

The future of digital retail payments in Europe: A role for central bank issued crypto cash?

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1 October 2017

Abstract

In the broader context of the arrival of distributed ledger technology (DLT) and in light of payments and regulatory innovation in the European market, this paper investigates the changing role of money in retail payments and the associated question as to whether central bank fiat currency risks to fall behind. Against this background, the paper asks whether the introduction of a form of central bank crypto currency (CBCC) – a central bank money based crypto retail payment method as a complement to physical cash - would be useful and explores what this could look like.

Such a new form of digital cash could be developed by building on DLT and cryptography, akin to the increasingly important space of private crypto currencies. In case of a central bank issued crypto cash equivalent, labelled 'Euro-cryptocash', key questions ranging from the involvement of banks and non-bank payment service providers, to privacy versus transparency, resiliency, efficiency and the role for consumer protection are discussed. As pressures on fiat currencies are increasing, the development of a form of 'Euro-cryptocash' is going to become an essential prerequisite for the future of the Eurosystem and the Eurozone.

¹ The views expressed here and any remaining errors are my own.

1. Introduction

Technological change in payments is not new. In the 1990s, the arrival of e-money promised to deliver benefits of speed, transparency and efficiency to payment users. Early on the question came up as to whether e-money could create distortionary effects on monetary policy (see Al-Laham et al, 2009) and thus whether central banks should also consider issuing e-money or leave this entirely to commercial entities (BIS, 1996, p.10). Eventually in Europe e-money issuance was left to the newly created and swiftly regulated e-money institutions as well as credit institutions. Since then, the interplay of technological and regulatory change in the context of retail payments has been particularly significant in the European payments market, which is the focus of this paper.

Over the last decade the European payments market has undergone major infrastructure harmonisation with the rollout of the Single Euro Payments Area (SEPA) as well as the next wave of change with SEPA Instant Credit Transfers, a scheme that will be launched in November 2017. The role of payment services and instruments has become a key focus for the industry, regulators and payment users, particularly given the growing digitisation of services across digital channels. The emerging business models of both bank and non-bank payment service providers (PSPs) that aim to leverage the role of technologies such as application programming interfaces (APIs), plus the demands of the growing e-commerce environment in response to these changes, are complemented by evolving regulatory requirements such as the Payment Services Directive 2 (PSD2) in Europe. Innovation in payments can facilitate the growth of e-commerce and allow new markets to develop. With these major changes unfolding, the role of physical cash is likely to become less relevant over time.

In addition to the European retail payment specificities, the arrival - at a global level - of private cryptocurrencies such as Bitcoin, Ethereum, Dash Coins and thousands of others opened up a new chapter for the world order of money and payments. These cryptocurrencies are a special form of private digital currency that operate on a distributed ledger, where encryption technologies are used to manage both generation of units as well

as their verification and transfer. The underlying systems operate outside governments and outside the banking system and mostly without backing by any tangible asset or value. The move from centralised to distributed systems that achieve seamless payment transactions across the globe is hailed as a computing revolution. As the technology opens up the path for ubiquitous global payments, we are likely to see a further increase of competition for central bank fiat currencies. Following the Internet, the potential for the Internet of Things and the Internet of Money is beginning to unleash.

In this broader context, the question for the Eurosystem is whether it will remain competitive with the regional payment innovation as well as the global decentralised cryptocurrencies without taking any action.

We can already observe that central banks around the world are researching and experimenting with the topic of Distributed Ledger Technology (DLT) and cryptography, where the theme of central bank issued digital or cryptocurrency (CBDC and CBCC) is coming to the fore. Whilst Sweden is preparing a plan to potentially launch an e-Krona, the local government of Dubai has emerged as the first to launch a DLT based cryptocurrency, '*emcash*', which has been declared legal tender and can be used for payments at both government related and non-governmental entities (Buck, 2017). Japan has designated Bitcoin and other cryptocurrencies as payment instruments, benefiting from legal tender status and Christine Lagarde, Head of the International Monetary Fund (IMF) has recently made a public statement, underlining the need for governments to take cryptocurrencies more seriously as there is a risk that weaker countries may be inclined to opt for cryptocurrencies rather than dollarization (Lagarde, 2017).

If DLT is going to become a foundational technology of the future and if competition between private cryptocurrencies and fiat currencies continues to be more pronounced, then central bank money on the ledger will become an important enabler for the regulated payment industry, facilitating ultimate settlement finality of fiat currency in this new technological construct. In order to start addressing this space, a first step in this direction could be the creation of a cash equivalent form of central bank money on a distributed ledger, where transactions would settle with finality. There is enough of a rationale to do so,

when we examine the European market across the different drivers of change, including PSD2 and access to accounts, cost of cash and the role of privacy in payments.

2. Literature Review

The total value of the increasing number of private cryptocurrencies in circulation as of September 2017 stands in excess of USD 123bn², up from around USD 100bn in June 2017. Comparing this ‘perceived’ market value in fiat currency terms with the amount of Federal Reserve issued paper dollars, around USD 1.4trn, obviously means that there is no ‘*clear and present danger*’ for central banks at this point in time. Cryptocurrencies are used not only for speculative purposes but also play a role in facilitating capital flight which is already a concern for less politically and economically stable regimes as well as any country that want to exert greater capital controls. Beyond that however, various central bank statements and actions point to the consciousness of needing to be aware of the long-term risks for the importance and role of their fiat currencies.

In the following literature review we will look at the very early work on CBCCs and then review research on the topic of cash more broadly, as this relates to our question on the relevance of CBCCs.

Central Bank Cryptocurrency

CBCC, a new form of fiat money, is being discussed as a potential means to keep fiat money competitive with private cryptocurrencies.

As described in Bech and Garratt (2017), there are two types of CBCC, one for the retail market and one for wholesale usage. They developed a taxonomy of money, which is based on four central properties: 1) issuance; 2) form; 3) accessibility; 4) transfer mechanism (Bech, Garratt, 2017, BIS, p. 55).

CBCC in that framework is defined as a currency that is 1) central bank issued; 2) electronic and 4) peer-to-peer exchanged in a decentralised manner. Going one level deeper, two forms of CBCC are differentiated in terms of 3) accessibility: a widely accessible retail CBCC and a restricted access wholesale application CBCC for settlement purposes (Bech, Garratt,

² See www.Coinmarketcap.com

2017, BIS, p. 56). They also address the question as to whether central banks should offer a digital alternative to cash and briefly consider a cost-benefit analysis without recommending any specific solution.

Existing papers on the Canadian interbank settlement experiment with DLT (Project Jasper, 2017) and theoretical considerations for a potential FedCoin (Koning, 2014) can find their respective places in the new money taxonomy of Bech and Garratt.

The most practical first set of research considerations on a possible way forward for a digital form of fiat currency (the exact technology choice is still left open) was recently presented by the Swedish central bank, which discusses various methods and implications of a potential e-Krona (Riksbank, 2017 (1)).

