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Virtual currencies and their potential impact on financial markets and monetary policy

Marek Dabrowski and Lukasz Janikowski

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Abstract

Virtual currencies are a contemporary form of private money. Thanks to their technological properties, their global transaction networks are relatively safe, transparent, and fast. This gives them good prospects for further development. However, they remain unlikely to challenge the dominant position of sovereign currencies and central banks, especially those in major currency areas. As with other innovations, virtual currencies pose a challenge to financial regulators, in particular because of their anonymity and trans-border character.

Executive Summary

- Virtual currencies (VCs) are a contemporary form of private money. Thanks to their digital form and the use of Blockchain technology (in many, but not all, cases), the transaction networks of VCs are relatively safe, transparent, and fast. Unlike their 18th and 19th century paper predecessors, VCs are used globally, disregarding national borders. However, as with any money or financial asset, investments in VCs are not without risk. VCs may be subject to fraud, the bankruptcy of an issuer (in cases of centralised schemes) or intermediary, or speculative bubbles and bursts, among others.

- In April 2018, there were more than 1,500 VCs; however, only a few recorded meaningful market turnover and capitalisation. Thus far, Bitcoin remains a leader among them. The VC business has seen continuous development in terms of number of VCs, number of transactions, and market capitalisation. However, as long as major trading platforms and financial intermediaries do not accept payments in VCs, their transactional role will remain limited and they will fulfil mainly the third function of money, the store of value—that is, they will serve as one of many investment assets.

- Similar to previous incarnations of private money, VCs face the challenges of gaining market and governmental recognition as a means of payment, building public trust concerning their stability, and achieving sufficient network externalities related to their use. While governments and central banks will unlikely accept them as an official legal tender in individual jurisdictions, the question of market recognition remains open, and the rapid expansion of Bitcoin and other larger VC projects worldwide indicate that it may happen (to some degree). And unlike previous incarnations, issuers of contemporary private money are able to ensure a transparent global network for circulation, a credible algorithm for the creation of the VC, and a transaction mechanism that is relatively safe, fast, and inexpensive.

- Despite their technological advances and global reach, VCs are far from being able to challenge the dominant position of sovereign currencies and the monetary policies

of central banks, especially in major currency areas. However, in extreme cases, such as during periods of hyperinflation, financial crisis, political turmoil, or war, they can become a means of currency substitution in individual economies.

- Financial regulators may dislike VCs because of their anonymity or cross-border circulation. They tend to fear that VCs will facilitate money laundering, the financing of illegal activities, tax avoidance, the circumvention of capital controls (in countries where such controls are in place), and fraudulent financial practices. Such concerns may be legitimate in some instances but must not be generalised. In most cases, transactions in VCs result from the free business choices of economic agents and, therefore, should be treated by regulators as any other financial transaction or instrument—that is, proportionally to their market importance, complexity, and associated risks. Given their global, trans-border character, it is recommended that regulations concerning VCs be harmonised across jurisdictions (which is far from the case now). Investment in VCs should be taxed similarly to investment in other financial assets.

1. Introduction

Less than a decade has passed since the development of Bitcoin, the first private decentralised digital currency with a global reach. Despite many sceptical opinions, this experiment has survived, enjoys broad popularity, and has found many followers. Today Bitcoin is not alone; there are more than 1,500 other virtual currencies (VCs), but only a few record meaningful market turnover and capitalisation. Bitcoin remains the leader among them.

Initially, Bitcoin and other VCs drew little attention from economists or monetary and regulatory authorities. VCs were considered a niche phenomenon—a sort of technological folklore—that could disappear any day. They were largely analysed and propagated by IT specialists.

However, more recently, the situation has changed radically. Because Bitcoin did not disappear and, on the contrary, has continued its expansion and found followers world-wide, it has become a popular subject of discussion among economists, financial market specialists, and even politicians. Public figures are now expected to offer opinions on the topic. This increasing interest in VCs was partially underpinned by the rapid build-up of the Bitcoin financial bubble in 2017 and its subsequent burst in early 2018.

The purpose of this paper is an analysis of the phenomenon of VCs (and how it is seen in economic literature and public debate) and their potential impact on both financial markets and monetary policy, as well as on the supposed central bank monopoly on issuing money.[1]

Our study will begin with an overview of the economic and technological characteristics of the VC phenomenon and will then provide a brief history of VCs, an analysis of their advantages and disadvantages, and a review of the regulatory approaches to VCs in

1 This is a revised version of the briefing paper titled "Virtual currencies and central banks' monetary policy: challenges ahead", which was prepared in response to the request of the European Parliament's Committee on Economic and Monetary Affairs ahead of the European Parliament's Monetary Dialogue with the President of the European Central Bank on 09.07.2018 - http://www.europarl.europa.eu/committees/en/econ/monetary-dialogue.html. The opinions expressed in this paper are the sole responsibility of the authors and do not necessarily represent the official position of the European Parliament, CASE, or other institutions of which the authors are associated. The authors would like to thank Kristen Hartwell for her editorial support.

various jurisdictions (Section 2). Section 3 provides a discussion of the potential impact that VCs may have on monetary policy and the future role of central banks. To better understand the factors which may determine this impact, we offer a brief historical overview of the era of free banking and private money in the 18–19th centuries (Subsection 3.1), followed by an analysis of the legal instruments regulating the use of money, the role of network externalities, and currency substitution. Based on our analysis in Sections 2 and 3, we summarise the main findings of our study in Section 4.

In our analysis of VCs (mainly in Section 2), we had to rely, to some extent, on information and data presented in various online sources. However, whenever possible, we attempted to cross-check this information to ensure its accuracy. In addition, we reviewed the existing literature on monetary history, private money, VCs, Blockchain technology, and central banking, among others. In Section 3, we used data from the International Monetary Fund (IMF) Monetary and Financial Statistics database and the US Federal Reserve System.

Our working hypothesis is that VCs are a contemporary form of private money and, as such, share certain historical advantages and disadvantages. That is, they will unlikely challenge the near-monopoly position of central banks in issuing money and the monetary policies conducted by them, at least in the near future. Nevertheless, due to their technological characteristics, such as their digital form, the possibility for cross-border circulation, network transparency, and a predetermined algorithm of issuing currency units, they have a better chance to survive and develop as compared to their predecessors in the 18th and 19th century.

Overall, in our analysis we try to take a middle ground between the optimism and excitement of the techno-enthusiasts and advocates of private money and the scepticism or even hostility of those who see VCs as product of monetary mania or utopia and a convenient instrument for money laundering, fraud, and other illegal activities. We believe that whether one likes them or not, VCs will remain a permanent element of global financial and monetary architecture for years to come.

2. The potential impact of virtual currencies on financial systems

In this section, we present the definition and economic characteristics of VCs (Subsection 2.1), their technological features (Subsection 2.2), the history of their development (Subsection 2.3), an analysis of their advantages and disadvantages (Subsection 2.4), the evolution of the regulatory approach to VCs in major financial jurisdictions (Subsection 2.5), and the limits of such regulations (Subsection 2.6).

2.1. Definition and economic characteristics of VCs

There is no one agreed-upon definition of VC. For example, the European Banking Authority (EBA) defines a VC as a "digital representation of value that is neither issued by a central bank or public authority nor necessarily attached to a fiat (conventional) currency, but is accepted by natural or legal persons as a means of exchange and can be transferred, stored or traded electronically" (EBA, 2014, p. 7). The European Central Bank (ECB) defines a VC as a "type of unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community" (ECB, 2012, p. 14). According to the definition of the Financial Action Task Force (FATF), "Virtual currency is a digital representation of value that can be digitally traded and functions as (1) a medium of exchange; and/or (2) a unit of account; and/or (3) a store of value, but does not have legal tender status (i.e. when tendered to a creditor, is a valid and legal offer of payment) in any jurisdiction". (FATF, 2014, p. 4).

That is, VCs' value emerges from the ability to transfer it from one place to another inside the particular VC's "electronic ecosystem", and relies entirely on trust, as there is no legal way of forcing anybody to accept it as a means of payment.

