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BEYOND BITCOIN AND CASH: DO WE LIKE A CENTRAL BANK DIGITAL CURRENCY?

A FINANCIAL AND POLITICAL ECONOMICS APPROACH

Emanuele Borgonovo[♣], Stefano Caselli[♣], Alessandra Cillo[♣] and Donato Masciandaro[♣]

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Abstract

The aim of this paper is to offer a theoretical primer in order to analyse the demand of a central bank digital currency (CBDC). Using a financial portfolio approach and assuming that individual preferences and policy votes are consistent, we identify the drivers of the political consensus in favour or against such as new currency. Given three different properties of a currency – where the first two are the standard functions of medium of exchange and store of value and the third one is the less explored function of store of information – and three different existing moneys – paper currency, banking currency and cryptocurrency – if the individuals are rational but at the same time can be affected by behavioural biases – loss aversion - three different groups of individuals – respectively lovers, neutrals and haters – emerge respect to the CBDC option. Given the alternative opportunity costs of the different currencies, 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.

JEL Classification: B22, D72, E41, E42, E52, E58, G38, G41, K42

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[♣] Department of Decision Sciences, Bocconi University.

[♣] Department of Finance, Bocconi University.

[♣] Department of Decision Sciences, Bocconi University.

[♣] Department of Economics and Baffi Carefin Center, Bocconi University, and SUERF.

1. Introduction

Do we would like a central bank digital currency (CBDC)? Should the demand of such as currency be relevant and which drivers could explain it? The macroeconomic interest of these questions becomes evident observing two recent and parallel trends in the advanced economies: on the one side the puzzling resilience of the public paper currency, notwithstanding the wide diffusion of the cashless payment technologies in advanced economies; on the other side a particular innovation is characterizing such as diffusion, i.e. the issuing of the so called crypto currencies, where cryptographic techniques are used to protect the identity of the exchangers that operate peer to peer via an electronic network without a trusted authority that managed it (blockchain technology).

Today the only public money available to all citizens is the paper currency, that still represents a relevant share of the money supply in the advanced economies. In 2015 per capita holdings of paper currency on GDP has been about 20 percent in Japan, 11 percent in Switzerland and in the Euro area, 8 percent in the US (Jobst and Stix 2017). Even more puzzling, the paper currency circulation gone up in the recent years and can be observed in several and heterogeneous economies (Jobst and Stix 2017), as well as inside and outside the issuing country if we are looking at a global reserve currency (Feige 2012, Judson 2012).

On top of that, most of the paper currency in circulation are large denomination banknotes, notwithstanding recent review of the paper currency denomination structures are reversing such as policies. For example on May, 4th, 2016 the ECB Governing Council decided to stop the issuance of €500 banknotes around the end of the 2018, and on November 8th 2016 the Indian government surprisingly announced a legal tender status taking off that targeted the 86% of the currency then in circulation in order to implement a radical demonetization policy (Dharmapala and Khanna 2017). The individual preferences toward cash seem to be also consistent with the increase in corporate cash (Graham and Leary 2017, Faulkender et al. 2017).

Yet the public utility of the paper currency is increasingly disputed, given that it has been claimed (Rogoff 2017) that paper currency has at least two important drawbacks: on the one side it facilitates the growth of the illegal economy, with the corresponding losses in terms of missing tax revenues, without mentioning other social negative spillovers; on the other side it hampers the effectiveness of the monetary policy, being the basis of the existence of the zero lower bound on the nominal interest rate.

It is worth recalling that the benefits of paper currency issuing are essentially two: the State gains the seignorage revenues, given that it acquires goods and services in exchange for paper currency, and the seignorage revenues are still relevant (Rogoff 2017); the anonymity of the paper currency can protect the individual privacy rights against the risk that a State – both democratic or dictatorial – can misuse the information that can be collected using the payment system.

At the same time the recent wave of innovation in the private payment systems has been characterized by the issuing of the so called crypto currencies. The crypto currencies represents a private supply of means of payment, that are produced and distributed using decentralized transfer system, i.e. the so called blockchain or peer to peer technologies (or distributed ledger technology DLT) (Bech and Garratt 2017). The usage of the crypto currencies as medium of exchange is so far limited: the use of Bitcoin proxied by the average number of daily transactions is equal to 250 thousands, while established electronic

payment systems such as Visa handled almost 100 billion transactions (Bruhl 2017). At the same time, since the introduction of Bitcoin more than one thousand crypto currencies have been registered (Bruhl 2017).

