

From cash to central bank digital currencies and cryptocurrencies: a balancing act between modernity and monetary stability

Digital currencies
and crypto-
currencies

911

Ansgar Belke
Universität Duisburg-Essen, Duisburg, Germany, and
Edoardo Beretta
Università della Svizzera Italiana, Lugano, Switzerland

Received 10 July 2019
Revised 12 August 2019
18 August 2019
Accepted 19 August 2019

Abstract

Purpose – The paper explores the precarious balance between modernizing monetary systems by means of digital currencies (either issued by the central bank itself or independently) and safeguarding financial stability as also ensured by tangible payment (and saving) instruments like paper money.

Design/methodology/approach – Which aspects of modern payment systems could contribute to improve the way of functioning of today's globalized economy? And, which might even threaten the above-mentioned instable equilibrium? This survey paper aims, precisely, at giving some preliminary answers to a complex – therefore, ongoing – debate at scientific as well as banking and political levels.

Findings – The coexistence of State's money (i.e. "legal tender") and cryptocurrencies can have a disciplining effect on central banks. Nevertheless, there are still high risks connected to the introduction of central bank digital currency, which should be by far not considered to be a perfect substitute of current cash. At the same time, cryptocurrencies issued by central banks might be exposed to the drawbacks of cryptocurrencies without benefiting from correspondingly strong advantages. A well-governed two-tier system to be achieved through innovation in payment infrastructures might be, in turn, more preferable. Regulated competition by new players combined with "traditional" deposits and central bank elements remains essential, although central banks should embrace the technologies underlying cryptocurrencies, because risk payment service providers could move to other currency areas considered to be more appealing for buyers and sellers.

Research limitations/implications – We do not see specific limitations besides the fact that the following is for sure a broad field of scientific research to be covered, which is at the same time at the origin of ongoing developments and findings. Originality and implications of the paper are, instead, not only represented by its conclusions (which highlight the role of traditional payment instruments and stress why the concept of "money" still has to have specific features) but also by its approach of recent literature's review combined with equally strong logical-analytical insights.

Practical implications – In the light of these considerations, even the role of traditional payment systems like paper money is by far not outdated or cannot be – at this point, at least – replaced by central bank digital currencies (whose features based on dematerialization despite being issued and guaranteed by a public authority are very different).

Social implications – No matter which form it might assume is what differentiates economic from barter transactions. This conclusion is by far not tautological or self-evident since the notion of money has historically been a great object of scientific discussion. In the light of increasingly modern payment instruments, there is no question that money and the effectiveness of related monetary policies have to be also explored from a social perspective according to different monetary scenarios, ranging from central bank digital currencies to private currencies and cash restrictions/abolition.

Originality/value – The originality/value of the following article is represented by the fact that it (1) refers to some of the most relevant and recent contributions to this research field, (2) moves from payment systems in general to their newest trends like cryptocurrencies, cash restrictions (or, even, abolition proposals) and



JEL Classification — E4, E5, G21, G23.

The authors gratefully acknowledge valuable comments received by Ansgar Belke on his invited keynote lecture on "Monetary Policy for Decentralized Currency" at the Davos Blockchain Economic Forum (BEF), 24 to 26 January 2019, Davos (Switzerland).

Journal of Economic Studies
Vol. 47 No. 4, 2020
pp. 911-938
© Emerald Publishing Limited
0144-3585
DOI 10.1108/JES-07-2019-0311

monetary policy while (3) combining all elements to reach a common picture. The paper aims at being a comprehensive contribution dealing with "money" in its broadest but also newest sense.

Keywords Cash, Central banks, Cryptocurrencies, Digital currencies, Monetary systems

Paper type Research paper

Introduction

A major economic concept, which scientific literature of the past has dealt with, is for sure "money." Far from aiming at resuming this deep-rooted debate, the paper, nevertheless, wants to explore how means of payments might evolve starting from what money actually (and currently) is. After having analyzed some major characteristics of today's payment systems (as simultaneously made of "legal tender" like paper money issued by central banks and electronic money created by commercial banks), the article will formulate some relevant questions. For instance, what are the pros and cons of still having (partially) tangible means of payment? At the same time, it has to be asked – perhaps, questioned – whether cryptocurrencies [1] and their underlying blockchain technology might somehow contribute to establishing a more modern, secure and stable payment system. Moreover, could paper money itself soon evolve into digital currency issued by the central bank? Would this new form of money have – if this might even apply – substituting or complementing characteristics? The paper will by using a survey approach to also explore which regulatory challenges the (inter)national payment systems will have to face. It will investigate how a global central bank – if, for the sake of international economic coordination and stability, necessary – should be designed in terms of monetary policy governance. At the same time, another relevant question will pertain to the way independent currencies might be regulated in order to reduce their volatility. By also referring to concrete examples, one relevant conclusion will be that – yes – the (inter)national monetary order has to be reformed, but to do this, the role of central banks (and their physical means of payments) has to be strengthened, and not weakened, by delegating functions to the commercial banking sector or by making legal tender immaterial. In order to provide some answers to these crucial questions, the paper will firstly analyze how a global central bank might work and why a similar step (though currently improbable) could be of great help. The next section will, hence, deal with the risks of independent currency supply, and the third section will deepen the role of virtual currencies and why they should matter to central banks. Finally, the fourth and fifth sections will critically question pros and cons of "stable" independent currencies as well as cryptocurrencies, cash and digital central bank currencies. The leading aim of the paper remains the same, namely, to show that recent trends in payment instruments bear several risks while traditional payments and clearing systems are still irreplaceable.

The design of a global central bank, its monetary policy and governance

As highlighted in [Belke et al. \(2011b\)](#), the global financial crisis of 2007–2008 on the one hand, and the "Euro crisis" on the other, have seriously challenged the stability (and sustainability) of the current global monetary system. These crisis episodes have dramatically revealed the actual system's weaknesses and shown its strategic importance for the stability of markets and, in the end, national economies themselves. With specific regards to a key point related to international monetary stability like the "right" exchange rate regime, the Deutsches Institut für Wirtschaftsforschung (DIW), with its headquarter in Berlin, was commissioned by the Federal Ministry of Finance to analyze potential alternatives. Some other relevant results are also reported in [Belke et al. \(2011a\)](#). Perhaps, neither of the two extremes (free *versus* fixed exchange rates) – should be considered truly "suitable." A mixed system would be instead preferable. More precisely, an exchange rate regime with few big currency areas linked to

each other by flexible (or adjustable) exchange rates might be the best-balanced solution. These improvements should be anyway followed by significant changes of the regulatory framework of financial markets, which are far from being able to regulate themselves or acting as a set of *homines oeconomici*, which are, for instance, able to make “conscious decisions about investments that they think will maximize profits for their clients and themselves” (Van Dalen, Svensson, Kalogeropoulos, Albæk and de Vreese, 2019, [no indication]). Fundamental elements would be a stronger global coordination and an international financial market authority. For instance, according to Arestis *et al.* (2005, p. 508), “[t]he sufficient condition [. . .] is that of a single currency and an international monetary authority to manage it [i.e. financial globalization],” which is a recurrent approach even in Bonpasse (2006, p. viii), who highlights that multi-currency exchange at the international level is “more obsolete than ‘wrong’ and will increasingly be subjected to the ‘reasons’ for replacing it with a Single Global Currency.”

The idea that a global currency – no matter, if it should be read as “single common currency” or as “currency for international exchange” – is for sure not new as well as far from being not captivating. Its roots trace back not necessarily to International Clearing Union (ICU) proposal of John Maynard Keynes, which introduced the term “bancor,” a “form of international bank money” (Whyman, 2018, [no indication]), but rather to economic thinkers of the remote past as highlighted in Beretta (2012a, b, 2013). Among the main reasons for thinking of the introduction of similar payment schemes are the high capital volatility endangering exchange rate stability (“With convertible national currencies and no exchange controls, lenders are exposed to the continuously possible flight of short-term capital. [. . .] This constitutes another important argument for dropping national currencies and adopting a common global currency” (Moore, 2004, p. 642)), reduction of financial unpredictability (“a single global currency as a way of reducing risk and also increasing income and improving business certainty for financial institutions and other business groups” (Moshirian, 2007, p. 4)) as well as following an already existing example like the European one (“The birth of the euro [. . .] has led a number of observers to advocate forming a world central bank to oversee a global currency” (Rogoff, 1999, p. 33)). However, even notable supporters of financial and monetary regulation at the international level prefer a “lighter” solution like retaining “at least, say, three or four currencies, if not n currencies” (Rogoff, 2001, p. 246) or expanding the role of special drawing rights (SDR) allocated by the International Monetary Fund (IMF) (“Thus the IMF would have a greater role in creating official liquidity [. . .]. All of this would make a contribution to enhancing global stability, without altering [. . .] existing monetary arrangements. And the dollar would continue as the main currency for private transactions, making this change more acceptable to the US” (Stiglitz, 2011; Internet)). Since only “non-key currency countries” have nowadays to discharge their international obligations in “real” terms, namely, either by transferring foreign reserves accumulated in commercial/financial transactions with the rest of the world or borrowing from outside, while “key currency countries” can simply use the local money units to “discharge,” authors like Rossi (2007) plead for the creation of a “central bank of central banks” issuing an international *numéraire* to be used to vehiculate transactions from one country to another. More precisely:

“[t]o make sure that every international transaction is finally paid, an international system of payments working under the real-time gross-settlement protocol needs to be created, imitating the RTGS systems that exist today within any advanced economies around the world. Any foreign trade transaction has to be finally settled in national currency within each of the countries concerned and in an international money unit [. . .] between them. [. . .] In a nutshell, the new monetary system for international payments has to consider that national currencies are means of payment in the relevant monetary space – in conformity with their nature – and not real goods or financial assets that can move across these spaces and thus beyond a country’s borders”

(Rossi, 2007, p. 102).

What remains true is that – in order to avoid another global financial and economic crisis – the world needs a more pyramidal system of payments (i.e. starting from commercial banks and systemically going through the respective national banks). Decentralization might be acceptable, if it is regulated and governed by central bodies themselves. A peer-to-peer approach (without any systematic control and regulation) would instead revitalize those speculative forces, which have contributed to the recent global crisis episodes. In the next parts of the paper, we will, nevertheless, discuss in detail some of the main arguments in favor as well as against monetary innovations like cryptocurrencies and central bank digital currencies (where the former are precisely a decentralized way of money issue while the latter aim at modernizing the legal tender like cash).

Regulation of independent currency supply: which way to mitigate volatility and inflation?

Parallel to rising trading volumes, the volatility of Bitcoin, namely, the leading cryptocurrency in circulation, seemed to slow down, which induced some experts to assume that “bitcoin’s peak volatility is reducing steadily and will enter the realms of fiat currency (below 5.5%) by around July 2019” (Woo, 2016, Internet). However, it is no secret that Bitcoin’s volatility (which has also increased since then) is still much more significant than that of other financial instruments, as shown in Figure 1.

