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

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Ansgar Belke
Edoardo Beretta

From Cash to Central Bank Digital Currencies and Cryptocurrencies: A Balancing Act between Modernity and Monetary Stability

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Ansgar Belke and Edoardo Beretta[1]

From Cash to Central Bank Digital Currencies and Cryptocurrencies: A Balancing Act between Modernity and Monetary Stability

Abstract

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. Which aspects of modern payments 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 the scientific as well as the banking and the political level.

JEL Classification: : E4, E5, G21, G23

Keywords: Cash; central banks; cryptocurrencies; digital currencies; monetary systems

July 2019

1 Ansgar Belke, UDE, CEPS Brussels, IZA Bonn & King's College London; Edoardo Beretta, c/o Università della Svizzera italiana (USI), Facoltà di Scienze economiche, Lugano. - *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).* – *All correspondence to: Prof. Dr. Ansgar Belke, Department of Economics and Business, University of Duisburg-Essen, Gebäude WST, Berliner Platz 6-8, 45127 Essen, Germany, e-mail: ansgar.belke@uni-due.de*

1. 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 payments 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, which 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[3] and their underlying blockchain technology might somehow contribute to establishing a more modern, secure and stable payments 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 also explore which regulatory challenges the (inter)national payments system will have to face. It will investigate how a global central bank – if, for 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.

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

As highlighted in Belke, Bernoth and Fichtner (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, Bernoth and Fichtner (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*, who are for instance able to make "conscious

[3] The paper itself is the result of the discussion of some relevant topics deepened at a Round Table on "The board and monetary policy for decentralized currency" at the Blockchain Economic Forum (24-26 January 2019, Davos) where Ansgar Belke presented his conclusions.

decisions about investments that they think will maximize profits for their clients and themselves" (Van Dalen, Svensson, Kalogeropoulos, Albæk and de Vreese 2019). Fundamental elements would be a stronger global coordination and an international financial market authority. For instance, according to Arestis, Basu and Mallick (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 the International Clearing Union (ICU) proposal of John Maynard Keynes, which introduced the term "bancor", a "form of international bank money" (Whyman 2018), but rather to economic thinkers of the remote past as highlighted in Beretta (2012a, 2012b and 2013). Among the main reasons for thinking of the introduction of similar payment schemes there are 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 ("the emergence of 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, not to mention despondency over exchange rate fluctuations, 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 2001)). 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 should be 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, deepen 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).

3. 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). However, it is no secret that Bitcoin's volatility (which is shown in **Figure 1**) is still much more significant than that of other financial instruments.

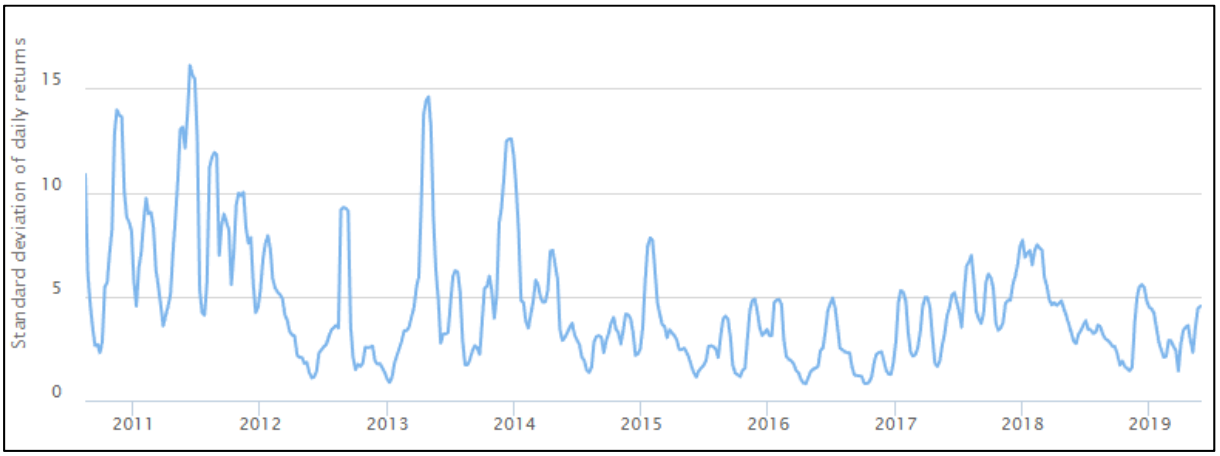


Figure 1: Bitcoin's volatility (16 August 2010 – 31 May 2019)
Source: Buy Bitcoin Worldwide (2019)

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-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)), which would be responsible for limiting trading volumes and maintaining high volatility. As 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 ("Our results suggest that 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.