Beyond the resilience of the traditional public paper currency on the one side, and the emerging interest for new private electronic currencies on the other side, a natural question arises: is it any role for a public digital currency? It has been claimed that (Bordo and Levin 2017) that the issuing of a central bank digital currency (CBDC) could transform all the aspects of the monetary system, serving as a costless medium of exchange, secure store of value and stable unit of account. In general the CBDC introduction could have deep consequences in the implementation of both monetary and banking policies (Niepelt 2017), but the issue needed to be tackled in a complete and systematic way, taking into account that the CBDC issuing can be designed in different ways, regarding for example the level of privacy and/or the possibility of having interest bearing mechanisms (Lober 2017).

The CBDC issuing is an option that both academics and central bankers are nowadays carefully considering (Fung and Halaburda 2016, Skingsley 2016, Danezis and Meiklejohn 2016, Bordo and Levin 2017, Bech and Garratt 2017, Hileman and Rauchs 2017, Lowe 2017, Segendorf 2017). At the same time it is worth noting that such a topic implies the need to consider both the economic and the political economy perspectives (Tucker 2017), as well as the role of the technological innovations (Velde 2017).

The aim of this paper is to propose a primer that can be used to analyse the CBDC demand. Using a portfolio approach and assuming that individual preferences and voting are consistent, it is possible to identify the drivers of the political consensus in favour or against such as new currency. The CBDC – being at the same time a public and virtual medium of exchange – should be completely different on the one side from the existing forms of virtual monies, which are issued from private regulated firms (banks) and private unregulated entities (blockchain network), and on the other side from the paper currency. In other words the existence of a CBDC should change the possibility of each agent to allocate her/his funds – thereafter her – given her financial preferences.

Therefore the key question arises: how the existence of a CBDC should change the portfolio allocation in an advanced economy? In order to address such a question, we propose a simple theoretical framework, where individuals choose their portfolio allocation when a new medium of exchange – i.e. the CBDC – is introduced, starting with rational citizens and then taking into account the possibility behavioural biases – i.e. loss aversion. We assume three different properties of a currency – medium of exchange, store of value and store of information – and that three different moneys – paper currency, banking currency and cryptocurrency – already exist. Finally, assuming that the individual votes on the policy option of issuing a CBDC are consistent with the financial preferences, the political consensus on the new currency is evaluated shedding light on its drivers.

The remainder of this paper is organized as follows. Section Two describes the basic framework, Section Three introduces the possibility of behavioural biases, and Section Four presents the political outcomes. Section Five concludes.

2. The Demand for CBDC

Consider a population with a continuum of individuals, each of them free to choose his/her – thereafter her – financial portfolio composition. Any available financial asset can be potentially use as a

medium of exchange, i.e. any individual can use it to finalize an exchange being alternatively the payer or the payee.

Our attention is focused on the individual demand for money. Owing to innovation, the demand for money is likely to change. Let us assume that the State decides to issue a E-Currency – a CBDC - that shares with the traditional (paper) currency two features: a) it is a legal tender, i.e. the State guarantees its role as medium of exchange (safe asset) and b) no return it is payed, while the main difference is that c) it is distributed via centralized electronic networks, and then it have not the anonymity property, which characterized the paper currency, which is distributed via decentralized physical exchanges.

The E-Currency issuing could be implemented by giving the public access to accounts at the central bank, which is already technically feasible (Bech and Garratts 2017), but without any lending option. In other words the E-Currency is a public debt- card; the public nature – legal tender – differentiate it from the electronic banking money, which is issued by private entities. Our E-Currency is a central bank digital currencies, i.e. electronic central bank money exchanged in a centralized manner (Jobst and Stix 2017).

Our analysis differs from a previous work (Hendrickson et al. 2015) that considers the economics of the policymaker perspective in allowing or not the coexistence between legal tender currencies versus cryptocurrencies, where the preferences of the traders are exogenous, as well as the drivers that give rise to such preferences. Here we try to explore such drivers in explaining the probability of success of a CBDC policy from a political economics point of view.

