Libra or Librae? Basket based stablecoins to mitigate foreign exchange volatility spillovers[1]

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ABSTRACT

The paper aims to assess, from an empirical viewpoint, the advantages of a stablecoin whose value is derived from a basket of underlying currencies, against a stablecoin which is pegged to the value of one major currency, such as the dollar. To this aim, we first find the optimal weights of the currencies that can comprise our basket. We then employ volatility spillover decomposition methods to understand which foreign currency mostly drives the others. We then look at how the stability of either stablecoin is affected by currency shocks by means of spillover networks built on VAR models. Our empirical findings show that our basket based stablecoin is less volatile than all single currencies. This results is fundamental for policy making, and especially for emerging markets with a high level of remittances: a librae (basket based stable coin) can preserve their value during turbolent times better than a libra (single currency based stable coin).

JEL classification: C01, C32, C58, G21, G32
Keywords: Cryptocurrencies; Fintech; Stablecoins; Spillover; Variance decomposition.

1. Introduction

[6] posed the question of whether a Synthetic Hegemonic Currency (SHC) would be best provided by the public sector. The rationale being that a global currency, underpinned by a basket of reserve assets, could better support global outcomes. For example, an SHC could dampen the dominating influence of the US dollar on global trade, alleviate spillovers to exchange rates from shocks to the US economy, and trade across countries would become less dependent on the dollar.

Discussions around global currencies, have been reignited in the overarching debate around central bank digital currency (CBDC) and stablecoins. Most notably, Facebook announced plans for its own privately issued stablecoin that would emulate the characteristics of an SHC. In the most recent iteration of Facebooks proposition, the idea is to supply digital tokens that are pegged to major currencies, i.e. LibraUSD would be pegged to the US dollar. Moreover, there will be another token whose value is derived from a weighted basket of the currencies provided on the platform. Currently, the exact composition of the underlying basket and its targeted exchange rate is unspecified. In this paper, we assume that the objective is to devise a digital currency whose exchange rate fluctuations are minimised against several currencies, hence a global stablecoin. Facebooks plans have been met with some resistance from regulators and face intense scrutiny before receiving any kind of regulatory approval.

Why have regulators reacted with such caution to Facebook's plans to issue a stablecoin? Firstly, as a tech-giant Facebook can push Libra to its vast user-base, approximately 2.41 billion monthly active users.[3] To put this into perspective, currently it is estimated there around 40 million bitcoin wallets and 1 million daily users.[4] Facebook would have to successfully penetrate 2% of its user base to match what is an upper bound on a proxy for the size of bitcoins user base, the most frequently used cryptoasset. There is consequently significant potential for Facebook to rapidly acquire a vast user base for its digital currency.

Against this background, we investigate the empirical aspects of the design of a currency basket i.e. "Librae" in the sense that the value is composed of several currencies. First, we consider the optimal weights of the basket of underlying reference currencies, such as those included in the International Monetary fund Special Drawings Rights (SDRs). After computing the optimal weights we construct the historical values of the currency and compare the volatility against a set of major currencies, wel also use the value of SDRs as a reference for currency baskets.

For the optimal allocation of weights in the currency basket we follow [17] to compute a basket whose value's variance is minimised against the currencies contained in the basket. We construct a reference basket that contains the Dollar (USD), the Euro (EUR), the Yen (JPY), the Renminbi (CNY) and the Pound Sterling (GBP), the same currencies that are employed for the determination of the IMF's Special Drawing Rights (SDR) basket. Currently, Facebook has not made explicit which currencies it intends to use in the basket. The weights are determined by minimising the variance of a portfolio of currencies, expressed in Reduced Normalised Values (RNVALs). The benefit of using the RNVALs is that the value of each currency is expressed in how much it varies against others included in the portfolio, therefore removing fluctuations in an underlying base currency. We use daily data from January 2002 up until November 2019. Comparing our weights with those of the SDR, less weight is given to the dollar, and more weight on the Euro and Renminbi.

By construction, our basket based currency should be the least varying in comparison to those contained in the

[3] https://newsroom.fb.com/company-info/

[4] The number of bitcoin wallets: https://www.statista.com/statistics/647374/worldwide-blockchain-wallet-users/ and the number of active wallets: https://coinmetrics.io/.

basket, and our results confirm this. However, it is of interest to see how our basket fares against currencies outside of the basket, for example against the currencies of the most important remittance markets. The comparison can answer a very important question, that is: is the exchange rate of the SHC less volatile then the exchange rate of the dollar and, consequently, could a basket currency increase the utility of individuals that make remittances? To answer this question, we recompute the currency invariant indices with the inclusion of additional currencies, namely the Indian Rupee, the Mexican Peso, the Philippine Peso and the Nigerian Naira. Our empirical findings show that, overall, the basket has the lowest volatility. Therefore acting as a safe store of value for overseas workers savings. The basket can be used as a hedge against fluctuations between the the domestic and foreign currencies of individuals that rely on remittances. that could be held in the basket currency. The IMF's SDRs, performs almost as well. Stablecoins based on single-currencies in this respect perform worse, although during the crisis the dollar had a lower volatility.

We then study the currencies which mostly determine volatility spillovers among exchange rates, using the framework of [10]. Specifically, we build a spillover network decomposition analysis of the currencies up to April 2020, thus including the period of the Covid-19 outbreak. Our spillover network decomposition shows that the USD is the currency whose dynamics has the largest impact on the others, especially in terms of exporting contagion, although in the latest period CNY has begun overtaking. As a consequence, a shock to USD, expressed by a one standard deviation decrease in its normalised value with respect to the other currencies, causes a shock on all currencies and, through high order contagion, on the USD itself, leading to a new lower equilibrium. Differently, a shock in the value of the SHC, caused by a shock of a currency in the basket, is offset by the diversification effect and, therefore, the starting equilibrium is maintained. This implies that remittances converted in basket based stablecoin better maintain their value, with respect to those converted in dollars (or dollar based stable coins).

The rest of the paper is organised as follows, Section 2 contains a review of the relevant literature, Section 3 outlines our proposed methodologies, Section 4 presents our data and the empirical findings, and finally in Section 5 we conclude.

