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Monetary Policy and Cryptocurrencies: Much Noise for Nothing?

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Abstract At the beginning of 2017, there were more than 500 digital currencies (DC) for a total market value of $ 16.8 billion or € 16 billion, the Bitcoin, launched in early 2009, representing alone about 85% of the market. In comparison, euro banknotes and coins in circulation at the end of 2016 amounted to EUR 1 150 billion, 72 times more, for the single currency in fiduciary form. However, some authors have suggested that increased use of DCs could, at some point and under certain circumstances, have profound consequences for the financial system and the conduct and effectiveness of monetary policy (Raskin and Yermack, 2016; Bordo and Levin, 2017). Under the same hypothesis that the consequences of monetary policy can only be significant if the use of DC was widespread, this article offers a more nuanced view. The first part recalls the main characteristics of DCs. The third part looks at Consequences and adjustments of monetary policy from widespread use of digital currencies. In this part, we describe scenarios of widespread use of DCs and their consequences for monetary policy. The fourth part concludes.

Keywords: *digital currencies, cryptocurrencies, blockchains, monetary policy*

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1. Introduction: Main Characteristics of Digital Currencies

In this article, as in the publications on the subject of the Bank for International Settlements (BIS, 2015), the term "digital currencies" is used in the narrow sense of "cryptocurrencies". This definition excludes physical currencies such as banknotes and coins or local currencies. It also excludes deposits at the central bank, commercial banks and electronic money, electronically encoded on cards or other devices, although in both cases, as in the case of DCs, digitalis.

Table 1. The different types of monetary instruments

		Physical representation	Digital representation
Denomination	**Legal unit**	Fiduciary currency (banknotes and coins)	Deposits, electronic currency
	Other units	Local currencies and tokens	Digital currency

The different types of monetary instruments currently available are presented in a simplified way in Table 1, adapted from Camera [1].

DCs can be considered as a combination of two elements [2,3]:

- An asset, similar to an ordinary modern currency in the sense that it has no intrinsic value, but which differs in that it does not have the support of an issuer (for example, Bitcoin is not payable to anyone) and where, a fortiori, it has not legal tender;
- An exchange mechanism that allows payment and settlement using Distributed Ledger Technology (DLT). A DL is a book of accounts that can be shared ("distributed") and updated in real time securely via a network of "nodes" (i.e. computers). The best-known DL is the Blockchain, used in particular by Bitcoin, where the data is organized in blocks linked by cryptographic techniques.

In particular, DLs allow peer-to-peer exchanges in the absence of trust between the parties and without the need for intermediaries. This result is achieved both because the use of cryptographic techniques limits the risk of intrusion because each user has access to the transaction history recorded on the DL, and because the process of validating transactions (also called "Consensus") requires the agreement of holders of a majority of DC units, in principle opposed to fraudulent use ("dual use") of units. As a result, each validated transaction increases the certainty of previous transactions, achieving almost absolute certainty in a limited time (one hour, or six

transactions, in the case of Bitcoin, since the validation of each Bitcoin transaction takes ten minutes).

The DC devices operate in two main modes of organization [2,4]:

- Some systems, such as Bitcoin, are known as public (or decentralized, or open or not allowed). In such systems, users can obtain units by "mining" (that is, a reward granted by the system for their transaction validation work) or by purchasing them on the secondary market. The "active" component of DCs plays an important role and the number of units that can be issued is usually fixed ex ante (this is the case for Bitcoin, although it seems that the emission rule can be changed provided that holders of a majority of units issued agree). The organized scarcity of assets supports its value, prompting the public to become a user and minors to validate transactions. A "speculative bubble" type element is therefore inherent to such devices;

- Other systems are said to be private (or centralized, or closed or "granted"). Such systems are characterized by the use of the DLT: the "exchange mechanism" component is prevalent. "Miners" are usually not paid and the process of validating transactions can be greatly simplified. In more detail, private systems can be of two kinds [4]: totally private systems where write permissions are centralized by a single organization and hybrid systems (sometimes called semi-permissive public systems) where the validation process is controlled by a predetermined set of nodes. In both cases, read permissions can be restricted but the main feature of these systems, common to all, is the prior restriction of write permissions in order to reduce operating costs. Indeed, the negative externality generated by the competition between "minors", implying in particular large energy expenditure, is thus reduced. However, the more the write and read permissions are centralized, the less the DL is "distributed", and therefore the less the currency it manages can be considered a DC. Thus, private systems where the reading permissions are restricted and where the embedded currency is backed by a bank issuer are in fact electronic money even if they use a DL.