The enduring phenomenon of volatility is motivated by lacking trading pairs, low trading volumes as well as significant uncertainty of demand, which characterize almost every cryptocurrency, as shown in Table 1. The fiat-to-crypto exchange rate volatility seems to be a common aspect to every cryptocurrency. The pegging of the remaining cryptocurrencies to Bitcoin, namely, the most important one among that plethora, also explains why the whole crypto-financial environment moves in a synchronous way as well as up and down with a strongly persistent momentum. Nevertheless, fluctuations of cryptocurrencies could decrease as Bitcoin dominance might decline, although this nexus is not necessarily given in the light of the speculative nature of demand for such financial instruments. In fact, “[s]afe financial assets – assets that are perceived as maintaining most of their principal value even in terms of extreme national or global financial stress – have many attributes that cannot be matched by nonofficial cryptocurrencies” (Prasad, 2018, p. 25). The reliance of trading with the remaining cryptocurrencies on the Bitcoin-to-fiat exchange rate could also soon disappear, since fiat-to-crypto trading pairs are progressively increasing. In this scenario, demand for single cryptocurrencies would be less (or not anymore) affected by Bitcoin’s volatility, leading to a significant desynchronization in terms of values of single crypto tokens. Despite these considerations, there are no doubts that cryptocurrency markets would still suffer from low liquidity levels and rather speculative approaches of investors (“A buy-

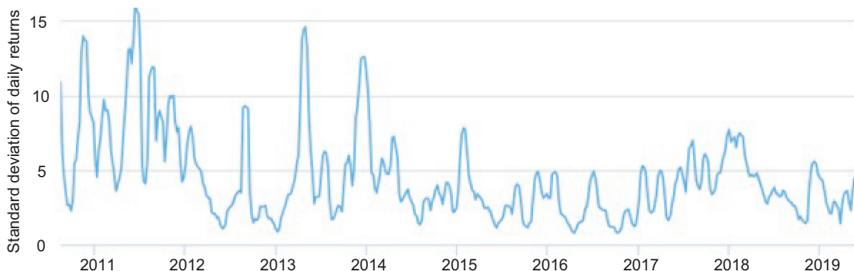


Figure 1.
Bitcoin's volatility
(August 16, 2010–May
31, 2019)

Source(s): Buy Bitcoin Worldwide (2019)

Table 1.
Top ten
cryptocurrencies by
market capitalization
(as of 1 June 2019)

Top ten cryptocurrencies by market capitalization (as of 1 June 2019)					
Ranking	Name	Market cap	Price	Volume	Change (24 h)
1	Bitcoin	\$152,124,154,397	\$8,577.65	\$24,037,571,422	3.21%
2	Ethereum	\$28,699,514,786	\$269.96	\$10,539,543,110	5.15%
3	XRP	\$18,401,892,280	\$0.436250	\$1,923,145,253	3.01%
4	Bitcoin Cash	\$7,892,992,342	\$443.08	\$2,011,224,992	4.51%
5	EOS	\$7,655,815,530	\$8.35	\$5,310,102,545	8.92%
6	Litecoin	\$7,065,695,375	\$113.91	\$4,407,460,570	5.13%
7	Binance Coin	\$4,680,277,159	\$33.15	\$551,659,894	5.08%
8	Bitcoin SV	\$3,441,259,386	\$193.20	\$580,786,438	5.08%
9	Tether	\$3,141,405,873	\$1.00	\$24,060,400,157	0.71%
10	Stellar	\$2,563,236,280	\$0.132623	\$443,749,812	2.93%

Source(s): [CoinMarketCap \(2019\)](#)

and-hold approach is one where you buy bitcoin and wait for its value to go up over the medium to long term. [...] The trading approach is a very short-term one, where you get in and out of bitcoin in a few days, hours, or even minutes” (Morse, 2017 [no indication]), which would be responsible for limiting trading volumes and maintaining high volatility. Frequently, there is no clear “signal” whether this trend might change in the future. The main idea is, for instance, that – if liquidity in cryptocurrency markets would become high enough and demand stabilize over time – volatility could decline to acceptable levels close to those of fiat currencies. Cryptocurrencies could therefore represent a way in order to diversify financial instrument portfolios and hedge against fluctuations in other asset typologies (“concerns about medium-term monetary stability and distrust in banks are associated with a higher ownership rate of crypto-assets” (Stix, 2019, p. 30)). At the same time, once cryptocurrencies’ value would become stable with respect to official currencies, their potentially hedging characteristics might soon adjust to similar levels of traditional currency.

In fact, it cannot be excluded that supply protocols of cryptocurrencies might become more sophisticated in order to reduce volatility or their ecological impact (“The largest cryptocurrencies[...] require vast amounts of energy consumption to function. Last year, blockchain used more power than 159 individual nations including Uruguay, Nigeria, and Ireland. Unsurprisingly, this is creating a huge environmental problem that poses a threat to the Paris climate-change accord” (Blinder, 2018, Internet)). For instance, creators of a new currency called “Basis” aim at providing a means of payments whose supply might fluctuate in pair with demand (which should, in turn, facilitate the maintenance of rather stable value as compared to legal tenders like the U.S. dollar). Recently, the above-mentioned project has been stopped by its creators because of regulatory reasons: “Basis remains stable by incentivizing traders to buy and sell Basis in response to changes in demand. These incentives are set up through regular, on-chain auctions of ‘bond’ and ‘share’ tokens, which serve to adjust Basis supply. [...] As such, after publishing our white paper, we raised a \$133M round of financing. [...] Unfortunately, having to apply US securities regulation to the system had a serious negative impact on our ability to launch Basis. [...] This also means, unfortunately, that the Basis project will be shutting down” (Basis, 2018, Internet).

Obviously enough, no technology (or sophisticated supply protocol) would be able to avoid that cryptocurrencies (like any fiat currency) might be vulnerable to changes in beliefs or expectations leading to self-fulfilling inflationary episodes. Besides elastic supply (which is not always sufficient to ensure price stability), currencies issued by central banks benefit from a particular level of acceptability guiding economic subjects toward a desirable equilibrium. Being “legal tender” means to be recognized by the legal systems and considered

acceptable means of settlement of commercial/financial transactions, as clearly understandable from art. 14 par. 1 of the Bundesbank Act (Bundesbankgesetz, BBankG) (“Without prejudice to Article 105 a (1) of the EC Treaty, the Deutsche Bundesbank has the sole right to issue banknotes in the area in which this Act is law. Its notes are denominated in Deutsche Mark. They alone are legal tender for any amount” (Deutscher Bundestag, 1992, Internet)). At the same time, the general public uses money issued by the traditional banking system as a medium of paying taxes or other “official” expenses. It has also not to be forgotten that such means of payments can count on several decades of price (or financial) stability, increasingly better practices and solid networks of users, which, in turn, allow them to be “natural monopolies” in terms of the three functions to be (generally speaking) fulfilled by currencies: units of account, means of payments and stores of value (Claeys *et al.*, 2018). In the light of this, it has to be questioned whether technological improvements might be sufficient to establish a wider use of cryptocurrencies and replace money units issued by traditional banking systems.

According to supporters of Hayek’s (1976, p. 20) way of reasoning, namely. that “[i]f governments and other issuers of money have to compete in inducing people to hold their money, and make long-term contracts in it, they will have to create confidence in its long-run stability,” cryptocurrencies could also become a way to ensure assets, but they could increase competition as well as financial stability. More precisely, any kind of competition between “traditional” currencies issued by central banks and cryptocurrencies could also turn out to be positive. Cryptocurrencies might also become an alternative diversification option as soon as the traditional currency system should fail. This scenario would imply a structural switch from a “lender of last resort” (where there is one economic subject like the central bank playing this role) to a “system of last resort” (where several actors are “in charge” of this duty), as mentioned by Kiel Institute for the World Economy (2018, p. 16). However, it seems that there would be more than just a few limitations. For instance, there is a variety of distributed ledger technologies, which are not always transparent or easily understandable by the general public. Making investors aware of risks should, however, represent a case for regulation in order to avoid criminal behavior. At the same time, crypto exchanges have revitalized trading practices being banned from the banking and financial sectors a long time ago. The risk of “spoofing” (“spoofing refers to impersonation, or pretending to be someone or something you are not. Web spoofing involves creating a ‘shadow copy’ of a Web site or even the entire Web of servers at a specific site” (Balasubramanian, 2016, p. 216)) or traditional money-laundering due to the absence of a regulatory framework is also influencing economic actors’ decision to enter the market providing new liquidity. In fact, besides volatility issues, “the most vulnerable points in the decentralized Bitcoin ecosystem have been the wallets and exchanges” (Fung and Halaburda, 2016, p. 17). As soon as cryptocurrency-related financial items should increase in number and volume, such a need for regulations as well as guidelines would grow accordingly. At the same time, within EU countries, there is a high degree of inhomogeneity in terms of treatment of cryptocurrencies (“Operating a Bitcoin ATM in Austria or the Czech Republic does not require specific authorization, whereas the provider of the same machine in Germany needs to own a full banking license” (Kiel Institute for the World Economy, 2018, p. 17)), as also highlighted in Table 2, which shows which countries have adopted a regulatory framework implying taxation of cryptocurrencies and/or anti-money laundering as well as anti-terrorism financing laws. At the same time, Table 2 maps the legal status of cryptocurrencies (where defined) and sums up which countries already issue regional and national crypto tokens. Similar attempts to define these new digital instruments are relevant in order to better understand their essence (which is still under consideration). For instance, the Federal Financial Supervisory Authority (*Bundesanstalt für Finanzdienstleistungsaufsicht* (BaFin)) classifies Bitcoin as a “financial instrument” or “unit of account,” which is somehow striking too (“Bitcoins are financial instruments. Units of

account are comparable to foreign exchange with the difference that they do not refer to a legal tender” (Federal Financial Supervisory Authority, 2019, Internet). Thus, there is no doubt that “banks monetize current output by issuing numerical units. Since numerical instrument, nominal money, have no intrinsic value, banks can freely issue any amount of nominal money required by the economy” (Carayannis *et al.*, 2012, p. 45), which, in turn, means that – if Bitcoin serves as a “unit of account” having no intrinsic value – it cannot be at the same time a “financial instrument” entailing a positive worth. If applicable, it might be just claimed that “some financial instruments are expressed in Bitcoin,” which would rather rightly imply that (1) Bitcoin might be a “unit of measure” (with no real value attached) (2) denominating non-bank financial instruments. Getting back to the main argument, the German Banking Act (*Kreditwesengesetz*) contributes to the reduction of demand for cryptocurrencies. Some of these preliminary argumentations confirm that cryptocurrencies are still a rather unexplored object. As we have already pointed out and will progressively further discuss, it even has to be questioned whether cryptocurrencies might be defined as “currencies”/“moneys” or – this point is, by far, more important as well as neglected – “assets” while the underlying technology might be called “decentralised virtual clearinghouse and asset register”” (Broadbent, 2016, p. 7). In fact, while the term “currencies”/“moneys” does not bear any “real value” without a corresponding amount of goods/services/financial securities to be associated with, “assets” already imply this fusion between physical goods (*alias* “goods/services/financial securities”) as counted by an equal number of money units issued by the banking system. More generally:

“[Adam] Smith defined real money as money’s worth and identified it with purchasing power. “That revenue, therefore, cannot consist in those metal pieces, of which the amount is so much inferior to its value, but in the power of purchasing, in the goods which can successively be bought with them as they circulated from hand to hand” (Smith, 1978, p. 387–8). [...] Real money is the result of production and cannot be directly issued by banks, whose task is to furnish what we have metaphorically called an empty vehicle”

(Cencini, 2013, pp. 35–36).

That cryptocurrencies in circulation have no intrinsic value (despite the implicit claim that commercial/financial transactions might be settled by means of an instrument created “out of

Absolute ban	Implicit ban	
<i>Legal status of cryptocurrencies</i> Algeria, Bolivia, Egypt, Iraq, Morocco, Nepal, Pakistan, United Arab Emirates	Bahrain, Bangladesh, China, Colombia, Dominican Republic, Indonesia, Iran, Kuwait, Lesotho, Lithuania, Macau, Oman, Qatar, Saudi Arabia, Taiwan	
Application of tax laws	Anti-money laundering and anti-terrorism financing laws	Both
<i>Regulatory framework for cryptocurrencies</i> Argentina, Austria, Bulgaria, Finland, Iceland, Israel, Italy, Norway, Poland, Romania, Russia, Slovakia, South Africa, Spain, Sweden, United Kingdom	Cayman Islands, Costa Rica, Czech Republic, Estonia, Gibraltar, Hong Kong, Isle of Man, Jersey, Latvia, Liechtenstein, Luxembourg, Singapore	Australia, Canada, Denmark, Japan, Switzerland
<i>Countries which have or are issuing national or regional cryptocurrencies</i> Anguilla, Antigua and Barbuda, China, Dominica, Grenada, Ireland, Lithuania, Marshall Islands, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Venezuela		
Source(s): The Library of Congress (2018)		

Table 2.
Legal status and
regulatory framework
for cryptocurrencies:
absolute and implicit
ban or application of
tax laws and/or anti-
money laundering/
anti-terrorism
financing laws? And
why not issuing
national or regional
cryptocurrencies?

thin air”) is also confirmed by the Committee on Payments and Market Infrastructures of the Bank for International Settlements (2015, Internet) stating that “[t]hese assets can have some of the characteristics of a commodity and some of a currency [. . .], are not a liability of any entity, are not backed by any authority and have no intrinsic value.” Does it perhaps mean that only means of payments issued by financial institutions affiliated to the banking system (and controlled by the central bank itself) have the ability to create “money”? Yes, of course. However, this conclusion is not justified by some chartalist reasons allowing the State to define “money” however it may want to (“Chartalism [. . .] posits that money [. . .] is a unit of account, designated by a public authority” (Tcherneva, 2006, p. 69)), but simply because of the fact that no one – neither central nor commercial banks as well as any economic subject – can (1) issue their own means of payments (2) in order to “finally” [2] discharge his/her economic obligations. Honestly, it would be too simple if anybody would be allowed to “create” his/her financial instrument to pay for commercial/financial transactions.