Top 10 cryptocurrencies by market capitalization (as of 17 July 2019)					
Ranking	**Name**	**Market cap**	**Price**	**Volume**	**Share of total market capitalization (dominance)[4]**
1.	**Bitcoin**	$169,802,928,617	$9,527.33	$27,069,875,829	66.25%
2.	**Ethereum**	$21,632,576,166	$202.29	$10,311,315,350	8.44%
3.	**XRP**	$12,821,888,865	$0.301220	$1,786,076,346	5.00%
4.	**Litecoin**	$5,246,186,624	$83.67	$4,275,295,555	2.05%
5.	**Bitcoin Cash**	$5,097,535,641	$284.84	$2,416,576,704	1.99%
6.	**Tether**	$3,944,252,558	$0.997893	$29,472,685,631	1.54%
7.	**EOS**	$3,430,770,848	$3.71	$3,374,901,742	1.34%
8.	**Binance Coin**	$2,902,002,354	$26.58	$500,721,672	1.13%
9.	**Bitcoin SV**	$2,085,156,947	$116.78	$462,076,225	0.81%
10.	**Stellar**	$1,534,529,110	$0.078274	$418,492,689	0.60%

Table 1: Top 10 cryptocurrencies by market capitalization (as of 17 July 2019)
Source: CoinMarketCap (2019b)

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 – Bitcoin, Bitcoin Cash, and Ethereum – 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)). 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. […] As such, we are sad to share the news that we have decided to return capital to our investors. This also means, unfortunately, that the Basis project will be shutting down" (Basis 2018).

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. Beside elastic supply (which is not always sufficient to ensure price stability) currencies issued by central banks benefit from a particularly level of acceptability guiding economic subjects towards 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

[4] The last column of **Table 1** compares market capitalization of each of the top 10 cryptocurrencies to total market capitalization ($256.296.314.733) as of 17 July 2019 (CoinMarketCap (2019a).

(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)). 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, namely that of units of account, means of payments and stores of value (Claeys, Demertzis and Efstathiou, 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.