For each individual in the population the E-Currency share π in her portfolio can be different from zero. Therefore, the overall demand for money will represent a share of the overall portfolio, being an individual component of it.

In general and in the absence of special factors, the demand for E-currency in nominal terms using a portfolio approach can be explained by the fundamental drivers that are usually present in a standard demand for money, both in normal (Gerdesmeier 1996, Sriram 1999) and in extraordinary times (Dreger et al. 2016, Jung 2016):

$$\pi = \Omega(Y, i, u)$$

With Y denotes a set of transaction variables – as income and wealth – while i is a set of rate of return on alternative assets and u are the individual preferences. Usually the transaction variables are positively associated with the demand for money, whereas the rates of return represent the opportunity cost, that is negatively associated with the demand for currency, and the individual preferences are homogeneous.

Now, given income and wealth, let us assume that the individual preferences are heterogeneous respect to the three crucial properties of a currency: medium of exchange, store of value and store of information. The three properties capture the different risks that the holding of a financial asset can imply in any given moment.

First of all we assume that any individual cares about the liquidity costs, which are associated with the probability that the asset cannot be traded, i.e. used as a medium of exchange and transformed in other goods and services. We assume that the issuer type influences the shape of the liquidity costs. When the currency is a legal tender, we assume that in a given territory it is the safer asset, being the obligation for each trader to accept in any exchange between both public and private traders; in other

words any trader cannot refuse to accept the legal tender as payment. The legal tender, which is also the unit of account, minimized the expected liquidity costs.

We assume that the legal tender property internalizes the public gains that such feature implies, as the monetary policy effectiveness, and/or the seignorage gains (Rogoff 2017).

Our definition of a safe asset zooms on its liquidity properties, rather than on the property to preserve its expected value – as for example in Caballero and Farhi 2017.

Regarding such as second property of a financial asset – i.e. its expected value – we acknowledge its relevance for the individuals, using as its proxy the real expected return of each portfolio asset, which summarizes the standard opportunity costs, i.e. the purchasing power expected gains/losses. Assuming that inflation is likely to be different from zero and that deflation is unlikely the opportunity costs of holding legal tender are positive. A positive expected return characterized a store of value (profitable) asset.

Finally a currency is also a store of information: the individuals consider the privacy (transparency) risks that using a given currency for trading can imply, given that any exchange can disseminate information on the exchangers. In general anonymity characterizes an asset as a store of information.

Among the individuals that like the currency anonymity a relevant group are the people that appreciate such as property being motivated by illegal reasons, given that an anonymous currency can be an effective device to implement money laundering operation. The attention to the study of money laundering has progressively increased, recognizing the importance of money laundering in the development of any law violation that generates revenues.

In fact, the conduct of any illegal activity may be subject to a special category of transaction costs, linked to the fact that the use of the relative revenues increases the probability of discovery of the crime and therefore the likelihood of incrimination. Those transaction costs can be minimized through an effective money laundering secrecy action, a mean of concealment that separates financial flows from their illegal origin; the specific economic function of this instrument is to transform potential income into effective purchasing power (Masciandaro 1999). Inside the general framework of the economics of money laundering (Masciandaro et al. 2007, Unger 2007, Schneider and Windischbauer 2008) a currency demand approach has been recently proposed (Ardizzi et al. 2014, Ardizzi et al. 2016) which zooms on the relationship between an anonymous medium of exchange – i.e. cash – and the illegal component of its demand.

On this respect it is a matter of fact that also the electronic peer to peer currencies has been associated with the risks of money laundering (Brayans 2014), given that the crypto currencies seem to be especially effective for conducting illegal transactions (Hendrickson et al. 2015).

We assume that the expected transparency risks are associated with the distributional property of any given currency, that can be centralized or decentralized, where the latter minimizes the privacy risks. The decentralized system – or peer to peer system – characterized both the paper currencies – physical peer to peer network - and the crypto currencies – electronic peer to peer network, via the blockchain technologies.

In our model we postulate that only the crypto currencies used the blockchain technology as platform. The blockchain mechanism can be characterized as follows: all the transactions are publicly recorded using the payer's and the payee's public email addresses, but such addresses do not need to reveal any information on the exchangers, being pseudonym based (Bech and Garrett, 2017).