Another option explored by recent literature is given by the so-called “non-collateralized stable coins,” which “are not actually “backed” by any real-world or cryptocurrency asset other than the expectation that they will retain a certain value. The main non-collateralized approach is the seigniorage shares approach” (Hyperquant, 2018, Internet). Through smart contracts, the supply of digital coins is regulated, which should, in turn, maintain their value against “legal tenders” like the U.S. dollar. At the same time, the platform issues digital coins as well as bonds, while smart contracts sell bonds for coins (coins for bonds) when the price of the latter decreases (increases) in terms of the associated legal tender. Investors might have an incentive to hold bonds (despite being less liquid than coins) since they could benefit from “dividends” in the form of digital coins as soon as additional volumes of the latter would be issued. The “remuneration” of bonds would be financed by use of the “seigniorage,” namely, a sort of “commission fee,” accruing to the platform as soon as it would sell additional coins. Obviously enough, such schemes are interrelated to the growth rates of the platform itself, since in the absence of additional stable coin users, bondholders would be exposed to risks of not being reimbursed. Clearly enough, even an expanding platform cannot remove doubt and uncertainties about its future. What if seigniorage generated by it would be insufficient to reimburse bondholders? Obviously enough, the latter would be discouraged to continue bidding for new bonds. Therefore, excess liquidity would become less easy to absorb (i.e. take out of circulation), which would, in turn, lead to an increase of the value of claims on dividends as compared to still circulating liquidity. But this scenario of self-reinforcing uncertainties is very similar to the pattern going on during speculative attacks on pegged exchange rates [3]. The whitepaper for Basis, “the first cryptocurrency to implement robust, decentralized, and protocol-enforced price stability” (Al-Naji *et al.*, 2017, p. 3), which has been until recently the leading stable coin, mentions a five-year expiration period on its bonds as a protection tool against risks that bondholder queues might increase too much to be serviced (“[w]e selected a 5-years bond expiration after rigorous simulation showed that this produced a robust system with sufficiently high bond prices even in the face of wild price swings” (Al-Naji *et al.*, 2017, p. 14)). They (2017, p. 21) even assert that such a system would be robust if bond prices hit zero. In fact, bonds would be automatically extinguished after having reached their maturity, although the extinction of previously issued bonds with no repayment of the principal itself would be nothing than a debt default or restructuring. But the expectation of a “haircut” will only lead investors to ask in advance for a higher risk premium, bringing forward a sustainability crisis implying the “haircut” itself [4].

Peer-to-peer loans *versus* banks loans. Should central banks be concerned about virtual currencies?

The following section aims at providing an extensive review of the existing literature. For instance, according to Bofinger (2018), the replacement of bank loans with peer-to-peer

lending might be of some interest despite entailing significant regulatory challenges. In fact, it bears a direct relationship between the lending and borrowing part, and, since peer-to-peer lending does not necessitate an intermediary, it also needs less regulatory measures. At the same time, the traditional banking sector might be challenged by such peer-to-peer lending activities (“For the central bank, an ‘uberisation’ of banking could imply less influence on financial processes and also on real processes. In the same way as capital markets, peer-to-peer lending makes it possible to mobilize the existing money stock for additional lending” (Bofinger, 2018, Internet)). If bank deposits should remain the leading typology of financing, even peer-to-peer lending would be influenced by the central bank through its interest rates decisions. On the one hand, transaction costs involved in payments processes would be reduced, but on the other hand, a peer-to-peer approach increases risks of double spending (because of the lack of supervision payment authorities). More precisely, “[t]echnological innovation could potentially lead to a diminished lending role from the traditional banking sector if phenomena such as peer-to-peer lending and cryptocurrencies become mainstream and grow” (Boel, 2016, p. 153).

It nevertheless remains true that central banks are interested to explore (and perhaps coordinate) the possibility of introducing virtual currencies, since in several advanced economies they already hit the zero lower bound. The question arising at this point might be how to further reduce interest rates without causing a flight into cash. In fact, in a cashless society, monetary policy rates would not be subject to any lower bound, which might eliminate the need for quantitative easing interventions (“It may indeed be the case that no amount of quantitative easing or credit easing can make up for the inability of the monetary authorities to set negative nominal interest rates” (Buiter, 2009, p. 50)). Cash’s anonymity has been also heavily criticized by Rogoff (2016) because of the risk of illegal business or tax evasion. More precisely:

“[f]irst, making it more difficult to engage in recurrent, large, and anonymous payments would likely have a significant impact on discouraging tax evasion and crime; even a relatively modest impact could potentially justify getting rid of most paper currency. Second, [...] phasing out paper currency is arguably the simplest and most elegant approach to clearing the path for central banks to invoke unfettered negative interest rate policies should they bump up against the ‘zero lower bound’ on interest rates”

(Rogoff, 2016, p. 1).

Beretta (2014, 2015a, 2015b, 2016, 2017) has nevertheless argued that cash restrictions (and, even more significantly, abolition) would be detrimental for economic growth as well as consumption rates in every country where cash would still be predominant in settling payments. In fact, paper money has taken the place of precious metals in systems of national fiat monies and can be considered a new “gold backing.” It is also no secret that private currencies might threaten the monopoly of issuance of the central bank itself [1]. If cash should be abolished, private economic subjects would have no access to risk-free central bank money. Private money – no matter which kind – is also not backed by central banks. The coexistence of parallel currencies can have an impact on the activity of the national bank itself, as explained by Fernández-Villaverde and Sanches (2016, p. 30) by claiming that “an equilibrium with valued private monies does not exist when the government [...] pegs the real value of government money, provided that the target value for real balances is sufficient.” But, according to Baliño *et al.* (1999, Internet), this scenario is similar to central banks dealing with partial dollarization of their economies (“When attempting stabilization from hyperinflation, in particular, a fixed exchange rate can be an effective instrument in highly dollarized economies. The same conclusion does not apply when dollarization reflects only asset substitution”). For instance, if transactions in that new currency were numerous, the central bank might experience severe difficulties in finding intermediate targets for its

monetary policy. As physical or juridical subjects would expand their holdings of the new currency, the financial system would become less stable. Under such circumstances, the national bank would have to retrieve liquidity in precisely those currencies. Uncertainty and volatility in terms of exchange rate would be, therefore, very likely (“Currency substitution may not only lead to higher inflation, for a given budget deficit, but also to more volatile inflation” (Calvo and Vegh, 1992, p. 17)).

Since circulating volumes of cryptocurrencies nowadays exist alongside officially issued and accepted currencies, they do not (significantly) influence the position of legal tenders. For sure, the current volumes are limited and do not threaten official money. Of course, due to improved algorithmic technology with the aim to reduce volatility of cryptocurrencies, they might accordingly benefit in acceptance and use terms. Therefore, it has to be explored whether any parallel coexistence would bear risks for monetary policies. Could the central bank lose its grip on the economy (Claeys *et al.*, 2018)? As already mentioned, Fernández-Villaverde and Sanches (2018, p. 39) have explored precisely this potential relationship and predict that any form of coexistence of central bank and private currencies will be interrelated to the monetary policy followed by the national bank itself (“the presence of privately issued currencies can create problems for monetary policy implementation under a money growth rule. [...] currency competition provides market discipline to monetary policy implementation by inducing the government to provide ‘good’ money to support exchange in the economy”). Their theoretical model predicts that the coexistence of central bank and private money depends on the type of monetary policy the former follows. Private currencies would be used if the official ones would not guarantee an adequate level of price stability and do not ensure price stability, but would at the same time lose their relevance as a medium of payments as soon as the central bank would credibly ensure existing purchasing power (Claeys *et al.*, 2018, p. 15). According to these authors, central banks might benefit from the ability to choose a specific type of monetary policy preventing cryptocurrencies from being valued as a medium of exchange, although they might still exist as speculative financial instruments (“[Cryptocurrencies] resemble speculative assets rather than money [...] because of their inherent volatility, which is the by-product of their inelastic supply, and which limits their widespread use as a medium of exchange” (Claeys *et al.*, 2018, p. 5)). Some other authors are, by far, more concerned about the impact of cryptocurrencies as well as their feasibility in terms of “money,” whose functions have even in progressively immaterial payments systems to be still fulfilled (“private cryptocurrencies cannot serve neither as money, nor as international reserves. On the other hand, central bank digital currencies would conceivably work in both these related roles, given the trust element of government backing, but there still lacks a strong reason for why they are needed and when” (Clark and Mihailov, 2019, p. 20)).

Of course, if we should take Hayek’s (1976, p. 39) views (“foreign currencies, and a host of illegal monies, replaced the hyper-inflated paper mark, in the last stages of the inflation. These alternative currencies were replaced, in turn, by the stabilised rentenmark. [The rejection of the hyper-inflated mark by the Germans] forced the government to stabilise the currency”) and transpose them to cryptocurrencies, we might even claim that their coexistence with legal tender might have a stabilizing and disciplining potential. Since a similar assumption is rather theoretical or at least belongs to times of extreme economic distrust, there are no doubt that central banks would be confronted with several risks. For instance, if savers should begin substituting paper money and deposits for crypto tokens, a similar behavior would have an impact on monetary policy too (which would suffer from shrinking volumes to be conducted on). More precisely, “[c]ompeting currencies can limit the ability of the central bank to use the interest rate as a policy instrument; they can also restrict the attainable equilibrium inflation rate. In a market with free entry for multiple currencies with profit-maximizing issuers, the central bank completely loses control of the interest rate

and the inflation rate” (Benigno, 2019, p. 19). At the same time, if central bank money should become less relevant, seigniorage revenues would shrink accordingly (“Although the ECB does not physically issue banknotes, it has been agreed that of all the banknotes in circulation in the euro area, 8% – in terms of value – are considered to be issued by the European Central Bank. The national central banks put the notes into circulation on the ECB’s behalf, and the ECB earns seigniorage [. . .]. Seigniorage income has been falling since 2008, in line with a decline in euro area interest rates” (European Central Bank, 2017, Internet)).

Although seigniorage inflows have lost relevance over time, they still are one of many fiscal sources. In addition, it has to be kept in mind that cryptocurrencies (being a purely speculative investment made in expectation of a return from capital gains) will be particularly likely to be subject to bubbles. As for instance, reminded by Eichengreen (2019, p. 1), “[digital currencies] do not yet provide the core functions of money. [. . .] The one unit that can clearly meet these challenges is central bank digital currency. But there would be both costs and benefits of moving in this direction.” The implosion of a cryptocurrency bubble could reverberate into wider financial instability if economic subjects – no matter, if financial or non-financial – would hold unhedged debt positions. In a similar scenario, central banks would be exposed to severe stability risks concerning the banking and financial institutions supervised by them. According to Cochrane (2018, Internet), “[c]ryptocurrencies like bitcoin have to solve two and a half important problems if they are to become currencies: 1) Unstable values 2) High transactions costs 2.5) Anonymity.” At the same time, it has to be asked whether digital currencies might affect central banks’ role as money issuers as well as regulators of the banking and financial sector (“So while virtual currencies will not replace sovereign-backed money, they are likely to raise policy issues for central banks and financial regulators for many years to come” (Whelan, 2018, p. 15)). More precisely, the question has to be raised whether cryptocurrencies might provide more privacy for users than “official” means of payments whose legal issuers might have been heavily criticized (and might have suffered reputation losses) during the global economic crisis. In fact, as rightly pointed out by Sauer (2016, p. 117), “[v]irtual currencies are in vogue mainly due to two factors. First, as a protest against authority-driven monetary policy decisions and second, as alternatives to deficits in some monetary systems arising out of political instability or other causes,” which also explains why Bitcoin’s birth (with its network coming into existence) was on January 3 2009 (Wallace, 2011), during particularly turbulent economic and financial times.