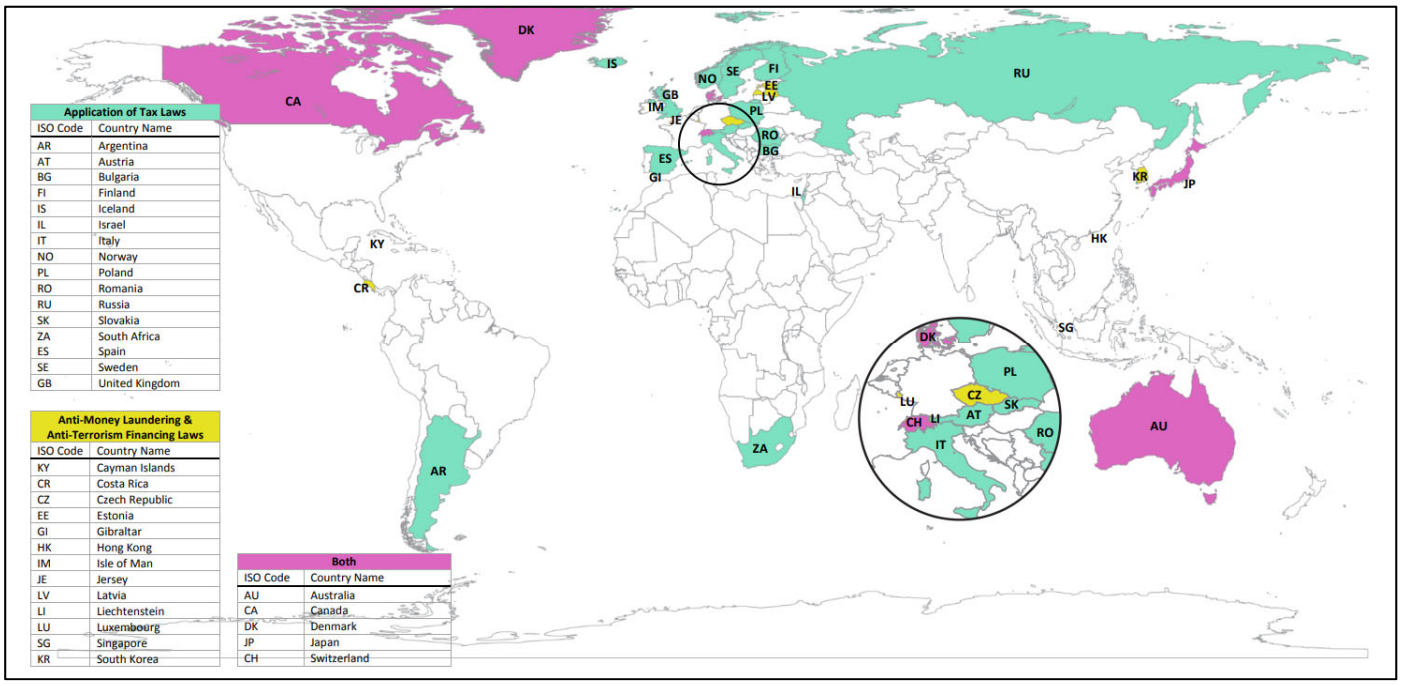
According to supporters of Hayek's (1976, p. 20) way of reasoning, namely that "[i]f governments and other issuers of money have to compete in inducing people to hold their money, and make long-term contracts in it, they will have to create confidence in its long-run stability", cryptocurrencies could 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 sector a long time ago. The risk of "spoofing" ("The term 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, beside volatility issues, "one lesson learned from the Bitcoin experience is that 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 terms, 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 depicted in **Figure 2**, which highlights which countries have adopted a regulatory framework implying taxation of cryptocurrencies and/or anti-money laundering as well as anti-terrorism financing laws. 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)). 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, Pirzadeh and Popescu 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 deepen, 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" ("Whether or not "digital currency" is the right way to describe something like bitcoin, or its central bank counterpart, is also unclear. A better term for the underlying technology, the distributed ledger, might be "decentralised virtual clearinghouse and asset register"" (Broadbent 2016, p. 7)). In fact, while the terms "currencies"/"moneys" do 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: 387-8). This clearly means that real money defines the product and not its monetary counterpart". […] 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. […] real money is identified with 'nominal money associated with its charge […]. Every increase of (national) product is an increase of real money, and correspondingly, no increase of real money can take place unless there is an equivalent increase of output. It remains true, however, that, although real money is indissolubly linked to production, its nominal form, being immaterial, is not the result of any production. It is the bank that, by issuing nominal money, emits the vehicle whose load is current output"
>
> (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 thin air") is also confirmed by the Committee on Payments and Market

Infrastructures of the Bank for International Settlements (2015) stating that "[t]hese assets can have some of the characteristics of a commodity and some of a currency. Currently, their monetary features (such as their use as a means of payment) are often more prominent, yet, these assets are not typically issued in or connected to a sovereign 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" whatever it may want to ("Chartalism […] posits that money (broadly speaking) is a unit of account, designated by a public authority for the codification of social debt obligations" (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"[5] 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.