2. Literature Review

2.1. Cryptocurrencies, stablecoins and e-money

Cryptocurrencies were first conceived with the advent of Bitcoin, large attributed by the work of [22]. This was the first decentralized payment system based on maintaining a public transaction ledger. Since then, as many as 5,500 cryptocurrencies exist as of 24 May 2020. With respect to the analysis of cryptocurrencies, the research covers a vast array of topics. Several dealt with the description and functioning of cryptocurrencies [24, 11]. Issues surrounding cryptocurrrencies from a legal perspective are discussed, for example, in [21]. [7] demonstrate the inflow capital control evasion phenomenon in cryptocurrencies and show that the relative CNY to USD bitcoin price, indicating capital inflow volume reacts more negatively to carry trade returns.

Many studies analyse cryptocurrencies and their features from a quantitative viewpoint. As an example, [8] investigate the dynamic spillovers of cryptocurrencies with other financial assets, and find that the two categories of financial instruments are isolated. With a similar methodology, [15] explore the dynamic relationship of Bitcoin exchanges and show their relative importance in transmitting information of fundamental Bitcoin price changes. [19] examine the volatility interaction of eight cryptocurrencies through the Diagonal BEKK and Asymmetric Diagonal BEKK methodologies and find that despite shocks in Bitcoin are the longest lasting, the cryptocurrency is not dominant. [4] evaluate the effectiveness of several technical trading rules in cryptocurrency markets and provide support to the best performances of moving average based strategies.

Research on stablecoins is instead quite limited. The [13] defines a 'stablecoin' as a crypto-asset designed to maintain a stable value relative to another asset (typically a unit of currency or commodity) or a basket of assets. [5] make the following distinctions between types of stablecoins.

- **Tokenised funds** - denote stablecoins that are a claim on a pool of collateral that consists of funds, including cash, electronic money, commercial bank money or central bank reserve deposits e.g. Tether, Utility Settlement Coin
- **Off-Ledger Collateralised** - stablecoins that are a claim on a pool of collateral that is comprised of various assets e.g. multiple currencies, T-Bills etc
- **On-Ledger Collateralised** - stablecoins that are a claim on a pool of underlying collateral that is held on a blockchain e.g. Dai
- **Algorithmic** - take users expectations into account to stabilise the value of the coin (mostly conceptual) e.g. BasisCoin

At present, tokenised funds and off-ledger collateralised are the most common occurring instances of stablecoins. The Libra concept, would fall into the later as the foundation has plans to invest the funds that are received in return for stablecoins. Stablecoins replicate close substitutes for cash, similarly to electronic money. This is not the first time that electronic money has been on the agenda for central banks and policy makers, after a flurry of innovations in this space, in 1996 and 1998 respectively the BIS and ECB published reports addressing the regulation of e-money and the implications for monetary policy.[5] For various reasons, these forms of e-money never really troubled the concerns of policy makers of the time.[6]. However, discussions around digitised forms of money have reared their head once again.

2.2. Global currencies

A global currency as put forward recently by [6] could address certain issues in the international monetary system. Keynes originally suggested the *bancor* as a unit of account of his proposed International Clearing Union, intended to fix to the dual dollar gold system. The solution was eventually conceived by the IMF who approved the Special Drawing Rights (SDRs) in 1967. The IMF's issuance of SDRs could be seen as a supranational currency issued by central banks, although the SDR does not fulfil all functions of money. Whilst serving as a store of value and unit of account, SDRs are only used by some central banks and international institutions as a means of exchange to pay each other [23]. For this, they may not be strictly considered as a"true" global currency.

A boost to the importance of SDRs was given in 2009, when China called for reforms to the international monetary system by adopting the SDR as a reserve asset. Against these developments, [18] suggests that while the adoption of the SDR as a reserve asset is technically feasible, it would not reduce the dollar's role any time soon. Many foreign-exchange transactions, even excluding US residents, are denominated and settled in dollars. Producers typically invoice their products in dollars, which keeps their prices in line with their competitors and simplifies cross-border price comparisons among producers [16]. Given the persistent importance of the US dollar, the question is whether this will remain so under the fintech transformation that is changing the financial world. And, in particular, whether a dollar based stable coin is more likely to be adopted than a basket based one.

[5] See [12, 2]
[6] For example, see [20]

2.3. Remittances and exchange rates

A stablecoin backed by a basket of currencies could be an attractive asset for foreign workers that make remittances to families in their home countries. In particular where its value is not directly tied to the domestic currency. Under the status quo, an appreciation in the value of the domestic currency can reduce the remittances ratio because workers want to to keep the additional earning from the appreciation of the currency. On the other hand, workers based in foreign countries, where the value of the domestic currency is declining, may remit money on an urgent basis. [14] recently notes the impact that blockchain could have on reducing costs in remittance markets.

One specific challenge for countries that face large inflows of worker remittances could lead to the emergence of ”Dutch disease,” that is, remittance inflows could result in an appreciation of the equilibrium real exchange rate that would tend to undermine the international competitiveness of domestic production, particularly that of nontraditional exports. [3] note that reasonable modifications in the modelling of the factors driving remittances, or in the various macroeconomic roles that remittances may play, could moderate or even reverse the expected impact of remittance flows on the equilibrium value of the real exchange rate. [1] discuss two mechanisms by which this occurs, the first mechanism is demonstrated in the Salter-Swan-Conder-Dornbusch model, which points to a “spending effect,” by which the increase in wealth following higher capital inflows from remittances, combined with exogenous tradable prices, causes the prices of nontradable goods and services to rise. These higher prices lead to an expansion in the non-tradable sector. By definition, an increase in the price of nontradables relative to the price of tradables translates into real exchange rate appreciation. The second mechanism is that remittances tend to increase household aggregate wealth. An increase in household wealth may lead to a decrease in labor supply as households substitute more leisure for work. A shrinking labor supply, in turn, puts upward pressure on wages. Rising wages raise production costs, and higher production costs can lead to a further contraction of the tradable sector. Both the resource reallocation effects and the labor effects can cause an appreciation of the exchange rate, thereby reducing the international competitiveness of the tradable sector, and may lead to tradable sector contraction, higher wages, and higher production costs.

A basket based currency could dampen some of these effects as it is less susceptible to appreciation and depreciation of the domestic and foreign currencies. However, the effects are likely to be ambiguous and depend on how the stablecoin is used. If it gains acceptability in the home currency this could leads to new episodes of dollarisation, whereas if the currency is only used as a medium of exchange the effect could be negligible.