The question of whether VCs share characteristics of full-fledged money remains controversial in the literature. For example, Söderberg (2018), the Bank of Canada (2014), the Bank of England (2014), and Yermack (2013), among others, argue that VCs do not satisfy the traditional definition of money discussed in economic literature. In particular, in their opinion, they do not meet the conditions outlined by Jevons (1875, Chapter 3). According to this definition, money shall fulfil three basic functions: be a means of pay-

ment, a unit of account, and a store of value. Critics argue that VCs serve as means of payment to a very limited extent, as only a very limited number of merchants accept them, the number of transactions is still negligible compared to sovereign currencies, salaries are not paid in VCs, and no known government accepts them as a legal tender or unit of account. They also fail to effectively serve as a store of value because of an enormous volatility of their purchasing power (see Subsections 2.3 and 2.4). On the other hand, one cannot exclude the possibility that a number of users and transactions will increase to the extent that VCs will become a fully-fledged substitute of sovereign currencies in the future. We assume that VCs have potential to serve as full-fledged private money regardless of their future share in the overall volume of transactions and financial assets.

VCs are often referred to as "cryptocurrencies" because the majority of VCs rely extensively on the use of cryptographic algorithms (Subsection 3.2). However, we will not use this term in our paper to avoid terminological confusion.

In summary, VCs share the following characteristics:

- They are form of private money usually created in decentralised way (which is not a new phenomenon in economic history—see Subsection 3.1);
- They exist exclusively in digital form;
- Thus far, most VCs have been based on Blockchain technology2 (see Subsection 3.2), but perhaps also other technologies can be employed in future; and
- Most of them have a global character—that is, they work across national borders.

2.2. Technological features of VCs

As of April 2018, over 1,500 VCs existed, and this number is rapidly growing. We are unable to discuss here the details of the construction of all of them. While most (including the most popular—Bitcoin) use Blockchain technology (see below), the particular features of some VCs can differ significantly. Moreover, it is impossible to predict the future technological innovations that may be used by the creators of new VCs.

An important feature of VC transactions is that units of VC are sent directly from one place in the electronic ecosystem to another, without the involvement of any intermediary (e.g. financial institution). Units of VC are usually stored in electronic addresses that have unique public IDs. Multiple addresses can be combined into "e-wallets". VC transactions are typically chronologically recorded in a public decentralised ledger, often referred to as "Blockchain". The ledger consists of "blocks" that contain records of the past transactions.

2 A notable exception is Ripple, which uses a unique distributed consensus mechanism—see Subsection 2.3.

The Blockchain is maintained by the community of so called "miners". Miners are the people who supply the computational power necessary for processing transactions and keeping the system functioning. In exchange for their services, miners get small amounts of VC units, either in the form of a voluntary fee or newly minted units of the VC.

Another important feature of the currently existing VCs is that most of them are not issued by any individual entity (e.g. a central bank). New units of VCs are created in a decentralised manner by the community of miners. The supply of new units of VC is kept under control thanks to the use of cryptographic algorithms. The easiest way of explaining how this system functions is to describe a VC transaction process step-by-step. Below we present an example of a transaction process using Bitcoin,3 which was the first and remains the most popular VC. As mentioned above, most other VCs have similar characteristics—that is, in most cases the transaction process looks similar.

The Bitcoin transaction process uses cryptography to verify transactions, process payments, and control the supply of bitcoins (Badev and Chen, 2014, p. 7). Cryptography has been used since antiquity to secure information; but in this particular case, it serves to create and control the supply of units of currency. The concept behind cryptography is that a message is encrypted using a certain algorithm in order to make it unreadable for anybody who does not have a key necessary to decipher this message. A Bitcoin transaction is basically such an encrypted message that facilitates a transfer of bitcoins from the sender's electronic address to the recipient's electronic address.

Bitcoin employs two cryptographic schemes: digital signatures and cryptographic hash functions. Digital signatures ensure that: (1) the recipient can verify that the message came from a particular sender, (2) the sender cannot deny sending a message, and (3) the message has not been tampered with. Cryptographic hash functions enforce discipline in writing transaction records in the public ledger. Both of these schemes existed before the creation of Bitcoin and were widely used to secure commercial and government communications (Badev and Chen, 2014, p. 7).

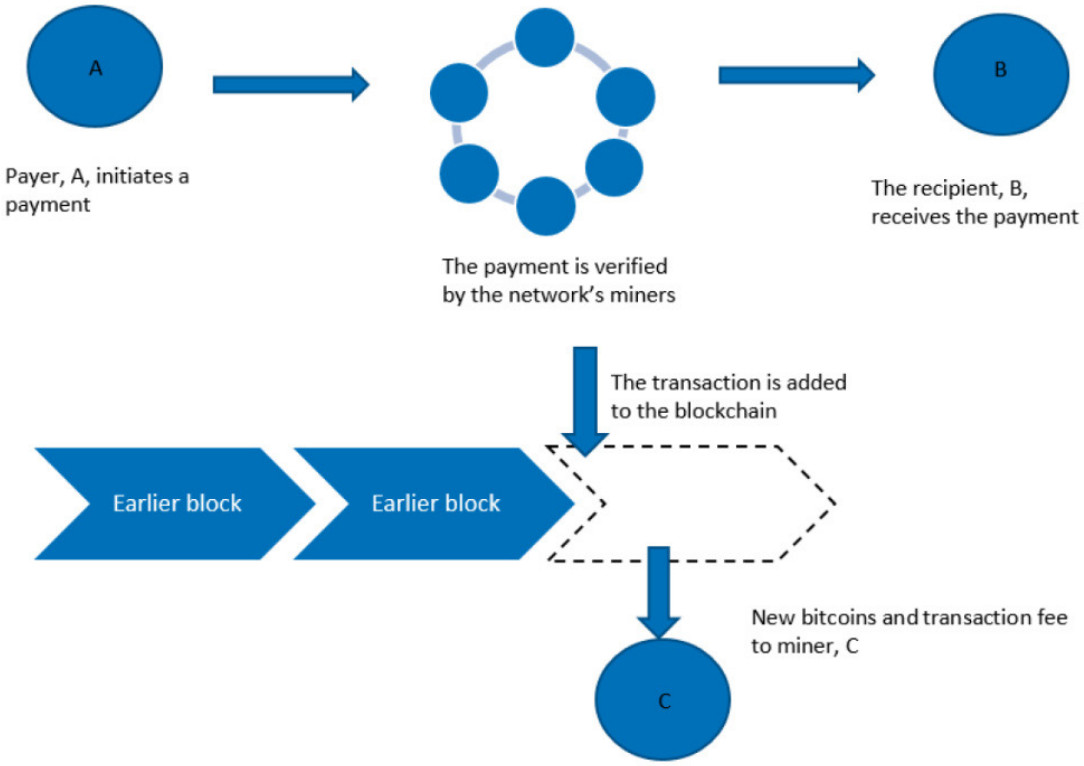
The Bitcoin system functions according to a set of rules known as the Bitcoin Protocol. When person A wants to pay a certain amount of bitcoins to person B, payment instruction is placed in the system, along with other payment instructions.

Miners validate payments and record them in a newly created block by solving a computationally demanding mathematical problem that is created and specified by the Bitcoin Protocol. Miners get compensation for their services in two forms: fees and freshly minted bitcoins that are created in the process of validating the transactions.

3 Bitcoin, written in upper case, refers to the transaction system, whereas bitcoin, written in lower case, refers to a unit of virtual currency.

Miners compete with each other, as the compensation is paid to the first miner that solves the problem, meaning that the system favours miners with the strongest computational power.

Figure 1: Overview of the Bitcoin structure



Source: Söderberg (2018)

Fees are voluntary, but as they attract miners to particular transactions, users can compete for miners' computational power and speed up the validation of transactions by offering higher fees. In addition to fees, miners receive bitcoins that are created in the process of the validation of transactions. The system is constructed in such a way that the amount of newly created bitcoins is constantly decreasing, meaning that the relative importance of this form of compensation will fall and fees need to increase over time.

The creators of Bitcoin set the maximum number of bitcoins to 21,000,000. When this number is reached, no more bitcoins will be created4 and the only remuneration that miners will receive will be the fees. When the transaction is validated by the miners, it is added to a new block that later is added to the Blockchain (public ledger). Figure 1 depicts the structure of a Bitcoin transaction.