Even the fact that virtual currencies like Bitcoin are subject to a limited supply up to 21 million units (“When Satoshi decided to use 21 million Bitcoins (BTC) as the finite number of Bitcoins, the global M1 money supply approximately stood at \$21 Trillion USD” (Coin Savage, 2018; Internet)) is taken as a further proof that they might fulfill the “store of value” function better than traditional money units. However, the problem is (without comparing gold to cryptocurrencies since only the former is a commodity to be retrieved in nature, counts on a deep-rooted history of “devotion” by people from all over the world which made it globally accepted as the epitome of wealth) whether such a supply constraint might not replicate the deflationary issues affecting the gold standard. More precisely, during that time “[p]rices declined in large part because of the constraints imposed by the gold standard in an environment in which there was a significant excess demand for gold. Increasing demand for money was being driven by technological change and population growth. At the same time, the supply of gold was largely fixed. The constraints imposed by the limited supply of gold manifested in part in the deflationary episodes and relatively weak growth” (Kumar *et al.*, 2003, p. 9). Therefore, strong doubts subsist that Bitcoin (or any other cryptocurrency limited in supply) might continue being subject to such an issue cap as soon as it would have to fulfill increasing payment needs of users. Elsewise stated, if such an upper limit should remain valid, deflationary pressures and less agile economic growth (because of lack of a corresponding increase in terms of circulating means of payments) would be almost certain.

A crucial question also pertains to the options at the central bank's disposal. Based on [Fatàs and Weder di Mauro's \(2018\)](#) analysis, the central bank might issue central bank digital currency (CBDC), while such a digital means of payments would be a claim on the national bank itself. On the one hand, individuals and corporations (not only belonging to the financial sector) might directly hold accounts – even bearing interests (“An interest-bearing CBDC could provide a secure store of value, with a rate of return in line with other risk-free assets such as short-term government securities. The CBDC interest rate could serve as the main tool for conducting monetary policy” ([Bordo and Levin, 2017, p. 2](#))) – at the central bank. On the other hand, central banks could issue own cryptocurrencies in a nearly anonymous way in order to provide an alternative to banknotes (“Imagine that the Fed, as the core developer, makes available an open-source Bitcoin-like protocol (suitably modified) called Fedcoin. The key point is this: the Fed is in the unique position to credibly fix the exchange rate between Fedcoin and the USD” ([Andolfatto, 2015, Internet](#))) and “enhance the operational efficiency of existing arrangements” ([Bank for International Settlements, 2018, p. 108](#)).

[Fatàs and Weder di Mauro \(2018\)](#) think that individuals could benefit from central bank digital currency, which would be among the pillars of an efficient payment system (“in order to preserve the effectiveness of monetary policy in a world increasingly flooded by private digital currencies, central banks will eventually have to issue their own digital currencies” ([Cukierman, 2019, p. 1](#))). At the same time, this would allow the public to hold “legal tender” (namely, “central bank money”) in its electronic form. In order to do this, it would be important to raise “the prestige of electronic money to bolster its use as the unit of account” ([Agarwall and Kimball, 2015, p. 29](#)). Because of having a centralized ledger, payment settlements would become very fast, since the need of intermediaries would also shrink. Deposit insurance would, hence, become less relevant. Central banks might even open accounts for non-residents, allowing its national currency to progressively become a medium of cross-border payments. Any central bank cryptocurrency using technologies similar to Bitcoin would be affected by some of the same problems as those currencies. More precisely, “[i]t is possible that new generations of crypto-assets may become more attractive as means of payment or payment solutions due to greater processing capacity, lower costs, increased speed and more user locations. However, cryptoassets have a long way to go to become more efficient than robust centralised payment solutions” ([Norges Bank, 2018, p. 21](#)). For instance, the decentralized validation process is inefficient and slow, while anonymity more a disadvantage (“Decentralized virtual currencies are of particular interest to central bankers because eventually they could change administration of monetary policy globally by allowing users to circumvent capital controls and managed exchange rates” ([Pieters, 2016, p. 1](#))). Centralization is also a key aspect, while some authors harshly criticize “that a central bank should be in the business to satisfy the demand for anonymous payments. [. . .] such a demand can and will be perfectly satisfied by the private sector, in particular through cryptocurrencies” ([Berentsen and Schär, 2018, p. 104](#)). More precisely:

“while replicating the anonymity of cash in electronic format might sound appealing, central banks would not want to offer cryptocurrencies as vehicles for illegal activities. [. . .] The presence of a safe deposit at the central bank could make commercial bank deposits highly volatile and bank runs could happen at the click of a mouse (or a nod to a mobile phone). The result may be sharply higher volatility and periodic panic flights to safety. In addition, shifting deposits to central banks might mean a challenge to existing business models of banks since they might lose a stable and cheap source of funding, namely, deposits”

([Fatàs and Weder di Mauro, 2018, Internet](#)).

Among the several doubts to be raised, [Abadi and Brunnermeier \(2019, p. 2\)](#) point out what they call “a ‘blockchain trilemma’: a ledger’s correctness requires either the remittance of rents to a centralized entity or a pure waste of physical resources. Hence, it is impossible

for any ledger to simultaneously satisfy the following three properties: (i) correctness, (2) decentralization, and (3) cost efficiency.” Otherwise stated, any correctly working ledger (which also wants to be efficient in cost terms) cannot be decentralized. At the same time, as soon as demand for central bank money would grow, sovereign debt or private assets might become a Sword of Damocles in the central banks’ balance sheets. According to this scenario, the central bank itself would be responsible for compliance with the principles of “know your customer” (“Know your customer (KYC) is the due diligence and bank regulation that financial institutions and other regulated companies must perform to identify their clients and ascertain relevant information pertaining to doing financial business with them” (Mishra, 2009, p. 169)) and “anti-money laundering” (AML) (“Private actors [. . .] are responsible for detecting and reporting transactions that may be linked to money laundering” (Verhage, 2011, p. i)). Although it could be imaginable to delegate private (external) operators, central banks would still carry any further (financial as well as reputational) risk. More precisely:

“the most significant and plausible financial stability risk of a general purpose CBDC is that it can facilitate a flight away from private financial institutions and markets towards the central bank. Faced with systemic financial stress, households and other agents in both advanced and emerging market economies tend to suddenly shift their deposits towards financial institutions perceived to be safer and/or into government securities. Of course, agents could always flee towards the central bank by holding more cash. But a CBDC could allow for “digital runs” towards the central bank with unprecedented speed and scale”

(Committee on Payments and Market Infrastructures – Markets Committee, 2018, pp. 16, 18).

On June 10, 2018, Switzerland held a referendum (rejected by approximately 74% of voters) called “Swiss Sovereign Money Initiative,” proposing that 100% of sight deposits should be transferred to the central bank, while commercial banks should not be allowed to issue money. More precisely, “[a]fter a changeover to sovereign money, the banks will continue to offer all the normal financial services (giving credit, enabling transactions, wealth management etc.). However, there will only be central bank money in our current accounts at the bank. [. . .] The banks can only work with money they have from savers, other banks or (if necessary) funds the central bank has lent them, or else money that they own themselves” (Swiss Sovereign Money Initiative, 2015, Internet). According to authors like Bacchetta (2018, [no indication]), “the initiative goes much beyond what would be the equivalent of full reserve requirement and would impose severe constraints on monetary policy; it would weaken financial stability rather than reinforce it; and it would threaten the trust in the Swiss monetary system”). At this point, it has necessarily to be asked how payment systems might be otherwise meliorated. More precisely, how could they become stronger without opting for central bank digital currencies? A CBDC would allow the broad public to make use of a non-tangible form of central bank money. According to authors in favor of a digital currency issued by central banks:

“[w]hile Bitcoin shows some promise as a digital currency, its volatility makes it inaccessible to the majority of consumers. A central bank digital currency might rectify this problem by allowing consumers to own a safe form of fixed-price electronic money that, like cash (but unlike Bitcoin), is denominated in the existing unit of account. At the same time, unlike cash (and like Bitcoin) this digital currency would be capable of being used over long distances”

(Koning, 2016, p. 36).

According to these scenarios, central banks would allow free convertibility of their digitally issued units to cash at a fixed Unitarian rate. At the same time, digital currency units would be another typology of central bank liability beyond cash or reserves. While cash can be used, reserves tend to be rather accessible to banks. If non-financial subjects want to hold non-tangible instruments, they must make use of deposits at commercial banks. It is evident

that these are claims against commercial banks (and not against the central bank). Central bank digital currencies would instead allow all remaining economic actors to hold non-tangible central bank money representing claims against the central bank itself. This would be another form of central bank liability in addition to cash convertible at par at a fixed (as well as Unitarian) rate (“In practice, the central bank would guarantee convertibility between CBDC units, cash and reserves at a fixed rate of 1:1:1” (Kiel Institute for the World Economy, 2018, p. 18)). A digital currency issued by the central bank could take the place of bank deposits and become the leading way of holding money. For sure, “[a] slow but large substitution from deposits into CBDC could pose a growing challenge to the sustainability of current bank business models” (Meaning *et al.*, 2018, p. 12). Customers would, then, have to decide to hold liquidity as cash, digital central bank money or bank deposits. If these alternatives were to be perceived as reliable enough, commercial banks would progressively lose deposits [5], since they typically collect short-run deposits and grant long-run loans (i.e. “maturity transformation”). The fractional reserve banking system would face big changes in the case of significant transfers of resources by customers to CBDC accounts and the fractional reserve banking system would be challenged to its core (Kiel Institute for the World Economy, 2018, p. 5). The latter point has been also recently highlighted by the President of the Deutsche Bundesbank, Jens Weidmann, who argued that “demand for digital money might be bigger and more volatile than for paper money” (Frankfurter Allgemeine Zeitung, 2019, Internet [own translation]).

Which roadmap for “stable” independent currencies?

As reminded in Kiel Institute for the World Economy (2018), it is clear that any sudden transfer of commercial bank deposits to central bank digital currency accounts would be potentially harmful for the financial sector as a whole. More precisely, it might have comparable effects to a bank run, with the only difference that no depositors would need to wait in front of ATMs (“Electronic transfers of balances from a commercial bank to a digital currency could occur quickly as the physical location of depositors and number of physical withdrawal points are not a limiting factor” (Wadsworth, 2018, p. 16)). Otherwise stated, liquidity would be conveniently transferrable via online banking to the central bank digital currency account. Liquidity would, nevertheless, flow out from the commercial banking sector at alarming rates. Therefore, financial institutions would have to replace lost liquidity by finding new ways of (re)financing, like selling assets. If this would not work, the central bank might even be required to provide needed liquidity in order to avoid a collapse of the banking and financial system. Since fractional reserve deposits are perceived as riskier in times of financial distress – this is also proven by “capital flights” during crises – the central bank (i.e. the lender of last resort) would have to compensate for high variation rates of liquidity in the banking system. But, this would pose a heavy burden on central banks’ shoulders, since “[t]he credibility of the obligation therefore turns on the central bank’s commitment to be the lender of last resort, potentially taking an unprecedented risk onto its balance sheet given the potential size of the liquidity requirements” (Kumhof and Noone, 2018, p. 14). Given the fact that deposits would be less reliable in order to make up for financing needs of the banking and financial sector, it would be not farfetched for (excess) reserves to become a new way to deal with this kind of instability. If a similar self-regulatory approach should turn out to be insufficient, an increase of the minimum reserve ratio on sight deposits might be a more structural solution. In general:

“deposits as a source of bank funding would be reduced (1) if there was an increased use of CBDC accounts instead of deposits, (2) if there was an increase in the minimum reserve requirement and (3) if there was an increase in excess reserve holdings out of risk considerations of the bank”

(Kiel Institute for the World Economy, 2018, p. 19).