Also, many current researchs focused in the study of the volatility of the cryptocurrencies. For example, Kristoufek [5] presents a comparison between the Bitcoin phenomenon and other Internet phenomena of the present day. By using wavelet coherence analysis, Kristoufek [6] examines the main drivers of Bitcoin price, such as the demand in China.

In addition, more recent researches study the essential importance of Bitcoin and its security aspects. The responsibility of Bitcoin in current day finance is questioned by Bouri et al. [7] and Dyhrberg [8]. Also, Bitcoin market efficiency is examined by Urquhart [9] with the main finding that it is still transitioning to the regime of currency market efficiency. Similarly, Bitcoin price clustering at surrounding statistics is captured by Urquhart [10].

The price dynamics and speculative trading in cryptocurrency is examined by Blau [11] with the main finding that speculative behavior cannot be directly connected to the unusual return and volatility of the cryptocurrency market. Cheah and Fry [12] study the role of speculation in the cryptocurrency market from the viewpoint of Bitcoin’s basic value.

Dwyer [13] investigates empirically the Bitcoin economy with the fundamental finding that Bitcoin is likely to limit authority regulation revenue from inflation. Branvold et al. [14] examines the role of different cryptocurrency exchanges in the price discovery procedure, representing that the information allocate is dynamic and significantly evolving over time.

In the same context, security problems, inherent in the cryptocurrency world, are studied by Bradbury [15] for the case of Bitcoin. Another analysis also exists for the period of crash in 2013 in the paper of Bouri et al. [16]. There are a number of interesting extreme events in the past of cryptocurrency market which can be investigated from multi-disciplinary perspective, such as employing the methodology of Franzke [17].

The main contributions of the present paper are; the main characteristics of DCs and the consequences and adjustments of monetary policy from widespread use of digital currencies.

2. Reasons for Widespread Use of Digital Currencies

As far as the public is concerned, to date, DCs are doing very poorly on the functions assigned to a currency [18,19]: medium of exchange, unit of account and store of value. Very few traders accept them as a means of exchange. Even those who accept them adjust their prices in DC according to the price fluctuations of DC against legal currencies, which show that DCs do not serve as a unit of account. Finally, their prices against legal currencies have so far been much more volatile than those of the latter among them, which makes them poor value reserves.

In addition, some technical difficulties, such as the ability to handle large volumes (scalability), but also issues of security and interoperability, the possibility of canceling operations - for example, in case of fraud, although this possibility does not fit well with the operation of the Blockchain and the high energy consumption during the validation of the transactions, should have been solved so that the use of the DC spreads widely.

In the rest of this article, the hypothesis that these difficulties have been solved is made. However, Rysman and Shuh [20] show that consumers are willing to adopt payment innovations, even if they only cover a limited scope of applications, provided that these applications are of clear utility. In this context, several factors could support increased demand for MD by the public [2,4]:

- DC transactions can be done under pseudonym, which protects privacy, especially in public systems. However, the argument has a recursive character: it is verified only if most transactions (for example, the payment of wages) are made in DC, avoiding that purchase and sales of DC leave traces on accounts banking. Moreover, from the point of view of the protection of privacy, the notes can be considered superior to the DC, since their use leaves no trace, even on a DL. On the other hand, if the use of DC were to spread significantly, it is highly likely that, as part of the anti-money laundering and terrorist financing measures, the use of pseudonyms would be made more

difficult or even prohibited. In general, public systems of DC seem very ill suited to the provision of regulated services, such as payment, banking and insurance services where a clear and precise allocation of responsibilities is required [21];

- DCs can be acquired for speculative reasons. This is particularly a factor often cited for Bitcoin. However, this argument is based on the scarcity of supply, a factor that opposes a widespread use of DCs that would require an elastic supply. On the other hand, changing the issuance rule for issued DCs would be very difficult under the current public systems since this measure should be taken by the holders and would go against their interests, most likely causing a drop in prices;

- Finally, DCs can be used to make quick and cheap payments worldwide. The reason for using DCs most often cited is the sending of funds by expatriates. For small sums, the cost of using Bitcoin is more than ten times lower than using standard service providers and payment can be made in minutes rather than days.