Therefore we assume that using the cryptocurrencies guarantee the counterparty anonymity and – at least partially - a full third part anonymity. It is worth recalling that a significant share of crypto currencies adopters so far sought the anonymity property, that wasn't available through the alternative electronic media of exchange (Bohme et al. 2015).

Our assumptions take stocks of the debate on the third party anonymity (TPA): the TPA is for sure a property of the paper currency, while the existence or not of such as property in the case of the blockchain transfer is controversial (Bohme et al. 2015) and the crypto currencies as been defined a quasi-anonymous medium of exchange (Hendrickson et al. 2015). At the same time is it unclear how much individuals actually value anonymity of either sort (Bech and Garrett 2017, Athey et al. 2017).

We assume that the degree of anonymity depends on the distribution properties, where the peer to peer or decentralized system (paper currency and blockchain) guarantee higher degree of anonymity. The electronic nature can characterized both the decentralized and centralized payment system networks.

In our framework we associate the distributional feature of a currency with the anonymity property. it is worth noting that here the distributional feature other summarizes two technical characteristics – accessibility and form – that can be separately analyzed (Bech and Garratt 2017). Further we do not associated the distributional feature with gains and/or losses in terms of efficiency – i.e. transaction costs - given that on this topic the debate is still in a state of flux; while someone assumes for granted that the crypto currencies are low cost payment platforms (Hendrickson et al. 2015), for others the opposite seems to be true (Lowe 2017, Kaminska 2017), then in general it seems so far not clear if consumers benefit from using electronic decentralized systems (Bohme 2015).

In any case the circulation of currencies with uncertain properties – as the crypto currencies can be considered - can be justified using the general assumption that the existence of good and services with such features can increase the consumer surplus via the resulting competition among produces (Berg and Binsbergen 2017).

Finally it is worth noting that we can enlarge without problem our taxonomy, if we assume that other private payment technologies which are not used by banks and at the same time are not based on blockchain mechanisms (shadow payment system) can enjoy – at least partially - the anonymity property (Gapper 2017).

Summing up, the financial assets that can be used as currencies are different respect to three main properties: 1) the issuer, that can be a public or a private entity; 2) the existence of an overall expected return; 3) the distribution network, that can be either centralized or decentralized.

In our economy, before the introduction of the E-Currency, in allocating her portfolio each individual can choose between the traditional paper currency, and two types of private assets that can be used as currencies: banking currency and crypto currency.

The three traditional key features of the paper currency are the role of the State as issuer, the absence of a nominal return and anonymity. The importance of such as drivers has been tested in the empirical analysis of the recent rising demand for paper currency (Jobst and Stix 2017), finding that the paper currency demand has been was mainly driven by higher level of uncertainty (legal tender effect) and lower level of the interest rates (expected return effect). while the absence of the anonymity effect has been explained with methodological difficulties, as well as well with the sample features. Finally the paper currency isn't electronically distributed.

Both the banking currency and the crypto currency are not legal tender, have a (different) real expected return, but only the crypto currency is distributed via a decentralized network, guaranteeing a certain degree of anonymity.

Regarding the expected return, the crypto coins are characterized by a value that changes, with ups and downs (Bech and Garratt 2017), in some cases financial anomalies (Caporale and Plastun 2017) and in general a complex volatility (Catania and Grassi 2017), while the banking currency traditionally yields a nominal return, which is relatively low and stable.

On this respect, the specialness of the crypto currencies is associated with the drivers of its value: unlike physical commodities it has no a positive direct utility due to practical use and it is not a liability of anyone, then it does not have any future dividends; its expected return relies exclusively on expectations of future demand with the corresponding increase of the resale value, given a supply that is supposed to be prospectively fixed – in the case of the Bitcoin the maximum amount is 21 million, and as November 27th 2017 16.7 million bitcoins have been issued (Bruhl 2017). The other drivers of the demand for crypto currencies are likely to be a loss of trust in the public authorities – it isn't a legal tender – and/or the desire among the exchangers to hide their identities (Niepelt 2016).

Respect to the E-Currency, both the private currencies have not a public issuer and lower opportunity cost risks. The banking currencies are private liabilities, while the crypto coins are not the liabilities of anyone (Bech and Garratt 2017).