In the scenario that a 100% reserve would be required (“During the last two and a half years there has been a fast growing interest in the plan to put and keep a 100% cash Reserve behind all Demand Deposits. [. . .] it would remove the chief cause of both booms and depressions, namely the instability of demand deposits, tied as they are now, to bank loans” (Fisher [1936], 2009, p. 8), banks would have to give up being financed with sight deposits. If central bank digital currencies should be successfully introduced, today’s fractional reserve system might become a full reserve system or, at least, limit commercial banks’ ability to issue money by a stroke of a pen. Sight deposits would, therefore, become the main source of financing. At the same time:

“[a] 100 percent reserve system dramatically reduces the elasticity of money and credit creation in the commercial banking sector. This would increase financial stability as the current maturity mismatch of banks’ assets and liabilities would be reduced by the substitution of short-term funding through deposits with longer-term financing instruments. Second, with less bank deposits and more CBDC units in use, base money would increase sharply and permanently. Due to this major increase of the monetary base, the government sector would generate higher revenues from money creation (at the expense of commercial banks)”

(Kiel Institute for the World Economy, 2018, p. 19).

The loss of revenue from money creation would be quite likely compensated by higher fees for financial services. Banks’ lending ability would be limited to financial intermediation, namely, the simple transfer of already electronically existing funds (like savings by depositors), while money creation would only pertain to the central bank (“Under a full reserve system, the central bank will have to issue central bank money to cover all deposits” (Nyborg, 2016, p. 270)). Many central banks conduct research on how to make use of blockchain technology, digital currencies or launching a digital currency. Among the central banks of advanced economies thinking of doing this, the Swedish Riksbank is openly discussing a CBDC for the Swedish currency (“e-krona”):

“[t]he Riksbank therefore proposes that a committee with all-round expertise be tasked with performing a review of the concept of legal tender, the state’s role with regard to means of payment in a digitalized economy and the role and responsibility of both the state and the private sector on the payment market”

(Sveriges Riksbank, 2019; Internet).

At the same time, abolishing cash would not limit monetary policies to the zero lower bound (“One promising opportunity for monetary policy is that a central bank digital currency could relax the so called ‘zero lower bound’ constraint on nominal interest rates; at least, to the extent that it would substitute for banknotes and coins” (Smets, 2016, p. 6)). As just anticipated, if cash were abolished and a CBDC simultaneously introduced, the effect would be stronger (“paper currency [. . .] makes it difficult for central banks to take policy interest rates much below zero, a limitation that seems to have become increasingly relevant during this century” (Rogoff, 2014, p. 1)). So far, it has been assumed that a central bank digital currency would have had to complement (not substitute) cash. In the latter case (namely, supposing an abolition of paper money), the impact on monetary policy would be particularly heavy. Obviously enough, unlike cash, central bank digital currency might be subject to interest rates, while any negative one would be nothing else than a tax on using money. *De facto*, the lower bound would be hereby removed. However, since cash still plays a significant role in people’s habits and maintains a high (or nearly complete) level of privacy, it would require a(n unlikely) strong power and willingness to abolish it, which might be at the origin of corresponding resistances at several levels (“the CBDC issuing is more likely to occur the more the individuals likes to use a legal tender, and/or are indifferent respect to anonymity; at the same time, the probability of the CBDC introduction increases if a return

can be paid on it, and/or its implementation can guarantee at least the counterparty anonymity” (Borgonovo *et al.*, 2017, p. 1)). As pointed out by the ECB Crypto-Assets Task Force (2019, p. 33), “physical cash provides a level of privacy that may prove difficult to replicate in its digital version (CBDC) from a technical perspective. If it were replicated, however, it would raise issues with respect to the enforcement of laws against money laundering and the financing of illegal activities.” The introduction of a CBDC parallel to cash would be, instead, a first step in order to accustom people to a new means of payments (“It seems crucial that academics and banks reconcile the benefits of a world with both fiat and virtual currencies and try to find ways to integrate physical cash into the electronic world” (Hernandez-Verme and Valdes Benavides, 2013, p. 340)). What has to be taken into consideration is that digital currencies issued by central banks might threaten the fractional reserve system itself. In fact, since today’s banking system is centered around fractional reserves, it might soon be endangered by alternative (as well as “safe”) forms of holding economic resources as digital currencies instead of bank deposits. Probably, the latter would have to be gradually replaced by other funding sources. However, according to Whelan (2018) – even if virtual currencies were to replace State-issued money – there would still be a significant need for financial intermediation (to be also regulated). At the same time:

“[i]f cash were abolished simultaneously, the impact on monetary policy would be more severe. So far, an effective lower bound on nominal interest rate policy prevails due to the option of withdrawing cash and receiving a nominal return of 0 percent. Unlike cash, CBDC units could easily be charged with positive and negative interest rates (with negative “interest rates” being a tax on money users). Without a way out of the banking system (cash), people would be forced to accept even negative interest rates, so that the effective lower bound would be removed”

(Whelan, 2018, p. 20).

Regulations about liquidity and solvency would be still required so that central banks would be able to maintain control over the total amount of credit as well as supply of broad money (including demand deposits). At the same time, “[m]ost likely, future financial intermediaries will continue to offer demand deposits to customers and this will mean operating a fractional reserve banking system. This would mean the supply of money, in the form of actual Bitcoins plus Bitcoin-denominated deposits people hold with banks, would be much larger than the monetary base of 21 million bitcoins”) (Whelan, 2018, p. 14). Since fractional-reserve banking is structurally unstable, a future Bitcoin-based banking sector would still necessitate a central bank as well as commercial banks having to store a part of their economic resources as “reserves” in the national bank itself. With specific regards to the Swedish case “[g]iven that the large majority of the general public in Sweden no longer uses cash, Riksbank has found it important to provide a safe, liquid payment instrument equally to both the general public and financial institutions for the sake of fairness in a democratic society. This reflects the concerns that private sector issuers may take advantage of their privileged positions” (Shirai, 2019, p. 15). Issuing a central bank digital currency might, therefore, be a strategic decision in order to avoid losing influence to the advantage of parts of the banking and financial sector.

At this stage, it seems that central banks are the only actors being potentially able to create a stable-value digital currency. National banks can issue digital currencies by fiat (“The word fiat has a Latin origin that means “let it be done.” As applied to money, fiat refers to the case where the state orders that a particular form of money serve as currency and be treated as legal tender” (Rickards, 2014, p. 138)), can pump it into circulation by buying financial assets and retire it by selling them. At the same time, it can guarantee the maintenance of parity between digital and non-digital liabilities by exchange them – if necessary – in unlimited amounts. In fact, “[a] World Economic Forum research paper revealed that more than 90 central banks are engaged in discussions worldwide about the

potential issuance of a central bank digital currency” (Roland Berger, 2016, p. 7). For sure, a central bank digital currency might be conceived in very different ways. One of the most evident approaches is allowing individual – otherwise stated: not only banking and financial institutions – to hold electronic accounts with the central bank. For instance, as Bjerg (2017, p. 8) reminds, “[w]ith universal access to the central bank balance sheet, ordinary money users now for the first time have the option to choose between holding electronic money with the central bank or with commercial banks.” Hence, the central bank would provide similar services to other affiliates of the banking and financial sector, meaning that “[a] central bank that took deposits from the public would end up competing head to head with commercial banks, even as it served as the regulatory overseer of the same institutions” (Raskin and Yermack, 2016, p. 13). Alternatively, the national bank could issue digital units circulating among mobile wallets or on electronic smart cards and allowing for direct payments (“Mobile money is an electronic wallet service that allows users to store, send and receive money using their mobile phones. The value stored in the wallets may be liabilities of the service provider or claims on money held in trust at a commercial bank” (Bech and Garratt, 2017, p. 60)). This model would be presumably useful especially for smaller transactions. It is also conceivable that access to central bank digital currency might be restricted to businesses and useable only for wholesale payments. At the same time, it has to be questioned if the monopolistic position granted to a public-sector company contributes to efficiency (or not).

Nevertheless, “Eichengreen recognizes that having “the central bank issue the digital currency, much less giving it a monopoly in this space, would not appeal to libertarians who oppose all government involvement”” (Albrecht, 2019, Internet). Of course, it could be imaginable to establish different systems in equally heterogeneous nations attaching various degrees of anonymity to transactions by means of central bank digital currencies. Even a blockchain-based approach where all transactions would be anonymous (obviously enough, bearing several risks in terms of tax evasion, money laundering or criminal activities) might be possible. Alternatively, the debate could be centered around a system where the central bank would be aware of residents’ balances but not their transacting counterpart. Obviously enough, concentrating all digital currency transactions at the central bank would also be responsible for accumulating excessive risks, which is for sure not a farfetched conclusion if the reader thinks of how clearing of trading with derivative securities in central clearing houses might concentrate failure risk. In the worst-case scenario (if digital currencies would have replaced paper money), a similar outcome might result in a complete stop of all transactions. At the same time, the central bank’s digital currency network might become a target for terrorists and hackers. Counterfeiting of digital currency and preventing its theft represent another critical aspect [6]. Blockchain might be an element contributing to find an adequate solution, as described by David Wen in Xintong and Yanqing (2018, Internet): “[t]o resolve an issue, we may need to use multiple technologies including blockchain. For [digital fiat currency], there are multiple technological layers, and the blockchain is just one of them. The blockchain protects data.” Nevertheless, Grym *et al.* (2017, p. 9) argue that blockchain would not be suitable for central bank digital currencies and plead for other alternatives (“Blockchain technology made known by Bitcoin would hardly be applicable to retail payments, at least in its current form. A more probable solution would be an arrangement based on a more centralised ledger, with many of the characteristics of traditional cash”).

Another concern related to financial stability is the potential danger of facilitating runs on conventional banks (“The conflation of broad and base money, and the separation of credit and money, would allow the [central bank] to control the money supply directly and independently of credit creation, calling for a reassessment of monetary policy” (Tolle, 2016, Internet)). Claims on the central bank are mostly free of any default risks, while this might not equally apply to commercial banks. Historically, as soon as doubts about the stability of the (commercial) banking system increase, depositors have “translated” their economic resources

into currency (Boughton and Wicker, 1979). Of course, the risk is that a similar behavior might become more frequent – for instance, if digital balances might be easily transferrable from commercial to central banks by use of the smartphone – with potentially destabilizing effects. Some observers have therefore suggested that this risk could be mitigated by limiting such transfers or the size of central bank digital accounts. For instance, the Danmarks Nationalbank (2016, p. 13) underlines that “[i]t is not part of Danmarks Nationalbank’s objectives to make unlimited claims on the central bank available to the general public,” while Coats (2018, Internet) confirms that “[t]he magnitude of the digital run could be limited by limiting the size of CBDC payments.” This scenario would, however, re-introduce a situation where central bank money would trade at a premium to accounts held at commercial banks, which would in turn reestablish all the complications of any non-uniform currency.

Finally, implications of central bank-issued digital currencies for monetary policy have to be taken into consideration. In fact, monetary policy operates primarily by influencing the deposit and lending interest rates of commercial banks. If digital currency issued by a central bank should be introduced, it would facilitate the shift of balances to the central bank by (non-)financial subjects. Obviously enough, if a positive interest rate would be paid on those central bank balances, individuals would have a structural incentive to do so. Commercial banks might also see more rapidly the effect of the change in the policy rate on their funding costs, which would, in turn, increase the speed of pass-through from the policy to other interest rates (“To the extent that pass-through from policy rates to deposit and wholesale rates has been estimated to be less than one, CBDC is likely to strengthen this stage of transmission” (Meaning *et al.*, 2018, p. 21)). If a certain change in the policy rate allowed for a larger shift away from retail deposits of commercial banks, the size of the induced change in lending rates might be accentuated too. These effects could, however, be eliminated (or, at least, reversed) if banks would respond to the greater flightiness of demand deposits by increasing reliance on time deposits as well as other forms of long-term funding.

Introducing a central bank digital currency could overcome the zero lower bound on interest rates [7], because central banks might decide to pay negative interest on the balances of customers, like some of them already did with specific regards to reserves. Since nowadays central banks have to make use of quantitative and credit easing (which are sometimes considered rather “opaque”), monetary policy might become more “transparent” in terms of interest-rate operations (“The launching of CBDC provides a landmark opportunity to enhance the transparency of the central bank’s monetary policy framework” (Bordo and Levin, 2017, p. 15) and “a clear lesson from recent experience is that unconventional monetary policy tools are complex and opaque” (Bordo and Levin, 2019, p. 18)). However, this would require the abolition of cash, which economic subject might hold to avoid negative rates (“Cash accrues zero interest and hence becomes increasingly attractive as a store of value when nominal interest rates are negative. [. . .] That constraint on monetary policy could be eliminated by establishing a graduated schedule of fees on transfers between cash and CBDC” (Bordo and Levin, 2017, p. 12)). Maintaining universal central bank digital accounts would be a way of facilitating the use of “helicopter money” (instead of quantitative easing). Of course, such an approach would imply a distribution rule answering to the following key questions: Would everyone get the same amount? Or, would it be based on existing holdings? Even after introducing central bank digital currencies, “helicopter money” would be likely to be highly improbable. Overall, it would appear that the implications for monetary policies would by far not be groundbreaking.

