raised by electronic money.

By contrast, *PCenBank* and *PComBank* stablecoins, if widely accepted, would involve the creation of digital fiat money beyond current fiat money. They thus come somewhat closer to the idea of Hayek (1976) for types of money being privately created, and competing with public money. Our empirical analysis suggests that the odds of these types of stablecoins gaining wider acceptance is currently limited, given their substantial volatility vis-à-vis fiat currency. Thus, central banks may not need to be overly concerned regarding current developments in private tradeable stablecoins, as the latter are unlikely to quickly gain much market capitalisation and user bases to pose a threat to monetary as well as financial stability.

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# Appendix

## Appendix 1. Licenses and Audit

**Table 8: Licenses**

| Name | Symbol | License |
|---|---|---|
| Binance USD | BUSD | New York State Department of Financial Services (NYDFS) |
| CryptoFranc | XCHF | Swiss AML regulations |
| Gemini Dollar | GUSD | New York State Department of Financial Services (NYDFS) |
| PAX Gold | PAXG | New York State Department of Financial Services (NYDFS) |
| Paxos Standard | PAX | New York State Department of Financial Services (NYDFS) |
| STASIS EURO | EURS | EU Nation - Malta law. |
| Tether | USDT | Money Service Business (Hong Kong, China) |
| Tether Gold | XAUT | Money Service Business (Hong Kong, China) |
| TrueUSD | TUSD | Money Service Business (US), |
| USD Coin | USDC | Money Service Business (US),BitLicense (NY),E-Money Issuer (UK). |
| xEURO | XEUR | Operated by licensed financial institution Etna Development OÜ (Estonia). |

*Note:Type of licenses when available. Source: Coinmarketcap and respective websites or whitepapers of single stablecoins.*

**Table 9: Audit**

| Name | Symbol | Audited |
|---|---|---|
| Binance USD | BUSD | Monthly |
| CryptoFranc | XCHF | Monthly |
| Gemini Dollar | GUSD | Monthly |
| HUSD | HUSD | Monthly |
| PAX Gold | PAXG | Monthly |
| Paxos Standard | PAX | Annually |
| STASIS EURO | EURS | Annually |
| Tether | USDT | Uncertain |
| Tether Gold | XAUT | Uncertain |
| TrueUSD | TUSD | Weekly, although only for entire portfolio backing different stablecoins |
| USD Coin | USDC | Monthly |
| USDK | USDK | Monthly |

*Note: frequency of audit. Source: Coinmarketcap and respective websites or whitepapers of single stablecoins.*

## Appendix 2. Descriptive statistics of stablecoins returns

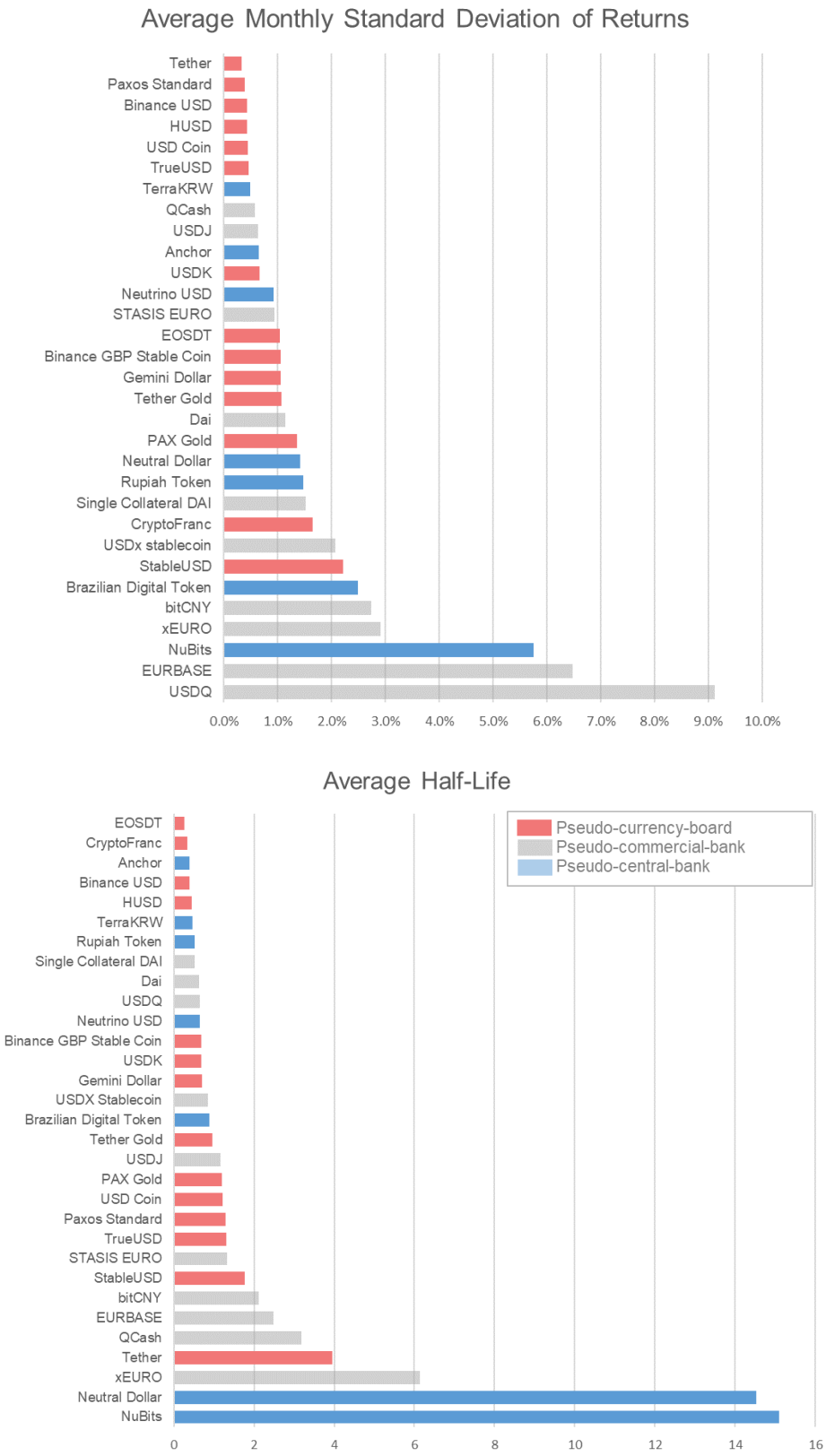
**Table 10: Descriptive statistics of the Returns**