Application of Tax Laws	
ISO Code	Country Name
AR	Argentina
AT	Austria
BG	Bulgaria
FI	Finland
IS	Iceland
IL	Israel
IT	Italy
NO	Norway
PL	Poland
RO	Romania
RU	Russia
SK	Slovakia
ZA	South Africa
ES	Spain
SE	Sweden
GB	United Kingdom

Anti-Money Laundering & Anti-Terrorism Financing Laws	
ISO Code	Country Name
KY	Cayman Islands
CR	Costa Rica
CZ	Czech Republic
EE	Estonia
GI	Gibraltar
HK	Hong Kong
IM	Isle of Man
JE	Jersey
LV	Latvia
LI	Liechtenstein
LU	Luxembourg
SG	Singapore
KR	South Korea

Both	
ISO Code	Country Name
AU	Australia
CA	Canada
DK	Denmark
JP	Japan
CH	Switzerland

Figure 2: Regulatory framework for cryptocurrencies: application of tax laws and/or anti-money laundering/anti-terrorism financing laws.
Source: The Library of Congress (2018)

Another option explored by recent literature is given by 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-

[5] "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).

collateralized approach is the seigniorage shares approach" (Hyperquant 2018). 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 sells 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 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 latters 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[6]. The whitepaper for Basis, "the first cryptocurrency to implement robust, decentralized, and protocol-enforced price stability" (Al-Naji, Chen and Diao 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-year 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. We save the details for later discussion" (Al-Naji, Chen and Diao 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 debt 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[7].

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

According to Bofinger (2018), another potential innovation might be the replacement of bank loans with peer-to-peer lending. Obviously enough, this phenomenon entails

[6] 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".

[7] 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.

significant regulatory challenges, because it bears a direct relationship between the lending and borrowing part. Since peer-to-peer lending does not necessitate an intermediary, it also needs less regulatory measures. The traditional banking sector might, therefore, 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)). 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). At the same time, central banks are for sure interested to explore (and perhaps coordinate) the possibility of introducing virtual currencies. It is already known that national banks in several advanced economies 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, as I have argued for some time, 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 and 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 no secret that private currencies, which 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 of − is 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 follows a policy rule that pegs the real value of government money, provided that the target value for real balances is sufficient". According to Baliño, Bennett and Borensztein (1999) this scenario is similar to central banks dealing with partial dollarisation 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 (the holding of foreign-currency-denominated assets as stores of value)"). 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. At the same time, as physical or juridical subjects would expand their holdings of the new currency, the financial system would become less stable. In order to stabilize it again, 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. 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, Demertzis and Efstathiou, 2018)? As already mentioned, Fernàndez-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. […] in a well-defined sense, 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 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, Demertzis and Efstathiou 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. Primarily this is 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, Demertzis and Efstathiou 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. Although the hyper-inflated mark was legal tender, it was eventually rejected by the Germans. Its rejection 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 potentially stabilizing and disciplining potential. Since a similar assumption is rather theoretical or at least belongs to times of extreme economic distrust, there are no doubts that central banks would be confronted with several risks. For instance, if savers should begin substituting paper money and deposits for cryptotokens, 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, which both come to be determined by structural factors (rate of time preference, entry cost, exit 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 income on the 8% through the claim it holds on the national central banks. Seigniorage income has been falling since 2008, in line with a decline in euro area interest rates" (European Central Bank 2017)). 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), "[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". Of course, 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) took place on 3 January 2009 (Wallace, 2011), namely 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. Every dollar can be divided into 100 cents, making the total number of the pieces of money to exist at around 2100 trillion" (Coin Savage 2018)) 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. 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, Baig, Decressin, Faulkner-MacDonagh and Feyzioğlu 2003, p. 9). More precisely, 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 payments 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 certainly predictable.

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)) and "enhance the operational efficiency of existing arrangements" (Bank for International Settlements 2018, p. 108).

According to Fatàs and Weder di Mauro (2018), individuals could at the same time benefit from central bank digital currency, which would be among the pillars of an efficient payments 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 some authors underline the "importance of raising 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 2017, 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. On several grounds, the case against central bank cryptocurrencies seems to be strong. […] 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).

It is also worth mentioning that 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, (ii) decentralization, and (iii) cost efficiency". Otherwise stated, any correctly working ledger (which also wants to be efficient in cost terms) cannot be decentralized. At the same time, becoming demand for central bank money higher risky financial instruments like 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 form the basis of the anti money laundering (AML) approach since they 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. […] The cross-border and global dimensions of CBDCs available to non-residents could be especially pronounced during times of generalised flight to safety"
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> (Committee on Payments and Market Infrastructures – Markets Committee 2018, pp. 16, 18).