Critical considerations on cryptocurrencies, cash and digital central bank currencies

Anyone having already heard about Bitcoin (i.e. the main cryptocurrency) (a “crypto-token” as recently renamed by the President of the Deutsche Bundesbank during a symposium on

the future of cash held in Frankfurt am Main on February 14, 2018) is aware of its technical complexity and how polarizing the debate might become. Just to make sure that some basic features of cryptocurrencies are not taken as implicit, they are recently (in 2009) created financial instruments of private issue being “minable” by economic subjects by using the computational capacity of their PC’s graphic card (which should be connected to a network of other processors). In other words, with the right computational power (as well as IT skills) as well as by letting a PC run for many hours, it might be possible to generate a number of cryptocurrencies of purely electronic nature. To this “output,” a positive price (determined by real-time exchanges and, basically, supply and demand) is then attributed. In 2018, it was big news in Italy that a Chinese buyer purchased a real estate in Turin by means of Bitcoins (Angius, 2018). However, why are they called “cryptocurrencies”? Without analyzing the linguistic origin of the term, this denomination goes back to the fact that each unit is constituted by a numerical block code, which after each transfer (e.g. payment of commercial/financial transactions) will be added to the previous ones (increasing the cumulative length), but at the same time ensuring a numerical history of all transactions carried out. In the light of such complexity, anonymity might not be complete but is still very high. Supporters of cryptocurrencies – there are more than 1,500 different ones, among which Bitcoin is certainly the most famous one (as well as the highest-pricing) – emphasize not only the innovativeness of their underlying technology (i.e. the so-called “blockchain”), but also the fact of being independent from central banks and banking systems (i.e. the so-called “money-issue monopoly”). In fact, among the arguments in support of their potential immunity against crises of the banking system, there is precisely that cryptocurrencies are not issued by financial institutions, but by single individuals. According to this analytical approach, cryptocurrencies would also perfectly match the functions normally held by “legal tenders” as traditionally defined, namely, that of “means of payment” (settling (inter)national commercial/financial transactions), “units of account” (denominating securities, deposits or other financial instruments) and “store of value” (representing an alternative way of holding savings). In other words, cryptocurrencies are not only considered to be a valid alternative payment instrument (as well as *numéraire*), but also a possible investment. At the same time, since they are mostly subject to an upper limit in terms of volumes of issue in order to avoid losses of value, their supporters emphasize the non-inflationary nature of cryptocurrencies.

Despite these considerations, there is no doubt that investing in cryptocurrencies is linked to a high level of risk (given by their unexpected price fluctuations). While it is true that the general public does not use them frequently (or, even, at all), potentially leading to significant price variations, it cannot be forgotten that it subsists, at least at a macroeconomic level, a precise difference between the terms “value” and “price.” To be clear, if the price of a cryptocurrency unit is certainly more than positive (Bitcoin’s price currently stands at 8,577.65 U.S. dollars), it could be hardly claimable that its value is different from zero (or something like this). Nevertheless, why? Because they are created “out of nothing” – otherwise stated, from a mere accounting perspective – without any coverage provided by precious metals or the economic strength of the corresponding country (i.e. its GDP) as it should in turn be in the case of “regular” money issues by the banking system. The principle of creation of similar financial instruments on a private basis (i.e. detached from the banking system) represents a completely new issue. Because, if it is true that “private currencies” have been theorized over the course of history by authors such as Friedrich August von Hayek (1976), it is equally correct that in time periods of economic bubbles with increasing gaps between “prices” of goods/services/financial securities and their actual “value,” cryptocurrencies are certainly not particularly dissimilar. In fact, it is hard to imagine how it might possible for private (but also public) subjects to create “wealth” out of nothing. The recurrent argument that cryptocurrencies would not be issuable above a given threshold is not necessarily a proper one since “scarcity” is just one of several elements, which financial

instruments should embody. Otherwise stated, scarcity of what “has no intrinsic value” certainly does not make it “more precious or worthy,” although (if there is a demand for it) the price of selling will be positive. As already mentioned, no economic subject can “discharge his/her obligations” by means of a simple monetary issue. It is unthinkable that payments in an economic system are not made in “real” terms (i.e. without making use of previous incomes, namely, savings or wealth). Obviously enough, central banks themselves have often over-issued liquidity to support the economic and financial system, but this will inevitably lead to “inflation” in its original monetary sense, namely “a rise of money in circulation in the economy (Hyman, 2011, p. 22). At the same time, it goes without saying that “economic bubbles” (which are made of initially soaring and unexpectedly, bursting price levels of goods/services/financial claims) are even terminologically linked to the concept of “inflation,” which comes from the Latin verb *inflare* meaning “to blow into” (Chambers, 2008, p. 695). As soon as such excess liquidity is disinvested/withdrawn from them, prices crumble, leading to an “exploding economic bubble.” These key-principles are worth mentioning in order to better understand some further risks affecting private currencies, which are not dismissed by the “scarcity argument.”

At the same time, if it is true that the blockchain technology has a great potential; its additional ability to make economic resources transferable within a limited space of time (and with no supervision of banking institutions) is paradoxical in the light of the fact that European countries are restricting the legal use of cash, which, for sure, guarantees anonymity but does not allow instantaneous transfers. Despite several criticisms, paper money is, therefore, less “comfortable” to be used in case of illegal activities. Anyway, there is, for sure, something fundamentally strange (if not even wrong) by comparing the price differential existing between an ounce (28.35 g) of gold – currently, at 1,336.05 U.S. dollars – and Bitcoin, which, in 2017, reached levels of almost 20,000 U.S. dollars.

Turning back to the “cash argument,” there is no doubt that transactions settled by means of paper money and coins (as compared to their immaterial competitors) are less efficient and modern. Should they be therefore replaced? Not at all! For instance, there are some deep-rooted emotive components justifying the usage and holding of cash, which – if suddenly limited by law – could even affect the economic well-being itself. It should be remembered that every national currency – especially, in its tangible form – represents an epitome of local identity. In addition, it is not unlikely that people prefer to conceive their own economic wealth as a mix of coins, paper money, shares, bonds, certificates of deposit and so forth. Economic subjects consume as long as they feel sufficiently “safe,” which is a subjective perception also oriented by several other factors. Abolishing and/or limiting cash could therefore have destabilizing effects, which could be even comparable to the demonetization of precious metals (collateralizing, in the past, the issue of paper money). Currently, in the absence of economic systems linked to gold, cash has taken over the same role of guarantee previously held by precious metals. Hence, it is no coincidence that – when the British financial institution Northern Rock collapsed in 2007 – depositors wanted to withdraw (and not transfer) their savings. Otherwise stated, cash turns from being a mere preference in good economic times into becoming a “safe heaven” as soon as a crisis occurs. Recent cash restrictions introduced in several European countries (Table 3), therefore, represent a concrete risk. In fact, if the most used payment instrument is limited by law by means of a “top-down approach,” similar measures will almost certainly have an impact on economic growth.

Obviously enough, emotive and historical reasons, practicality or payment finality, are not the only ones in support of the role of cash. Privacy (which is a fundamental right at the origin of trust, which is, in turn, responsible for the decision to accumulate wealth) is also a valid justification. Central bank digital currencies, namely, a sort of compromise between “not abolishing cash” but at the same time “making it immaterial,” are (at least, in 2019) not a

Cash payment limitations (set by law and not on a contractual basis) in European countries

Belgium	3,000 Euro (→ goods/services)
Bulgaria	9,999 leva (≈5,110 Euro)
Croatia	15,000 Euro
Czech Republic	350,000 CZK per day (≈14,000 Euro)
France	1,000 Euro (→ taxpayers based in France as well as for foreign salesmen)/15,000 Euro (→ non-resident taxpayers)
Greece	1,500 Euro
Italy	2,999.99 Euro
Poland	15,000 Euro (≈62,220 PLN)
Portugal	1,000 Euro (→ goods and services between consumers and traders)
Romania	10,000 RON/person/day (≈2,260 Euro)
Slovakia	5,000 Euro (→ B2B-, C2B- und B2C-payments)/15,000 Euro (→ natural person who is acting for purposes which are outside his or her trade)
Spain	2,500 Euro (→ residents)/15,000 Euro (→ non-residents)

Source(s): [European Consumer Centre Germany \(2019\)](#)

Table 3.
Cash payment
limitations (set by law
and not on a
contractual basis) in
European countries

solution, even if they would overcome the zero-lower bound issue. In fact, bank runs have (even recently) occurred not because savers feared for their savings deposited with commercial (instead of central) banks. They just took place, because depositors have become reluctant to hold their savings on a bank account (i.e. in their immaterial form) and wanted to get them back in their tangible form. Physicality and tangibility are – as we already said, at least in 2019 – a still important aspect, which becomes even more relevant during bad economic times.

Concluding remarks

The paper has highlighted why traditional payments and clearing systems are still relevant despite ongoing developments in digital settlement instruments. At the same time, the latter have to be critically analyzed in order to understand how they might contribute to improve today's (inter)national payments schemes. According to several authors, the coexistence of State's money (i.e. "legal tender") and cryptocurrencies can have a disciplining effect on central banks. It is no secret that [Hayek \(1976\)](#) heavily criticized the State's monopoly of money issue. At the same time, [Fatàs and Weder di Mauro \(2018\)](#) recognize that cryptocurrencies may contribute to a new interpretation of the concept of "money" intended as "means of payment." Nevertheless, there are still high risks connected to the introduction of central bank digital currency, which should not be considered to be a perfect substitute of current cash. At the same time, cryptocurrencies issued by central banks might be exposed to the drawbacks of cryptocurrencies without benefiting from correspondingly strong advantages. A well-governed two-tier system to be achieved through innovation in payment infrastructures might be, in turn, more preferable. Regulated competition by new players combined with "traditional" deposits and central bank elements remains essential, although authors like [Niepelt \(2016\)](#) argue that central banks should embrace the technologies underlying cryptocurrencies, because risk payment service providers could move to other currency areas considered to be more appealing for buyers and sellers. In the light of these considerations, even the role of traditional payment systems like paper money is by far not outdated or cannot be – at this point, at least – replaced by central bank digital currencies (whose features based on dematerialization despite being issued and guaranteed by a public authority are very different). Finally, the very recent announcement that Facebook might issue its digital coin (called *Libra*) proves once again how current the topics

analyzed above are. And, by the way, concerns about it should not be due to the increasing economic power of some multinational enterprises (already storing relevant and strategic data on individuals' behavior). In fact, what remains true is that nobody can create wealth (or positive purchasing power) by a stroke of a pen, but just (excess and, therefore, inflationary) liquidity. Otherwise stated, the increased frequency of such attempts to avoid the monopoly of issuance of the central bank can be compared to a "modern Middle Age" in monetary terms when seigniorage still ruled. If Libra should be instead inflation-neutral, namely, based on existing bank deposits (for instance, denominated in US-dollars), it has to be asked why individuals should opt to hold a non-official currency. For sure, the scientific debate will bear further developments in the next future.