Cash Usage in Europe

In the context of the question of whether and if so what type of CBDC or CBCC would be useful, we can look to the research that has been done on the topic of cash.

Even though we have entered the digital payments world, the most prominent form of payment instrument in the retail space until today is cash. According to soon to be published research on behalf of the ECB, around 80% of Point of Sale (PoS) transactions in Europe are made in cash, representing in value terms more than 50%, and the demand for physical cash is growing faster than Nominal GDP (Mersch, 2017 (1)). A 2016 Cash Use Index joint study of PYMTS.com and Cardtronics covering 15 Western European Countries³ found a 0.3% compound annual rate of increase of total cash use, based on a weighted average for the timeframe of 2010 to 2015, where 2.1 trillion EUR of total amount of cash was used for payments in 2015. For the future, between 2015 and 2020, their report estimates a 0.7% compound annual rate increase, again based on a weighted average (Paymnts, Cardtronics, 2016, p.3). By way of highlighting the degree of differences in cash usage between countries

³ Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Spain, Sweden, Switzerland and the UK

in Europe, Germany runs on a cash usage level of more than 80 % of transactions by volume and rising (Schmidt, 2016), whereas in Finland cash payments in retail stores were at 13% in 2016 (Untiset, 2016) and in Sweden the proportion of retail cash payments has fallen from 40% in 2010 to 15% in 2016 (Riksbank, 2017 (1), p. 4). Denmark is another example of a country where cash makes up a mere 15% of retail payment transactions at PoS, representing less than 3.5% of GDP (Jensen, 2017).

Cost of Cash

Another aspect investigated in the context of retail payments is of course cost. Various studies have been undertaken in recent years in Europe to examine the cost of retail payments in Europe and beyond. Schmiedel, Kostova and Ruttenberg (2012) find that the social cost of cash across a sample of 13 European countries, measured as the resource cost that has to be borne by all stakeholders ranging from consumers, retailers, banks, central banks, cash transportation companies, businesses etc., amounts to roughly 1% of GDP. In particular, the portion of social costs associated with cash was the largest at approximately 50% (of the 1% of GDP) of the total cost identified in this study. This finding is also consistent with the European Commission's Merchant Indifference Test of 2015, where "for the merchants surveyed the total cost of cash represented 1.26% of the total turnover" whereas for debit cards it amounted to 0.67% and for credit cards 1.17% (EU Commission, 2015, page 54).

Looking at the cost of cash from the central bank's perspective, Van Hove (2015) modeled the challenges of central bank related banknote printing costs in the context of societies that experience a steady reduction in the use of cash. His conclusion is that central banks that have decided to issue the more costly and more durable polymer notes, but are faced with a decline in demand for physical cash, should switch to reinjection of redundant notes in order to limit costs. Furthermore, he recommends that central banks relax their recall approach to old-technology based notes to allow for a longer life span of notes in a reduced cash note demand scenario, which may result in different forms of notes circulating in

parallel (this may not be welcome for high denomination notes, which thus could be recalled more specifically), but would have a positive impact on central bank costs.

None of these studies specifically examine the factor of cost of fraud or cost of counterfeit instruments, which means that the picture remains incomplete. For example, according to the European ATM Crime Report, ATM related losses due to physical attacks continue to increase, representing 27 million euro in the first six months of 2016 (European Association for Secure Transactions, 2016).

Going beyond cash, none of the existing studies on the cost of retail payments are yet taking into account the efficiencies delivered by SEPA, in particular in the space of credit transfers and direct debits. SEPA has been able to significantly lower the cost in particular for cross-border euro payments and direct debits, which in the past relied on correspondent banking and credit cards. Furthermore, European law requires since 2016 to maintain a cap on card interchange fees of 0.2% for debit and 0.3% for credit cards, which again will have beneficial impacts on the cost of retail payments for different types of users. An EU-wide analysis of the social and economic costs of retail payments in the post-SEPA and card interchange regulatory context would be an interesting future research.

Cash Payment Behavior

The study of 2014 by Bagnall et al. analyses the cash payment behavior of consumers across three European countries, France, Germany and the Netherlands, as well as the United States, Canada and Australia, using the method of consumer payment diaries. Importantly, this paper complements the social cost of cash research by identifying significant correlations of cash usage with demographics as well as PoS characteristic, e.g. what types of payment instruments are accepted at merchants. The latter is relevant when looking at how innovation can effectively percolate through the ecosystem.

Loix, Perpermans and Hove (2005) develop survey-based research, which investigates the propensity of retail payment users to adopt new electronic solutions in Belgium. Results are still to be officially published.

Another aspect that is missing in current research on the usage of different retail payment instruments is the question of privacy in payment transactions. This should be a focus for future research, as privacy becomes an increasingly important factor in a world where big data, social media and personal profiling are creating and leveraging massive amounts of data about individuals, which can easily be used to monitor, influence and even manipulate individuals for all types of good and bad intentions. The arrival of decentralised systems and private cryptocurrencies, allowing for pseudonymity, can in parts be seen as a response to the increasing lack of privacy, which in itself bears risks of identity theft, manipulation and other associated risks or annoyances. See also Kahn et al (2005) and McAndrews (2017) for a discussion on the legitimate reasons for anonymity in payment transactions. This may explain why cash usage for retail payments, at least in some European countries, is not decreasing but increasing. It should therefore be investigated, whether there is a potential model for a CBDC or CBCC that would preserve the characteristics of cash to the extent possible, and what challenges and questions should be considered in this regard. In particular, cultural differences are likely to play an important role as we look to countries such as Sweden and Denmark, where transparency is a common trait, which means that privacy of transactions is culturally a less accepted concept.

The role of Cash

In the Eurozone, given the absence of an ECB cash office, the practical role of cash issuance and withdrawal is performed by the National Central Banks (NCBs) that form together with the ECB the Eurosystem. The Governing Council of the ECB acts as the overseer and supports further harmonising cash services within the Eurozone. Physical cash is the most “visible manifestation of the central bank” (Gray, 2006, page 11) and as highlighted by Yves Mersch, cash represents “people’s only direct link to central bank money” (Mersch, 2017

(1)). In fact cash is the only direct claim that citizens hold against the central bank. Mersch thus sees cash as a means to gain public support for the central bank's monetary policy and ultimately its independence. At the same time the role of cash as a store of value and means of payment fulfills a social function, including the protection of privacy.

3. Research Questions and Method

In light of the retail payment innovation that is currently unfolding in Europe as well as the potential of private cryptocurrencies to challenge central bank fiat currencies, is there a broader retail payment related rationale for the Eurosystem to develop a form of CBDC or CBCC and if so, what could this look like?

Against the geographical backdrop of Europe, this paper will provide a comparative analysis of different retail payment options across existing and emerging technologies with a view to paving the way for the future. More specifically, the analysis will identify the parallels and differences between different forms of money as well as their properties as retail payment instruments. Based on this background the paper will develop the rationale for and considerations around a Euro denominated retail CBCC.

