School of Business and Economics
Loughborough University, Leicestershire LE11 3TU, UK
www.lboro.ac.uk/sbe

Loughborough University

Alistair Milne, Professor of Financial Economics
Direct Line: +44 (0)1509 222718 **Mobile**: +44 (0)7491 627451
E-mail: A.K.L.Milne@lboro.ac.uk
http://www.lboro.ac.uk/

Thursday, 04 June 2020

Consultation Response

Digital Currencies Team
Bank of England
Threadneedle Street
London, EC2R 8AH

Email: cbdc@bankofengland.co.uk

Dear Sir,

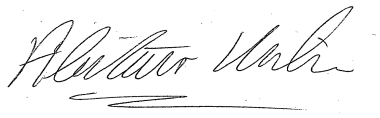
I am responding as an individual researcher to your discussion paper "Central Bank Digital Currency: Opportunities, challenges and design." I have previously discussed the technologies of money and payments with several Bank research and policy staff over the past two decades, most recently as you will be in a short meeting in your offices in November, 2019.

I provide here a summary of my views on central bank and commercial bank money. I then provide responses to the specific questions in Chapter 7 of your discussion paper.

You will see that position I take is very different from your own. I do not think the Bank, or any other central bank, should be engaged in providing any form of retail customer services even at the most basic level of pooled accounts described in Section 4.2of your paper. This involves commercial and technological risks that are outside your main sphere of competence and unnecessary for achieving the policy benefits envisaged in your policy paper.

I argue instead that your responsibilities are providing the foundational layer for recording ownership and transfers on settlement money, which can support the most efficient possible private money and payment solutions over the decades ahead. This will include a directly transferable central bank e-money held at retail level, if there is demand, but avoid the Bank taking any commercial risk in its launch.

Yours sincerely



Alistair Milne

Central Bank 'Digital Currency' and Payments Technologies

This response, drawing on my two decades of research on payment economics, highlights the importance of considering central bank issue of 'digital currency' in the broader context of ongoing reform and digital transformation of our wholesale and retail payment systems. It cannot be sensibly addressed in isolation.

I argue that the role of the Bank should be identifying the irreducible minimum requirements for a core ledger that underpins all sterling payments activity. In my view consultation is not so much about CBDC (an ill defined concept) but about the role of the Bank in payments and ensuring we have an architecture that appropriately supports that role for the coming decades.

From this broader perspective, I believe that much of what is written in the discussion paper is misconceived, seeing the Bank as providing an alternative to private payments solutions when in fact what you need to focus on is providing a strong foundation for all private payments solutions, without favouring any one over any other.

With this in mind, I first set out what I believe to the fundamental question addressed in your discussion paper (expressing this differently than you do).

I then review some relevant research papers of mine on payment technologies including the digital ledger technologies used to support cryptocurrencies and stable coins.

After this I address the specific questions in your consultation.

Getting the question right

What exactly is the question that you are addressing? I think for the sake of clarity this requires a restatement. This is because the terms 'digital currency' (in general) and of 'central bank digital currency' (in particular) are unclear. These terms mean different things to different people and in different contexts.

The primary question posed in the forward to your discussion paper is as follows:

> *"…as the issuer of the safest and most trusted form of money in the economy, should we innovate to provide the public with electronic money — or Central Bank Digital Currency (CBDC) — as a complement to physical banknotes?"* (BoE discussion paper page 5)

Here we have an immediate problem. This appears to be a definition of central bank digital currency (CBDC = electronic money, presumably meaning a liability of the central bank). This definition may be a useful shorthand for subsequent discussion (though still problematic, the concept of issue is clear for physical bank notes, unclear for electronic money). The main problem though is that including the shorthand here unnecessarily complicates the question. This question is more clearly stated without the definition as

"…as the issuer of the safest and most trusted form of money in the economy, should we innovate to provide the public with electronic money as a complement to physical banknotes?"

This is clearer because often the term digital currency is used in a narrower sense than appears to be intended in your discussion paper, referring e.g. to a particular supporting technology, for example money held on a distributed database with no central authority responsible for maintaining records of ownership (a 'distributed ledger' used for existing stable coins and the proposed Facebook Libra are examples).

"Innovate" is also problematic here because it overly restricts the role of the Bank. It is important not to ignore the role of the central bank, the FCA, the payments regulator and the competition authorities in support of private innovation in payments. Also, what is at issue is not innovation per se (which is to be encouraged), but particular forms of innovation. Therefore, for the purposes of my response to your consultation, I interpret your question in the broader and I think most practically useful form:

"…as the issuer of the safest and most trusted form of money in the economy, what forms of innovation should we support that provides the public with electronic money as a complement to physical banknotes?"

My answer to this question, is that the Bank should provide a core platform with the minimum functionality to support all possible transactions in central bank money whether for direct payment or settlement purposes. The Bank may also consider supporting some specific solutions built on that core platform; also as regulator you may require use of this core platform in specific ways for particular forms of payment and deposit service from banks or non-bank payment services providers. But there is no need for you to "issue CBDC", a commercially risky venture which Central Banks in my view should not get involved in.

Some of my principal relevant research - introduction.