Notes

1. Blinded.
2. "Finally" has to be intended in the traditional sense implied by international monetary institutions, namely, as "the discharge of an obligation by a transfer of funds and a transfer of securities that have become irrevocable and unconditional" ([Committee on Payment and Settlement Systems, 2003](#), p. 24).
3. Routledge and Zetlin-Jones (2018, p. 1) instead argue that "blockchain distributed ledger technologies, such as those which support Bitcoin and Ethereum, can be adapted to eliminate self-fulfilling speculative attacks on a currency."
4. Proof-of-Burn (PoB) is an alternative blockchain mechanism inducing arbitrarily low volatility with arbitrarily enhanced welfare. As pointed out by Auer (2019, p. 23), "in the digital age too, good money is likely to remain a social construct rather than a purely technological one: the efficiency of decentralized exchange via proof-of-work exclusively is much lower than would appear at first sight, and alternative technologies still need to demonstrate that they can function without institutional backing." The paper by Saleh (2019), for instance, shows how PoB entails PoW characteristics like free entry and deflationary monetary policies, but fulfills this task without (too) high volatility or welfare losses.
5. In this specific regards, it has to be mentioned that if commercial banks would replace the outflow of deposits with repos (*alias* repurchase agreements), collateral eligibility would increase. Otherwise formulated, the central bank would suddenly become more exposed to credit risks. This mechanism is also explained by the Committee on Payments and Market Infrastructures – Markets Committee (2018, p. 13) by stating that "[a]s central bank credit to monetary counterparties is collateralized, a widening of collateral eligibility may be necessary to accommodate banks' increased recourse to credit facilities to compensate for the loss of funding due to CBDC inflows."
6. Enterprises like eCurrency aim at providing central banks with hardware and software and advanced cryptography protecting them against counterfeiting, theft and security threats ("the eCurrency technology powers an instrument that has the same legal tender status as banknotes and coins. Digital fiat currency is secure, transparent, and efficient. The digital payment instrument issued by the Central Bank infuses trust in all digital transactions" ([eCurrency, 2019](#), Internet)).
7. For instance, [Barrdear and Kumhof \(2016\)](#) find that "[i]n a DSGE model calibrated to match the pre-crisis United States, we find that CBDC issuance of 30% of GDP, against government bonds, could permanently raise GDP by as much as 3%, due to reductions in real interest rates, distortionary taxes, and monetary transaction costs" ([Barrdear and Kumhof, 2016](#), p. i). In this context, the authors assume that cash and the limits imposed by the zero lower bound would not exist.

References

- Abadi, J. and Brunnermeier, M. (2019), "Blockchain economics", NBER Working Paper Series, Working Paper 25407, National Bureau of Economic Research, Cambridge, MA.
- Agarwal, R. and Kimball, M. (2015), "Breaking through the zero lower bound", IMF Working Paper Series, Working paper 15/224, International Monetary Fund, Washington, DC.

- Al-Naji, N., Chen, J. and Diao, L. (2017), "Basis: a price-stable cryptocurrency with an algorithmic central bank", *BitMEX*, available at: https://www.basis.io/basis_whitepaper_en.pdf (accessed 31 May 2019).
- Albrecht, B.C. (2019), "The history of money and the future of cryptocurrency", *American Institute for Economic Research*, available at: <https://www.aier.org/article/sound-money-project/history-money-and-future-cryptocurrency> (accessed 3 June 2019).
- Andolfatto, D. (2015), "Fedcoin: on the desirability of a Government cryptocurrency", *MacroMania*, available at: <http://andolfatto.blogspot.com/2015/02/fedcoin-on-desirability-of-government.html> (accessed 29 May 2019).
- Angius, R. (2018), "Una cinese ha comprato casa in bitcoin. A Torino", *Agenzia Gionalistica Italiana*, available at: https://www.agi.it/economia/comprare_casa_bitcoin-3415428/news/2018-01-26 (accessed 12 June 2019).
- Arestis, P., Basu, A. and Mallick, S. (2005), "Financial globalization: the need for a single currency and a global central bank", *Journal of Post Keynesian Economics*, Vol. 27 No. 3, pp. 507-531.
- Auer, R. (2019), "Beyond the doomsday economics of "Proof-of-Work" cryptocurrencies", BIS Working Paper Series, Working paper 765, Bank for International Settlements, Basel.
- Bacchetta, P. (2018), "The sovereign money initiative in Switzerland: an economic assessment", *Swiss Journal of Economics and Statistics*, Vol. 154 No. 3, pp. 1-16.
- Baliño, T.J.T., Bennett, A. and Borensztein, E. (1999), *Monetary Policy in Dollarized Economies*, IMF Occasional Papers, Paper 171, International Monetary Fund, Washington, DC.
- Balasubramanian, K. (2016), "Web application vulnerabilities and their countermeasures" in Balasubramanian, K.N, Mala, K. and Rajakani, M. (Eds), *Cryptographic Solutions for Secure Online Banking and Commerce*, Information Science Reference, Hershey.
- Bank for International Settlements (2018), "V. Cryptocurrencies: looking beyond the hype" in *Bank for International Settlements* (Ed.), *BIS Annual Economic Report*, Bank for International Settlements, Basel.
- Barrdear, J. and Kumhof, M. (2016), "The macroeconomics of central bank issued digital currencies", Bank of England Staff Working Paper Series, Working paper 605, Bank of England, London.
- Basis (2018), available at: <https://www.basis.io> (accessed 12 June 2019).
- Bech, M.L. and Garratt, R. (2017), "Central bank cryptocurrencies", *BIS Quarterly Review*, pp. 55-70.
- Belke, A., Bernoth, K. and Fichtner, F. (2011a), *Die Zukunft des Internationalen Währungssystems*, Vol. 37-38, DIW Wochenbericht, Berlin, pp. 11-19.
- Belke, A., Bernoth, K. and Fichtner, F. (2011b), "The future of the international monetary system", *DIW Economic Bulletin*, Vol. 1 No. 4, pp. 11-17.
- Benigno, P. (2019), "Monetary policy in a world of cryptocurrencies", LUISS Guido Carli Working Paper Series, Working paper 4/2019, LUISS Guido Carli – School of European Political Economy, Rome.
- Berentsen, A. and Schär, F. (2018), "The case for central bank electronic money and the non-case for central bank cryptocurrencies", *Federal Reserve Bank of St. Louis Review*, Vol. 100 No. 2, pp. 97-106.
- Beretta, E. (2012a), "Silvio Gesells Internationale Valuta-Assoziation – Das Gestern und Heute eines noch aktuellen Beitrags zur Reform der globalen Währungsordnung", *Zeitschrift für Sozialökonomie*, Vols 174-175, pp. 15-24.
- Beretta, E. (2012b), "Some monetary lessons from the German economists of the past: lights and shadows in the collective memory", *Journal of Security and Sustainability Issues*, Vol. 1 No. 3, pp. 205-217.
- Beretta, E. (2013), "Zwischen Gesells IVA-Note und Keynes' Bancor-Plan", *Zeitschrift für Sozialökonomie*, Vols 178-179, pp. 25-36.

- Beretta, E. (2014), "Expert opinion – The irreplaceability of cash and recent limitations on its use: why Europe is off the track", *Banknotes of the World*, Vol. 12, pp. 21-23.
- Beretta, E. (2015a), "Europe's cash restrictions: a recipe for home-made economic instability", *Applied Economics Quarterly*, Vol. 61 No. 4, pp. 373-390.
- Beretta, E. (2015b), "Europe's new but wrong approach to cash", *Currency News*, Vol. 13 No. 4, pp. 5-8.
- Beretta, E. (2016), "The wrong fight against cash: an update", *Currency News*, Vol. 14 No. 7, p. 8.
- Beretta, E. (2017), "Cash restrictions, alias the EU's brake on growth: new analytical and empirical evidence", *Currency News*, Vol. 15 No. 7, p. 7.
- Blinder, M. (2018), "Making cryptocurrency more environmentally sustainable", Harvard Business Review, available at: <https://hbr.org/2018/11/making-cryptocurrency-more-environmentally-sustainable> (accessed 12 June 2019).
- Boel, P. (2016), "Thinking about the future of money and potential implications for central banks", *Penning- och Valutapolitik*, Vol. 1, pp. 143-154.
- Bofinger, P. (2018), *Digitalisation of Money and the Future of Monetary Policy*, VOX – CEPR Policy Portal, available at: <https://voxeu.org/article/digitalisation-money-and-future-monetary-policy> (accessed 10 June 2019).
- Bordo, M.D. and Levin, A.T. (2017), "Central bank digital currency and the future of monetary policy", NBER Working Paper Series, Working paper 23711, National Bureau of Economic Research, Cambridge, MA.
- Bordo, M.D. and Levin, A.T. (2019), "Digital cash: Principles and practical steps", NBER Working Paper Series, Working Paper 25455, National Bureau of Economic Research, Cambridge, MA.
- Borgonovo, E., Caselli, S., Cillo, A. and Masciandaro, D. (2017), *Beyond Bitcoin and Vash: Do We like a Central Bank Digital Currency? A Financial and Political Economics Approach*, BAFFI CAREFIN Centre Research Paper Series, Research paper 2017-65, Università Commerciale L. Bocconi, Milan.
- Boughton, J.M. and Wicker, E.R. (1979), "The behaviour of the currency-deposit ratio during the Great Depression", *Journal of Money, Credit, and Banking*, Vol. 1 No. 4, pp. 405-418.
- Broadbent, B. (2016), *Ben Broadbent: Central Banks and Digital Currencies. Speech by Mr Ben Broadbent, Deputy Governor for Monetary Policy of the Bank of England, at the London School of Economics, London*, available at: <https://www.bis.org/review/r160303e.pdf> (accessed 9 June 2019).
- Buiter, W.H. (2009), "Negative nominal interest rates: three ways to overcome the zero lower bound", NBER Working Paper Series, Working paper 15118, National Bureau of Economic Research, Cambridge, MA.
- Buy Bitcoin Worldwide (2019), *Bitcoin Volatility Time Series Charts*, Buy Bitcoin Worldwide, available at: <https://www.buybitcoinworldwide.com/volatility-index> (accessed 1 June 2019).
- Bjerg, O. (2017), "Designing new money. The policy trilemma of central bank digital currency", CBS Working Paper Series, Copenhagen Business School, Copenhagen.
- Bonpasse, M. (2006), *The Single Global currency. Common Cents for the World*, Single Global Currency Association, Newcastle, Maine.
- Calvo, G. and Vegh, C. (1992), "Currency substitution in developing countries: an introduction", IMF Working Paper Series, Working paper 92/40, International Monetary Fund, Washington, DC.
- Carayannis, E.G., Pirzadeh, A. and Popescu, D. (2012), *Institutional Learning and Knowledge Transfer across Epistemic Communities. New Tools of Global Governance*, Springer, New York, Dordrecht, Heidelberg and London.
- Cencini, A. (2013), *Money, Income and Time. A Quantum-Theoretical Approach*, Bloomsbury Academic, London and New York.