One of the features of VCs is a greater degree of anonymity of transactions compared to traditional banking services. Although all transactions are recorded in a public ledger, they are linked to electronic addresses, not natural or legal persons. As long as the owner/user of a particular electronic number is not disclosed, the transaction remains anonymous. It can be compared to writing a book under a pseudonym: as long as the pseudonym is not linked to the author, the author preserves her or his privacy. However, once the link between the pseudonym and author is established, authorship of all books published under the particular pseudonym is revealed. In the case of transactions using VCs, once the owner of particular electronic address is identified, all past transactions linked to this address (and, with some effort, also to other electronic addresses in the same e-wallet) can be linked to this person, as they were recorded in the public ledger. There are many techniques to try to preserve anonymity, and one of the simplest is to use a different electronic address for every transaction. Goldfeder et al. (2017) argue, however, that none of these techniques is perfect.

4 This ceiling makes supply of Bitcoin extremely rigid, even more rigid than it was under the gold standard, when the fresh production of gold created room for additional money supply.

2.3. Bitcoin, Ethereum, Ripple, and others—the history of the development of VCs and their markets in 2009–2018

Among the over 1,500 VCs existing in April 2018 (see Subsection 2.2), most are new and have negligible market capitalisation. Therefore, we will concentrate on the five VCs with highest market capitalisation as of 20 April 2018 (Table 1).

Table 1: Top five VCs by market capitalisation, April 2018, in US$

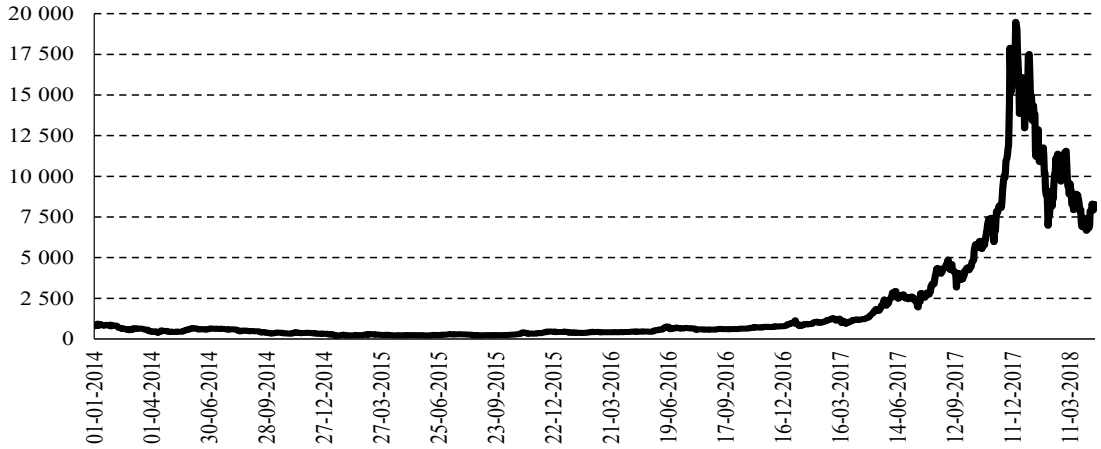
No.	Name	Symbol	Market capitalisation	Unit price	Circulating supply	Volume (24h)
1	Bitcoin	BTC	$141,230,856,668	$8,313.26	16,988,625	$7,096,370,000
2	Ethereum	ETH	$56,442,400,865	$570,51	98,933,063	$2,469,830,000
3	Ripple	XRP	$32,984,545,806	$0.84	39,122,794,968	$1,688,280,000
4	Bitcoin Cash	BCH	$16,639,053,113	$973.98	17,083,550	$740,993,000
5	Litecoin	LTC	$8,186,324,143	$145.76	56,164,963	$439,487,000

Source: https://coinmarketcap.com, date of access: 20 April 2018

2.3.1. Bitcoin

Bitcoin was the first decentralised VC that employed cryptographic technologies and reached broader economic significance. It was created in the beginning of 2009 by an unknown person or group hiding behind the pseudonym of Satoshi Nakamoto (Söderberg, 2018). 5 Initially, it did not gain much of attention from the public and was mostly used for online gambling, especially through the internet service named "Satoshi Dice" (Badev and Chen, 2014, p. 19).

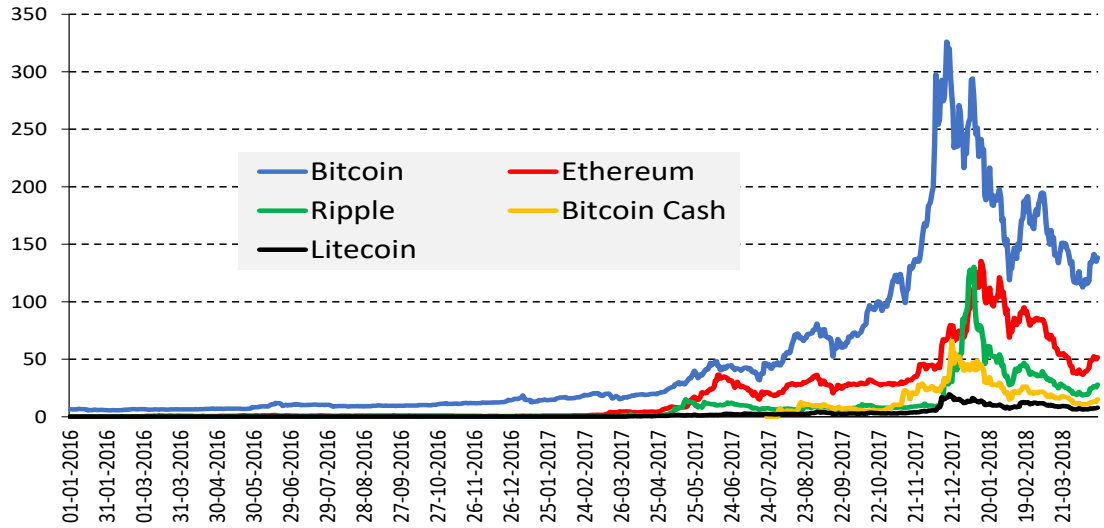
Figure 2: Bitcoin exchange rate against the US dollar, 2014–2018, in US$ per 1 BTC



Source: https://coinmarketcap.com, date of access: 20 April 2018

5 Bitcoin had technological predecessors, for example, the World of Warcraft Gold used in the online computer game "World of Warcraft" designed by Blizzard Entertainment (ECB, 2012, p. 13), but their use was limited.

Figure 3: Market capitalisation of major VCs, 2016–2018, (in US$ billion)

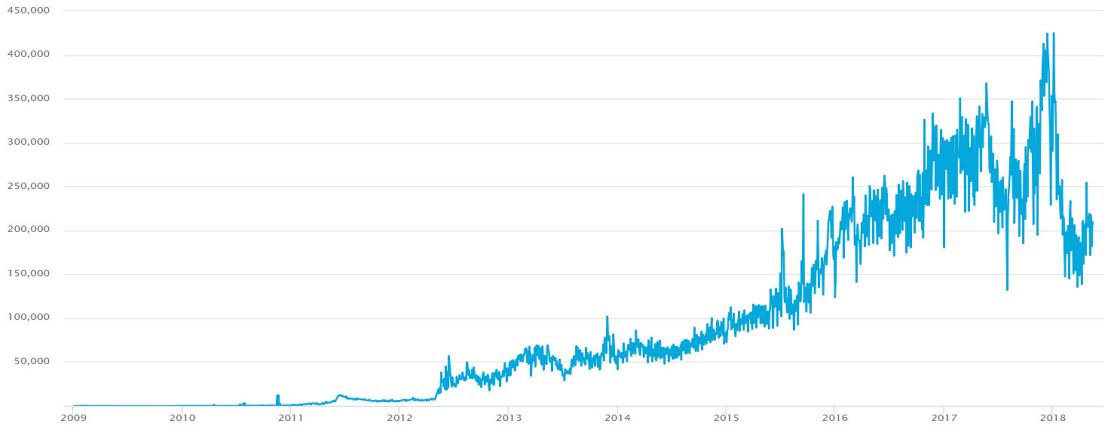


Source: https://coinmarketcap.com, date of access: 20 April 2018

In the beginning of 2017, demand for bitcoins started to grow rapidly, resulting in the exponential growth of its exchange rate to nearly US$ 20,000 (see Figure 2) and market capitalisation of over US$ 300 billion (see Figure 3). The behaviour of Bitcoin's exchange rate clearly displayed features of an asset bubble, which eventually burst on 17 December 2017, resulting in rapid depreciation (by 64.7% over less than 2 months). However, in April 2018, it remained the most popular VC with nearly 17 million units in circulation and market capitalisation of over US$ 140 billion.