4. Introduction to the retail payments framework

As part of exploring the possible answers to the question of whether and how the Eurosystem could respond to the various challenges that central bank fiat money is beginning to face, it is appropriate to first of all take a close look at money itself. Understanding the role and key characteristics of different forms of money and how these relate to the European retail payments and legislative landscape will help frame the potential role of a CBCC.

Different forms of Money

Let us begin with the definition of money. In classical economic theory (e.g. Jevons, 1875), money is defined by virtue of three key characteristics: medium of exchange, store of value and unit of account. It is the medium of exchange, which allows economic actors to transact with each other, i.e. it serves as a payment instrument between parties. Since the 1800s, governments have issued fiat currencies with territorial features that reflected their claim of monopoly in the issuance of banknotes. Before that time, currencies, both private and government issued, were circulating within and across borders with no territorial limitations. In a strange way, innovation in technology may be moving us back to an approach that is very akin to this, with the difference that currency comes in form of a digitised medium.

The largest part of money today is already digital, meaning that it is represented in binary form and is able to be moved across digital networks. At a general level we make a distinction between digitising and digitisation. "Digitising connotes a technical process of representing diverse types of information in digital form. Digitisation, in contrast, refers to the socio-technical process of applying such techniques across industries and contexts in ways that affect and shape their underlying infrastructures for the creation, storage, and distribution of content, applications, and services." (Tilson et al., 2010, page 3).

The most common form of money is *'fiat money'*, which has no intrinsic value. Therefore fiat money can be notes, coins or electronic deposits in accounts. This is different from commodity money, such as real gold coins, which were used in the past.

Depending on the type of money, the role and implications for central banks can differ. Two forms of money stand out primarily, central bank issued money and commercial bank money; the latter is held at the central bank in the name of commercial banks. Note here that the majority of money stock is represented by commercial bank money, while the central bank only issues a small portion, but has the task to maintain price stability for the whole stock of currency (BIS, 2003, page 1). Central bank money in the retail payment context is represented in Europe by Euro banknotes, which are legal tender and constitute a non-interest-bearing liability for the ECB. All other retail payment instruments are based on electronic commercial bank money (with some minor exceptions such as bank notes issued by individual banks in Scotland and Wales). A sub-category of electronic commercial bank money is e-money in the sense of the European E-money Directive (2009/110/EC), which is issued by designated e-money institutions as well as credit institutions. E-money is fully prefunded by fiat deposits, which e-money institutions will have to ring-fence with regulated credit institutions. E-money constitutes a liability for the issuing institution and European legislation requires e-money issuers to redeem e-money at par upon customer request. The amount of e-money in this specific sense in Europe is very limited.

In parallel to money that circulates within the regulated market, the arrival of Bitcoin in 2009 ushered in the era of private cryptocurrencies that utilise cryptographic technology and are based on a distributed ledger. Since then, thousands of cryptocurrency variants, known as 'altcoins', have emerged. Nevertheless, as shown by the Cambridge Global Cryptocurrency Benchmarking analysis of March 2017, Bitcoin still has the largest level of money supply value (assuming the money has a value that can be converted back to fiat currency) of 72 per cent of the major cryptocurrencies reviewed in the report, followed by Ether with 16 per cent and Dash coins with 3 per cent. More interestingly though, the share of private cryptocurrency payment transactions compared with traditional fiat currency based payments is still minuscule, as most participants in the network are not using

cryptocurrency for payment purposes, but rather as a speculative tool, or more recently as a fundraising tool (e.g. in case of initial coin offerings, ICOs).

To perform a cryptocurrency payment, there is no need for a centralised authority or system. The whole process takes place peer-to-peer on the basis of computer code, where cryptographically secured data is exchanged, similar to the peer-to-peer characteristic of physical cash. The process is not restricted to national boundaries or regulatory frameworks, thus allowing for a ubiquitous payment solution that can move freely within the global digital ecosystem. In the new world of private cryptocurrencies and the systems they support, there is no clear and agreed legal regime that defines these as either a liability or asset of the respective issuing system. This constitutes a challenge to the domestic nature of traditional payment systems, processes and instruments. Several governments are analysing how to respond to this challenge. For example, Japan has amended its Payment Services Act (Act No. 59 of June 24, 2009) by creating the 'Virtual Currency Law', which recognises Bitcoin and other cryptocurrencies as legal tender and came into force on 1 April 2017. Unlike with e-money, the issuance of cryptocurrencies is not tied to a specific regulated entity and acceptance is not restricted. In parallel, cryptocurrency exchanges have to comply with know-your-customer (KYC) rules as well as liquidity and IT security requirements. These are signs that private cryptocurrencies are becoming embedded into the financial and payment ecosystem of Japan. Russia is also working on legislation that would recognise Bitcoin and other cryptocurrencies as legal financial instruments and apply more rules in this space to counter money laundering. The US currently recognizes Bitcoin as a commodity under the Commodity Exchange Act (Shadab, 2014).

We will now move to a comparative analysis of different types of money and their properties in the context of retail payments, with a view to benchmarking them across key variables such as creation, control of supply, anonymity, legal framework and resiliency. A focus will be placed on fiat money, electronic commercial bank money, e-money and Bitcoin as a specific example of a private cryptocurrency.

Table 1 highlights key characteristics of a select group of different types of money. In the absence of a harmonised legal categorisation of private cryptocurrencies, we will treat those as a form of digital money. Arguably, this could be further classified as digital commodity money in the particular case of Bitcoin, given the cost of supplying it (Proof of Work related energy consumption).

Table 1. Money types and their characteristics in the context of retail payments

Key characteristics & processes	Fiat money (notes & coins)	Electronic commercial bank money	E-money	Bitcoin (as a specific example of a private cryptocurrency)
Creation	Notes are printed by the central bank; the mint creates coins.	Commercial bank issued liability (credit multiplier). Electronically credited to a central bank reserve account.	E-money is issued by licensed e-money institutions against the receipt of equivalent amounts of electronic commercial bank money or cash.	Mining nodes on the network are awarded Bitcoins each time they find the solution to a certain mathematical problem (and thereby create a new block).
Money supply	The supply is controlled through issuance and redemption process.	The supply is indirectly controlled by the central bank altering interest rates on lending to banks as well as changes in fractional reserve banking rules.	The supply of money cannot exceed the amount of electronic commercial money or cash held.	The reward for solving a block (i.e. money issuance) is automatically adjusted so that every four years of operation of the Bitcoin network, half the amount of Bitcoins created in the prior four years are created. The total number of coins cannot exceed 21 million (deflationary currency). Bitcoins cannot be destroyed, but something akin to destruction results when private crypto keys are lost.
Claim on issuer	Yes	Yes	Yes	No
Interest rate based remuneration	No	Yes; but negative interest rates could apply	No	No
Anonymous payment transaction	Yes	No; unique bank accounts associated with personal identity are used to reflect an electronic record of transfer events, increment and decrement of balances.	If e-money is electronically spent, transactions can be traced. If e-money is withdrawn as cash, transactions would then be anonymous.	Pseudonymous users; identification of actors that own "wallets" and cryptographic tokens is complicated but technically possible.
Assertion of ownership	The holder of the physical item denotes ownership.	Ownership by the account holder is validated by the authority of the bank that provides the account.	E-money is held in e-wallets, with specific security and authorisation mechanisms build around it.	Each transacting participant in Bitcoin has control of one or more unique private crypto keys. The sequence of ownership changes of any coin is encoded into the block chain such that at any time one can read the total of coins at any one address. What is not asserted, however, is a connection