2.4. Contribution of the paper

The paper combines the background of the previous streams of literature, namely: the need of a global currency, which is ”optimal” in terms of minimum volatility (maximum stability), and resilient to exchange rate shocks; with the emergence of fintech technologies, and of blockchain based stable coins in particular. Against this background, we contribute to the previous literature, from an economic viewpoint, by answering the following research question: is a basket based stable coin better than a single currency one, in terms of stability? To answer the this question, we contribute to the literature, from a methodological viewpoint, with two main innovations: i) we provide a methodology to build a minimum variance basket of currency, to derive the optimal weights for a ’global stablecoin’; ii) we provide a methodology aimed at assessing contagion spillovers among foreign exchange markets, based on Diebold and Yilmaz variance decomposition model.

3. Methodology

In this section we outline the methodologies employed in our empirical application. Firstly, we describe the optimal control problem which yields to the optimal stablecoin weights. Secondly, we introduce our VAR model and, based on it, we study the spillover effects across the currencies in the basket to determine their interconnectedness and, therefore, to understand which are the most relevant ones in terms of shock transmission.

3.1. Optimal control problem

We aim to build a basket of predetermined (reference) currencies with optimal weights, namely, weights which minimize the variability of a basket based stablecoin. This translates into an optimal control problem which minimize the variance of the basket constructed with the above mentioned currencies.

[17] show that the values of any given currency depends on the base currency chosen. The latter fact creates ambiguity in evaluating the currency itself and its dynamics. To overcome this issue,[17] proposed a reduced (to the moment t_0) normalized value in exchange (RNVAL) of the i-th currency:

$$\mathrm{RNVAL}_i\left(t/t_0\right) = \frac{c_{ij}(t)}{\sqrt[n]{\prod_{k=1}^{n} c_{kj}(t)}} \Big/ \frac{c_{ij}\left(t_0\right)}{\sqrt[n]{\prod_{k=1}^{n} c_{kj}\left(t_0\right)}} = \sqrt[n]{\prod_{k=1}^{n} \frac{c_{ik}(t)}{c_{ik}\left(t_0\right)}} \tag{1}$$

By reducing to the moment t_0 and normalizing each currency observation by the geometric average of the other currencies at that specific point in time, the RNVAL allows the computation of a unique optimal, minimum variance currency basket, despite the base currency choice. The minimum variance currency basket is derived by searching the optimal weight vector w^* which solves the following optimal control problem:

$$\mathrm{Min}\left(S^2(w) = \sum_{i,j=1}^{n} w_i w_j \operatorname{cov}(i,j) = \sum_{i=1}^{n} w_i^2 s_i^2 + 2\sum_{i,j=1}^{n} w_i w_j \operatorname{cov}(i,j)\right) \tag{2}$$

subject to

$$\begin{cases} \sum_{i=1}^{n} w_i = 1 \\ w_i \geq 0 \end{cases}$$

The optimal control problem in Equation (2) yields to the minimum variance weights which enable us to construct the stablecoin value.

3.2. VAR models and spillover analysis

We evaluate spillovers through the methodology by [9]. As in their seminal paper, we start from estimating a Vector AutoRegressive (VAR) model, that is :

$$x_t = \sum_{i=1}^{k} \Phi_i x_{t-i} + \varepsilon_t \tag{3}$$

where x_t being the $(n \times 1)$ vector of first differences in RNVALs at time t, Φ_i the $(n \times n)$ VAR parameter matrices, k the autoregressive order, ε_t a zero-mean white noise process having variance-covariance matrix Σ_ε, with n being the number of currencies considered in order to build the basket. Note that the VAR model is built on the variables' first differences, as this ensure the stationarity of the analyzed time series.

The VAR in Equation 3 may also be rewritten in its corresponding vector moving average (VMA) representation, that is

$$x_t = \varepsilon_t + \Psi_1 \varepsilon_{t-1} + \Psi_2 \varepsilon_{t-2} + \cdots \tag{4}$$

where $\Psi_1, \Psi_2, ...$ the $(n \times n)$ are the matrices of VMA coefficients. The VMA coefficients are recursively computed as $\Psi_i = \Phi_1 \Psi_{i-1} + \Phi_2 \Psi_{i-2} + ... + \Phi_i \Psi_1$, having $\Psi_i = 0 \; \forall i < 0$ and $\Psi_1 = I_n$.

As it is widely accepted in the financial econometric literature, the variance decomposition tools are used to evaluate the impact of shocks in one system variable on the others. Strictly speaking, variance decompositions decompose the H-step-ahead error variance in forecasting x_i which is due to shocks to x_j, $\forall j \neq i$ and $\forall i = 1, ..., n$.

In this paper we make use of the KPPS H-step-ahead forecast error variance decompositions, as [9] do. This is because we avoid imposing an a priori ordering exchange rates regarding the influence of shocks across the system variables, as popular techniques like the Cholesky identification scheme do. Indeed, the KPPS H-step-ahead forecast errors have are convenient as they are invariant with respect to the variable ordering.

As already stated, [9] found their methodology on the H-step ahead forecast error variance decomposition. Considering two generic variables x_i and x_j, they define the own variance shares as the proportion of the H-step ahead error variance in predicting x_i due to shocks in x_i itself, $\forall i = 1, ..., n$. On the other hand, the cross variance shares (spillovers) are defined as the H-step ahead error variance in forecasting x_i due to shocks in x_j, $\forall i = 1, \cdots, n$ with $j \neq i$.

In other words, denoting as $\theta_{ij}^g(H)$ the KPPS H-step forecast error variance decompositions, with $h = 1, \cdots, H$, we have:

$$\theta_{ij}^g(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e_i' \Psi_h \Sigma e_j)^2}{\sum_{h=0}^{H-1} (e_i' \Psi_h \Sigma \Psi_h' e_i)} \tag{5}$$

with σ_{jj} being the standard deviation of the innovation for equation j and e_i the selection vector, i.e. a vector having one as i^{th} element and zeros elsewhere. Intuitively, the own variance shares and cross variance shares (spillovers) measure the contribution of each variable to the forecast error variance of itself and the other variables in the system, respectively, thus giving a measure of the importance of each variable in predicting the others.

Note that the row sum of the generalized variance decomposition is not equal to 1, meaning $\sum_{h=0}^{H-1} \theta_{ij}^g(H) \neq 1$. [9] circumvent this problem by normalizing each entry of the variance decomposition matrix by its own row sum, i.e.

$$\tilde{\theta}_{ij}^g(H) = \frac{\theta_{ij}^g(H)}{\sum_{j=1}^{n} \theta_{ij}^g(H)} \tag{6}$$

This tackles the above mentioned issue and yields to $\sum_{j=1}^{n} \tilde{\theta}_{ij}^g(H) = 1$, and $\sum_{j,i=1}^{n} \tilde{\theta}_{ij}^g(H) = n$.