The use of VCs in day-to-day transaction remains negligible. During 2017, the number of Bitcoin transactions in the world was, on average, around 275,000 per day, compared to over nine million card transactions per day in Sweden (Söderberg, 2018) and 295 million traditional transactions per day in Europe in 2014 (EBA, 2014, p. 7). The number of confirmed Bitcoin transactions is shown in Figure 4.

Figure 4: The number of confirmed Bitcoin transactions per day, 2009–2018



Source: www.blockchain.info

2.3.2. Ethereum

The VC with the second-largest market capitalisation, as of 20 April 2018, is Ethereum. Ethereum also uses Blockchain technology to process transactions but is different to Bitcoin in several aspects (Madeira, 2018):

- Block time in Ethereum is shorter than in Bitcoin (14–15 seconds compared to 10 minutes) which allows for faster transaction times;
- The number of newly created bitcoins decreases over time, while in the case of Ethereum, a constant number of new currency units is infinitely created every year;
- Ethereum has a different method of costing transactions;
- Ethereum was crowd funded while Bitcoin was released. As a result, early miners own most of the bitcoins that will ever be mined, while in the case of Ethereum, the fraction owned by miners increases over time; and
- Ethereum discourages centralised pool mining and encourages decentralised mining by individuals using their computers.
- Ethereum started being traded in August 2015 and, since its launch, the exchange rate against the US$ increased over 200 times. From 19 April 2017 to 19 April 2018, its exchange rate increased by 1076%, from US$ 48.31 to US$ 567.89. The highest exchange rate was recorded on 13 January 2018 when one unit of Ethereum cost US$ 1,396.42. As shown in Figure 3, the market capitalisation (and the exchange rate) of this VC are highly correlated with those of bitcoin.

2.3.3. Ripple

The VC with the third-largest market capitalisation, as of 20 April 2018, is Ripple. More precisely, Ripple is the name of the payment settling system and a unit of the VC is called an "XRP". Ripple is very different from Bitcoin in many aspects:[6]

- Ripple was created and is controlled by a single private company;
- Ripple was not designed to be used by natural persons for payments for goods and services. The target groups are banks and other financial institutions that can use it as a payment settling, currency exchange, and remittance system. The business goal of the creators of Ripple is that it will replace SWIFT[7] as a global provider of secure financial messaging services;
- Ripple does not use Blockchain technology. A unique distributed consensus mechanism through a network of servers is used to validate transactions;
- XRPs are not mined. 100 billion units were issued by the creators of Ripple, 55 billion of which are deposed in a special escrow account and slowly released to the market as governed by an in-built "smart contract".[8] Any unused XRPs are shifted back to the escrow account;
- The average transaction cost is currently approximately 10,000 times lower than in the case of Bitcoin, the limit of transactions per second is 150 times higher, and the transaction time is just about 3–4 seconds; and
- Ripple uses a negligible amount of electricity as compared to Bitcoin.

Since its creation in 2012 until April 2017, the exchange rate of the XRP never exceeded US$ 0.05. In May 2017, the XRP started to appreciate and reached US$ 0.25 on 11 December 2017. After this date, the exchange rate of the XRP increased very sharply and reached a record-high of US$3.38 on 7 January 2018. This appreciation was very short-lived, as later the exchange rate fell dramatically. On 19 April 2018, one XRP was worth US$ 0.79.

2.3.4. Acceptance of VCs as means of payment

Only a very limited number of merchants accept bitcoins as means of payment. Examples of major merchants that accept bitcoins are: Microsoft, Overstock—an online shop with furniture and home appliances, Expedia—an online travel booking agency, Newegg—an online shop with electronics, Shopify—an e-commerce platform, Dish

6 See ripple.com/xrp/; www.finder.com/bitcoin-vs-ripple; Seth, 2018; Marr, 2018

7 The Society for Worldwide Interbank Financial Telecommunication. See www.swift.com

8 www.investopedia.com/terms/s/smart-contracts.asp

Network—a satellite television and Internet service provider, Roadway—a moving company, Reeds Jewellers, and CheapAir—a travel company (Moreau, 2018).

There exist, however, services that enable indirect payments in bitcoins on other platforms as well. For example, companies such as eGifter[9] and Gyft[10] enable payments in bitcoins for goods and services bought from, among others, Amazon, Starbucks, Walmart, and Uber. From a technical point of view, the customer buys gift cards for bitcoins, which are later used to pay for goods and services. In other words, the aforementioned companies act as intermediaries between the clients and a particular merchant. Since the merchant receives payments for the gift cards in a sovereign currency (usually US$), one cannot consider these transactions as payments in VCs.

2.4. Potential economic advantages and disadvantages of VCs (opportunities and risks)

Enthusiasts of VCs refer to a number of their potential benefits. Most important of them are: low transaction costs (especially across borders), speed of transactions, and increased anonymity (no need for disclosure of sensitive data while making transactions). The EBA (2014) argues that these benefits may be substantial outside the European Union (EU) where payment infrastructure is less developed or less trustworthy, but EU legislation makes them less significant inside the Union. Moreover, some of these alleged benefits incur associated risks that are discussed below.

As mentioned earlier, VC transactions are conducted directly between the payer and the recipient and are validated by the community of miners, who compete for transactions in exchange for fees and newly minted units of VC. The cost of fees is hard to estimate due to a lack of reliable data, but anecdotal evidence suggests that they tend to be less than 1% of the transaction amount, compared to 2–4% for traditional online payment systems (EBA, 2014, p. 16). Moreover, the use of VCs enables the involved parties to avoid costly conversions of currencies, which is why transactions in VCs are particularly popular in the case of cross-border trade.[11]

The EBA argues, however, that the lower cost is partly associated with the lack of any regulatory requirements that would guarantee the safety of these transactions. Moreover,

9 www.egifter.com/buy-gift-cards-with-bitcoin/

10 www.gyft.com/bitcoin/

11 Currency conversions are particularly costly when currencies used by the payer and the payee are not directly convertible and the local currency of the payer needs to first be converted to a reserve currency (e.g. US dollar or euro) and then to the local currency of the payee.

in addition to fees, miners are also compensated with newly created VC units, the supply of which is set to decrease over time. Having that in mind, it is reasonable to assume that the fees need to increase over time in order to compensate the miners for their investment in necessary processing power. Finally, the difference in costs between VCs and traditional payment systems is much lower in countries that are part of the Single Euro Payments Area (SEPA)—the EU's payment integration and simplification initiative. Furthermore, EU regulations equalise fees for national and cross-border payments in euros, significantly reducing the potential benefits of using VCs inside the Union.

Another alleged benefit of VCs is higher speed of transactions compared to traditional banking transactions in sovereign currencies. For example, Bitcoin is referred to as a near-instantaneous payment system, as it takes on average 10 minutes to process one transaction (Badev and Chen, 2014, p. 6-7). Another advantage of VCs is that payments are validated on 24/7 basis, whereas traditional payment systems usually have no more than several clearing sessions per day and do not function during holidays and weekends. What must be mentioned here, however, is that several countries have already established instantaneous payment services for sovereign currencies and they process transactions even faster than Bitcoin. Badev and Chen (2014, pp. 6–7) argue that the VC transaction process is fairly complex, and some computer scientists have questioned its suitability for fast payments.

Transactions in VCs also offer increased anonymity resulting in the higher security of personal data and limited interference by public authorities. An advantage of VCs is that payments do not require the provision of sensitive data such as name, address, credit card number, or phone number, which are often necessary to authorise payments in conventional payment systems. This feature of VCs excludes the possibility of potential identity theft (EBA, 2014, p. 19). On the other hand, as it was written above, perfect anonymity would be very hard or even impossible to achieve (Goldfeder et al., 2017).

Another potential advantage of VCs is greater financial inclusion. The EBA (2014, p. 18–19) argues that this argument does not apply to the EU, as the Payment Accounts Directive provides cheap basic bank accounts for all citizens in the EU that, contrary to VCs, are subject to safeguarding requirements. Moreover, one could argue that the construction of VCs is very complicated and ordinary people have no chance to understand how they function, especially when it comes to the details regarding cryptology and IT technology, which makes them a potential target of fraudulent activities. This stays in sharp conflict with the alleged benefit of greater financial inclusion.