With this reformulated question in mind, I now turn to a summary of my principal relevant research and how it answers this broad question.

I have conducted research on payments, financial infrastructures and financial technologies for the past two decades. My approach to these topics has been largely institutional, informed by the concepts of network economics and using interviews and case studies to understand the operational systems underpinning retail and wholesale payments and transactions in capital and foreign exchange markets. I use these findings to assess the potential impact of these arrangements, and potential regulatory interventions, both for market power and departures from productive efficiency and for incentives for innovation.

I have also recently authored/ co-authored a number of conceptual papers about money. A major goal of mine here has been to connect current discussions about electronic money to earlier debates about innovation in money and payments, with active debate in the 1990s (in relation to e-money), in the 1970s and 1980s (in relation to financial deregulation) and to the wider conceptual and institutional literature on

money in classical, Keynesian and Austrian traditions. Fascinating intellectually, but also I think providing useful practical insights relevant to your consultation questions.

A final introductory remark. A number of economic researchers have developed formal models of CBDC. These are valuable, but they often assume without further justification a large unsatisfied demand to directly hold central bank liabilities in electronic form for monetary transactions. This assumption is made even in normal times not just as part of a flight to safety during a financial crisis. They then find that introducing CBDC increases social welfare and/ or provides low cost government funding. These models are technically impressive, but they develop the consequences of their own assumptions. Whether is substantial demand to hold CBDC in normal times is a major open question.

I now summarise some of my relevant work under two broad headings. First, conceptual analysis of money. Second, the institutional analysis of payments and financial infrastructures.

Relevant research of mine: conceptual analyses of money

- M1. Argument by False Analogy: The Misclassification of Bitcoin as Token Money (2018, revised 2020)

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3290325

The purpose of this paper is to challenge the frequently stated view that cryptocurrencies and stable coins (and by implication any central bank supported electronic money based on similar technologies) are “tokens” or “objects” whose validity in payment transactions is verified by confirming that they are valid not forged (as opposed to account based bank money where a payment transaction is validated by confirming that the instruction to debit the account is valid). Reality is simpler than these statements suppose. Cryptocurrencies and stable coins are account based. They differ from conventional bank account money simply because there are no real world identifies associated with the account holdings.

The principal comment I have had on this paper has been “yes, your point is correct, but does it matter that much? It can still be useful to use the term token to refer to pseudonymous electronic money, where the real-world identity of the account holder is not known.” My response, discussed in the final section, is that there are other more important features distinguishing cryptocurrencies. This further analysis distinguishes three conceptual levels in monetary arrangements: the abstract (the underlying monetary standard, whether commodity or fiat based), the concrete (the forms in which money is held) and the transaction level (the mechanisms through which money changes hands). Cryptocurrencies combine all levels in a single platform. Stable coins are distinguished by combining the concrete and transaction levels in a single platform. Central bank electronic money will combine the abstract level and the concrete level, but with different possible choices about the transaction level.

- M2 The forms and functions of money (2020, with John Vaz and Kym Brown)

https://www.researchgate.net/publication/340828115_The_Forms_and_Functions_of_Money

This paper investigates how different forms of money fulfil the widely accepted 'triad' of monetary functions – unit of account, store of value and medium of exchange. The triad itself reflects a general understanding of the role of money that can be traced back to classical Greece (the use of money as medium of exchange is described in Aristotle's Politics section 1257a and as a unit of account in Aristotle's Nichomachen Ethics Book 5, chapter 5) and is restated in numerous economics text books. This paper looks at how the attributes of any particular form of money, both intrinsic attributes inherent in the form of money itself and extrinsic attributes resulting from the context in which it is used.

From our abstract "*We propose a richer framework – the Domain, Manifestation and Function (DMF) framework – as a better approach to analyzing existing or proposed forms for money and the extent to which they fulfil the functions of money. We apply this framework to historical, established and new forms of money. We find that the extent to which different artefacts that are adopted as money can provide the three functions is more accurately viewed as a degree or scale measured along the three separate dimensions. Performance under the triad depends on the capabilities required in particular transaction domains. The capabilities of any form of money is determined by its intrinsic and extrinsic attributes supplemented by institutional settings and financial networks. This in turn means that the adoption of new forms of money is an inherently evolutionary process, driven by institutional and technical change and network adoption. New forms of money such as Bitcoin, may be dismissed as not being money in some domains, but this oversimplifies, as it can fulfil monetary functions in other domains where its capabilities as media of exchange outweigh disadvantages in the remaining triad functions*."

- M3 What is new about cryptocurrencies: a visual Analysis (2019, with Anil Kavuri and Justine Wood, revision in progress anticipated for end-June ?))

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3473528

This paper revisits some of the visual characterizations of money that have been put forward in recent years to capture the key features of monetary innovation, especially the "money flower" diagram of Morten Bech and Rod Garrett and the classification of money of Adrian and Mancini-Griffoli.. We argue that these visualisations are unsatisfactory because they confuse together two separate aspects of money that are best kept clearly distinct.

a) The technologies of recording and transfer of money

b) The arrangements that give holders confidence in the value of money

We offer two new diagrams, the first highlighting the differences in record keeping and transfer technology between commodity money and representative money and also between physical money and account-based money. The second looking at the different institutional arrangements that underpin the value of money.