However, companies in the sector can respond to DC competition by lowering their prices and have begun to do so [4]. Above all, the use of DC for remittance involves, in addition to the cost of routing, transaction costs both at entry (purchase of DC) and at the exit (sale of DC) which can make it much more expensive than the use of traditional means of payment which involves at most a foreign exchange transaction, at entry or exit. In this case also, the argument in favor of a use of DC is recursive: it is only valid if this use is generalized, presupposing the fulfillment of the condition that it is supposed to justify.

It therefore seems difficult, at this stage and even assuming that the technical difficulties mentioned above have been resolved, to find credible grounds for widespread use of DCs. As a result, network effects, which are very important in payment systems, should continue to favor legal currencies. Moreover, the main use of MDs today is to avoid capital controls in an environment of financial repression, as recent increased use of Bitcoin in China and Venezuela have shown.

In comparison, the use of DL by financial institutions, within private DC systems, is often considered much more promising as long as the cost of validating transactions can be set low enough [4,22]. In particular, the use of DCs would lower costs in international payments, financial market infrastructures and post-market activities, allowing for lighter procedures and greater security. This would result in downsizing of the businesses involved, reduced reliance on intermediaries, better tracking of transactions and property rights, and increased transaction and clearing speed, reducing liquidity requirements and expense of capital.

In addition, financial innovation would be promoted by developing "smart contracts" (that is, contracts that run by themselves when predefined events occur) supported by DLT. However, in all these examples, the DC devices involved would be centralized and would most likely be implemented on a large scale only if there was a high degree of certainty about the value of the units exchanged. This requires that either the transactions are carried out extremely quickly to limit the risk of exchange (case of occasional transactions and small amount), or that the legal tender (or tokens the representative) is recorded on the DL so as to eliminate exchange rate risk (repeated transactions and / or large amounts, for example in the settlement and clearing of securities or repurchase transactions).

In the remainder of this article, the assumption is made that the widespread use of DC, either by the public or by financial institutions, could only occur if DCs are substitutes very close to the legal tender, or even its representation.

3. Consequences and Adjustments of Monetary policy from Widespread Use of Digital Currencies

Three main scenarios that would see the use of DCs spread are first described and their probability of occurrence assessed qualitatively. The monetary policy adjustments that may be required are then mentioned.

3.1. Three Main Scenarios and Their Respective Probability

In a first scenario, called A, financial institutions use DCs only internally and among themselves, within private devices. As a result of the liquidity savings permitted by the use of DLs, banks would require fewer central bank reserves for the final settlement of their transactions. For the reasons explained above, this scenario can be seen as probable, provided, as the hypothesis has been made, that certain technical difficulties are solved.

In a second scenario, called B, possibly encouraged by regulators if the use of DCs spreads to the public, there is a convergence between DC devices and banking activities: DC devices collect deposits and distributes credits and / or banks issue DCs. In the first case, the DC devices would at some point be subject to the same requirements by the regulators as the banks; in the second case, the DCs would be guaranteed by an issuer (a bank), thus greatly differing from current DCs such as Bitcoin. In both cases, the monetary consequences would vary depending on the level of services provided by the DCs: if minimum payment services were provided, DCs could substitute for unpaid notes and demand deposits (scenario B1); if LDs paid interest on DCs, they could also replace paid interest deposits and term deposits (Scenario B2 which includes B1). In what follows, it is assumed that all bank deposits are remunerated. Scenario B is also assumed to include A since the latter is considered probable.

However, because of the superiority of species over DC to protect the privacy mentioned above, scenario B1 can be seen as unlikely or at least remote in time: individuals would not want everyone to know, thanks to DL, what use they made of DC. The B2 scenario would therefore be even more unlikely than the B1 scenario.

In a third scenario, called C and envisioned by Raskin and Yermack [23], the central bank issues DC (digital currency of central bank: DCCB). This scenario could arise in two cases: either at the initiative of the central bank, concomitantly with or following A ("offensive" strategy), or in response to B ("defensive" strategy). The main merit of scenario C would lie in its high degree of

credibility, with the central bank in a unique position to guarantee a fixed exchange rate between DCCB and legal tender since it is able to create both without limit. The monetary consequences of scenario C at least partially deflect and at most would reverse those of scenario B. They depend on who would have access to the DCCB but also, to the analogue of B, services provided by the DCCB. If access to DCCB was restricted to banks within private DC devices (Scenario C1), the decline in demand for reserves would be lowers than in Scenario A[1].