Table 1 summarizes the three features of the four different currency types:

TABLE 1: CURRENCY TYPES

CURRENCY TYPES	SAFE ASSET (legal tender = low liquidity costs)	STORE OF VALUE ASSET (store of value asset = low opportunity costs)	STORE OF INFORMATION ASSET (decentralized distribution= low privacy costs)
E-CURRENCY (CBDC)	YES	NO	NO
PAPER CURRENCY	YES	NO	YES (full) (technology: decentralized physical chain)
BANKING CURRENCY	NO	YES	NO
CRYPTO CURRENCY	NO	YES	YES (partially: quasi anonymous) (technology: blockchain, pseudonym based, decentralized electronic chain)

The specialness of the E-Currency depends on being both an electronic and a public currency. For a portfolio diversification point of view, an increasing share of E-Currency triggers expected benefits respect to both the paper currency (less transaction costs) and the private coins (less liquidity costs), but also expected costs comparing it with on the side with the paper currency (more transparency costs) and the crypto currencies (more transparency costs and more opportunity costs) and the private currencies (more opportunity costs).

The individual heterogeneous preferences are summarized in a parameter t , that represent the individual type and captures her/his – thereafter her – degree of *aversion* toward the introduction of the E-currency (*E-currency aversion*), which is common knowledge.

The heterogeneity among individuals may arise from any driver that can affect personal preferences, for example from their ideology and culture to the nature and origin – legal or not – of their income and wealth. The degree of aversion summarizes three possible individual and specific features: 1) Public issuing aversion ; 2) opportunity loss aversion; 3) transparency aversion.

Having an E-Currency share π in her portfolio can influence the utility function of each individual, which can be different across individuals. Using the utility function introduced in Alesina and Passarelli (2015) and used in Favaretto and Masciandaro (2016), let $V(t_i, \pi)$ be the description of the preferences of the individual i :

$$V(t_i, \pi) = B(t_i, \pi) - C(t_i, \pi) \quad (1)$$

Where $B(t_i, \pi)$ and $C(t_i, \pi)$ are respectively the individual benefits and costs. We assume that for each individual the abovementioned comparative benefits in having E-Currency are increasing and concave in the E-Currency share:

$$\frac{\partial B(t, \pi)}{\partial \pi} > 0 \quad \frac{\partial^2 B(t, \pi)}{\partial \pi^2} < 0 \quad (2)$$

We assume that the benefits of having an electronic safe asset - i.e. less transaction costs respect to the paper currency and less liquidity costs respect to the private coins - is increasing but at a decreasing rate with its share.

At the same time we assume that the individual comparative costs in having E-Currency - more opportunity costs respect to the private coins and more transparency costs respect to the decentralized payment systems, i.e. paper currency and crypto currency - are increasing and concave in the E-Currency share:

$$\frac{\partial C(t, \pi)}{\partial \pi} > 0 \quad \frac{\partial^2 C(t, \pi)}{\partial \pi^2} \geq 0 \quad (3)$$

Finally recalling that the individuals are heterogeneous with respect to their degree of E-currency aversion, they can be indexed such that more adverse individuals bear higher marginal costs and/or enjoy lower marginal benefits from having the E-Currency in their portfolios :

$$\frac{\partial B_\pi(t_i, \pi)}{\partial t_i} \leq 0; \quad \frac{\partial C_\pi(t_i, \pi)}{\partial t_i} \geq 0 \quad (4)$$

Given the assumption from (1) to (4), the equilibrium is interior, i.e. the E-Currency share is non negative:

$$\frac{\partial B(t_i, 0)}{\partial \pi} > \frac{\partial C(t_i, 0)}{\partial \pi} \quad (5)$$

For each individual the utility is increasing in the E-Currency share and the optimal E-Currency share, π^* is such that marginal benefits match marginal costs:

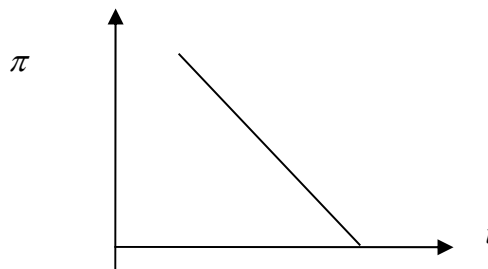
$$\frac{\partial B_{\pi}(t_i, \pi)}{\partial \pi} = \frac{\partial C_{\pi}(t_i, \pi)}{\partial \pi} \quad (6)$$

And that:

$$\frac{\partial \pi^*}{\partial t_i} < 0 \quad (7)$$

In words, the optimal degree of E-Currency will be depend on the personal degree of E-currency aversion, i.e. the more the individuals dislike the public nature of the issuer and/or to have opportunity costs and on the contrary like the anonymity gains, the less will be the E-Currency share in their portfolios (Figure 1).