As a measure of the fraction of forecast error variance coming from spillovers, [9] define the total spillover index (TSI):

$$TSI(H)=\frac{\sum_{\substack{j=1\\ j\neq i}}^{n}\tilde{\theta}_{ij}^{g}(H)}{\sum_{j,i=1}^{n}\tilde{\theta}_{ij}^{g}(H)}\cdot 100=\frac{\sum_{\substack{j=1\\ j\neq i}}^{n}\tilde{\theta}_{ij}^{g}(H)}{n}\cdot 100 \tag{7}$$

Moreover, we also make use of directional spillovers indexes (DSI) to measure, respectively through equations (8) and (9), the spillover from exchange i to all other exchanges J (cfr. Eq. 8) and the spillover from all exchanges J to exchange i (cfr. Eq. 9) as:

$$DSI_{J\leftarrow i}(H)=\frac{\sum_{\substack{j=1\\ j\neq i}}^{n}\tilde{\theta}_{ji}^{g}(H)}{\sum_{j,i=1}^{n}\tilde{\theta}_{ij}^{g}(H)}\cdot 100 \tag{8}$$

$$DSI_{i\leftarrow J}(H)=\frac{\sum_{\substack{j=1\\ j\neq i}}^{n}\tilde{\theta}_{ij}^{g}(H)}{\sum_{j,i=1}^{n}\tilde{\theta}_{ij}^{g}(H)}\cdot 100 \tag{9}$$

Directional spillovers may be conceived as providing a decomposition of total spillovers into those coming from - or to - a particular variable. In other words, they measure the fraction of forecast error variance which comes from (or to) one of the variables included in the system - and, hence, the importance of the variable itself in forecasting the others. From the definitions of directional spillover indexes, it is natural to build a net contribution measure, impounded in the net spillover index (NSI) from market i to all other markets J, namely:

$$NSI_i(H)=DSI_{J\leftarrow i}(H)-DSI_{i\leftarrow J}(H) \tag{10}$$

Another very important metric to measure the difference between the gross shocks transmitted from market i to j and gross shocks transmitted from j to i is the net pairwise spillover (NPS), defined as:

$$PNS_{ij}(H)=\left(\frac{\tilde{\theta}_{ij}^{g}(H)}{\sum_{q=1}^{n}\tilde{\theta}_{iq}^{g}(H)}-\frac{\tilde{\theta}_{ji}^{g}(H)}{\sum_{q=1}^{n}\tilde{\theta}_{jq}^{g}(H)}\right)\cdot 100 \tag{11}$$

All the metrics discussed above are able to yield insights regarding the mechanisms of market exchange spillovers both from a system-wide and a net pairwise point of view. Furthermore, performing the analyses on rolling windows we are able to study the dynamics of spillover indexes over time.

4. Data and empirical findings

4.1. Data

To test our proposal, we make use of historical data, according to a retrospective analysis. In particular, we use daily foreign exchange rate data over the period January 2002 - November 2019, obtained from *investing.com*. To build our optimal basket of currencies, we collect data relative to the foreign exchange pairs between the currencies

Currency	USD	CNY	EUR	GBP	JPY
Optimal Weights	0.17	0.2	0.23	0.19	0.21
IMF SDR Weights	0.42	0.11	0.31	0.08	0.08

Table 1
Weights of the currency in the chose basket, according to our methodology (Optimal) and the IMF Special Drawing Rights (IMF SDR)

that are included in the IMF's Special Drawings Rights: the US dollar, the Chinese Renmimbi, the Euro, the British pound and the Japanese Yen. According to our research assumption, we will assume that the obtained basket of currencies correspond to a stable coin which can be exchanged and compared with a single currency based stablecoin, for example based on the US dollar. This, in particular, for foreign individuals sending remittances to their home country. To understand the relationship between major currencies and remittances we also collect data on the largest remittance markets - namely, the Indian Rupee, Mexican Peso, Philippines Peso, Nigerian Naira. Moreover, for what concerns the volatility analysis, we divide the sample into subsets which define the pre-crisis period (2002-2008), crisis period (2009-2011) and post-crisis period (2012-2019).

Finally, for the sake of comparison with a widely known basket-based currency such as the IMF SDR, we also collect data relative to the foreign exchange pair of the dollar with the IMF Special Drawing Rights.

4.2. Optimal basket and stability analysis

First of all, we compute the RNVALs as described in Section 3. The resulting weights are contained, together with those of the IMF SDR, in Table 1.

From Table 1 note that our method yields weights which are relatively equal among each other, in fact each are approximately a fifth, with a slightly heavier weighting on the EUR. The weights are quite different from the weights of the IMF SDR, which are highly concentrated on the USD dollar. Fluctuations of SDRs will strongly be correlated with fluctuations in USD and EUR. The SAC distributes the weights more evenly across the basket to minimise the variations in fluctuations. Since, the basket is comprised of hard currencies the diversification tends to work since the currencies move systematically over time relative to one another. Such that, if the value a particular currency depreciates relative to the SAC, but simultaneously there is an appreciation of another currency, their movements would tend to cancel each other, all else the same. Note, that China has managed a floating peg against the USD and hence these two currencies are likely to be strongly linked. In the SDR these two currencies make up 53% of the basket compared to 37% in the SAC. Indicating, perhaps more diversification is needed to offset movements in the dollar. To better interpret the results, Figure 1 represents the time series of the Reduced Normalised Values of all considered currencies in the basket, along with our basket based stable coin, in the considered period.

Figure 1 shows the evolution of the RNVALs of the currencies composing the basket during the whole sample period. From Figure 1 note that, after a first period of small turbulences, the time series start to diverge roughly from the beginning of 2006 onwards. From that point in time onwards, two clusters seem to emerge from the graph: the first one includes USD and CNY, while the second one pertains EUR, GBP and JPY. This is arguably due to the fact that, for many years, the CNY value was pegged to the dollar and, therefore, its dynamics over time shows quite similar patterns to that of the USD. Note that, as expected by construction, the Reduced Normalised Value of the basket based stable coin lies in the middle, "mediating" between the different currencies, and compensating single deviations with diversification benefits.