Since scenario A is considered probable, scenario C1 is also probable. If access to DCCB was open to the public (scenario C2 assumed to include C1 since it would be strange, and probably as difficult to implement, to allow the public and not banks to use DCCB[2]), DCCB The latter could also replace notes, such as DC issued by the private sector in scenario B1, and possibly also bank deposits. In fact, the C2 scenario could be built as part of a plan, together with the removal of large denominations from the fiduciary circulation, to gradually reduce the use of cash in order to make the financing of illegal transactions more difficult and to reduce costs of fiduciary money management. The C2 scenario is seen as at most as likely as the B1 scenario.

A last possibility (scenario C3 assumed to include C2 and therefore C1), constitutes the counterpart for the central bank of scenario B2 for the banks and devices of DC: the public would have access to an DCCB on which not only, as the hypothesis is As regards the DCCB held by the banks in scenario C as a whole, interest would be paid, but credits could also be granted. This scenario is considered to be even less likely than the C2 scenario, for reasons of both supply and demand. On the supply side, scenario C3 would put the central bank in direct competition with the banking system for the collection of deposits, which central banks have refused to do since the transition from metal currencies to fiduciary currencies, both to avoid conflicts of interest but also for reasons of equality of competition, the central bank benefiting from their role to regulate monetary market.

On the demand side, under normal circumstances - that is, in the absence of a run on bank DCs - the public should prefer to use DCs issued by the private sector rather than DCCB, issued by a public organization, both for reasons of privacy protection, as it now uses bank deposits, and because individuals have a relationship often old with their bank.

[1] Such a fall may not even occur if, as envisaged by the Bank of England, payment service providers are granted access to central bank money, whether in the traditional or DCCB form.

[2] This approach differs from Barrdear's and Kumhof's [3] view that an DCCB could be issued as a kind of parallel currency for an equal amount of public debt, at par with the legal tender, bearing interest without providing other services, held only by non-banks, preferably weakly substitutable for bank deposits (the authors do not indicate how), and used by the central bank as an additional monetary policy instrument, by varying the amount issued or "spread" with the main rate of monetary policy. In addition, they do not take reservations, notes or other DCs into consideration. In fact, the system they describe, like that of Bordo and Levin [24] emerges from an electronic money issue by the central bank, with the difference, highlighted by the authors, that the DL, with permissions restricted reading and writing, would allow decision-makers to have access to the entire "story" of transactions, a feature seen here as unprivileged in privacy and thus likely to be detrimental to DCCB's success.

The three scenarios and their respective probabilities are summarized in Table 2 below where:

- Changes in level are indicated by signs, compared to a base scenario where DCs would not be used, corresponding to the current situation;
- The demand for central bank reserves is assumed not to be fully satisfied as it may occur after asset purchases (if this were the case, there would be no impact on demand for reserves until for example, because of the issuance of DCCB or the unwinding of asset purchases by the central bank, a demand for reserves is reformed);
- As detailed above, the assumption is made that each scenario includes the previous one in the lexicographic sense. An exception is that Scenario C1 could occur concurrently with Scenario A;
- Banks and DC devices are merged in Scenarios B and C since, as mentioned above, DC devices would be subject by regulators to the same requirements as banks if they provided the same services as the latter;
- DCCB is considered central bank reserves and therefore appears in its balance sheet;
- In scenario C1, the assumption is made, for reasons of simplicity, that the impact of the DCCB issue on the demand for reserves is at most neutral. In other words, even if the use of DCCB were to be more efficient than that of traditional reserves, this is not supposed to encourage banks or other financial institutions with access to credit. DCCB to settle in DCCB enough transactions, which otherwise would have been settled out of the books of the central bank, for the demand for reserves, including DCCB, to increase.