				between that key and the owner's true identity.
Legal status of money and underlying payment process	Cash is legal tender in Europe; payment process itself is unregulated	Regulated deposit taking activities and payment service provision is subject to national conduct rules and consumer protection.	Regulated e-money issuance and payment service subject to national conduct rules and consumer protection.	The specific treatment differs across geographies. Several governments apply rules to Bitcoin exchanges and levy tax on Bitcoin related gains.
Finality of payment	Through the direct transfer of bank notes from one person to another.	Transactions settle with 'ultimate finality' (i.e. final settlement in central bank money) through a movement of funds between commercial bank accounts held at the central bank.	Settlement happens in commercial bank money.	Bitcoin achieves probabilistic settlement, which can be expressed in degree of settlement finality (DSF), which increase with the publication of subsequent blocks (h) in the chain. The DSF required for final settlement is equal to $h+6$, which translates into 1 hour and 10 minutes (see forthcoming paper of Wandhöfer and Berndsen). Note that there is no legal settlement finality.
Money laundering and payment screening	Money in cash form is reasonably difficult to launder in large amounts. Numbering on cash notes makes tracing possible.	A lot of resources required detecting and deterring money laundering. Data analysis tools are used to help automate this process.	Electronically spent e-money can be traced but challenges are at par with electronic commercial bank money.	Bitcoin assumes no connection between addresses and actual identities. But all movements of any "Coin" are recorded; all addresses of all senders and recipients are recorded. Those records are immutable and accessible, which makes it easier than tracing cash. The issuer is linking any address or movement to anything outside the network! Many Bitcoin exchanges are now required by law to identify their users. For those that do not, this leaves opportunities for exchange of currency based on illicit activity or criminal proceeds.
Prevention of fakes/duplicates/forgeries	Notes and coins can be forged, but technology advancements are employed to reduce the risk of forgery.	Security protocols controlling who initiates electronic transfers. Identity verification, card PINs and double entry bookkeeping etc. are all used to reduce security risks.	E-wallet security protocols are applied.	However, security risks exist in relation to crypto wallets and keeping access to private crypto keys secure. Duplicate transactions are avoided through the consensus validation and cryptographic protocols embedded in the network.
Handling of double spending problem	The physical nature of cash makes it impossible to double spend. It physically moves towards the intended owner.	Unique transaction IDs; software to flag duplicate payments; reconciliation systems.	Similar to electronic commercial bank money.	The ordered time stamped and linked encrypted record of all transactions is extremely difficult to falsify. An attempt at re-spending would be mathematically rejected by all validating nodes in the system. However, if more than 50 per cent of the miners colluded, they could forcibly confirm a forked version of that history

				wherein a number of coins could be double spent.
Risk Potential	Attack	Risk of physical attack to steal cash is high. Physical security measures, i.e. protection in vaults and transport with security vans, are therefore important.	Yes; banking systems take required precautions to prevent attacks. Many types of fraud activity take place, such as identity theft, phishing, social engineering, cyber-attacks, malware etc.	E-wallets can be hacked.
				Crypto wallets can be hacked. A coin's history can be traced to connect identities to addresses. As DLT embeds cryptography in the protocol, which differs from other digital systems, the risks are really at the edges; i.e. exchanges and wallets.

As can be seen from Table 1, money can have very different properties across economic, regulatory and technical/operational dimensions as expressed by the categories in the table. This table can help to develop a best of breed set of criteria for what a cryptocurrency retail payment solution could look like in the future.

Interplay of Retail Payment Legislation and Innovation in Europe

Moving from money to the retail payment services space, the last two decades have seen the payments industry in Europe together with the ECB and EU regulators pursuing a joint agenda of payment system and service innovation and harmonisation, underpinned by common conduct of business legislation. The building blocks of SEPA, the PSD, as well as alignment and modernisation of automated clearing house and central bank settlement capabilities have underpinned the introduction of new euro currency-based payment instruments to the market, namely SEPA Credit Transfers, SEPA Direct Debits and SEPA Card payments.

As the next phase, SEPA Instant Credit Transfers are about to be launched in Europe in November 2017. This will deliver a cross-border instant payment solution for Euro, which promises to give users an alternative to cards, in particular in the online space of e-commerce. The ECB will be supporting this new scheme with a specially developed central bank settlement offering in the form of TARGET Instant Payment Service, or TIPS. This 24/7/365 service is planned to be ready for launch in November 2018 and will play a key role in ensuring financial stability in the context of accelerated retail payments in Europe.

A further retail payment enhancing measure in progress, under the auspices of the European Retail Payments Board (ERPB) is the creation of a pan-European Standardised Proxy Lookup service that will enable person-to-person payment data exchange, such that individuals can pay on the basis of providing for example their mobile phone number as the proxy for their IBAN. Additional proxy types will be considered at a later stage and the overall proposition of this service is to provide more user choice and competition in the market.

And at a broader level, the regulatory driver of PSD2 is poised to *'change banking as we know it'*. Newly defined third-party providers (TPPs), are permitted by this legislation to access the payment account information of customers that hold their payment accounts at an Account Servicing Payment Service Providers (ASPSP). An ASPSP is a credit institution or an e-money institution. ASPSPs can also act as TPPs. Services such as payment initiation and account information are enabled and can insert themselves into the broader digital economy, where APIs can be leveraged as a tool to allow account-related data transfers between ASPSPs and third parties. This opening up of payment accounts unlocks the opportunity to develop new services around payments and has the power to make the bank account itself the central payment instrument.

As part of the PSD2 Level 2 requirements on Secure Customer Authentication and Communication, ASPSPs will have to open up access to their customers' payment accounts by providing a secure communication interface, commonly referred to by the market as an API that TPPs can connect to in order to allow them to offer these new types of services. At the level of the ERPB discussions have been taking place to consider developing a framework for PSD2, which would not only help to bring forward a harmonised pan-European API standard to enable streamlined connectivity for all TPPs, but also consider developing a common framework for the many business and governance related aspects that are not included in the legislation. At the same time, given the open access model, all payment users will need to decide how comfortable they are with third parties accessing their payment data and what it can be used for. The balance between competition – and hence facilitating access – and data privacy and security will be an important focus for

ASPSPs and their customers. In particular, there is currently still an open question regarding the interaction of PSD2 and the General Data Protection Regulation⁴ (GDPR) EU 2016/679 and the question of 'explicit consent'. Given the fact that under PSD2, customers can directly give as well as withdraw consent to TPPs in terms of the respective services they provide and given that there is no formal requirement for either the customer or the TPP to inform the ASPSP accordingly, ASPSPs will need legal assurance from the European Commission that they will not be fined under data protection law if they have shared data of their customers in response to TPP requests based on the PSD2, even though customer consent to the TPP may have been already been withdrawn. Once this is clarified, the general expectation is that the move into the API world will help banks and non-bank PSPs to become more attractive for consumers and small and medium-sized enterprises as new services can be developed and launched much faster, leveraging the creativity of multiple third parties.