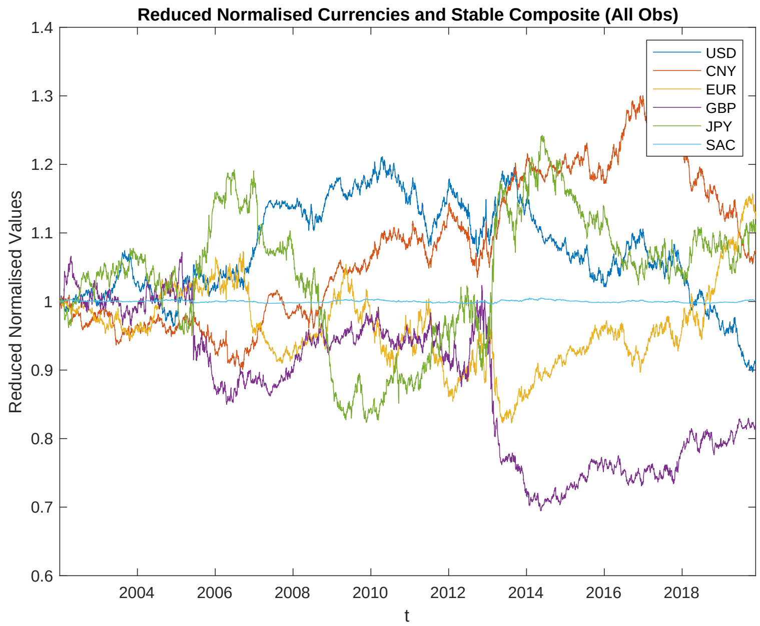

Figure 1
Time evolution of the Reduced Normalised VALue of the basket currencies (USD, CNY, EUR,GBP, JPY), and of the basket based stable coin (SAC)

From Figure 1 note that, after a first period of small turbulences, the time series start to diverge roughly from the beginning of 2006 onwards. From that point in time onwards, two clusters seem to emerge from the graph: the first one includes USD and CNY, while the second one pertains EUR, GBP and JPY. This is arguably due to the fact that, for many years, the CNY value was pegged to the dollar and, therefore, its dynamics over time shows quite similar patterns to that of the USD. Note that, as expected by construction, the Reduced Normalised Value of the basket based stable coin lies in the middle, "mediating" between the different currencies, and compensating single deviations with diversification benefits.

For the sake of analyzing the world's emerging market currencies with the highest portions of remittances, we recompute the RNVALs including them. The corresponding graphical representation is contained in Figure 2. In the figure we have included, besides our basket based stable coin, another one that employs the same weights as the Special Drawing Rights.

Figure 2 shows that emerging market currencies such as the Mexican Peso (MXN) and the Philippine Peso (PHP) appreciate consistently with respect to the other fiat currencies in the basket over time. All the other currencies, instead, seem to belong to another cluster, in the sense that they do not follow an upward trend as the previous ones, but rather fluctuate below the value of 1, with different patterns. The only exception is the Indian rupee (INR), whose value grows over time, although not with the same magnitude as MXN and PHP do. Note that both basket based stable coins lie in the middle, similarly as in Figure 1, although their Reduced Normalised values fluctuate. This because the baskets are built using only five currencies, but are normalised with respect to all nine included in Figure 2.

To understand more precisely which stable coin is more stable (Libra: single currency based, or Librae: basket based), Table 2 presents their volatilities, measured by their standard deviations in the considered time period. The table presents also the correlations between the currencies, which help in the interpretation of the results.

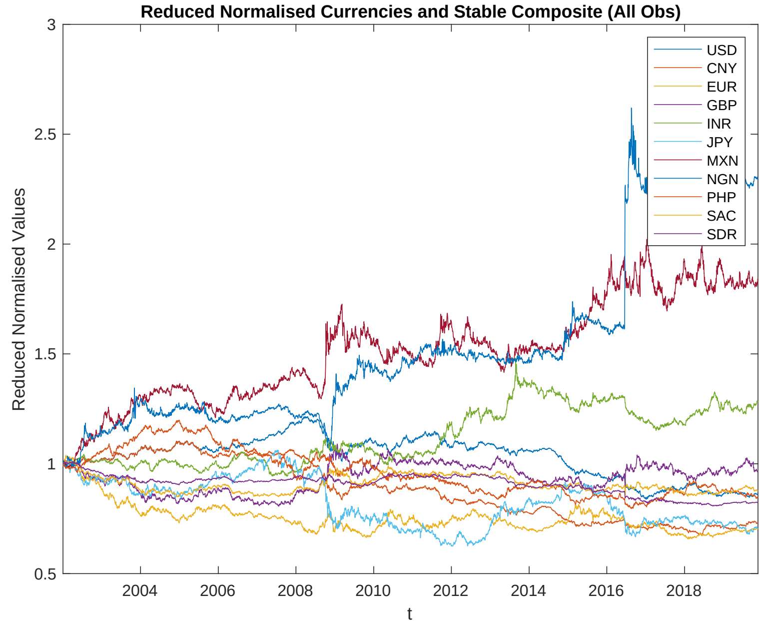

Figure 2
Time evolution of the Reduced Normalised Value of the basket currencies (USD, CNY, EUR,GBP, JPY), of the considered emerging market currencies (INR, MXN, NGN, PHP) and of the basket based stable coins (SAC, SDR)

Table 2 shows, as far as correlations are concerned, that USD and CNY exhibit relatively strong negative or little correlation with others currencies in the basket, but are weakly positive between themselves, consistently with what observed in Figure 1. Moreover, one can clearly notice that the EUR acts as a good diversifier, as its pairwise correlations are quite low if compared to those between other currencies. More importantly, from the correlation matrix we can deduce that the stablecoin shows correlations with the other currencies whose values are very close to zero. Low correlations with the other currencies is a clear sign of the goodness of our stablecoin in being isolated with respect to the fiat currencies' dynamics and, therefore, arguably stable. In terms of volatility, the standard deviations show that the most volatile currency is CNY, followed by JPY and USD. Our stablecoin exhibits a standard deviation magnitude which is much lower than those of the other currencies and about ten times lower than that of the least volatile one, namely EUR. This is a clear sign of stability of the proposed stablecoin, as opposed to an hypothetical

	USD	CNY	EUR	GBP	JPY	SAC
USD	1	0.14	-0.68	0.01	-0.41	0.02
CNY	0.14	1	-0.4	-0.8	0.17	0.02
EUR	-0.68	-0.4	1	0.26	-0.09	0.03
GBP	0.01	-0.8	0.26	1	-0.64	0.02
JPY	-0.41	0.17	-0.09	-0.64	1	0.02
SAC	0.02	0.02	0.03.	0.02	0.02	1
σ	0.07	0.1	0.06	0.1	0.09	0.002

Table 2
Volatility and Correlations between the RNVALs of the basket currencies, and the optimal basket based stable coin.