3.2. Monetary Policy Adjustments

Whatever the scenario that materializes, as indicated in the first section, a widespread use of DC is likely to occur only if the latter are substitutes very close to the legal tender or even of its representations, as c is currently the case for bank deposits. The result is an important consequence of monetary policy: the central bank would still be able to set a level of interest rates

- Usually in the very short term which would be relevant for the entire economy, including for DC users. This would still be the case even if the use of DC spreads to the point where there is no longer any demand for fiat money or central bank reserves. As shown by Woodford [25], the only difference would be that then the central bank would collect deposits at an interest rate that would provide a ceiling.
- Instead of today a floor - at very short-term interest rates: in order for monetary policy to have power over the economy, it would be sufficient for the liabilities issued by the central bank to play the role of account. Nevertheless, the question arises then of the coverage by the central bank of its expenses: dependent on a subsidy of the public authorities, its independence risks much being questioned at one time or another.

In more detail, depending on the impact of the diffusion of DCs on the balance sheets of the banks and the central bank (see Table 2) and therefore according to the scenario that would prevail, the consequences of monetary policy would differ.

Table 2. Scenarios of widespread use of digital currencies

Scenarios	Probability	Impact on demand			Impact on the size of the balance sheet	
		Central bank reserves	Fiduciary currencies	Bank deposits	Central bank	Banks
A (use within the financial system excluding the central bank)	Strong	-	Non pertinent	Non pertinent	-	-
B (convergence)	B1 (minimum services)	Low	-	-	Non pertinent	-
	B2 (all banking services)	Very low	-	-	-	-
C (Digital Currency of Central Bank)	C1 (no public access)	Strong/ average	-/=	Non pertinent	Non pertinent	-/=
	C1 (minimum services)	Low	?	-	-	?
	C2 (all banking services)	Extremely low	?	-	-	?

Note: A sign (+, - or =) refers to the expected impact. A question mark (?) indicates uncertainty on the sign of the impact.

3.2.1. Impact on Balance Sheets According to the Three Scenarios

In Scenario A, substitution between DC and central bank reserves results in a significant downsizing of central bank balance sheets and banks. In scenario B, the balance sheet of the central bank is also reduced. However, the reduction is greater than in scenario A because DCs replace reserves, as in A, but also notes. In addition, because of the substitution of DC for bank deposits, the demand for reserves is reduced by the erosion of the reserve requirement base. As DCs also replace fiduciary money, the aggregate balance sheet of banks and DC devices is increasing.

Scenario C at least partially offsets the impact of Scenario B on reserve demand and possibly changes the sign if DCCBs success with the public in Scenarios C2 and C3 more than compensates for the decline in demand for banknotes and the consequences on the amount of reserve requirements of the erosion of their base. Indeed, banks should "buy" the DCCB, just as today they "buy" the notes, that is to say by refinancing with the central bank. As the issuer of the DCCB, "external currency" in the same way as the notes, the central bank would not be justified in refusing to refinance the application provided that the guarantees presented are sufficient.

In fact, in Scenarios C2 and C3, refinancing by the central bank would only replace public deposits in banks' balance sheets[3]. Overall, the sign of the impact on the size of the central bank's balance sheet is unclear and depends on the extent to which the public arbitrates in favor of DCCB at the expense of the banknotes (which should occur in a limited way because the bill has privacy benefits), privately managed DCs (which is possible if agents give DCCB more confidence) and bank deposits (which is less likely, except bank run, as the public is unlikely to be in favor of a banking monopoly and / or believes that the central bank is a better protector of privacy than commercial banks). Even if the sign is a priori indeterminate, this impact on the central bank's balance sheet should be more favorable to it in scenario C3 than in scenario C2, the larger services provided by V in scenario C3 making it more attractive. Correspondingly, the impact on the size of the Aggregated Balance Sheet sector of the banking sector and DC devices is an uncertain sign but should be more unfavorable in Scenario C3 than in Scenario C2.

At the extreme, in scenario C3, if the public were to exchange all their deposits for V and obtain all of their central bank loans, the banking sector would disappear. Such a situation, which is relative to "financial socialism", would, however, have very little chance of happening, as previously explained.

3.2.2. Consequences for Monetary Policy

A distinction is made between the consequences for strategy i), conduct ii) and instruments iii) for monetary policy. In the latter two respects, some of the consequences are very similar to those resulting from the use of electronic money [26]. This is not surprising given the similarities already reported between electronic money and private DC systems.

i) Monetary Policy Strategy

A frequently mentioned monetary policy challenge is that due to DC's limited supply, their widespread use should introduce a deflationary bias into the economy; in addition, the inflexibility of DC's supply would create difficulties in smoothing the cycle [4].