- M4a Cryptocurrencies from an Austrian Perspective (2017) , working paper:

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2946160

- M4b and shorter version as book chapter

https://www.springerprofessional.de/cryptocurrencies-from-an-austrian-perspective/15972234

This paper and associated book chapter examines the possible use of distributed ledger technologies to support a regime of 'narrow banking' or '100% reserved money'. The novelty here is the use of 'smart contracts' to allow pledging of short term loans by banks to the narrow banking ledger, with automated repayment to the ledger by the bank if the borrower defaults on their obligations on repayment to the ledger. The pledging of loans to the ledger allows banks to create money to fund their lending, so addressing the principal criticism of narrow banking that it limits the supply of private sector credit.

This is a truly radical proposal. It removes the role of the central bank in interest setting. This is replaced by two new, novel instruments. The first direct control over the quantity of money used in transactions. The second an 'x% reserving requirement' that determines how much funding is obtained by the pledging of loans.

With this reform, I argue, there is no longer any need for bank capital regulation or to save banks from failure (the payment system is isolated), though there may still be a need for some occasional central bank intervention to stabilise credit markets. I also suggest that, to avoid excessive fluctuations in short term interest rates, asset managers should be allowed to use short term government bonds as a medium of exchange for portfolio reallocations.

- M5. Revolution of Evolution? Distributed Ledger Technologies in Financial Services (2020, with Anil Kavuri)
  https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3527192

This is an extensive (140 page) review of the application of distributed ledger technologies (DLT)in financial services. It provides a conceptual framework and then looks at more than 100 cases, seven in some detail. It also discusses the costs and benefits of adopting DLT from both private and social perspectives. The paper contains many messages, no easy read. We have provided an 18-page summary version with the key insights (this is what is on SSRN with a link to the longer paper). The most important findings include (a) there are many component technologies, DLT is not one thing and the combination of technologies used varies considerably from case to case; (b) adoption is piecemeal, most initiatives do not proceed beyond proof of concept, commercial implementation is proceeding slowly in only a few specific contexts where sharing and mutual governance of data is critical; (c) DLT technologies involve a centralisation of operations, not a decentralisation, with adoption of common standards and business processes and agreement to keep data on a shared ledger (they are though decentralised in other respects, e.g. governance and data processes in contrast to utility based shared data solution where governance and data is the responsibility of a single controlling entity.)

Existing research on payments and other financial infrastructures

I now turn to the related fields of the network economics of payments and other financial infrastructures, an area where I have made a number of small contributions over the past two decades.

Rather than attempt a full summary of papers that I think are important int his field (mostly papers of others not my own), I will just note some main insights that emerge from this literature.

One is that the key issues of promoting competition and efficiency are often best addressed by the very standard frameworks developed originally for utilities regulation, distinguishing downstream potentially competitive markets from upstream markets where technological constraints limit competition.

The best regulatory response is then scaling down the role of the upstream market to its irreducible minimum level (e.g. by separation of activities) and then in addition intervening to support access to the upstream market.

In the case of payments a key "upstream" market is the exercise of transfers in central bank money, whether for settlement of credit money (amongst banks and other non-bank providers of credit e.g. credit card companies) or direct access to central bank money.

This approach is relevant both to promoting competition and also to promoting innovation.

A similar point applies to another central issue in financial infrastructure, that of setting communication and data storage standards. Here there has been progress over the years, especially through the work of ISO68 and the promotion of the ISO20022 standard and accompany shift from fixed field to XML standards. But there is also resistance, because of costs of co-ordination and from vested interests seeking to resists erosion of their market power.

It is from this perspective that I have developed the response set out in this consultation.

Further insights about competition and innovation in payments emerge from the literature on two-sided platforms. These play a lesser role in what follows so I do not review them here.

Specific questions raised in your discussion paper

Throughout my answers I generally use the term "central bank e-money" or simply "e-money", to avoid the ambiguity and confusion associated with the term "central bank digital currency". I do though refer to wholesale CBDC as a useful expression for non-bank financial intermediary access to the central bank balance sheet.

While I keep to the order of questions, my answers will be easier to follow if you first read my answer to Question 19.

1 *How could CBDC be designed to support a more resilient payments landscape in the UK?*

Resilience has many aspects. My Austrian paper and book chapter M4a, M4b propose what may be the most resilient possible model for operating the payments system, at least with respect to the credit risk associated with financial intermediaries. This envisages using central bank e-money (central bank account holding by households and firms) to entirely remove the role of commercial bank balance sheets in payments. This is a form of narrow banking, but carried one stage further: bank deposits are not

100% reserved but rather banks operate as ‘wallets’ managing the deposits of central bank c-money.

Such radical reform of the kind I describe in M4 is not an immediate or even medium-term prospect. But the analytical exercise does indicate that this is a very deep question. Fundamental redesign of our payment system to promote financial stability is conceivable.

Reform of the kind described in the answer to question 19, which I see as the only realistic way to pursue the goals of “CBDC” i.e.. achieving private and social benefits from widespread access to central e-money accounts, will have relatively little impact on credit risks.