On 10 June 2018, Switzerland held a referendum (rejected by approximately 74 percent of voters) called "Swiss Sovereign Money Initiative" proposing that 100 percent of sight deposits should be transferred to the central bank while commercial banks should not be anymore 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. This electronic money has value exactly like today's coins and bank notes have value. 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). According to authors like Bacchetta (2018), "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. Finally, there is high uncertainty both on the details of the reform and on its impact"). At this point, it has necessarily to be asked how payments systems might be otherwise meliorated. More precisely, how could they become stronger without opting for central bank digital currencies? A central bank digital currency (CBDC) would allow the broad public to make use of a non-tangible form of central bank money. According to authors in favor of introducing a digital currency issued by central banks:

> "the technology underpinning Bitcoin and the blockchain has inspired a number of central banks to pursue research on the topic of central bank digital currency. While 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 fixes (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, Dyson, Barker and Clayton 2018, p. 12). Customers would, then, have to decide whether holding 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[8]. Since banks 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 central bank digital currency (CBDC) accounts the fractional reserve banking system would be challenged at 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, [own translation]).

5. 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 not even 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)).

[8] 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".

Otherwise stated, liquidity would be conveniently transferrable via online banking from 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 to (excess) reserves would 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"
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> (Kiel Institute for the World Economy 2018, p. 19).

In the scenario that a 100-percent-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. […] I have come to believe that the plan, "properly worked out and applied, is incomparably the best proposal ever offered for speedily and permanently solving the problem of depressions; for 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 of how to make use of blockchain technology, digital currencies or launching a digital currency. Among the central banks of advanced economies thinking of making 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. The committee should propose the legislative amendments needed so that Sweden continues to have a stable and efficient payment market"
>
> (Sveriges Riksbank 2019).

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 ("It is precisely the existence of paper currency that 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, does maintain 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, Caselli, Cillo and Masciandaro 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 central bank digital currency (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 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 instable, 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, possibly by increasing fees and lending interest rates and misusing the information obtained from tracking transactions" (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, "[c]entral bank digital currency is a hot topic among central bankers. 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 (2018, 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 2018, 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 usable 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" He concludes that "this would be less bothersome to the rest of us"" (Albrecht 2019). 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[9]. Blockchain might be an element contributing to find an adequate solution as described by David Wen

[9] Enterprises like eCurrency aim at providing central banks with hard- and software and advanced cryptography protecting them against counterfeiting, theft and security threats ("Enabling central banks to issue digital fiat currency, 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)).

in Xintong and Yanqing (2018): "[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, Heikkinen, Kauto and Takala (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)). 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 should 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) 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 a to accounts held at commercial banks, which would in turn re-establish 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 see 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, Dyson, Barker and Clayton 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[10], 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, including its nominal anchor, its tools and operations, and its policy strategy" (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 key-questions like: 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.

6. 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 14 February 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 (namely 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

[10] 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.

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:

> "[i]nflation is a rise of money in circulation in the economy. Because there is more money in circulation, the value of each dollar is less than it was before, because there are more dollars to go around […]. Each dollar has less buying power/value. The result is that people will charge more for goods and services, because there is more money for people to buy with. From the perspective of the buyers, they now will need more money to buy the same product, their dollars are worth less. Inflation is NOT just higher prices, as many believe, but rising prices are many times the result of inflation"
>
> (Hyman 2011, p. 22).

If it should be claimed that the consumer price indexes in advanced countries have not registered any significant price increase (which is, once again, a possible consequence and not cause of inflation), it would equally go without saying that:

1. exceeding liquidity does not necessarily lead to higher prices of consumer goods but − in a globalized world, by far more likely − rather of financial securities;
2. "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). Otherwise stated, an over-supply of money (with respect to real goods) generates an increase of prices in different economic sectors and, as soon as such excess liquidity is disinvested/withdrawn from them, prices crumble leading to an "exploding economic bubble".

If it is true that the blockchain technology has a great potential, its 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 etc. 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 2**), 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.

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)

Table 2: Cash payment limitations (set by law and not on a contractual basis) in European countries
Source: European Consumer Centre Germany (2019)

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 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.

7. Concluding remarks

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 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 benefitting 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 payments system 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).

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