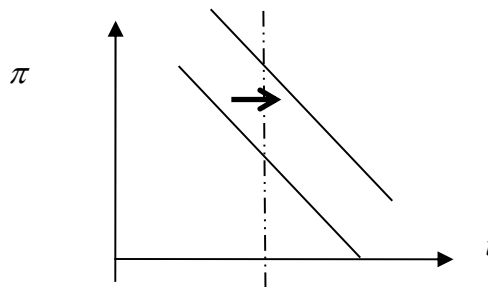
FIGURE 1 AVERSION AND E-CURRENCY SHARE



It is worth noting that:

Any shock that modify the drivers that influence both the benefits and costs in having E-Currency will change the optimal share, given the individual aversion; for example, given its legal tender status, any policy that increases the efficiency and the security of the public digital currency (Bordo and Levin 2007) will increase the optimal E-Currency share (Figure 2):

FIGURE 2 LEGAL TENDER GAINS AND E-CURRENCY SHARE



Similarly an increase in the E-Currency share will occur if a return can be paid on it. In fact, as with other kinds of electronic money, it could be technically possible to pay interest on a central bank digital currency, as it is possible today to pay interest on the reserves of the commercial banks (Bech and Garratt, 2017, Bordo and Levin 2017, Segendorf 2017).

The same is true if the E-Currency implementation would reduce the transparency costs, for example allowing E-currency exchanges where the payer unknown to payee but the central bank have all

information, having counterparty anonymity without third-party anonymity (Segendorf 2017). Given the individual sensibility respect to the transparency costs, if the existence of CBDC would be a device to isolate the demand for privacy due to illegal reasons, the CBDC issue can be an effective strategy against money laundering and all the correlated illegal activities (Bordo and Levin 2017).

3. CBDC Demand and Loss Aversion

Now we assume that with loss aversion, and for every portfolio choice, losses loom larger than gains, and both are evaluated with respect to a given *status quo*. Let $z > 0$ be the parameter which captures loss aversion and let π^{SQ} be the *status quo* E-Currency share. Given condition (5), the status quo E-Currency share is non negative so we can analyze in general how a given portfolio allocation can change if a shock occurs ; on top, if we assume that the E-Currency can be arbitrarily small we can also mimic the specific real world situation of the E-Currency introduction.

With loss aversion an increasing E-Currency share - $\pi > \pi^{SQ}$ - entails more benefits than costs, but higher expected costs yield psychological losses which amount to:

$$z(C(t_i, \pi) - C(t_i, \pi^{SQ})) \quad (8)$$

Vice versa reducing the E-Currency share - $\pi < \pi^{SQ}$ - overall entails less benefits than costs, with psychological losses in terms of benefits – i.e. due to less public guarantees and/or less efficiency - which amount to:

$$z(B(t_i, \pi^{SQ}) - B(t_i, \pi)) \quad (9)$$

Therefore the individual goal function with loss aversion $V(t_i, \pi / \pi^{SQ})$ is given by the basic utility $V(t_i, \pi)$ minus the psychological losses due to the departures from the *status quo* allocation:

$$V(t_i, \pi / \pi^{SQ}) = V(t_i, \pi) - z(C(t_i, \pi) - C(t_i, \pi^{SQ})) \text{ if } \pi > \pi^{SQ}$$

$$V(t_i, \pi / \pi^{SQ}) = V(t_i, \pi) - z(B(t_i, \pi^{SQ}) - B(t_i, \pi)) \text{ if } \pi < \pi^{SQ}$$