Resilience of payments also refers to liquidity risks. These are managed at present through intraday and overnight borrowing from the central bank. In the context of “CBDC” this this principally relates to wholesale CBDC, i.e. non-bank institutional access to deposits at the Bank, and consequent shifts in liquidity management by banks and non-banks which could be quite significant within the London money markets.

I hope to do further work on the impact of wholesale access to the central bank balance on the demand for money market liquidity in coming months. For now I can only give a preliminary view on how widening access to central bank e-money accounts will impact of liquidity risks in the payment system. I see no qualitative change resulting from this change. The Bank will still be the ultimate provider of sterling money market liquidity and this (together with any interest paid on overnight central bank deposits) will determine short term money market interest rates. While I would expect some increased demand for liquidity, in order to preposition for large value payments, I still expect the present situation of over supply of liquidity, since the development of QE, to continue i.e. the Bank provides such an ample supply of short term transferable liabilities and so interest rates are pushed down to the floor level determined by the remuneration of central bank deposits. If however this proves wrong, then the Bank will still be able to provide additional short term liquidity to deal with liquidity problems in payments.

Finally, resilience refers to operational risk. You might argue that a central bank provided alternative payments solution, which can be operational when private sector solutions fail, is a sensible way to protect our payment system against operational risk. Certainly, there is need for offline payment functionality. But there are many other ways to address other aspects of operational risk, this is not on its own a sufficient argument for a central bank engaging in direct competition with private sector providers.

2 *How could CBDC be designed in a way that improves the efficiency and speed of payments, while also facilitating competition and innovation?*

My view, elaborated fully in my answers about platform design, especially Q19, is that the main role of the Central bank in e-money provision is to be service provider agnostic, providing secure and efficient support to digital payments execution of all kinds; and that this can be based on moving the entirety of central bank liabilities onto a single platform, offering rapid, secure transfer in as simple a way as possible.

The Bank should not be offering any competing payment functionality itself. It may however sponsor some particular solutions for private sector development and investment (stored value cards as a substitute for bank notes are the most obvious such project). And it will of course continue to be involved in regulation of the private providers of payment services.

3 *How could CBDC be designed to meet future payment needs? How might future innovations and evolutions in technology (e.g. the Internet of Things) change these needs?*

See my answer on 2. and on platform design below. The Bank need not worry about this at all, provide it is modernising the mechanisms for access to and transfer of liabilities on its balance sheet appropriately.

4 *As usage of cash as a means of payment declines, is it important to preserve access to central bank money for households and businesses?*

Yes, and a core platform reduced to an irreducible minimum as a foundation for payments (as I describe below) will enable this to happen in several ways. First wallet providers will be able to provide direct transactions in central bank money. Second the Bank may sponsor specific solutions (I envisage a smart card solution that can serve those without bank accounts or as an alternative when bank account transactions are not possible or preferred, this is discussed further below.). Third such a foundation will help support a wider range of opportunities e.g. at point of sale, to obtain bank notes in exchange for bank money.

5 *Does CBDC pose other opportunities or challenges with respect to the payments landscape that we have not discussed?*

As long as you avoid seeking to compete directly with private sector payment solutions, no.

6 *What factors would determine the level of adoption of CBDC as a means of payment in the UK?*

I interpret this question (for the sake of consistency with the rest of my analysis), as asking what would determine the adoption of personal accounts held on the core central bank ledger for payment purposes as an alternative to commercial bank deposits. This will depend inter-alia on:

a) Prices i.e. Charges and interest income credited on commercial bank transaction balances
b) The functionality and service quality offered by non-bank or bank 'wallet services' for management of central bank account holdings and use of payment
c) The extent to which these wallet services support direct integration into the standard payment mechanisms, whether card at point of sale, online transactions, person to per
d) Public perceptions about the safety and security of commercial bank balances relative to deposits held directly with the central banks.

The latter will depend critically also on treatment of central bank account balances, in the event that wallet services providers fail for either operational or financial reasons. Properly developed (see my discussion of core architecture below) any holder of central bank accounts will be able to transfer both their account balance and transaction history to another provider with a single instruction (based on the secondary keys system I propose). Provided this facility is available and clearly understood then personal holders will recognise central bank e-money as being clearly distinct from commercial bank e-money. They will see that a claim on the Bank that will always be available to them, whereas a claim on a commercial bank while protected by deposit insurance would still leave them at risk of at least temporary loss of access.

The first three commercial factors will in turn then depend on how platform competition in payments evolves after the move to a core Bank e-money platform used for all payment purposes. Network effects lead to varied potential outcomes. They can either restrict movement of business between platforms, generate tipping points where users move 'en masse' from one platform to another or result in 'multi-homing' where users engage with several platforms. The Bank's own core platform should be agnostic to all platform providers. Whether regulatory intervention is then required to promote a more socially desirable outcome, e.g. through promoting greater standardisation and platform interoperability, becomes a question for the payments regulator not the Bank.