In addition to SEPA credit transfers, direct debits and cards as well as classical e-money instruments, such as virtual cards held in e-money wallets or physical pre-paid cards that can be used at PoS or online, new types of solutions are being experimented with. A recent example is a DLT based smart card solution developed by a blockchain company that participated twice in the UK FCA Regulatory Sandbox. The first experiment demonstrated that near real time retail payments at merchant PoS can be delivered through a scalable DLT based technology solution. The solution pilot was built on the regulatory framework of the E-Money Directive. For the purposes of the test, the Fintech maintained a client account and a client money account, for segregated balances of clients, at a retail bank. The client account was prefunded and enabled the creation of e-money credits onto the FinTech's distributed ledger via tokenisation. The test participants received a smart card, which enabled them to make payments at the selected test merchants in less than 2 seconds (the time it took from the presentation of the card to the change in the ledger balance of the payer and merchant), where the test achieved peak processing of three transactions per second with an overall 121 transactions made in the 25 minute test timeframe. More

⁴ The GDPR is a significant European regulation, where providers are required to comply with strict personal data protection standards.

experiments for retail payments on the blockchain are likely to develop in the near future as this technology is increasingly understood and enhanced.

What does this mean for retail payments in Europe?

Retail payments have clearly become cheaper and more efficient over the last decade and innovative service propositions to customers continue to expand. Credit and debit card transaction costs for merchants have been reduced due to the Card Interchange Fee Regulation (Regulation EU 2015/751), whereas previous benefits to consumers, such as bonus points were relegated as a consequence. Further steps to make e-commerce more efficient are coming to the fore via TPP-intermediated account based payments that consumers can make to web merchants. So in two areas, the merchant community is gaining increased benefits from regulation and the arrival of new business models. SEPA credit transfers and direct debits also brought lower cost payment services to consumers and businesses around Europe, where cross-border euro payment pricing was kept at the level of domestic pricing via means of Regulation (EC) 924/2009. With the arrival of SEPA Instant Credit Transfers, another retail payment instrument is born, which could become a catalyst to creating the currently missing link of account-based payments at PoS. Again this is poised to bring cost and efficiency benefits and further increase the competitiveness of European payment services. Ultimately the role of TPPs may become less relevant in a world where payments execute in near real time, as merchants may not need a middleman that guarantees the payments through having sight over payers' account information. And when looking at the next generation of technology, experiments with innovations such as DLT demonstrate that e-money based payment services for near real time PoS payments are already technically and legally feasible and could start gaining more traction in the near future.

In sum, while it has taken a long time, Europe's electronic payment ecosystem is moving to the next level of maturity, and early experiments with DLT in the retail payment space, in addition to private cryptocurrencies are being undertaken. But one thing needs to be remembered: all of these retail payment instruments we just reviewed are based on commercial bank money. As the market evolves towards further digitisation and as cash may become challenged by this, the question is whether the Eurosystem should not look at creating a digital or crypto version of what is today the only direct link it has to the citizen. To fill this research gap, the next section examines the specific theoretical case of CBCCs with a view to identifying the potential properties of this form of money and considering what role it could play in the European retail payments context.

5. A CBCC retail payment instrument for Europe: why and how?

Recent years have seen a growing interest in private crypto currency systems such as Bitcoin and Ethereum. The combination of speculation and growing popularity of ICOs as a way to raise funds has led to an increase in the market valuation of these coins, where Bitcoin's highs alone have reached in excess of US\$80bn of market capitalisation in 2017⁵, with more than 16.5 million bitcoins (of a maximum of 21 million) in circulation as of 10th September 2017. However, most merchants and consumers still prefer to use 'real' money, and even if merchants accept bitcoins for payment, they still tend to use digital currency exchanges to convert bitcoins into their preferred fiat currency. It is therefore still premature to ask whether central bank issued currency, or commercial bank money for that matter, could be crowded out in the near term. However, '*preparation is everything*', which might be one of the reasons why central banks around the world have begun to experiment with the underlying technology of distributed ledgers. Central bank research has thus far focused on various aspects ranging from resilience, reliability, scalability and performance to settlement finality, privacy and ease of integration with existing systems. It is worth pointing out a few examples here (Table 2 and 3), in order to set the scene.

Table 2. Settlement System and Technical Focus

Project	Focus Areas	Status/Conclusions
Canada Project Jasper	Interbank high value payment space: Focus on DLT system ability to meet international Standards for Systemically Important Payment Systems and collaboration with the private sector. Built on Ethereum Proof of Work (PoW) system.	The work done to date has shown that the test system could meet the international standards concerning collateral, credit risk, money settlement and liquidity risk. Future research could focus on enabling pledging of general collateral, beyond cash, at the Bank of Canada. The aspect of national and/ or international integration with other DLT types is another area to explore.
Singapore Project Ubin	Interbank high value payments space: Development and tokenisation of a digital SGD that is used on the DLT platform; a form of continuous depository receipt with no impact on monetary	Phase 1 of the project completed. Leveraging Ethereum based private DLT network, where Quorum was used as a consensus mechanism, a working interbank payment type was successfully developed and integration with the existing RTGS system MEPS+ was delivered. Open questions: deterministic finality,

⁵ See Crypto Currency Market Capitalisations for more detail: <https://coinmarketcap.com/> (last accessed: 22/09/2017)

	policy.	privacy, scalability, ease of integration, resiliency, Phase 2 of the project started in Q2 2017 and is focusing on cross-border payments and DvP in the securities space.
ECB & BoJ Project Stella	Testing the viability and characteristics of DLT based structures in the context of the ECB's RTGS service to understand if performance needs can be met. Key focus performance of liquidity savings mechanism.	Leveraging Hyperledger Fabric 0.6.1 the central banks established good results on resilience and reliability in the context of validating node failures and incorrect data format handling; good smart contract performance on the latter. The role and importance of the certification authority within the structure could however become a single point of failure risk. Trade-off between network size and performance was again validated. More scope for future studies around cost efficiency, oversight and market integration.