	USD	CNY	EUR	GBP	INR	JPY	MXN	NGN	PHP	SAC	SDR
σ_{all}	0.09	0.14	0.07	0.06	0.13	0.11	0.23	0.41	0.10	0.04	0.05
σ_{pre}	0.04	0.03	0.08	0.05	0.02	0.05	0.10	0.07	0.06	0.04	0.02
σ_{cri}	0.05	0.05	0.03	0.06	0.03	0.10	0.09	0.10	0.03	0.03	0.02
σ_{post}	0.1	0.06	0.03	0.04	0.08	0.07	0.16	0.39	0.04	0.03	0.05

Table 3
Volatility of the RNVALs of the basket currencies, of the emerging market currencies, and of the two basket based stable coins, over the whole period (all), the pre-crisis period (pre), the crisis period (cri) and the post-crisis period (post).

stablecoin pegged to one single currency.

To determine whether a basket-based stablecoin would be a more valuable and more stable alternative than a stablecoin pegged to a single currency, especially for remittances, we can, in analogy with 2, compare the volatility of our stablecoin with that of a SDR based basket, and with the currencies of the most important emerging markets in terms of remittances. Table 3 contains the comparison, over the whole period and also in three distinct periods, corresponding to the pre-crisis period, the crisis period and the post-crisis period.

From Table 3 first row, it is clear that overall the stablecoin exhibits lower values of volatility, when compared to the other traditional fiat currencies. The other rows in the Table show that is often the case, although especially during pre-crisis and crisis period few currencies exhibit slightly lower volatilities, depending on how and when they were affected by the global financial crisis. However, we can notice that the stablecoin's volatility is much more stable than that of the other currencies which, although for some period slightly lower, show quite relevant jumps in magnitude. Moreover, the proposed stablecoin exhibit lower volatilities over the whole time period if compared to the single currencies in the basket and to the single emerging market currencies. This can be read as a strength of our stablecoin, as it could function as a better medium of exchange than a country's single currency, in particular as far as remittances are concerned. Note also that the SDR is a valid alternative to our stable coin, possibly easier to implement, from a political consensus viewpoint.

4.3. Spillover network analysis

We now consider spillovers between exchanges, to evaluate the price change connectedness of the currencies that compose the basket, and to understand which is the relative importance of each of the currencies in transmitting shocks. In this way, we are also able to determine which currencies potentially cause strong (or weak) price changes in our proposed stablecoin value.

As far as specifications are concerned, VAR models are built on price changes in reduced normalised values (RNVALs). We use a VAR lag determined by a Bayes-Schwarz information criterion (BIC) that penalises over-parameterisation compared to other widely employed information criteria. The optimal number of lag determined by the BIC is 1. We use a $H = 100$ step-ahead forecast horizons for forward iteration of the system. Additionally, dynamic spillovers use a rolling estimation window of length 100 observations.

Firstly, we provide an analysis of unconditional price change spillovers, that are spillovers evaluated on the whole sample period. The results are shown in Table 4.

From Table 4 note that there are two currencies which are highly interconnected with the others, meaning USD and CNY, whereas EUR, GBP and in particular JPY are more isolated in terms of return connectedness. Furthermore,

	USD	CNY	EUR	GBP	JPY	FROM
USD	44.94	35.33	13.02	6.67	0.04	11.01
CNY	34.49	49.40	10.76	5.34	0.00	10.12
EUR	15.81	15.22	62.29	6.48	0.19	7.54
GBP	11.4	10.21	6.28	69.58	2.53	6.08
JPY	0.41	0.14	0.01	3.94	95.51	0.90
TO	12.42	12.18	6.01	4.49	0.55	35.66

Table 4
Currency spillovers

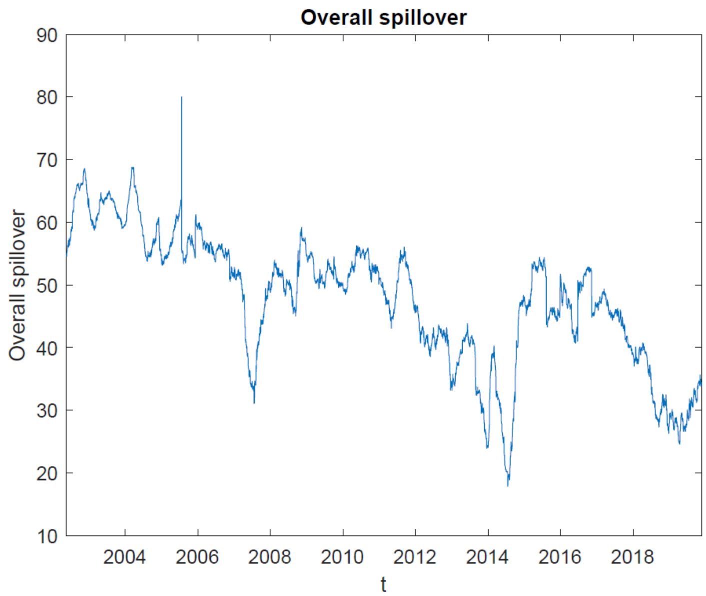

Figure 3
Overall spillovers

the scene appears to be dominated by USD and CNY, whose contributions in terms of price change spillovers towards other currencies are much higher than those of the remaining currencies in the basket.

The analysis of dynamic spillovers is able to clarify the results obtained in the unconditional spillover analysis by means of observing the evolution of spillovers over time. Figure 3 shows the results.

Figure 3 depicts the overall dynamic spillover plotted over the sample period. The overall spillover within the basket ranges from a minimum of 17.87% to a maximum of 80.00%. It seems that the overall spillover follows a generally decreasing trend, as it starts from 54.51% at the beginning of the sample period, while it diminishes to 34.43% at the end of the studied time frame.

Dynamic directional spillovers can shed light on which of the currencies transmit price change spillovers to others and which of them receive price change spillovers from others. We plot from, to, net and pairwise spillovers in Figures 4, 5 and 6, respectively.