7 *Are the design principles described in Chapter 3.2 comprehensive? What are the most significant trade-offs between some of these design principles?*

All the design principles 15 design principles are best delivered by adopting a minimal core-design, in which the Bank provides no customer facing payment services, only interacting with the regulated intermediaries supporting payments. Provides the Bank does not get involved in customer service delivery, then I see no trade-off between these principles. All can be met, with appropriate and standard tools of regulation and competition law, which can then ensure that these same design principles are reflected in the final payment services offered to both natural and legal persons.

There are significant initiatives underway in the UK to facilitate improvements in both electronic and cash payments. These initiatives are outlined in the appendix. The Bank will continue to fully support these initiatives, recognising the significant benefits they could provide for the UK payments landscape. It is essential to understand how CBDC would work alongside these existing initiatives, and how CBDC fits into the wider payments landscape.

8 *How could CBDC be designed to complement other public and private sector initiatives to improve payments in the UK?*

The recommendations I make in this response are that the Bank focus on the irreducible core functionality needed as a foundation for all sterling digital payments over coming decades, while playing a minimal role in the provision of deposit and payment services. This approach will be the best possible complement to other public and private sector initiatives. It will:

- Automatically support the objectives of your balance sheet access review

- Provide the strongest possible backbone for the new payments architecture
- Support liquidity management in wholesale markets through (i) allowing transparent transactions in fully backed settlement assets (I avoid the word “token” because I suspect these are better identity linked, they certainly need not be anonymous), where all liquidity is prepositioned; and (ii) rapid and efficient monitoring of liquidity needs and provision of intraday and overnight liquidity to meet the Bank’s responsibilities for monetary and financial stability.

9 *Could CBDC provide unique benefits, over and above existing initiatives, to improve UK payments?*

You will potentially undermine benefits of centre bank e-money to UK payments, if you go beyond these of core irreducible minimum responsibilities. Competition from a state supported service can blight private initiative. Only where private initiative is clearly not meeting essential needs do you have a reason to do more.

I think there is one form of e-money payment solution though, where I think it likely that the Bank will have to take a lead. This is providing an adequate substitute for banknotes that can service the needs of particular user groups when the provision of notes becomes difficult. I suppose this could proceed by designing a solution and then commissioning its implementation from a private sector provider and paying the costs from the Bank’s own income account.

I envisage this being designed something as follows

- A stored value card solution, representing balances on the core ledger
- An option for anonymity provided limits are maintained on balance and transaction value, e.g. balance less £2500, transaction value less than £50.
- Payment functionality at point of sale through NFC communication; through the internet; as a plug into stripe or similar payments aggregator; also allowing mirroring of the card on mobile or PC; i.e. aligning with existing payment instruments.
- Broader functionality when e-identity is verified, e.g. for receipt of social security, bill payment in response to e-invoicing, maybe even salary payments (not direct debit or standing order because these require supporting credit facilities). Also larger value card-to-card payments.
- Facility to top up online or by cash payment at ATMs or some points of sale; and to withdraw as cash at ATM or point of sale.
- Integration with Open Banking APIs to support limited banking services for vulnerable individuals.

10 *Could the potential benefits of CBDC alternatively be achieved with policy levers to (a) influence the private sector to deliver a better payments landscape, or (b) address market failures or co-ordination problems in the private sector?*

My entire response, but especially to Q19, is an extended answer to this question. I suggest that the Bank provides the necessary foundation of the modern e-payments, through a core foundational layer for payments, both payment instrument and payment scheme agnostic and offering indirect and direct access with appropriate supporting regulation of providers. There is no need for the Bank to then involve itself in any form

of customer service provision. Standard policy levers, of prudential regulation, customer protection, and competition regulation are sufficient to achieve improvements in the payments landscape.

11 *Could the potential benefits of CBDC be alternatively achieved by enabling new innovative private sector arrangements (eg stablecoins) to develop?*

Stable coins are another substantially misunderstood phenomena. It is necessary to distinguish coins created purely for cryptotransacting (principally Tether) from private fully reserved money that supports day to day transactions (including Paypal, US style money market mutual funds, and will likely extend to Facebook Libra).

The crypto wild west, provided it does not impinge on retail financial series, can be left to its own devices (and is in any case impossible to control).

Other private fully reserved money must be adequately regulated to protect retail holders. The key regulation is what reserves must be held. The most obvious regulation is requiring 100% reserving in central bank money, as has already been the case since Jan 2019 in China for AliPay and WeChat Pay.

Such 100% reserve requirements make stable coins into what Adrian and Mancini-Griffoli (2019) describe as “synthetic CBDC”, synthetic because the payment of value on these coins still remains an obligation of the provider of the stable coin. This is in contrast with “genuine CBDC” where the holdings are accounting liabilities of the central bank.

The difference is immaterial for the provider of the stable coin. However, it matters to the holder if the provider fails for either operational reasons or financial loss. The provision of the core irreducible platform for transferring of central bank e-money described here can overcome this apparent divide, based on the introduction of primary and secondary keys. In the event of such failure, this enables the holder to instantly transfer the underlying claim on central bank e-money to an alternative provider i.e. in my schema to revoke the supporting secondary cryptographic keys, replacing with a new key for a new provider. In this case there is then no real distinction between “synthetic” and “genuine” CBDC.