Besides potential benefits, VCs have many disadvantages and create many potential risks for users, merchants, sovereigns, financial market regulators, and financial stability in general. The EBA (2014) identified over 70 potential risks associated with VCs. Some of them apply exclusively to VCs, and others apply to sovereign currencies as well,

but are more profound in the case of VCs due to a lack of prudential regulations and supervision. Below we briefly present the most important of them.

First, it can be the loss of units of the VC due to theft or fraud. VC units can be potentially stolen from an e-wallet or an exchange due to intentional fraud, misconduct, or a cyber-attack (hacking). The best example of this is the bankruptcy of the Tokyo-based company Mt. Gox in February 2014—one of the biggest bitcoin exchanges at that time. It resulted in the loss of 850,000 bitcoins valued at almost US$ 0.5 billion (Badev and Chen, 2014, p. 25 after Hals, 2014). The bankruptcy was the result of a combination of misconduct, corruption, and fraud. During only a few years of its existence, the company was the target of several successful hacking attacks, governmental investigations, and a massive run on deposits.[12]

VCs can be also subject to significant and unexpected exchange rate fluctuations. Although this is not a unique characteristic of VCs and there are many historical episodes of the extreme volatility of the exchange rates of sovereign currencies, the intensity (probability and magnitude) of this risk seems to be more profound in the case of VCs, especially when compared to major sovereign currencies. Exchange rate fluctuations could (but do not have to) be the result of involvement in a Ponzi scheme or the build-up of a price bubble. Another reason of relatively high exchange rate volatility is the small size of most VCs markets, resulting in insufficient liquidity. An excellent example of high exchange rate volatility is the behaviour of the bitcoin exchange rate to the US dollar, which fell from US$ 19,435 on 17 December 2017 to US$ 6,858 on 5 February 2018—that is, it suffered from a depreciation of 64.7% over a period of less than two months.

As was already mentioned above, enthusiasts of VCs say that their major advantage is increased anonymity. Even if absolute anonymity is not possible, VCs seem to help hide the identity of the natural and legal persons making transactions. This feature of VCs may be exploited by those involved in illegal and criminal activities such as terrorism, drug dealing, illegal weapons trade, tax avoidance, and others. Hypothetically, VCs could also help entire jurisdictions to circumvent financial sanctions and therefore undermine the effectiveness of foreign policy. Foley et al. (2018) estimated that approximately one-quarter of bitcoin users and one-half of bitcoin transactions are associated with illegal activities.

There are also other disadvantages of VCs that are quite extraordinary in their nature. First, some VC payment systems consume enormous amounts of electricity. Even though computers in traditional banks also use electricity, the amounts are not even remotely comparable.

12 www.digitaltrends.com/computing/worst-bitcoin-scams/

Bitcoin's energy consumption is a subject of controversy, mainly due to the fact that it cannot be precisely calculated. Energy consumption estimations are very diverse, depending on the method of estimation. According to Digiconomist[13] on 20 July 2018 Bitcoin's estimated annual electricity consumption was 71.12 TWh, which is the same as that of Chile—an entire country with a population of nearly 18 million people, and 0.32% of the world's total electricity consumption. In a recent peer-reviewed study, de Vries (2018) estimates Bitcoin's electricity consumption at 2.55 GW, which translates to 22.4 TWh per year. The author argues that because the marginal cost of mining bitcoins is still lower than the marginal revenue, one should expect new investments in processing power. The author estimates that the equilibrium level of electricity consumption is 7.67 GW (or 67.2 TWh per year) and it could be reached already in 2018. In another study, Bendiksen and Gibbons (2018) estimate Bitcoin's energy consumption to be around 35 TWh. When interpreting these numbers, one should bear in mind that the Bitcoin payment system processes a negligible fraction of the payments, compared to traditional payment systems. This raises serious environmental concerns, especially in the context of climate change, and stays in sharp contrast with the alleged benefits of low transaction costs. Another consequence of the development of VCs is the increase of prices and shortages of some computer components, especially graphic cards, which are used to "dig" VCs (Gilbert, 2018).

2.5. Evolution of regulatory approach to VCs in major financial jurisdictions

VCs are a relatively new invention and have only recently begun to attract the attention of financial regulators. Individual countries have different attitudes towards VCs. For example, China explicitly or implicitly bans them while others, like Switzerland, are trying to attract VC scheme investors and operators. Some others (e.g. Venezuela) even issue or plan to issue their own national VCs.[14] In most countries, especially in major jurisdictions, authorities have adopted the "wait and see" attitude, while closely monitoring developments in VC markets. Several financial authorities (for example, in Germany,[15] Poland,[16]

13 digiconomist.net/bitcoin-energy-consumption

14 Which would no longer have a character of private money but rather a digital version of sovereign currencies.

15 https://www.bafin.de/dok/10202490

16 www.knf.gov.pl/o_nas/komunikaty?articleId=57363&p_id=18

the UK,[17] the US,[18] Singapore,[19] and the EBA20) have issued informal warnings to the general public, advising of the dangers of involvement in VCs.

Many representatives of monetary and financial authorities and international financial organisations emphasise the need for the supervision and regulation of VCs. For example, Christine Lagarde, the Managing Director of the IMF, highlighted VCs' potential as a vehicle for money laundering and the financing of terrorism and called for "...policies that ensure financial integrity and protect consumers in the crypto world just as we have for the traditional financial sector" (Lagarde, 2018). During the G20 meeting in March 2018 in Argentina, ministers of finance and governors of central banks agreed to keep a watchful eye on cryptocurrencies. On the one hand, France and Germany proposed banning deposits and loans in VCs as well as the marketing of investments based on them to the general public (Canepa, 2018). On the other hand, Mark Carney, the Chair of the Financial Stability Board (FSB) and the governor of the Bank of England, wrote in a letter to the G[20] that "...FSB's initial assessment is that crypto-assets do not pose risks to global financial stability at this time" due to their limited use.[21]

Public authorities seem to be the most concise and decisive when it comes to tax-related issues. In many countries, VCs are recognised as some form of financial asset or property by the tax authorities. Consequently, tax authorities demand payment of capital gains tax on profits made on the trading of VCs. Such decisions were made, for example, in Australia, Germany, Israel, Norway, Poland, Singapore, Sweden, and the US (McKenna, 2017).

Some countries introduce measures aimed to deal with the problem of increased anonymity and related money-laundering issues. For example, on 7 December 2017, the Australian Parliament passed amendments to the Anti-Money Laundering and Counter-Terrorism Financing Act of 2006 (McKenna, 2017). In many other countries, authorities are currently working on similar laws and one should expect the introduction of such regulations in those countries in the near future.

Some countries are considering the issuance of their own VCs based on Blockchain technology. In February 2018, Venezuela was the first country in the world to issue a sovereign virtual currency—the "petro", which was widely interpreted as an attempt to

17 www.fca.org.uk/news/news-stories/consumer-warning-about-risks-investing-cryptocurrency-cfds

18 https://www.sec.gov/news/public-statement/enforcement-tm-statement-potentially-unlawful-online-platforms-trading

19 www.mas.gov.sg/News-and-Publications/Media-Releases/2017/MAS-cautions-against-investments-in-cryptocurrencies.aspx

20 https://www.eba.europa.eu/-/esas-warn-consumers-of-risks-in-buying-virtual-currencies

21 www.fsb.org/2018/03/chair-sets-out-fsb-priorities-for-the-argentine-g20-presidency/

circumvent the economic sanctions imposed by the US (Fanusie and Frai, 2018). In response to this decision, the President of the United States, Donald J. Trump, issued an executive order banning any transactions related to any VC issued by or on the behalf of Venezuelan government.[22]

As we can see, attitudes towards VCs vary significantly from country to country and there is no clear trend in regulations. Below we summarise the regulatory approaches of three major jurisdictions (the US, Switzerland, and China) as of April 2018.

2.5.1. The United States

The Financial Crimes Enforcement Network of the US Department of the Treasury (FinCEN) does not recognise VCs as a "real currency" (a legal tender), but recognises the administrators and exchangers of VCs that are convertible into sovereign currencies as "money services businesses" (MSBs), which means that they are subject to FinCEN's registration, reporting, and record keeping regulations for MSBs (FinCEN, 2013).