From the joint analysis of Figures 4, 5 and 6 we can highlight that that USD is the most influential currencies in terms of return spillovers. Indeed, the magnitude of spillovers received from others is weak compared to that

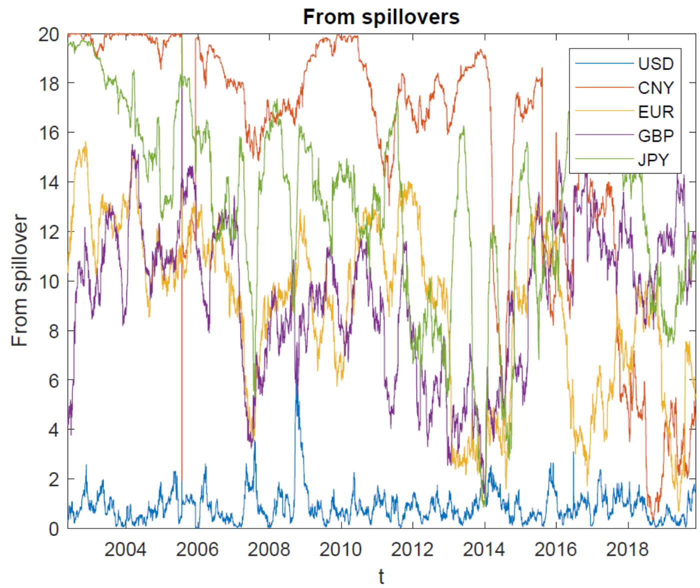

Figure 4
From spillovers

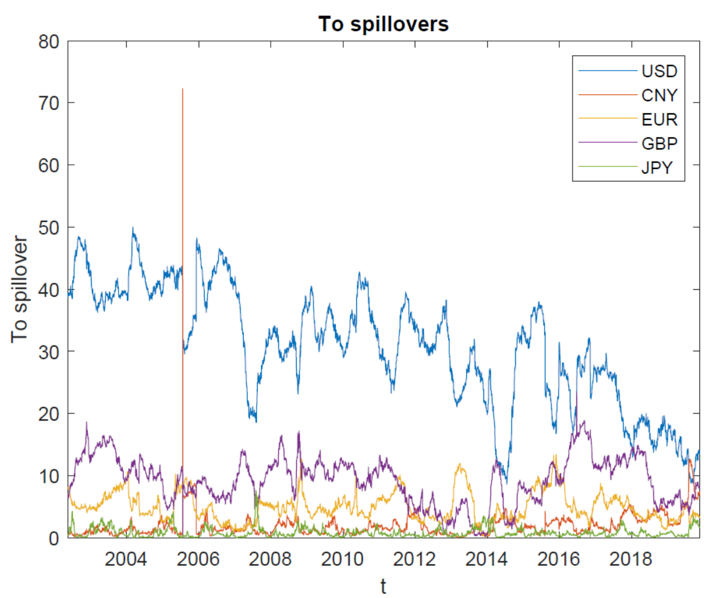

Figure 5
To spillovers

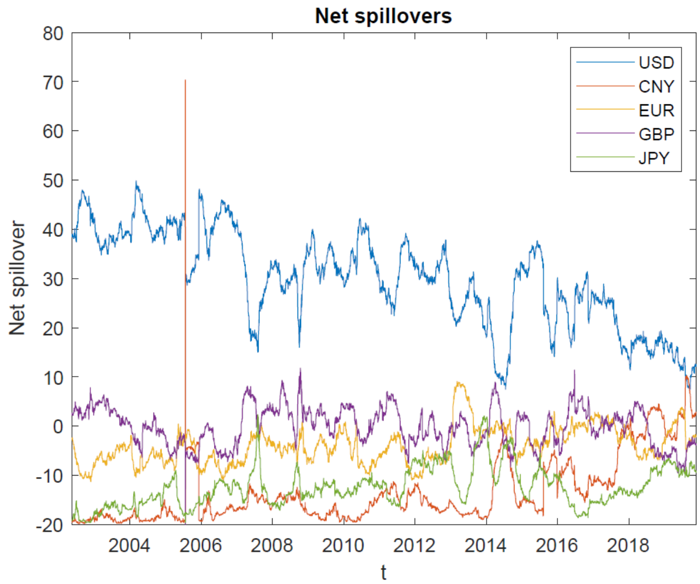

Figure 6
Net spillovers

transmitted to others. Moreover, the net spillover dynamics summarizes the dominant position of the USD, being it always positive and taking relatively high values over the sample period. However, the magnitude of spillovers transmitted by USD follows a negative trend over time, meaning the currency is gradually losing its potentiality to contribute to the evolution of the others, perhaps due to the affirmation of emerging economies in the latter period, especially after the 2009 crisis. CNY is indeed emerging as a dominant currency during the recent times. Despite that, the latter considerations are in line with the full sample results obtained above, which point to the dominance of USD as a spillover transmitting currency.

Differently from what emerged in the full sample analysis, instead, the dynamic analysis shows that CNY has not been such a leading currency in transmitting price change shocks from an historical viewpoint. Indeed, the full sample result is arguably driven by a noticeable spike which occurred on 21 July 2005. Indeed, during that day the Chinese Central Bank officially announced the abandonment of the eleven-year-old peg to the dollar and pegged the CNY to a basket of currencies whose composition was not disclosed. This caused a prompt revaluation to CNY 8.11 per USD, as well as to 10.07 CNY per euro. However, the peg to the dollar was reinstituted as the financial crisis strengthened in July 2008. These results indicate that CNY does not particularly contribute to the price change evolution of the other currencies in the basket, although it can exert shocks through sudden policy decisions.

The dominance of the USD and, to a lesser extent, of CNY emerges also when analyzing the directed network structure of the currencies in terms of net pairwise spillovers represented in Figure 7. In this context, the network edges are represented by the currencies in the basket, whereas edges represent the magnitude of net pairwise spillovers for each currency pair.

To verify the loss of importance of the dollar, we can extend the spillover network analysis to cover the Covid-19 outbreak period of March-April 2020. Specifically, we analyze two subsamples with the year 2020 as cutting point, to detect major changes in country forex spillover dynamics.

The spillover network gives a ranking in terms of spillover transmission capacity and, therefore, price discovery.