There could still be a difference of perception. Holders may perceive such stable coins as a form of “wallet” for holding central bank money or as a private money provided by the stable coin issuer. But in either case these become an alternative, and from the perspective of the Bank more natural and lower risk route to the creation of widely held retail central bank e-money.

I note how in China has already taken the first major step in this direction, since their Jan 2019 requirement that AliPay and WeChat Pay balances must be fully backed by central bank deposits. Arguably these already are “CBDC” though a final step of ensuring that holders have direct and independent access to the underlying central bank e-money deposits has not yet been taken.

7.1 Understanding the impact of CBDC on monetary and financial stability

As discussed in Chapter 5, CBDC could impact the structure of the banking system and the way that the Bank achieves its primary objectives to maintain monetary and financial stability. It is important to fully understand these impacts, and ways to mitigate any risks through the design of CBDC.

12 *What opportunities could CBDC provide to enhance monetary or financial stability?*

As you will be aware, there are major open questions on the widespread holding of central bank e-money on fiscal and monetary stability. Broadly I see widening access to central bank e-money, in the way outline here, as creating positive opportunities that will allow the Bank and other financial authorities to better achieve their statutory objectives.

As an example, a key opportunity, that must in my view be grasped, is bringing UK CASS rules on the management of client money into the digital age. Provided that the Bank provides the minimal core-central payments ledger I outline here, then the FCA and the PRA will be able to require that all client money is held as central bank accounts. The system of primary and secondary keys that I outline will allow the identified main holder to delegate authority to a financial intermediary, e.g. a broker or asset manager, to use their money. But they will be fully protected from loss of their cash holdings in the event of failure. This in turn can help support the agenda of being able to much more easily resolve failing firms.

13 *How much demand would there be to hold CBDC? How would that demand vary depending on the economic design choices outlined in this paper?*

A central question. My key point here is that if the Bank goes beyond the development of the minimum irreducible core functionality to support sterling e-payments, then it begins to take on substantial commercial risks.

Retail demand may simply not be there, if holders of central bank e-money view the services provided by commercial banks as equivalent in quality to those available on central bank e-money balances, and with the commercial banks able to use leverage and particular reserving to either offer interest on accounts or lower charges than those levied by wallet providers in order to provide equivalent services on central bank e-money accounts.

There will though be wholesale demand, to provide supplementary payment services. I actually wonder why the Bank has conducted two separate consultations on “CBDC” and on Balance Sheet Access since to me these are ultimately the same thing. The only differentiator is between wholesale and retail, with retail brining in the more challenging issues of identity and legal responsibility that I address later in this response.

The wisest route for the Bank is to avoid any development that depends for success on large scale demand for direct retail holding of e-money at the central bank which simply may not transpire. Hence the alternative solution I outline in my answer to

question 19.

14 *To what extent might CBDC lead to disintermediation of the banking system? How would the degree of disintermediation vary with different economic, functional and technological design options outlined in this paper? How would different degrees of disintermediation affect the stability of banks and the rest of the financial system?*

This is the other face of question 13 (you are between Scylla and Charybdis). Suppose there is no demand for central bank e-money, then Bank investment in providing additional payment services going beyond the irreducible minimum will have to be written off. So, no demand is a problem. But so is substantial demand. If there is substantial demand then this could undermine commercial bank balance sheets. The Bank could in turn respond by giving commercial banks favourable treatment, e.g. interest rates on reserves higher than available on other central bank e-money. But this then becomes a commercial intervention with considerable political risks for the Bank.

In my view the best way to deal with this dilemma is again, as in the framework for provision of central bank e-money I set out here in my response to Q19, if to limit yourself to providing the minimum framework for provision of access to the central bank balance sheet. This way you are exposing your self to little commercial risk. Also commercial banks then become some of the major providers of wallet services to access central bank e-money and can from this obtain a compensating revenue stream. Incentive wise (but in the UK politically problematic) bank risks might be limited by a move away from 'free in credit' banking to explicit charging of all payment transactions for households as well as businesses.

Yes, there are risks associated with technology undermining bank business models. Ultimately, though I do not see this happening so rapidly and other tools of supervision and regulation are appropriate for dealing with this challenge (notably improved identity solutions to reduce the burden of regulatory compliance and allow outsourcing of KYC).

15 *How would CBDC affect the monetary transmission mechanism and policy setting under existing monetary policy frameworks? What overarching analytical frameworks could be used for modelling how CBDC would affect the macroeconomy and monetary policy?*

Provided the bulk of transaction deposits remain with commercial banks, then I do not see the introduction of retail access to the central bank balance sheet having a major impact on the standard tools of monetary operation and conventional channels of transmission. The Bank will still determine interest rates through the provision of money market liquidity. Unconventional tools of monetary policy are even less affected.

If instead there is large scale movement out of commercial bank transaction deposits into central bank e-money, whether driven by depositor preferences or mandated (as under my M4 scheme) then the situation is different. Commercial banks will have to "work harder" to attract funding for their assets, so the bank loan response to monetary policy will be more limited.

This though is not really today's question. Create the new foundation for money and payments first. Ultimately the Bank might want to consider something along the lines of my M4a, M4b proposals if they see benefits to monetary policy of supporting more direct quantity-based transmission.