Table 3. Domestic Cryptocurrency Focus

Country	Project/Approach	Status/Conclusions/Next Steps
Sweden Project E-Krona	With only 2% of the value of all payment transactions made in cash in 2016 and 20% of cash payments at PoS, Sweden seriously considers the development of the e-Krona. Focus will be consumer/retail payment, where e-Krona would be a complementary instrument next to physical cash. The choice of technology for a potential e-Krona may not be DLT.	Project Plan phase 1 launched in 2017. Development of theoretical proposal and system outline in progress. Phase 2 during 2018 will focus on regulation and operational proposal and technologies End 2018/early 2019 a decision to issue or not will be taken. Possible implementation from 2019 onwards.
Tunisia	In October 2015 the Tunisian Post began collaborating with a Fintech to deliver blockchain inspired e-dinar wallet payment solution based on the pre-paid e-money model. Around 2.5 Mio transactions per year are executed and PoS connectivity has also been delivered. Consensus is done via notarisation process.	Importance of privacy and security continues to be a key focus. The fact that Anti-Money-Laundering (AML) rules are strict makes further innovation difficult.

As reflected in the above selection of initiatives, some central banks focus more on the technical side of DLT with a view to understanding the properties of the technology in relation to speed of interbank settlement and resiliency. Other central banks are looking at the potential of issuing their own domestic cryptocurrency for economic efficiency reasons. Japan and China are both looking at the potential of a domestic cryptocurrency with more geopolitical considerations in mind.

Based on the broad classification of Bech and Garratt (2017), the following section will elaborate the specific case for and considerations around a Euro based CBCC retail payment solution.

The Rationale for retail-use cryptocash

There is an argument to be made that societies will continue to move towards digitisation at an exponential pace, fueled by the increasing speed of technology innovation and adoption as well as government policies and regulations that support increased digitisation, including digitising money. Whilst DLT is not the only design approach for CBDC, I am making the assumption that DLT will become the foundational technology for the Internet of Money. Therefore my proposition is that central bank money on the ledger is going to be an essential building block for the future of fiat currency based payments i.e. although the underlying technology may be new, the currency unit would not change.

When zooming in on the case of Europe, empirical evidence shows that the usage of cash in most of Europe is still significant despite the existence of seamless and low cost electronic payment alternatives such as those based on SEPA and national equivalents. Furthermore, the ECB points out in various speeches, that physical cash is not the primary instrument that is used for illicit activities including tax evasion and that as the need for cash continues to exist, the ECB is willing to provide for this as long as required (Mersch, 2017 (1)). Studies also show that the cost of cash remains an important factor across a broad set of stakeholders. Indeed, the relative cost of cash increases as cash usage is declining, pointing in the direction of growing inefficiency as electronification of payments increases.

Looking ahead, there could be different future scenarios in the European payments landscape that may trigger the decision to provide a digital or crypto form of Euro cash. A first scenario could be an accelerated pace of adoption of electronic payment instruments, leading to a significant reduction of the use of physical cash driven by the combination of PSD2, SEPA Instant

Credit Transfers and the GDPR. Sweden has already arrived at a point of digitisation of payments, such that the central bank has felt the need to explore the potential for creating an e-Krona in order to provide a digital central bank money based retail payment alternative to electronic commercial bank money. If the Eurozone were to reach a similar point of inflection, the issuance of a digital or crypto form of Euro cash may become a priority, in particular, given the fact that central bank notes in the Eurozone represent the only truly risk free asset in the hands of the citizens of Europe (notwithstanding the overall risks of currency devaluation and inflation). The link between the ECB and the European citizen plays a key role in strengthening the public's support of the ECB's monetary policy and thus its independence - anchored in Article 130 of the Treaty of the European Union – where the latter is instrumental in the pursuit of the ECB's central objective of price stability. In a dwindling cash scenario, several questions would therefore arise. What happens to payment system stability if users have less and less option to pay with or save on the basis of risk-free central bank money? Given that the Eurosystem is developing TIPS as a dedicated settlement solution of SEPA Instant Payments, settlement risk will be eliminated for a part of the commercial bank money driven system. But what if participants don't make use of the offer? Of course, policy could mandate the use of TIPS by the payments industry. Saving in risk-free asset terms would however become less and less possible in an increasingly cashless context.

Another question might be: how will the ECB engage with citizens on the topic of ECB independence if there is little to no direct link (in the form of cash) left? This would potentially become a more relevant political driver to issuing a digital or crypto form of Euro cash.

In a second scenario (which could play out in parallel to scenario 1) it could be imagined that the rise of private cryptocurrencies could translate into a significant reduction of cash. In this case central banks and governments would need to act in order to maintain their sovereignty expressed by fiat currency. The concept of legal tender, which today only applies to euro cash notes in Europe, would either become irrelevant or would require reinterpretation. There are also questions around competition and consolidation and whether the absence of central bank retail money would impact resilience and efficiency of

the overall market. A key driver in this scenario is where the general public puts its trust: in private cryptocurrency or fiat currency in digital form?

A third scenario could be that of increased market uncertainty in the context of new business models and providers as a consequence of payment related regulatory reform and innovation in Europe. The role and risk around customer payment data could become a critical element in this. If consumer uncertainty were to increase for example as a consequence of data privacy breaches and thus result in a reduced use of commercial bank money based electronic payment instruments, accompanied by an increased citizens' demand for central bank money, then central banks could offer both physical and digital or crypto Euros, where the latter may hopefully find accelerated adoption due to users' increased digital payment habits. Financial inclusion related points, in the context of this topic, will require that physical cash is still provided, but one could imagine that the role of the mobile device across this segment of payment users will become increasingly important and will over time be a critical factor to bringing these users into the digital or crypto cash space. The potential of such a step in reversing the logic that non-financially included, poor people on average pay more for payments, would likely be significant.

If we reverse the argument, a key question that would need to be asked is 'how will the argument for CBCC change if physical cash is gone and if through the adoption of DLT by the financial system commercial banks no longer demand to store balances at the central bank for settlement purposes?' This would indeed raise issues at the level of the central bank.

Taking these key points and assumptions together leads to the proposition that a form of retail CBDC could be the next step in the evolution of money and payments in the Eurozone.

At a high level, the ECB is conducting thought experiments in this space, which is reflected in the fact that central bank issued digital currency in the context of retail payments featured in an ECB speech of Executive Board member Yves Mersch, who describes this as '*Digital Base Money*' (DBM) (Mersch, 2017 (2)). Even though DBM already exists in the form of commercial bank and other institutions' deposits held at the central bank, Mersch discusses the option to expand this to non-monetary counterparts, including citizens. A key distinction

is made between a *'value-based'* and an *'account based'* form of DBM, where the first would have properties similar to physical cash, while in the latter case, the central bank would have to open DBM accounts for every user. The latter has been referred to in literature as *'deposited currency account'* (Tobin, 1987).

Extending the approach discussed by Mersch, this paper will analyse a more detailed set of questions and criteria for a Eurosystem issued DBM. Given the historical background of a general absence in the market of *'account based'* central bank deposit offerings for the broader public – even though this would have been an option irrespective of digitisation, the assumption here is that the ECB is unlikely to be willing to provide account-based services to consumers, given that this is neither part of its mandate, nor is it something that would be easy to deliver without relevant experience and then scale. As the ECB is unlikely to want to become a certain type of retail bank, the value-based form of DBM is considered here to be the most likely scenario in the context of the creation of a new digital central bank retail payment instrument. I will therefore refer to this instrument as *'Euro-cryptocash'* (particularly given the technological features that I will be proposing in this regard).