The optimal conditions are as follows:

$$B_\pi(t_i, \pi) = (1 + z)C_\pi(t_i, \pi) \text{ if } \pi > \pi^{SQ} \quad (10)$$

$$(1 + z)B_\pi(t_i, \pi) = C_\pi(t_i, \pi) \text{ if } \pi < \pi^{SQ} \quad (11)$$

Therefore for each individual it will be true that, given her level of aversion t_i , she will set her preferred E-Currency share π_i according to the following rule:

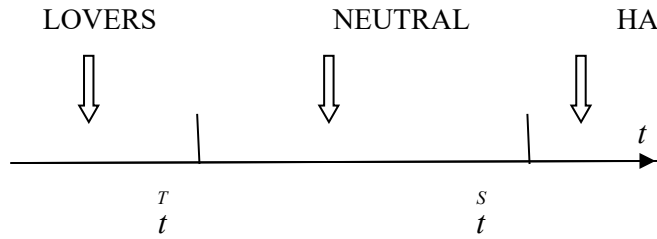
$$\begin{aligned} B_\pi(t_i, \pi) &= (1 + z)C_\pi(t_i, \pi) \text{ if } t_i < t^S \\ (1 + z)B_\pi(t_i, \pi) &= C_\pi(t_i, \pi) \text{ if } t_i > t^T \end{aligned} \quad (12)$$

$$\pi = \pi^s \text{ if } t^T < t_i < t^S$$

It is worth noting that t^T and t^S with $t^T < t^S$ represents respectively a lower bound and a higher bound in the distribution of aversion that depend on the status quo portfolio allocation.

Therefore every population can be splitted in three different groups: E-Currency Lovers people - $if t_i < t^T$ - E-Currency Haters people - $if t_i > t^S$ and Neutral people - $if t^T < t_i < t^S$ (Figure 3).

FIGURE 3 INDIVIDUALS: LOVERS, NEUTRAL AND HATERS

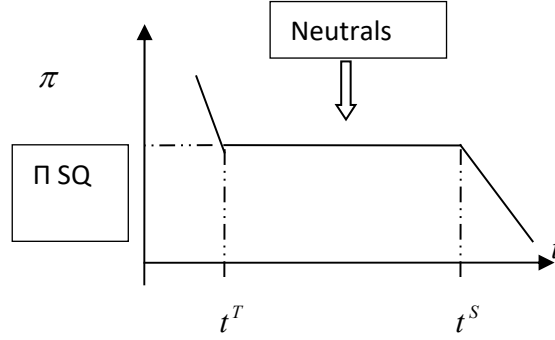


Each individual will express well defined E-Currency share preferences. With respect to the basic situation we are now assuming that i) each individual will evaluate any situation in terms of changes from the E-Currency share status quo; ii) any negative effect of a change with respect to the status quo are thought to loom larger than a positive effect of equivalent magnitude. The two assumptions are a simple application of the loss aversion principle (Kahneman and Tversky 1979, Tversky and Kahneman 1991), highlighting the fact that if there is a loss/gain asymmetry for individuals, inertia is more likely to occur, as we will see below.

Given the preferences, for each individual the optimal E-Currency share will depend on her aversion t_i , having three possibilities: lover, neutral and hater. More precisely three different equilibria can arise (Figure 4):

$$\begin{aligned}
 \pi &= \pi^{SQ} \text{ if } t^T < t_i < t^S \\
 \pi &< \pi^{SQ} \text{ if } t_i < t^T \\
 \pi &> \pi^{SQ} \text{ if } t_i > t^S
 \end{aligned}
 \tag{13}$$

FIGURE 4 PEOPLE TYPES AND E-CURRENCY SHARE



The existence of loss aversion influences the portfolio decisions at least via a *Moderation Effect*:

The E-Currency share outcome will be the status quo share π^{SQ} if the individual is neutral. Further, given that the distance between t^T and t^S is increasing in $z > 0$, the more the loss aversion is increasing the more likely the individual is neutral: a status quo bias – i.e. portfolio inertia - will emerge. In other words more loss aversion among individuals reduces the distance between their E-Currency share positions. As the individuals become more loss averse, neutral people increase in number and portfolio inertia is likely to increase. In other words being π^* the equilibrium E-Currency share, we have that increasing loss aversion triggers portfolio inertia, i.e. :

$$\pi^* = \pi^{SQ} \text{ if } z > 0 \quad (14)$$

In words: the more that are individuals that disproportionately dislike the expected losses the less there will be change in the E-Currency share.