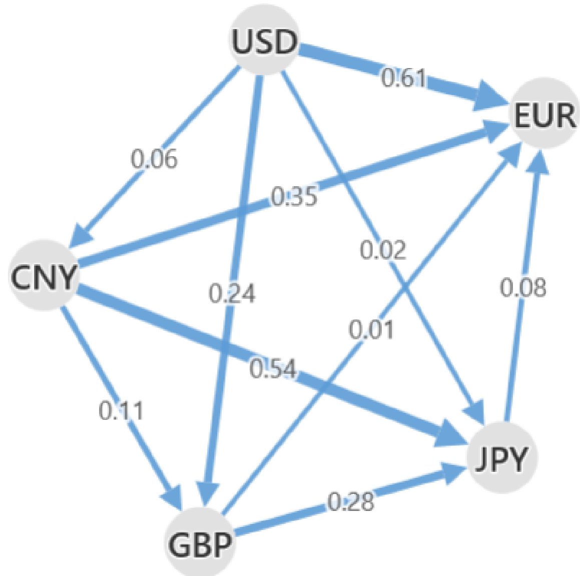

Figure 7
Spillover network (full sample). The figure represents the spillover network of the currencies included in the basket over the full sample period. The nodes are represented by the currencies included in the basket. The magnitude of the links is represented by the net pairwise spillovers between each currency pair.

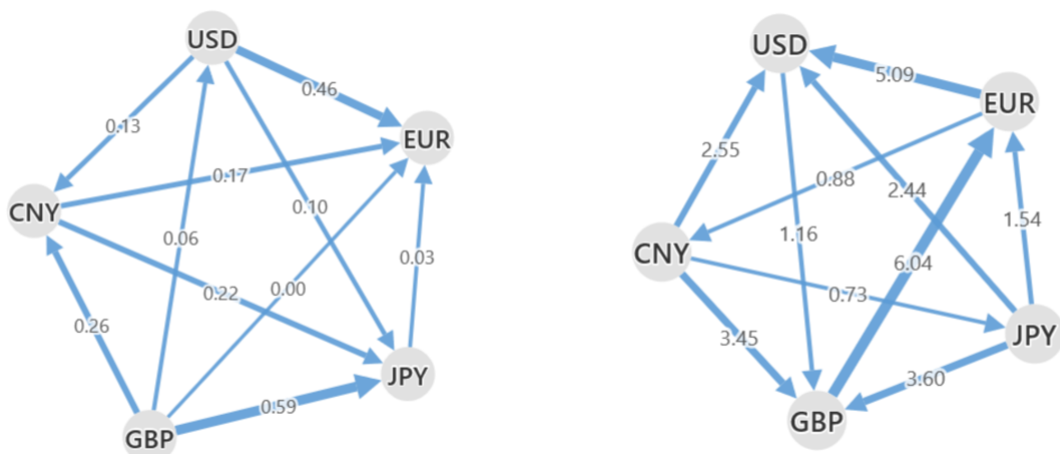

Figure 8
Spillover network (sub-samples). The figure represents the spillover network of the currencies included in the basket. The first representation corresponds to the period September 2017 to December 2019 (panel a), while the second one from January 2020 to April 2020 (panel b). The nodes are represented by the currencies included in the basket. The magnitude of the links is represented by the net pairwise spillovers between each currency pair.

The most influential currency in terms of price change shock transmission is USD, followed by CNY and, to a lesser extent, GBP. The two receivers are instead JPY and, at most, EUR. The highest influence is given by USD towards EUR, followed by CNY to JPY. This suggests that the contagion occurs to a greater extent within Asian currencies and across American and European ones.

However, the picture is different when analyzing spillovers during two distinct sub-samples: one ranging from September 2017 to December 2019, and another one from January 2020 to April 2020, both depicted in Figure 8. Indeed, overall interconnectedness has increased in the second sub-sample, likely due to the Covid-19 outbreak, thus markets move more similarly as a consequence of the epidemic. This is equivalent to say there are more contagion dynamics occurring since the Covid-19 outbreak and that magnitude of information transmitted from the currencies sharply increased after the Covid-19 crisis. Moreover, they highlight that the contagion dynamics is very different from that of the pre-crisis period. USD is no longer dominant, whereas Asian countries with CNY and JPY, which encountered the Covid-19 outbreak before others, turn out to be the strongest currency shock propagators, along with an augmented relative importance of GBP. This suggests that the spillover dynamics has been somehow linked to the virus spread, meaning financial shocks occurred first in the countries first hit by the virus, specifically the Asian ones, and then awareness gradually spread through the Euro zone and the United States. It also highlights the importance of monitoring the spillover dynamics in the basket both to have a systemic risk indicator and to determine lead-lag relationships among currencies in the basket when designing basket-based stablecoins.

5. Conclusion

In the paper we present a methodology to build a basket based stable coin whose weights can maximise stability over a long time period. The weights have been calculated, retrospectively, for the period that follows 2002, and show a distribution more even than the IMF Special Drawing Rights weights.

The proposed stable coin (Librae) appears to be less volatile than single currencies and, therefore, with respect to single currency stable coins (Libra). It can thus constitute a valuable proposal especially for workers who live abroad and make remittances to their own country, a market segment with a high potential of being attracted by payments in stablecoins.

We have also proposed a variance decomposition technique based on a VAR model aimed at showing which currencies mostly impact the Foreign Exchange market and whether a single currency or a basket based stablecoin is more resilient to currency shocks. Our results show that the dollar is the currency which mostly impact the market, and that a basket based coin is better than a dollar based one, from a stability and value maintenance viewpoint. However, CNY is taking over as spillover transmitter and USD is gradually losing its influence over time, especially with regards to the latest period, characterised by the Covid-19 otubreak.

With a basket based stablecoin it is possible to offset the risk of currencies shocks. This is of relevance for different policy purposes and, in particular, for emerging markets and countries having high remittances. Indeed, by holding stablecoins rather than single currencies the risks associated to currency shocks are mitigated and stablecoins holder can count on a currency whose value is less volatile than traditional fiat currencies and, thereby, more reliable. The latter fact has also positive consequences on cross-border payments side, provided that the stability of the stablecoin mitigates the foreign exchange risk, thus contributing to the fact that buyers and sellers give or receive an amount of money whose value is less sensitive to variations over time.

Future research may consider basket that dynamically evolve over time (”AI baskets”), although these are bound to be more difficult to achieve consensus. Furthermore, currency volumes in circulation may be taken to account, along with the technical characteristics of the coins (for example: cybersecurity, redeemability, reliability), from a different, more theoretical, viewpoint.

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