16 *What are the most significant risks to monetary policy implementation, and how could those risks be addressed?*

No significant short-term risks. For longer term risks see answer to previous question.

17 *How could CBDC affect the portfolio of unconventional monetary policy tools available to the central bank? How effective would a remunerated CBDC be in relaxing the effective lower bound on monetary policy?*

I do not want to get into this difficult question in great detail. I restrict myself to a few points

- The impact of central bank balance sheet holdings on broader measures of money, commercial bank plus direct at the central bank, or on longer term asset markets are largely unaffected.
- If there is a near disappearance of cash then (which again I only see happening relatively slowly) then short term money market rates of interest could be pushed more substantially below zero.
- If my radical scheme (M4) were adopted then a range of new tools become available, including direct expansion of transaction balances and alterations in the reserving rate for commercial bank loans to the ledger.

So the short answer: nothing much to worry about in the near term.

18 *How would increasing the efficiency of payment systems affect the macroeconomy and monetary policy?*

There an be a macroeconomic long term productivity and growth benefit from reduction in margins from payment services (which could be large, e.g. a reduction of 1% of GDP or more). Beyond this I see no other macro impact.

In the platform model of CBDC, presented in Chapter 4, the Bank would build a fast, highly secure, and resilient technology platform — the 'core ledger' — which would provide the minimum necessary functionality for CBDC payments. This would serve as the platform to which private sector firms, called Payment Interface Providers, could connect in order to provide customer-facing CBDC payment services.

My answers given here to question 19 is the core of my entire consultation response.

19 *What are the advantages and disadvantages of this public-private payments platform approach? What alternative approaches might be considered?*

I respond to the second question first. There are no realistic alternatives to ‘public/ private’. The Bank is not going to take on responsibility for servicing retail customers or detailed management of bank/ payment services providers/ wallet providers interaction with the system. The Bank is not going to entirely delegate the provision of central bank money to the private sector.

The issue is having clear stated demarcation of responsibilities

There are a range of possibility, but I believe that the central point is to ensure that the responsibilities of the Bank are kept to an absolute minimum. There is a very real danger of mission creep. I believe your proposals for the underlying platform (the ‘core ledger’) are overengineered, putting a good deal more responsibility than necessary on the Bank and potentially locking the UK into an inflexible payment system for years to come.

There is no requirement for example for APIs (those will be needed only if the Bank creates a complex platform whose records must be ‘translated’ in order for direct interoperability with other platforms).

The principle question to ask is the following: Q1 what is the irreducible core of functionality that will have to be provided by the core-platform to best support UK payments? Separate this from the further question: Q2 what further functions can be envisaged and should the Bank consider taking on responsibility for any of these further functions other than what are required for the irreducible core?

Q1 should be front and centre of your discussion of central bank e-money. Here is my answer on the irreducible functionality of the core platform:

- The core platform will offer accounts with access supported by public key cryptography. Here access means (a) reading balance of accounts and record of previous transactions; (b) making a transfer from the account to another account on the ledger.
- A basic, ISO20002 compliant messaging protocol, covering reading of records and execution of transfer instructions and also the creation of accounts and cryptographic keys. The ledger responds to a transfer request with one of two answers (i) insufficient balance, transfer refused; (ii) sufficient balance, transfer executed. In the case of (ii) the message is sent to the key holder of both accounts. My believe is that this messaging protocol will need to be XML based and designed for near instantaneous response. But further technical advice would be required on format and ensuring best possible performance.
- I suggest a system of primary (permanent) and secondary (temporary) keys. Secondary keys themselves can be one time or for a period of time. A primary key holder can delegate rights (a) or (b) or both by issuing a secondary key. Secondary keys are also given rights over receipt of messages triggered by incoming balance transfers. Secondary keys can be cancelled by the primary key holders at any time
- Accounts will divided into two groups: identity linked with no restrictions on

balances or transfers; restricted accounts with a limit on account holding and transfers.

- The platform will be comprehensive. All Bank of England balance sheet liabilities will be represented on the platform (i.e. there is no immediate move to the form of state e-money envisaged in my work on 100% reserving M4; if that were to take place then the core platform would have to be separated from the Bank of England with the Bank holding its own monetary accounts on the platform).
- The platform will be closed with no transfer of balances on or off the account. One exception. The Bank will be able to create money through expansion of its equity account, allowing it for example to purchase government bonds or provide intraday or overnight lending.

That's it. You do not *need* to provide anything else.

Turning now to the subsequent question Q2, what further functions are needed and should the bank provide them? My answer here, the critical additional functions are (i) identity and (ii) legal liability for transaction execution, which in turn and together underpin security.

- E-identity for individuals and legal persons is a key issue in e-government and e-commerce. This requires a comprehensive and flexible and politically acceptable solution, at national or perhaps better European/ global level. It is not within the Bank's remit to provide an architecture for e-identity, and the Bank does not have competence in providing identity solutions. But the core ledger must support links to identity solutions, both as they currently exist and to ensure that the Bank's e-money adjusts appropriate to all possible future developments in e-identity.