The US Securities and Exchange Commission (SEC) issued a public statement[23] saying that some (but not all) VCs meet the definition of securities as specified in federal securities laws and therefore platforms that offer trading of such "digital assets" must register with the SEC as a national securities exchange or be exempt from registration. Senior SEC officials, including SEC Chairman Jay Clayton, have said publicly that Bitcoin and Ether are not securities, primarily due to their decentralisation. They confirmed though that most of the coins/tokens offered through Initial Coin Offerings (ICOs) are securities under federal law (Pisani, 2018).[24]

The Internal Revenue Service (IRS) issued a notice stating that for federal tax purposes VCs are treated as property and general tax principles applicable to property transactions apply to transactions using VCs (IRS, 2014). The notice outlines the rules applying to transactions using VCs with respect to federal taxes. For example, "mining" VCs is considered to be self-employment and income from "mining" is subject to self-employment tax.

The federal authorities are working on stricter laws regarding potential money laundering and tax evasion issues. Steven Mnuchin, the US Treasury Secretary, said that he will work with the G20 to prevent VCs "from becoming the digital equivalent of an anonymous Swiss bank account" (Mohsin, 2018).

22 www.whitehouse.gov/briefings-statements/presidential-message-congress-united-states-2/

23 www.sec.gov/news/public-statement/enforcement-tm-statement-potentially-unlawful-online-platforms-trading

24 https://www.cnbc.com/video/2018/06/06/sec-chairman-cryptocurrencies-like-bitcoin--not-securities.html

2.5.2. Switzerland

Switzerland is considered to be one of the countries with the friendliest attitude when it comes to VCs. As a result, according to a PwC Report, Switzerland has emerged as a hub for several successful ICOs (Diemers, 2017). The Swiss Financial Market Supervisory Authority (FINMA) even issued guidelines for ICOs.[25] Companies issuing VCs are required to obtain a license from FINMA, which recently closed down a company issuing a "fake cryptocurrency E-Coin" for not having such a license.[26]

2.5.3. The People's Republic of China

Chinese authorities have taken an entirely opposite attitude towards VCs. Seven government agencies, including the People's Bank of China, the China Securities Regulatory Commission, the China Banking Regulatory Commission, and the China Insurance Regulatory Commission issued a joint statement where they essentially banned funding through ICOs.[27] The statement declares that offering tokens such as bitcoins or ethers is "...an illegal public financing without approval". According to (Nelson, 2018), China appears to have the most stringent cryptocurrency regulations among large economies. This is motivated by authorities' desire to fight capital outflow and corruption.

2.6. Limits of effective regulations and control of VCs

One may expect that, with some time lag required to learn and comprehend the new phenomenon and its potential economic and legal consequences, all major jurisdictions will attempt to regulate the use of VCs, and perhaps, as in case of other financial regulations, there will be some effort to harmonise them.

Under one of the potential scenarios, financial supervisory authorities can increasingly consider VCs as risky financial assets subject to strict precautionary prudential regulations or even legal bans, which may limit their use by licensed financial institutions and, therefore, the general public.[28] The same concerns anti-money laundering and anti-terrorist finance legislation. Investment in VCs may become increasingly subject to income or transaction

25 www.finma.ch/en/authorisation/fintech/, www.finma.ch/en/~/media/finma/dokumente/dokumentencenter/myfinma/4dokumentation/finma-aufsichtsmitteilungen/20170929-finma-aufsichtsmitteilung-04-2017.pdf?la=en, www.finma.ch/en/~/media/finma/dokumente/dokumentencenter/myfinma/1bewilligung/fintech/wegleitung-ico.pdf?la=en

26 www.finma.ch/en/news/2017/09/20170919-mm-coin-anbieter/

27 http://www.pbc.gov.cn/english/130721/3377816/index.html

28 We abstract here from the question: which VCs can be used for various types of financial transactions for technological reasons (see Subsection 2.2)?

taxes, a phenomenon already observed in several countries (see Subsection 2.5), which can limit the interest of potential investors.

However, one cannot have the illusion that even the strictest regulations and bans can entirely eliminate the use of VCs as a means of payment in cases of private transactions (especially cross-border ones) or as a store of value (a financial asset in which some economic agents will be interested to invest). The cross-border harmonisation of financial and tax regulations and the cooperation of financial regulatory authorities is never perfect, which will leave room for cross-border arbitrage. Furthermore, as history teaches us, financial regulations always lag behind financial innovations (Dabrowski, 2017), while VCs are a new invention with great potential for further technological development. Therefore, financial supervisory or monetary authorities will not be able to regulate in advance all new potential variants of VCs that may appear.

For all of the above-mentioned reasons, one must be prepared that VCs will remain a stable component of the global monetary and financial architecture for several years to come.

3. Can virtual currencies break central banks' monopolies on money issuance?

In this section, we summarise the historical experience with private (decentralised) money and try to explain why it failed in competition against sovereign currencies (Subsection 3.1). Next, we discuss the role of legal instruments in the hands of governments and central banks to support demand for sovereign currencies (Subsection 3.2), and the role of network externalities in shaping global demand for transaction currencies (Subsection 3.3). Then we turn our attention to the factors which can undermine demand for sovereign currencies in favour of alternative money—that is, the phenomenon of currency substitution—and ask whether VCs can potentially benefit in such circumstances (Subsection 3.4). Finally, we present a short statistical analysis that demonstrates the rapidly increasing demand for central bank money in major currency areas since the beginning of the global financial crisis of 2007–2009 (Subsection 3.5).

3.1. Historical experience with private currencies and why did they fail in competition against sovereign currencies?

To understand what kind of challenges VCs can create for central banks concerning their supposed monopoly on money issuance and the monetary policies conducted by them, it is worth taking a brief look back at the history of private money. As we argue in Subsection 2.1, despite their technological novelty, VCs are a contemporary form of private money.

Strictly speaking, private money (or currency) is a liability issued by a private business entity such as a private bank or other financial institution, non-financial corporation, non-profit private institution, or individual, which is accepted as a means of payment by other economic agents. However, this term is also sometimes applied to similar liabilities issued by subnational or municipal public authorities or publicly-owned banks. In such broader interpretations, one should speak about decentralised money rather than private money.

In modern economic history, private money was a quite popular phenomenon between the end of 18th and the beginning of the 20th century, in particular, in various parts of the British Empire and the US, and was associated with the era of "free banking"—that is, when banks were subject to no or relatively light regulation and had a right to issue notes serving as a means of payment for the general public. Usually, such private money existed in parallel with sovereign money such as coins minted by the government or notes from government-owned banks (which, as in the case of the Bank of England, then gradually assumed the role of central bank).

Several factors contributed to the expansion of private money in the early industrial era. First, it was the rapid increase in the demand for money and credit, which could not be met by traditional payment means (such as gold or silver coins minted by the government). The rapid expansion of banking and other financial services also played a role. Second, the dominant free-market economic school largely supported free banking and private money issuance.[29] Third, in some instances, there was no political consensus to establish a centralised monetary authority and banking regulation. This concerned, in particular, the US after the expiration of the mandate of the Second Bank of United States as the federal central bank in February 1836 (Frieden, 2016).

However, since the middle of the 19th century, the opposite tendency has started. Country after country established central banks and gradually granted them regulatory powers over private commercial banks, the role of a lender of last resort and the central monetary authority with dominant or even exclusive rights to issue national currencies. The Bank Charter Act of 1844,[30] which gave the Bank of England nearly full control over issuing banknotes in the UK,[31] and the US National Banking Act of 1863 (of similar content but without establishing the central bank, which happened only in 1913) can be seen as important milestones in establishing contemporary sovereign monopolies on issuing national currencies and gradually closing the era of private money and free banking.

In the 1970s, during a period of high inflation in several advanced economies, the idea of free banking and private money was raised again by Friedrich August von Hayek (Hayek, 1990) and his followers, but did not garner broader political attention.

29 Interestingly, Adam Smith was among their advocates. The only restrictions he proposed were the ban on issuing small-denomination notes by private banks and the obligation of immediate and unconditional redemption of issued notes on demand—see Smith (2005, p. 269).