4. Voting for CBDC Issuance

Now we assume that our individuals is a population of citizens that have to choose if and how to introduce the E-currency; the overall procedures can be summarized through a unidimensional policy $p \in R^+$. On top we assume that for each individual her optimal policy p can be proxied using her optimal E-currency share. Therefore haters vote for lower CBDC policies, i.e. against them; the opposite is true for lovers preferences.

The policy outcome will depend on the voting rules. First of all, which should be the optimal policy if a social planner is in charge? The benevolent dictator would maximize the overall sum of individuals' preferences:

$$\int [B(t, p) - C(t, p)] dFt \quad (14)$$

Where the first best CBDC policy will be define in order to equalize the average marginal benefits $\bar{B}_p(p)$ and the average marginal costs $\bar{C}_p(p)$, i.e. solving the equation:

$$\bar{B}_p(p) = \bar{C}_p(p) \quad (15)$$

The social planner goal is to maximize the effectiveness of the CBDC issuing taking into account its relative properties as medium of exchange, store of value and of information. But the social planner solution is not necessarily the equilibrium solution if a voting regime is in action. If for the sake of simplicity, we assume that the voting regime is governed via a majority rule, the selected CBDC policy will depend on the preferences of the median voter, i.e. it will be equal to p_m . Therefore the introduction of the CBDC will be more like if the median voter is a lover; the opposite is true if in the given individual preferences distribution the median voter is an hater. The distribution of the preferences among the citizens becomes crucial to define will the actual CBDC policy.

At the same time, given such as distribution, the likelihood of a CBDC establishment will increase whatever event will increase its expected gains and/or will decrease its expected costs.

Finally, if we introduce the loss aversion, we can assume that in the status quo situation the E-Currency doesn't exist, i.e. in our model such an assumption implies $p_{ST} = \pi_{ST} = \varepsilon$, where ε is infinitely small. Now we assume that the reference point for the citizens is the status quo situation, our assumption seems to be sufficiently robust, given that usually the debate on the pros and cons of introducing a CBDC is usually assessed against the existing payment system situation; it is a backward looking reference point (Alesina and Passarelli 2015).

Given the abovementioned three group of citizens – lovers, neutrals and haters in Figure 4 – if the median voter is the intermediate group, the policy outcome is the status quo, i.e. the CBDC is less like to be introduced.

5. Conclusion

Exploring the link between individual liquidity preferences and CBCD issuing and business cycle can help in shedding light on the micro foundations of both normal time and extraordinary time phenomena – banking runs and financial instability (Haldane 2017), interest rate lower bounds (Rogoff 2017), precautionary cash trends (Graham and Leary 2017 and Faulkender et al. 2017) – and its consequences for the design of the two main tasks of the modern central banking: monetary policy and banking regulation.

The existence of a relevant demand for E-currency would have implications for:

- a) Monetary Policy: if we assume that the individuals are sensible to the technological properties – i.e. they completely dislike the physical form - the demand for E-currency would completely replace paper currency, and consequently the E-currency issuing has the potential to address and fix the zero lower bound constraint in the monetary policy implementation.
- b) Banking Policy: In normal time, the more the opportunity cost discrepancies between the E-currency and the banking currency become smaller, the higher will be the risks to the business model of commercial banks, due the disintermediation. In extraordinary times - for example when bad news on the state of the banking health circulate - if we assume that the individuals can become extremely sensible to liquidity risks, a bank run is more likely to occur.

The aim of this paper has been to offer a primer in order to analyse the effects of the issuing of a central bank digital currency (CBDC). The analysis has been based on the assumption that the perspective of the

CBDC issue influences the individual portfolio choices and consequently the voting in favour or against the introduction of such new currency.

Given three different properties of a currency – medium of exchange, store of value and store of information – and three different already existing moneys – paper currency, banking currency and cryptocurrency – if the rational individuals can be also affected by behavioural biases – loss aversion - it has been shown that it is possible to disentangle in the population three different groups – lovers, neutrals and haters – respect to their preferences towards the CBDC introduction. Given the alternative opportunity costs of the different currencies, 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.

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