| *Name* | *Obs* | *Average Return* | *Standard deviation* | *Min* | *Max* |
|---|---|---|---|---|---|
| **Pseudo-Currency-board stablecoins** | | | | | |
| Binance GBP Stable Coin | 399 | -0.012% | 1.102% | -3.482% | 3.492% |
| Binance USD | 346 | -0.003% | 0.454% | -1.638% | 1.434% |
| CryptoFranc | 426 | 0.020% | 1.667% | -4.487% | 4.374% |
| EOSDT | 441 | -0.010% | 1.060% | -3.792% | 2.913% |
| Gemini Dollar | 695 | -0.010% | 1.232% | -5.635% | 4.503% |
| HUSD | 321 | -0.005% | 0.449% | -1.460% | 1.340% |
| PAX Gold | 340 | 0.020% | 1.426% | -3.758% | 4.589% |
| Paxos Standard | 704 | 0.001% | 0.413% | -1.330% | 1.429% |
| StableUSD | 572 | 0.016% | 3.193% | -15.386% | 16.657% |
| Tether | 2,009 | -0.002% | 0.433% | -1.631% | 1.733% |
| Tether Gold | 206 | 0.006% | 1.170% | -3.148% | 4.136% |
| TrueUSD | 909 | 0.001% | 0.485% | -1.609% | 1.651% |
| USD Coin | 693 | 0.000% | 0.476% | -1.687% | 1.761% |
| USDK | 399 | -0.007% | 0.826% | -3.405% | 3.825% |
| **Pseudo-Commercial-bank stablecoins** | | | | | |
| Dai | 283 | 0.024% | 1.241% | -3.553% | 4.080% |
| EURBASE | 315 | -0.259% | 7.077% | -43.449% | 16.178% |
| QCash | 263 | -0.002% | 0.602% | -1.774% | 2.267% |
| STASIS EURO | 763 | 0.002% | 1.016% | -4.013% | 3.114% |
| Single Collateral DAI | 895 | 0.017% | 1.635% | -5.465% | 6.272% |
| USDJ | 139 | 0.016% | 0.611% | -1.639% | 1.855% |
| USDQ | 440 | -0.092% | 15.073% | -61.783% | 63.288% |
| bitCNY | 2,149 | -0.031% | 3.322% | -14.800% | 13.510% |
| USDx stablecoin | 245 | -0.006% | 3.257% | -18.965% | 19.871% |
| xEURO | 381 | 0.067% | 3.611% | -13.487% | 25.634% |
| **Pseudo-Central-bank stablecoins** | | | | | |
| Brazilian Digital Token | 409 | 0.033% | 2.968% | -10.992% | 12.763% |
| Neutral Dollar | 347 | -0.077% | 2.080% | -12.167% | 8.469% |
| Neutrino USD | 214 | 0.010% | 1.056% | -3.363% | 3.346% |
| NuBits | 2,168 | -0.127% | 8.033% | -30.669% | 32.472% |
| Rupiah Token | 342 | 0.028% | 1.612% | -4.657% | 7.453% |
| TerraKRW | 229 | -0.002% | 0.526% | -1.591% | 1.375% |

*Note: descriptive statistics of the returns. Source: authors' estimation on data from Coinmarketcap*

## Appendix 3. Stablecoins performances

**Figure 7: Overview of stablecoins' performances**




*Note: average monthly standard deviation of returns is obtained using daily return and then calculating the simple standard deviation of returns for each month. The average half-life is calculated using a rolling window of three months of data in order to estimate the AR(1) coefficient. Source: authors' estimation on data from Coinmarketcap.*