30 See https://www.legislation.gov.uk/ukpga/1844/32/pdfs/ukpga_18440032_en.pdf

31 Even if, technically, a few commercial banks in Scotland and Northern Ireland continue to issue their own banknotes today, they remain under the full control of the Bank of England in this respect.

To have a complete picture, one should also mention the various episodes of money surrogates, such as scrips, promissory notes, IOUs,[32] barter transactions, and bilateral and multilateral clearing accounts, among others, which were designed to avoid liquidity constraints. They were used under special circumstances, such as for business activities in remote locations, bank closures in periods of financial crisis (see Champ, 2007), wars and other conflicts, conducting trade operations in the absence of currency convertibility, or circumventing hard budget constraints by state-owned enterprises in the early stages of post-communist transition (Rostowski, 1994). However, money surrogates cannot be considered as fully-fledged money and do not offer a good benchmark for comparison with VCs.

Why, historically, did private money fail in competition against sovereign currencies?

It seems that there were two major advantages of sovereign currencies: network externalities and the potential ability to address the problems of information asymmetry and adverse selection.

Network externality means that a given currency is broadly accepted by other economic agents on a given market and performs all functions of money (see Subsection 2.1). This allows the creation of a sufficiently deep and liquid financial market for various instruments.

Unfortunately, this was not possible in the environment where several private currencies circulated in parallel and competed with each other. The multiplicity of private currencies meant higher transaction costs for all economic agents on a given territory. Even if they were denominated at the same currency unit (for example, pound or dollar), they were traded at various discount rates depending on the reputation and reliability of their issuers—that is, there were de facto exchange rates between them, sometimes volatile and unpredictable ex ante.

Sovereign currencies eliminated this multiplicity (not entirely because of the use of foreign currencies – see Subsections 3.3 and 3.4) and helped to create single domestic markets for goods and services in individual monetary jurisdictions. This was an important network externality for all economic agents—using the same currency as your purchasers, suppliers, creditors, debtors, and tax authorities, among others.

The problem of information asymmetry (i.e. the information advantage of the provider of financial services over its clients and the inability of the latter to fully assess the quality of the purchased product, including private currency) is inherently present in financial intermediation. This creates the potential for taking excessive risk at the cost of clients and even the risk of the intentional abuse of rules or fraud. Furthermore, opposite to the arguments

32 An acronym for "I owe you", a sort of debt obligation paper.

of Smith (2005) and Hayek (1990), free banking competition does not always lead to the selection of the best products (in this case, private money) and the best providers. Hence, the necessity to address the problem of information asymmetry and adverse selection[33] serves as the main argument in favour of the government regulation of financial services.

The same argument has been often used in favour of the government monopoly on issuing money, even if history offers a large number of abuses of such monopolies, mainly for fiscal reasons (see Reinhart and Rogoff, 2009). Eventually, the importance of having stable and trusted money for the proper functioning of the market economy forced most countries to adopt the gold standard in the second half of the 19th century, which largely eliminated the discretionary monetary power of governments. After several modifications of the gold standard in the first half of the 20th century and its definite demise in the early 1970s (see Eichengreen, 1998) and short period of higher inflation, the role of the stabilisation mechanism was taken by central bank independence and publicly declared monetary policy rules such as inflation targeting.

Looking at the technological characteristics of VCs (Subsection 2.2), at least some of them (like Bitcoin) offer the chance to eliminate at least part of the above-mentioned disadvantages of private money. The transparency of their functioning and the predetermined algorithm of their creation reduce information asymmetry and the risk of over-issuance. However, their exclusively digital form, the quite complicated and labour-intensive mechanism of their creation, and the lack of political willingness to accept them as official legal tender in any jurisdiction (at least in the near future) will limit their circulation and use and make them unlikely competitors to sovereign money.

3.2. Legal instruments in the hands of governments and central banks to support demand for sovereign currencies

In most countries, demand for sovereign currencies issued by central banks or governments is supported through various kinds of legal regulations, beginning with the constitution and going through central bank legislation, banking and financial sector regulation, civil code, labour and tax legislation, foreign exchange regulations, and accounting and statistical standards, among others. Usually, these regulations require conducting and reporting domestic transactions in the respective sovereign currencies. The same

33 A large body of economic literature on asymmetric information and adverse selection goes back to the seminal papers of Akerlof (1970) and Stiglitz and Weiss (1981).

concerns paying taxes,[34] wages and salaries, social benefits, and government subsidies. The regulations also give the central bank the exclusive right to issue money.[35]

However, all of these legal instruments have limits of their enforcement. First, most economies are open to an external world in terms of trade in goods and services, financial transactions, investment, and movement of people, to name a few. Transactions with non-residents often require using other currencies than the domestic currency, unless it is one of the major global currencies accepted worldwide (see Subsection 3.3). Second, in most countries, residents have freedom of choice, de jure or de facto, of the currency in which they make their savings or financial investments—that is, to use money in its function as a store of value. Such freedom is the norm in all economies that accept capital account convertibility. It is also accepted or tolerated in countries that continue capital account restrictions. Furthermore, the history of communist or other totalitarian regimes demonstrates that even the strongest bans on using foreign currency (backed by criminal penalties) remained unenforceable. Third, if residents consider domestic currency unstable or if using it is inconvenient for any practical reason, they may prefer using foreign currency for transaction purposes as well (see Subsection 3.4). Usually, this applies to larger transactions such as selling or purchasing real estate, cars, or other durable goods of a larger value or making private loans. Legislation that requires making such transactions in the sovereign domestic currency can usually be easily circumvented.

In summary, legislation that requires using the sovereign domestic currency can help boost demand for that currency and discourage the use of other currencies, but only as far as it does not contradict the interests of economic agents. If the economic agents consider a given sovereign currency unstable or if using it remains inconvenient for other reasons (for example, for transactions with non-residents or for portfolio diversification), they will circumvent such legislation.

The above conclusions apply also to VCs. While the legal instruments discussed in this subsection and the various regulatory measures analysed in Subsection 2.5 do not help in the broader use of VCs and, in fact, diminish their chances of competition with sovereign currencies, they are unable to eliminate them completely from economic life (see Subsection 2.6).

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34 There are a few local exceptions, such as Arizona's bill that allows paying income taxes in VCs after 2019 (but converted to US$ at the current exchange rate plus the costs of such a conversion – see https://www.azleg.gov/legtext/53leg/2R/bills/sb1091s.pdf or the decision of the municipality of Chiasso, Switzerland to accept tax payments up to 250 CHF in bitcoin (O'Leary, 2017). One will see whether these cases will find more followers in the future.

35 Article 128.1 of the Treaty on the Functioning of the European Union also gives the ECB this exclusive right in respect to the euro area.

3.3. Private sector preferences—the role of network externalities

What about the potential role of VCs in international transactions that are not necessarily subject to the regulations of any particular country? The era of the gold standard and the Bretton Woods system is gone; in reality, we live in a world of free currency competition with largely floating exchange rates.

The very fact that the US dollar and—to a lesser degree—euro have dominated trade and financial transactions and have become the major reserve currencies does not make politicians in many countries happy. Hence, political initiatives to invent a politically "neutral" reserve currency other than the US dollar or euro based, for example, on the IMF's Special Drawing Rights SDR.[36] However, these initiatives have had no chances to materialise thus far because there has not been market demand for such a currency (see below).

Obviously, due to their private nature and technological characteristics, VCs (at least in their current form and in the foreseeable future) do not have the chance to become official reserve currencies. However, is it possible that they could overtake at least part of the role played by the US dollar, euro, and a few of the other major currencies (e.g. the Japanese yen, British pound, or Swiss franc) in international private transactions? Unlike the above-mentioned political proposals to create a new international currency, VCs were spontaneously created by market forces and have developed thanks to market demand.

Again, network externalities play a dominant role here: the strong market position of major sovereign currencies, especially the US dollar, is determined not only by their reputation and expected stability, the size of their markets, and, sometimes, financial and foreign exchange regulation, but, in the first instance, by the dominant preferences of other market players. This allows for reduced transaction costs. In turn, these preferences are determined by the size and depth of a global financial market in a given currency—that is, the availability of various kinds of financial instruments in a given currency and, to some degree, by inertia.

This is the key reason behind the continuing dominant role of the US dollar as the international reserve and transaction currency, both in government and in the private sector, despite its periodic fluctuations against other currencies and the not always superior macroeconomic performance of the US economy (Dabrowski, 2010).