A multitude of considerations will need to be made in the context of a potential project to develop Euro-cryptocash. The Bank of International Settlements Committee on Payment Market Infrastructures' paper on *'Distributed ledger technology in payment, clearing and settlement'* (BIS, 2017) provides a good first pass at relevant questions that will need to be asked in the broader context of DLT. At a general level, the approach to developing a CBDC/CBCC product should look to first 1) develop the customer value proposition; 2) to then create a resulting set of business requirements; 3) in order to derive the technical requirements that can satisfy the business requirements and then 4) to assess competing technical solutions against these technical requirements. Here, I will elaborate a set of more specific arguments, questions, proposals and suggestions to develop a proposal for Euro-cryptocash.

What could Euro-cryptocash look like? How would Euro-cryptocash be created and how would supply be controlled?

All three possible future scenarios could be drivers to propose the following approach for the arrival of Euro-cryptocash: Euro-cryptocash would be a cryptocurrency issued by the Eurosystem, denominated in Euro, made available to the general public 24 hours, 7 days a week, 365 days a year in real, or near real time. Similar to physical cash, Euro-cryptocash would become a liability of the issuing central bank, i.e. the Eurosystem. The instrument would be for online usage and crypto wallets would store the units of Euro-cryptocash on each person's smart phone, for example. The key characteristics of cash - universality, enablement of peer-to-peer transactions, protection of privacy once issued by virtue of being a bearer instrument, issued by a public body and legal tender status – would be preserved.

Key criteria for the Eurosystem would encompass technology safety and neutrality, efficiency as well as freedom of choice for users. The choice of DLT would need to be carefully considered and tested, but the proposal here is that the deployment of a private permissioned ledger structure with the option of enabling third party node verification that could be provided by the participating Eurosystem central banks – reflecting the already distributed nature of the Eurosystem in a DLT structure – would be a potentially well suited technical model for Euro-cryptocash. The choice of consensus protocol would determine how efficient and speedy the transaction verification and execution would be. The Monetary Authority of Singapore (MAS) is currently experimenting with different permissioned DLT solutions including the deployment of the Quorum consensus algorithm that enables Raft Consensus⁶, which allows for privacy and has significant advantages for the regulated industry compared to permissionless structures that use for example PoW (such as in Bitcoin). More research would have to be undertaken in this space in order to balance efficiency, resilience, privacy and security.

The Eurosystem's role would be to maintain the distributed ledger, ensure issuance of Euro-cryptocash on demand, organise transaction verification, allow for redemption and also

⁶ The RAFT Algorithm has been developed by Diego Ongaro and John Ousterhout of Stanford University with the purpose of increasing understandability in order to enable easier implementation compared to Paxos algorithms.

have the ability to destroy Euro-cryptocash. As Euro-cryptocash would be the digital mirror of cash, an approach could be to issue Euro-cryptocash one-to-one against physical cash or electronic commercial bank balances, and leave distribution to the commercial banking system, similar to the way physical distribution of notes and coins takes place today.

This method of issuance would resemble the e-money model, with the crucial difference that the type of money issued against cash/electronic deposit money would be central bank money. The size of the central bank balance sheet would remain the same given the one-for-one exchange from banknotes to Euro-cryptocash. A similar scenario has been referred to by the Swedish Central bank for the potential issuance of an e-Krona, where the banking system has a positive position in relation to the central bank (Riksbank, 2017 (2), page 27).

An example: Whether a customer holds an account or not, she could place cash at a bank, which then performs relevant KYC and AML checks and confirms receipt of cash to the relevant Eurosystem NCB, against which Euro-cryptocash would be issued. To ensure that the substitution of commercial bank money with central bank money is limited – in order to avoid destabilizing the commercial banking system – user limits could be imposed. Technically issuance would result in distribution of public and private cryptographic key pairs. The same process of issuance could apply to customers that want to convert parts of their commercial bank money balances to Euro-cryptocash. To avoid dependencies on physical bank branches, ATMs could play a role for issuance in case of existing bank customers, where KYC is already in place. This would be similar to the way Bitcoin ATMs operate today. Over time authentication factors such as biometrics will become more relevant and allow for a more ubiquitous availability of such a solution.

Would Euro-cryptocash be remunerated?

In line with physical cash there would be no remuneration of Euro-cryptocash. This would be consistent with private cryptocurrencies as well. As Yves Mersch points out, there could be implications of negative central bank rates on banks that may therefore want to convert reserves into the new digital or crypto cash (at 0 per cent interest rate) via non-bank subsidiaries (Mersch, 2017(2)). However, appropriate regulations including macro-

prudential policy frameworks combined with better control through increased transparency and data could prevent such a potential risk.

Would Euro-cryptocash be anonymous? How would ownership be asserted?

Physical cash transactions in the retail space, as long as below regulatory thresholds are anonymous. The first question to ask therefore is whether cryptocash should equally allow for anonymity of transactions. As underlined by Mersch, the feature of anonymity does not automatically mean that transactions made in such a way are illegitimate (e.g. tax evasion, terrorist financing, money laundering). The high percentage of cash usage at PoS in Europe (forthcoming ECB study), suggests that privacy is a key factor, which is likely going to become more important in an increasingly digitised and data transparent world that bears increasing risk of data and identity theft. A suggestion could therefore be that value-based Euro-cryptocash is designed such that users are identified at the point of conversion, see above, but that there is no linkage of identity information to the cryptographic key used for transaction purposes. This could be enshrined in data protection legislation, requiring compliance by issuing central bank(s). In addition, technologies such as zero-knowledge-proof can be applied to protect user information from being shared outside the individually transacting counterparties. Z-cash, a private cryptocurrency that enables user anonymity, can be a case study for how privacy of individuals can be ensured at transactional level. In order to ascertain that existing regulatory frameworks around AML and counter-terrorist financing (CTF) are upheld, individual transaction limits of EUR 250 in line with the fourth Anti-Money-Laundering Directive (AMLD) (EU 2015/849) could be imposed via smart contracts embedded in the ledger. The current progress report on the Swedish e-Krona project also suggests anonymity for value-based e-Krona transactions (Riksbank, 2017 (2), page 19).

The alternative of establishing transparency on who owns which Euro-cryptocash coin at any point in time would be unlikely to gain adoption traction and presupposes a high degree of citizens' trust in the central bank. Whereas this would for example reflect the situation of Denmark (Jensen, 2017), it should not be forgotten that cash is a form of civil protection against surveillance and control of the population, which could become more relevant as

the data economy unfolds. Such an approach would also reflect the account-based model – where all users can hold accounts directly at the central bank. This would entail a significantly larger amount of liability for the central bank as it would need to deliver such a solution in line with existing legislation on payment services, consumer protection, AML/CTF rules etc.