However, the objection has the same recursive character as that put forward with regard to the use of DCs in international payments: it presupposes widespread use of DCs despite their unsatisfactory characteristics in comparison with legal currencies. Why should private agents choose to elect new currencies clearly unable to play the proper roles of means of exchange, unit of account and store of value, due in particular to an inelastic offer?

In the same vein, it has been suggested that if the substitution of DCs for cash and deposits becomes very important and transactions between DC users and users of legal money become scarce (in other words, if the legal currencies lose their role units of account), monetary policy would lose its power [2]. However, such a dichotomous scenario seems to be fiction: why would a substantial proportion of agents abandon the legal tender for DCs that would not be linked to it? And why would these agents no longer interact with those who continue to use legal money? In fact, such a scenario would only materialize if a significant loss of credibility of the legal tender occurred. This loss of credibility should also be common to all major currencies since a loss of confidence

[3] More worrisome for banks, they would lose access to at least some of the information removed from depositors' account management. They should therefore acquire the corresponding information, for example from payment service providers, and their loss of informational capital would be reflected in the prices of their securities. This is precisely why scenarios C1 and C2 are considered as unlikely.

in the legal tender usually leads to dollarization or "euroisation" of the economy[4].

Finally, Bordo and Levin [24] propose that, in a C3-type scenario, the central bank sets a zero long-term inflation target. Their proposal is based on the idea put forward by the authors that the DCCB issue would allow the central bank to set negative interest rates. However, apart from the existence of an effective downward limit on interest rates in negative territory related to the issuance of unpaid fiduciary money, there are other reasons - such as the lack of continuous optimization prices, the desire to facilitate relative price adjustments and biases in the measure of inflation - to set a slightly positive inflation target. In addition, according to Friedman, the difficulty of remunerating the notes justifies pursuing a negative rather than zero inflation target and the disappearance of this constraint, assuming that the DCCB issue allows it (see (ii) below), would justify a slight increase in the inflation target [27]. Finally, in the scheme envisaged by the authors, individuals should open accounts with the central bank that would systematically protect the confidentiality of their transactions: this proposal is more the issue of the issuance of central bank electronic money than the issue of DCCB.

(ii) Conduct of monetary policy: Four questions arise:

- With regard to monetary policy indicators, would the informational content of monetary aggregates (i.e. money and credit) run the risk of being reduced by arbitrage of deposits to DCs? This might actually be the case, but the standard approach for taking into account the impact of financial innovation on money aggregates is to change the definition by expanding it to include new assets similar to those to which they are attached. In this case, the DCs devices are subject to declarative obligations, for the similar case of electronic money [27]. Similarly, in Scenario B, credit aggregates could be expanded by reporting the DC devices that should establish a situation. Assuming, however, that DCs allow non-financial agents to save cash, as noted for financial institutions, the stability of the relationship between money and activity could be more significantly and sustainably challenged;

- Concerning the transmission mechanism of monetary policy, would it be affected? In all scenarios, the use of DLT should change the roles of bank capital and financing costs in the credit channel, as liquidity requirements and capital costs would be reduced (see first section). As a result, guarantees should be released, possibly leading to a decrease in liquidity premiums and thus to a rise in interest rates on public securities, the most liquid ones. In addition, the increased speed of transactions enabled by the DLT, as well as the execution of smart contracts, could contribute to faster transmission via the interest rate channel. Finally, in Scenarios C2 and C3, the transmission of interest rate pulses could also become more powerful if the weight of central bank refinancing in banking resources increases (the opposite would occur in all other scenarios, where demand reserves would decline). However, these developments would probably take the form of ad hoc and limited adjustments in the transmission mechanism;

- In terms of setting interest rates, would the DCCB issue allow the central bank to reach significantly negative levels [23,24]. This seems to be the case in case of widespread use of DC, provided of course that the DLT allows the payment of negative interest. However, the problem of the effective interest rate limit (that is, the negative interest rate level at which agents actually start exchanging their deposits for notes) would continue to arise as long as the bank central would not abolish cash, exchanging them for DCCB or foreign exchange reserves for the note [26];