That is, if VCs were to challenge, at least partly, the international transaction position of the US dollar or euro, a sufficiently large volume of transactions would have to be developed first. This looks like the typical chicken or egg dilemma, which will unlikely be solved, at least in the near future. Most probably, a large-scale global crisis which would

36 For example, such a proposal was presented by China and Russia in 2010 (Dabrowski, 2010).

undermine market confidence in all major sovereign currencies (not just the US dollar) would be required in order for VCs to have a chance to play a more powerful role.

3.4. The source of potential competition to sovereign currencies —the role of currency substitution

As discussed in Subsection 3.2, the legal monopoly for sovereign currencies in individual countries is not and cannot be complete due to the role of international transactions, the freedom of choice of economic agents in respect to the currency of their savings or financial investments, and the unenforceability of rules that are too restrictive. That is, financial globalisation and the increasing sophistication of financial services facilitate an increasing competition between individual currencies—perhaps in the Hayekian spirit—even in macroeconomically and financially stable economies.

If a given country suffers from macroeconomic or political instability and uncertainty (or both), there are strong incentives to run away from its sovereign currency—this is the phenomenon known as currency substitution. Again, the question arises as to whether VCs can benefit from such situations—that is, will the person fleeing the troubled sovereign currency be ready to choose a VC instead?

The increasing interest in mining bitcoin in Venezuela, a country that is suffering from hyperinflation (The Economist, 2018), suggests a positive answer to this question. However, it does not seem to be comparable with the flight to the US dollar, especially in the form of cash—the most popular variant of currency substitution. Unfortunately, we do not have statistics illustrating the size of the additional demand for bitcoin in Venezuela, as we do not have data on the circulation of the US dollar in this country.

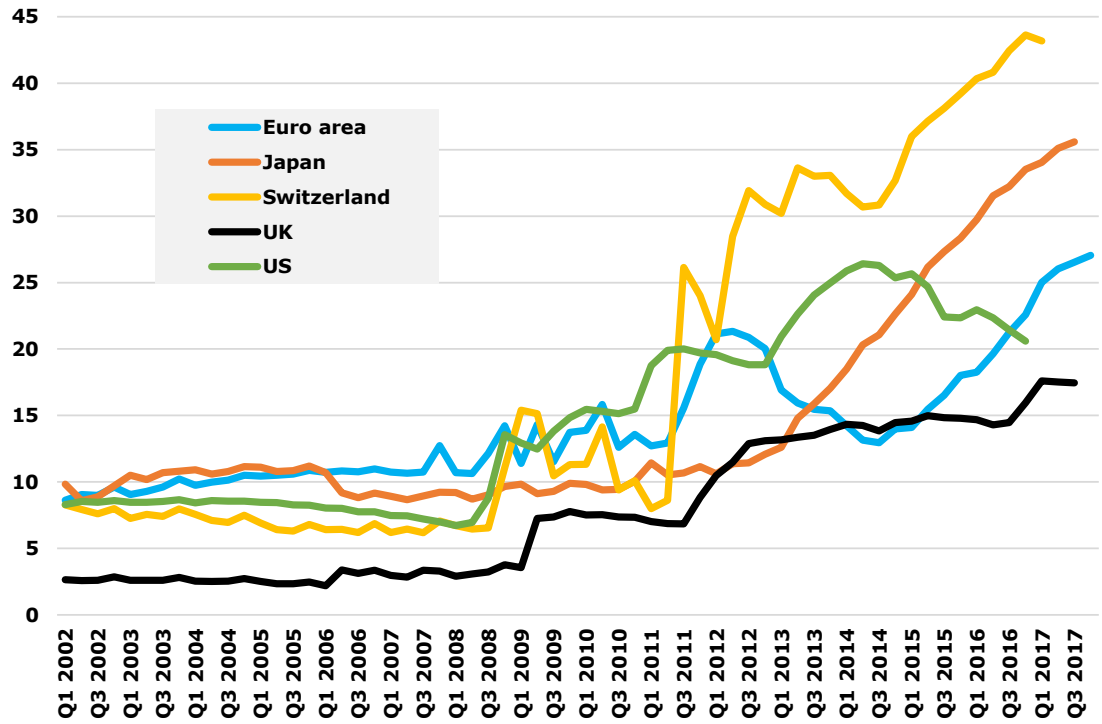
3.5. Increasing demand for central bank money in major currency areas

Despite all speculation about perspectives to crowd out central bank money, especially cash, by digital money—both sovereign currencies in an electronic form and private VCs (see Dabrowski, 2017 for an overview of this debate)—the available statistics do not confirm such a trend. On the contrary, since the beginning of the global financial crisis in 2008, one may observe a rapidly increasing share of the central bank's money (called reserve money, monetary base, base money, or high-powered money) in broad money in the major currency areas (Figure 5) as result of crisis-related financial disintermediation, tighter post-crisis financial regulation, currency substitution in favour of major currencies (mostly in the form of cash), low inflation, and low interest rates, among others (Dabrowski, 2018). Other

analyses (see, for example, Jobst and Stix, 2017; Gros, 2017) also confirm an increasing demand for cash issued by major central banks.

Even if this trend is going to be reversed at some point as result of the expected monetary policy "normalisation" and the recovery of financial intermediation, central banks—especially in major currency areas—will not face the risk of a diminishing demand for their money and, hence, losing control over monetary policy.

Figure 5: Reserve money in major monetary areas, 2002–2017, in percent of broad money



Source: IMF Monetary and Financial Statistics

4. Summary and conclusions

VCs are a contemporary form of private money, which was largely absent from economic life in the 20th century. Thanks to employing Blockchain technology (which may also be used in the financial industry for other purposes), the transaction networks of VCs are relatively safe, transparent, and fast. Unlike their 18th and 19th century paper predecessors, VCs are used globally, disregarding national borders.

The economists who attempt to dismiss the justifications for and importance of VCs, considering them as the inventions of "quacks and cranks" (Skidelsky, 2018), a new incarnation of monetary utopia or mania (Shiller, 2018), fraud,[37] or simply as a convenient instrument for money laundering, are mistaken. VCs respond to real market demand and, most likely, will remain with us for a while.

Policy makers and regulators should not ignore VCs, nor should they attempt to ban them. Both extreme approaches are incorrect. VCs should be treated by regulators as any other financial instrument, proportionally to their market importance, complexity, and associated risks. Given their global, trans-border character, it is recommended to harmonise such regulations across jurisdictions. Investment in VCs should be taxed similarly to investment in other financial assets.

Analysing the impact of VCs on monetary policy, the main question is whether they have the potential to compete with the sovereign currencies issued by central banks. Enthusiasts of private money and free banking are excited about such a prospect and hope to see it materialise (see, for example, Lietaer and Dunne, 2013; Milling, 2012).

However, the answer seems most likely "no", despite the relative market success of Bitcoin and the chances for similar successes with its followers. After almost a decade since its creation, and notwithstanding its acceptance by some digital platforms and strong market value, its role remains marginal. In April 2018, the total market capitalisation of all VCs was below US$ 300 billion (Subsection 2.3, Table 1), while broad money (M3)

37 Comment of Jamie Dimon, CEO of JPMorgan, in September 2017—see https://www.cnbc.com/2017/09/12/jpmorgan-ceo-jamie-dimon-raises-flag-on-trading-revenue-sees-20-percent-fall-for-the-third-quarter.html. A few months later, he partly recalled this comment.

in the US approached US$ 14 trillion at the end of 2017.[38] Differences in the number of transactions is even more strikingly in favour of sovereign currencies.

That is, the monetary dominance of major central banks and major currencies seems to remain unchallenged in the near future. However, the prospects may look different in smaller monetary jurisdictions, especially in countries where the sovereign currency remains inconvertible or does not enjoy the trust of economic agents due to its poor record of stability or due to political and economic uncertainty. Such countries already struggle with the phenomenon of currency substitution in the form of spontaneous dollarisation or euroisation. VCs may offer another avenue for currency substitution, as observed recently in Venezuela.

One cannot rule out that future progress in the area of information technologies can bring even more transparent, safe, and easier to use variants of VCs. This might increase the chances for VCs to effectively compete with sovereign currencies, including the major ones.

38 See https://fred.stlouisfed.org/series/MABMM301USQ189S

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