A change of ownership of Euro-cryptocash would be reflected in the exchange of cryptographic keys supported by algorithmic consensus. A legal framework that defines settlement finality for Euro-cryptocash transactions would need to be put in place. See more on the topic of finality in distributed systems (Wandhöfer, Berndsen, forthcoming).

What about consumer protection for Euro-cryptocash and the question of legal tender?

Regulatory measures to protect consumers would play a more important role for Euro-cryptocash than for physical cash. Even though the plethora of conduct of business rules for PSPs as defined by the PSD in Europe would practically be difficult to apply to Euro-cryptocash, one could think about developing consumer protection measures with regard to crypto wallets, mandating security measures to protect them from hacking.

The Eurosystem as issuing institution would be responsible for the overall framework under which crypto wallets would likely operate as outsourced solutions with a set of regulatory obligations imposed on wallet providers. The role of commercial banks in terms of their potential support in the conversion process would need to be clearly defined as part of the appropriate policy framework.

Giving consumers more choice in payments will also become increasingly important as data analytics and artificial intelligence will allow banks and FinTechs to further monetize customer data, with the risk of pushing the market to an inefficient state of over-financialisation. Add to this the efficiency impact on financial inclusion and a central bank's core product of cash in a digitised medium would certainly help improve the market.

Decisions would need to be taken as to whether Euro-cryptocash should gain the status of legal tender, which today is anchored in Article 128 of the Treaty on the Functioning of the European Union and further underpinned by the European Commission's Guiding Principles issued as part of a Recommendation in 2010. Legal tender acceptance is mandatory at full face value, enables discharge of debt and no surcharges should apply to cash transactions. Declaring Euro-cryptocash as legal tender would thus mean that, unlike in case of physical cash, technological readiness of payers and in particular payees becomes an important element. Practically the loss of private cryptographic keys to access Euro-cryptocash would be commensurate with the physical loss of cash. In sum, this would require the Eurosystem to play a role in terms of supporting appropriate financial education measures and overall a phase in approach would be helpful in supporting stakeholder readiness.

What are the potential impacts of Euro-cryptocash on commercial banks, financial stability, resiliency and efficiency?

Operating Euro-cryptocash on a Eurosystem-operated distributed ledger means that traditional intermediaries in payments, primarily banks, would not play a role in providing services for payment. However, this is largely consistent with the reality of physical cash outside the support banks provide in terms of distribution. Risks for the banking system could arise if consumers and businesses were to convert significant parts or all of their commercial bank deposits into Euro-cryptocash, in which case banks would see their traditional customer deposit-based funding shrink. To ensure the same amount of lending activity, banks would have to replace this low-cost funding with more expensive funding available in the market. This could have negative effects on the broader economy, given the increase in cost and potential reduction in lending. At the same time Jensen (2017) argues that CBDC/CBCC would make bank runs easier and create systemic risk, removing protection that the inefficiency of physical cash represents, i.e. ATMs will eventually be empty but the central bank would not run out of CBDC/CBCC. The latter would risk translating into a bailout of the banking system, which is not envisaged by EU legislation such as the Bank Recovery & Resolution Directive (2014/59/EU). Furthermore, CBCC would not necessarily be restricted to retail users only, and just like cash, large corporations could start converting large sums of commercial bank balances to CBCC in

times of crisis. Again, appropriate macro-prudential rules and policies will be required to mitigate these risks.

Offering a central bank money retail payment instrument in addition to commercial bank electronic payment solutions and private cryptocurrencies would most likely provide enhanced stability for the overall payment ecosystem.

The problems associated with physical cash such as security risks around physical cash transport or ATM related security concerns would no longer be an issue. Different forms of technology and data related security risks may however arise and would need to be identified and managed. Depending on the type of DLT set-up, resiliency could be enhanced compared to centralised systems; i.e. removal of a single point of failure. Technology configurations can be established to limit the risk of double spending. The role of the Eurosystem would need to be clearly defined across technical aspects such as system operation and security, interoperability, as well as user related aspects in the context of issuance. For the latter, the role of commercial banks could be to ensure that appropriate KYC is done at the point of cash/electronic money conversion to Euro-cryptocash. As stated above, as long as there are relevant checks at this point, and as long as there are transaction and overall conversion limits, the process could allow for privacy of Euro-cryptocash transactions.

From an efficiency perspective more research and experimentation would be required to determine the cost of operating Euro-cryptocash as well as the implications for the broader payment market to be able to accept this form of money. The role of policy, both in terms of potentially designating Euro-cryptocash as legal tender but also with regard to rules around charging and pricing of Euro-cryptocash will be important. In particular given that private cryptocurrencies such as Bitcoin require users to input transactions fees - where the latter increase over time, given that Bitcoin mining will eventually end and transaction fees will over time become the only way to compensate the network - setting policy to limit user fees and or prohibit surcharging by merchants would help make Euro-cryptocash competitive with certain types of private cryptocurrencies.

Acceptance of Euro-cryptocash for payment in retail stores and online could become a cheaper option compared to card based transactions, e.g. via PoS terminals, given that merchants only

need to download the Euro-cryptocash wallet. Thorough cost assessments would need to be made up front to gain more clarity around potential efficiencies. However, payments would execute in real or near real time and settlement would be final in the true sense of the definition, as it would be a bearer instrument that is central bank money, thus removing counterparty credit risk.

6. Summary and Conclusions

The payments world is living through unprecedented times of change. Digitisation of payment services and cryptocurrencies are beginning to challenge the status quo of fiat money and possibly over time in a more serious way than non-bank issued e-money. Furthermore, European regulatory drivers are poised to unfold in a further increase of electronic and digital payments, reducing the role of physical cash.

These digital challenges for fiat money are already perceived as significant in Sweden, which is why the Swedish Central Bank is contemplating the issuance of an e-Krona.

This paper has therefore taken a tour across the nexus between money and payments, discussing both the evolution of digital payment innovation in Europe and the development of a Eurosystem issued Euro-cryptocash.

The arrival of DLT is poised to provide a technical opportunity to improve payments across various aspects in comparison to the electronic status quo, including resiliency, reconciliation, speed and ultimately cost, which could finally end the prominent role of physical cash.

In the broader context of ECB independence and the link that physical cash provides to the European citizen today, the relevance of Euro-cryptocash will become a political imperative over time.

Developing a cryptocash equivalent, which would have similar properties to physical cash, could be a viable method to reduce usage and thus cost of cash across the European Single Payments Market, freeing up capacity to enable a more efficient allocation of resources.

Having reviewed some of the perspectives, challenges and practical steps that come into play, there are also economic, stability and competition related reasons that call for further investigation into creation of a crypto brother for cash.

Whilst DLT is not the only possible technology that should be explored, preparing a technical Proof of Concept (PoC) for Euro-cryptocash in the broader context of the experimentation with this nascent technology would be a relevant starting point. A thorough analysis of requirements including regulatory and legal measures as well as an initial thought process for implementation would complement these steps.

There may ultimately be a future for a Eurosystem operated retail payment system, TARGET for Euro-cryptocash, in short TECC.

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