- Regarding the role of the central bank as lender of last resort, would it be compromised? Here, the question is not whether DC devices could replace central banks, since the hypothesis was made, in scenario B, that these devices and the banks would converge: as they would become very similar to banks, they would very likely benefit from access to the lender of last resort. Rather, in Scenarios C2 and C3, central bank refinancing could be a significant portion of bank liabilities, in the unlikely event that the public would largely adopt DCCB in place of banknotes, deposits, and other DCs[5]. Also, the DCCB issue would facilitate bank runs, exacerbating liquidity risk. For both of these reasons, it should become even harder than today for the central bank to refuse support. The risk that it is not excluded but on the contrary too present would then be an additional reason, in addition to the current ones, to limit the considerations of moral hazard inherent in the conduct of lender-of-last-resort operations by making access more rule-based [26].

(iii) Monetary policy instruments:

There are two types of monetary policy instruments: reserve requirements, which are used to increase the demand for reserves, and interest rate instruments (open market operations and permanent facilities) which serve to signal the direction of monetary policy.

In the event that demand for reserves decreases sharply (scenario A, B1 and especially B2), the central bank could react in several ways:

- It could expand the reserve base by including DCs. This would be logical, especially in Scenario B since DC schemes and banks would move closer together and bank deposits of non-financial agents are subject to reserve requirements;

- It could increase reserve ratios, although it would penalize deposits over DCs, unless the reserve base is also extended to them;

- It could increase the demand for reserves by issuing DCCB (scenario C), as it was envisaged that it could issue its electronic money in response to a substitution of bank electronic money for banknotes [27];[6]

- It could finally choose to implement monetary policy by withdrawing rather than providing liquidity, although this could make it more difficult to cover its expenses and ultimately undermine its independence.

[4] The case of Cyprus in 2011, in which deposit holders in Cypriot banks bought Bitcoins, leading to a sharp appreciation of the digital currency following the introduction of capital controls, shows nevertheless that with DCs central banks face increased competition from currencies.

[5] This evolution has sometimes been described as a step towards a "narrower" banking system [23], which some authors consider to be more stable than the existing one [28]. However, scenarios C2 and C3 differ in that they would lead to substitution between bank liabilities (central bank refinancing instead of deposits) rather than between assets. In addition, these switches would leave maturity transformation by banks unchanged if refinancing is granted in the short term, as is usually the case.

[6] Another way to increase demand for reserves would be for the central bank to sell assets.

With regard to interest rate instruments, the question arises in scenario C as to how much to pay the DCCB. This rate could be the excess reserve rate (the deposit facility rate in the Eurosystem), in order to avoid creating arbitrage opportunities between DCCB and conventional reserves, or a little less in order to take into account the larger services provided by DCCB. In Scenarios C2 and C3, however, interest may be paid only on the DCCB held by the financial institutions, if the central bank wishes not to encourage a substitution of the DCCB for the notes. Finally, it is possible to design an intermediate scenario between C2 and C3, where the DCCB, whether owned by financial institutions or the public, would be remunerated at the same rate as excess reserves or slightly below, but would not allow offering other banking services. This would avoid arbitration between DCCB and the banknotes, particularly if the central bank would introduce a currency exchange rate [26].

This would also circumvent the thorny technical problem of setting a central bank lending rate to non-financial agents, which could differ from that of its lending to financial institutions, and which would become an additional monetary policy rate, raising the question of the level of the "spread" between the two rates, with the risk of sending contradictory signals and that of creating distortions of competition with the private sector.

4. Conclusion

The use of DCs is very likely to spread only under conditions that would fundamentally leave the central bank's ability to pursue an identical inflation target by the same means as today, by setting a level of interest rates. However, some adjustments may need to be made to the definition of monetary aggregates as well as to the base and / or reserve requirement ratios. Even in the extreme and highly improbable case where DCCB with deposit attributes would be issued and the public would adopt it massively, the role of banks in credit distribution, although exercising in more difficult conditions because less direct information about their clientele, should not be seriously compromised. Banks would become rather heavily dependent on central bank refinancing, which would militate for the announcement of a lender-of-last-resort policy based on rules to limit moral hazard [25]. Banks would only disappear in the extreme case of "financial socialism" [23]. However, the decision to pursue such a route would be highly political and would not necessarily be accepted by the public.

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