- Chambers (2008), *21st Century Dictionary (Revised Edition). Unique Focus on Language as it Is Used Today*, Allied Publishers, New Delhi.
- Claeys, G., Demertzis, M. and Efstathiou, K. (2018), *Cryptocurrencies and Monetary Policy. Monetary Dialogue*, Brussels European and Global Economic Laboratory (Bruegel), Brussels.
- Clark, A. and Mihailov, A. (2019), *Why Private Cryptocurrencies Cannot Serve as International Reserves but Central Bank Digital Currencies Can*, University of Reading – Department of Economics Discussion Paper Series, Discussion paper 2019-09, University of Reading – Department of Economics, Reading.
- Coats, W. (2018), *Free Banking in the Digital Age?*, Warren’s space, available at: <https://wcoats.blog/2018/05/01/free-banking-in-the-digital-age> (accessed 2 June 2019).
- Cochrane, J. (2018), “Basecoin”, *The Grumpy Economist*, available at: <https://johnhcochrane.blogspot.com/2018/04/basecoin.html> (accessed 28 May 2019).
- CoinMarketCap (2019), *Top 100 Cryptocurrencies by Market Capitalization*, CoinMarketCap, available at: <https://coinmarketcap.com> (accessed 1 June 2019).
- Committee on Payment and Settlement Systems (2003), *A Glossary of Terms Used in Payments and Settlement Systems*, Bank for International Settlements, Basel.
- Committee on Payments and Market Infrastructures (2015), *CPMI Report on Digital Currencies*, BIS Press Releases, Bank for International Settlements, Basel.
- Committee on Payments and Market Infrastructures – Markets Committee (2018), *Central Bank Digital Currencies*, Bank for International Settlements, Basel.
- Crypto-Assets Task Force (2019), “Crypto-assets: implications for financial stability, monetary policy, and payments and market infrastructures”, ECB Occasional Paper Series, Paper 223, European Central Bank, Frankfurt am Main.
- Cukierman, A. (2019), *Welfare and Political Economy Aspects of a Central Bank Digital Currency*, Centre for Economic Policy Research (CEPR) Discussion Paper Series, Discussion paper DP13728, Centre for Economic Policy Research (CEPR), London.
- Danmarks Nationalbank (2016), “Central bank digital currency in Denmark”, in *Danmarks Nationalbank’s Analyses, Analysis*, Vol. 28, Danmarks Nationalbank, Copenhagen.
- Deutscher Bundestag (1992), “Bundesbank act (Bundesbankgesetz, BBankG)”, German Law Archive, available at: <https://germanlawarchive.iuscomp.org/?p=833> (accessed 12 June 2019).
- eCurrency (2019), *Central Bank Issued Digital Currency (CBDC)*, eCurrency, available at: <https://www.ecurrency.net> (accessed 3 June 2019).
- Eichengreen, B. (2019), “From commodity to fiat and now to crypto: what does history tell us?”, NBER Working Paper Series, Working paper 25426, National Bureau of Economic Research, Cambridge, MA.
- European Central Bank (2017), “What is seigniorage?”, available at: <https://www.ecb.europa.eu/explainers/tell-me/html/seigniorage.en.html> (accessed 10 June 2019).
- European Consumer Centre Germany (2019), “Cash payment limitations”, available at: <https://www.evz.de/en/consumer-topics/buying-goods-and-services/shopping-in-the-eu/cash-payment-limitations> (accessed 13 June 2019).
- Fatás, A. and Weder di Mauro, B. (2018), “Cryptocurrencies’ challenge to central banks”, Vox – CEPR Policy Portal, available at: <https://voxeu.org/article/cryptocurrencies-challenge-central-banks> (accessed 29 May 2019).
- Federal Financial Supervisory Authority (2019), *Virtual Currency (VC)*, Federal Financial Supervisory Authority, Bonn and Frankfurt am Main.
- Fernández-Villaverde, J. and Sanches, D. (2018), “On the economics of digital currencies”, Working Papers Research Department, Working paper 18-07, Federal Reserve Bank of Philadelphia, Philadelphia.

- Fisher, I.[1936] (2009), *100% Money and the Public Debt*, ThaiSunset Publication, Pakthongchai.
- Frankfurter Allgemeine Zeitung (2019), *Weidmann warnt vor digitalem Zentralbankgeld*, Frankfurter Allgemeine Zeitung, available at: <https://www.faz.net/aktuell/wirtschaft/diginomics/bundesbank-praesident-weidmann-warnt-vor-digitalem-zentralbankgeld-16212112.html> (accessed 7 June 2019).
- Fung, B.S.C. and Halaburda, H. (2016), *Central Bank Digital Currencies: A Framework for Assessing Why and How*, Bank of Canada Staff Discussion Paper Series, Staff discussion paper 2016-22, Bank of Canada, Ottawa.
- Grym, A., Heikkinen, P., Kauko, K. and Takala, K. (2017), “Central bank digital currency”, *BoF Economics Review*, Vol. 5, pp. 1-10.
- Hayek, F.A. (1976), *Choice in Currency. A Way to Stop Inflation*, Occasional Papers, Paper 48, The Institute of Economic Affairs, London.
- Hernandez-Verme, P.L. and Valdes Benavides, R.A. (2013), “Virtual currencies, micropayments and the payments systems: a challenge to fiat money and monetary policy?”, *European Scientific Journal*, Vol. 1, pp. 325-343.
- Hyman, E. (2011), *Where’s the Money? Economics & Personal Finance Curriculum. Recommended Age: 12+*, lulu.Com, Morrisville.
- Hyperquant (2018), “Non-collateralized stablecoins”, available at: <https://medium.com/hyperquant/non-collateralized-stablecoins-efc904b5e06a> (accessed 12 June 2019).
- Kiel Institute for the World Economy (2018), *Virtual Currencies. Monetary Dialogue July 2018*, European Parliament, Brussels.
- Koning, J.P. (2016), *Fedcoin: A Central Bank-Issued Cryptocurrency*, Squarespace, available at: <https://static1.squarespace.com/static/55f73743e4b051cfcc0b02cf/t/58c7f80c2e69cf24220d335e/1489500174018/R3+Report.+Fedcoin.pdf> (accessed 9 June 2019).
- Kumar, M.S., Baig, T., Decressin, J., Faulkner-MacDonagh, C. and Feyzioğlu, T. (2003), “Deflation. Determinants, risks, and policy options”, IMF Occasional Papers, Paper 221, International Monetary Fund, Washington, DC.
- Kumhof, M. and Noone, C. (2018), “Central bank digital currencies – design principles and balance sheet implications”, Bank of England Staff Working Paper Series, Working paper 725, Bank of England, London.
- Meaning, J., Dyson, B., Barker, J. and Clayton, E. (2018), “Broadening narrow money: monetary policy with a central bank digital currency”, Staff Working Paper Series, Working paper 724, Bank of England, London.
- Mishra, P. (2009), *Sales Management. Keys to Effective Sales*, India Publications, New Delhi.
- Moore, B.J. (2004), “A global currency for a global economy”, *Journal of Post Keynesian Economics*, Vol. 26 No. 4, pp. 631-653.
- Morse, E. (2017), *Cryptocurrency: A Complete Introduction. Five Entry Level Guides to Bitcoin*, CreateSpace Independent Publishing Platform, Scotts Valley, CA.
- Moshirian, F. (2007), “Global financial services and a global single currency”, *Journal of Banking and Finance*, Vol. 31, pp. 3-9.
- Niepelt, D. (2016), “Central banking and Bitcoin: not yet a threat”, Vox – CEPR Policy Portal, available at: <https://voxeu.org/article/central-banking-and-bitcoin-not-yet-threat> (accessed 29 May 2019).
- Norges Bank (2018), “Central bank digital currencies”, Norges Bank Paper Series, Paper 1/2018, Norges Bank, Oslo.
- Nyborg, K.G. (2016), *Collateral Frameworks. The Open Secret of Central Banks*, Cambridge University Press, Cambridge.
- Pieters, G.C. (2016), *The Potential Impact of Decentralized Virtual Currency on Monetary Policy*, Federal Reserve Bank of Dallas – Globalization and Monetary Policy Institute 2016 Annual Report, Federal Reserve Bank of Dallas, Dallas.

- Prasad, E. (2018), *Central Banking in a Digital Age: Stock-Taking and Preliminary Thoughts*, Hutchins Center on Fiscal & Monetary Policy at Brookings, Washington, DC.
- Raskin, M. and Yermack, D. (2016), "Digital currencies, decentralized ledgers, and the future of central banking", NBER Working Paper Series, Working Paper 22238, National Bureau of Economic Research, Cambridge, MA.
- Rickards, J. (2014), *The Death of Money: The Coming Collapse of the International Monetary System*, Portfolio/Penguin, New York.
- Roland Berger (2016), "New realities in central banking", *The Rise of Cryptofinance in Central Banking*, Roland Berger, Munich.
- Rogoff, K. (1999), "International institutions for reducing global financial instability", *Journal of Economic Perspectives*, Vol. 13 No. 4, pp. 21-42.
- Rogoff, K. (2001), "Why not a global currency?", *American Economic Review*, Vol. 91 No. 2, pp. 243-247.
- Rogoff, K. (2014), "Costs and benefits to phasing out paper currency", NBER Working Paper, Working paper 20126, National Bureau of Economic Research, Cambridge, MA.
- Rogoff, K.S. (2016), *The Curse of Cash*, Princeton University Press, Princeton and Oxford.
- Rossi, S. (2007), *Money and Payments in Theory and Practice*, Routledge, London and New York.
- Routledge, B.R. and Zetlin-Jones, A. (2018), "Currency stability using blockchain technology", Society for Economic Dynamics – 2018 Meeting Papers, Paper 1160, Society for Economics Dynamics, Minneapolis.
- Saleh, F. (2019), "Volatility and welfare in a crypto economy", Social Science Research Network (SSRN), available at: <https://ssrn.com/abstract=3235467> (accessed 31 May 2019).
- Sauer, B. (2016), "Virtual currencies, the money market, and monetary policy", *International Advances in Economic Research*, Vol. 22 No. 2, pp. 117-130.
- Savage, C. (2018), "The 21 million Bitcoin story explained: why is the number special?", available at: <https://coinsavage.com/content/2018/11/the-21-million-bitcoin-story-explained-why-is-the-number-special> (accessed 9 June 2019).
- Shirai, S. (2019), "Money and central bank digital currency", Working paper 922, Asian Development Bank Institute, Tokyo.
- Smets, J. (2016), *Fintech and Central Banks. Fintech and the Future of Retail Banking, Brussels, December 9, 2016. Colloquium of the Belgian Financial Forum in Cooperation with SUERF, The European Money and Finance Forum and Eggsplora*, available at: https://www.suerf.org/docx/1_ec5decca5ed3d6b8079e2e7e7bacc9f2_9467_suerf.pdf (accessed 9 June 2019).
- Stiglitz, J. (2011), "The best alternative to a new global currency", Financial Times, available at: <https://www.ft.com/content/c2215510-5bc4-11e0-b8e7-00144feab49a> (accessed 27 May 2019).
- Stix, H. (2019), "Ownership and purchase intention of crypto-assets – survey results", Working Paper Series of the Oesterreichische Nationalbank, Working paper 226, Oesterreichische Nationalbank, Vienna.
- Sveriges Riksbank (2019), "The riksbank proposes a review of the concept of legal tender", Press release, available at: <https://www.riksbank.se/en-gb/press-and-published/notices-and-press-releases/press-releases/2019/the-riksbank-proposes-a-review-of-the-concept-of-legal-tender> (accessed 5 June 2019).
- Swiss Sovereign Money Initiative (2015), "The swiss sovereign money initiative: five questions with answers", available at: https://www.vollgeld-initiative.ch/fa/img/English/2015_10_22_Swiss_Sovereign_Money_Initiative_-_five_questions_with_answers.pdf (accessed 11 June 2019).
- Tcherneva, P.R. (2006), "Chartalism and the tax-driven approach to money' in: Arestis, Philip", Sawyer, M. (Eds), *A Handbook of Alternative Monetary Economics*, Edward Elgar, Cheltenham and Northampton.

-
- The Library of Congress (2018), "Full report", available at: <https://www.loc.gov/law/help/cryptocurrency/cryptocurrency-world-survey.pdf> (accessed 12 August 2019).
- Tolle, M. (2016), "Central bank digital currency: the end of monetary policy as we know it?", Bank Underground, available at: <https://bankunderground.co.uk/2016/07/25/central-bank-digital-currency-the-end-of-monetary-policy-as-we-know-it> (accessed 2 June 2019).
- Van Dalen, A., Svensson, H., Kalogeropoulos, A., Albæk, E. and De Vreese, C.H. (2019), *Economic News. Informing the Inattentive Audience*, Routledge, New York and Abingdon, Oxon.
- Wadsworth, A. (2018), "The pros and cons of issuing a central bank digital currency", Vol. 81, Reserve Bank of New Zealand Bulletin, Wellington.
- Wallace, B. (2011), "The rise and fall of Bitcoin", *Wired*, available at: <https://www.wired.com/2011/11/mf-bitcoin> (accessed 11 June 2019).
- Whelan, K. (2018), *Should Central Banks Be Concerned about Virtual Currencies? Monetary Dialogue July 2018*, European Parliament, Brussels.
- Whyman, P.B. (2018), *Rethinking economic and monetary union in Europe. A Post-Keynesian Alternative*, Routledge, Abingdon, Oxon, and New York.
- Woo, W. (2016), "Bitcoin volatility will match major fiat currencies by 2019", Woobul, available at: <https://woobull.com/bitcoin-volatility-will-match-major-fiat-currencies-by-2019> (accessed 1 June 2019).
- Xintong, H. and Yanqing, Y. (2018), "Interview with David Wen: developing countries are likely to outrace developed countries in digital fiat currency", Yicai Global, available at: <https://www.yicai.com/news/interview-david-wen-developing-countries-are-likely-outraced-developed-countries-digital-fiat> (accessed 3 June 2019).

Corresponding author

Ansgar Belke can be contacted at: ansgar.belke@wiwinf.uni-due.de