  At the moment in the UK identity is a delegated and piecemeal legal responsibility with a substantial burden of responsibility for financial institution (under KYC) and also for tax authorities, health services, utility service providers and others. To deal with this, I think it will be necessary for the Bank to commission an outsourcing entity to maintain a parallel ledger, used to manage the relationship between e-identity and the issue of cryptographic keys for the core ledger. The nature of this identity information need not be incorporated into the core ledger, but the messaging system will have to confirm, for identity linked accounts, that a satisfactory e-identification has been made.

- Legal responsibility for transfers. My biggest surprise about your consultation document is the limited discussion of legal issues. To quote the first sentence of one of the classics of monetary economics (Knapp 1924 edition, chapter 1, paragraph 1 , the RES translation: https://socialsciences.mcmaster.ca/econ/ugcm/3ll3/knapp/StateTheoryMoney.pdf

  "*Money is a creature of Law*".

With respect to the core ledger as I envisage it what are the legal issues? A central issue will be the responsibility for fiduciary duties associated with both management of keys and of issue and use of secondary keys. The creation of secondary keys with rights to execute transfers must be identity linked. This then determines legal responsibility. Arguably, in the spirit of multi-factor authentication, two separate secondary keys might be required to execute transactions.

Another key legal issue is inheritance and also consequences of the dissolution of legal person (company, charity etc.). The primary key holder has, in effect, two choices (a) accept that their money becomes frozen forever; (b) issue a secondary key for inheritance/ liquidation with the right to close the account or at least reduce balance to zero. Arguably there might be a requirement for a default secondary key being given to the exchequer, if no active choice is made.

Another key legal issue is management of the accounts in the event of dissolution of a legal – person i.e. bankruptcy resolution.

20 *Are there viable business models that would incentivise firms to offer CBDC-related payment services in this approach?*

This need not be the concern of the bank, because you are providing a single platform that is the foundation for all transactions in central bank e-money. This will be an issue for the payments regulator and competition and markets authority.

21 *What are the respective advantages or disadvantages of (a) the pooled accounts model described in Chapter 4.2, and (b) the alternative approach described in Box 3 in Chapter 4?*

The contrast between these two approaches is overstated, a consequence of the overengineered outline in your Chapter 4.2. They key principle, in my view, are minimal core functionality in which most accounts , and all those exceeding minimum balance and transaction limits, are linked to personal identities. There is no need for APIs. If this then is supplemented by a regime in which transfer of secondary keys ensures immediately transfer of central bank e-money from a "wallet provider" that fails, then the bank has two subsequent choices

- it can be left up to the market demand to determine whether depositors prefer "synthetic" or direct holding. It is difficult though to see how synthetic provision could survive commercially, since it provides no advantage over direct holding
- the bank could require synthetic providers to shift over time to direct holding in order to protect retail customers who are unaware of their exposure to resolution risk, avoided by direct holding.

The main point here is that is not a design choice that needs to be addressed at the present time. Wait and see what happens. Intervene later if necessary.

In the platform model, Payment Interface Providers would build 'overlay services'— additional functionality that is not part of the Bank's core ledger, but which could be provided as a value-added service for their users.

22 *What kind of overlay services would be most useful? What functionality would a CBDC core ledger need to provide to enable these?*

This is of no concern to the design of the core irreducible foundation for modern payments. NO additional functionality required other than what I outline here.

23 *How could CBDC be designed to ensure businesses are able to easily accept CBDC payments at the point of sale?*

This is of no concern to the design of the core irreducible foundation for modern payments. Again NO additional functionality required other than what I outline here. It will hover be necessary to consider the implications for the New Payments Architecture to ensure that it can offer transactions in all forms of e-money.

24 *What would be needed to ensure that CBDC would be inclusive and accessible by all sectors of society in the UK?*

This reflects a misconception that universal access to e-money on the Bank balance sheet requires a universal solution. No, there will be several solution and the Bank's responsibility is limited to providing some back up solution that serves those customers who are not served by private initiative. Here, as described above, I envisage a smart card based solution sponsored by the Bank.

25 *What is the appropriate privacy model for CBDC? Is it necessary, or feasible, to replicate any of the privacy aspects of cash?*

See my answers above about smart card cash and anonymity of smaller value accounts on the core ledger.

26 *Would offline payments functionality be required in CBDC?*

Again, the question is somewhat misstated. The issue is not CBDC offline payments functionality, but offline functionality for payments in general. I do not give a full answer here. A smart card solution could provide limited off-line functionality. The question then arises whether more is needed.

One potential driver of demand for retail access at the central bank, as I envisage it being provided with primary and secondary keys, is that in the event of a failure of commercial bank other wallet provider systems, the holder of the e-money could transfer near instantaneously to another provider. This is good protection against individual institutional failure, rather than system wide failure.

How we operate in say a nuclear winter is another matter. I suspect that additional emergency plans will then have to be ready for activation. A single universal central bank money and payments platform will, I think, help with implementation off such plans.

7.2 *Technology, infrastructure and further innovation*

The questions in this section are misconceived. You are "putting the technological cart before the service-level horse" (sorry, rather a mixed metaphor). Technical details do not need to be determined at this stage and need be taken into consideration only to extent that they will limit the services that can be offered. Moreover I believe they will not pose any practical limits.

The correct questions to ask at this stage of consultation is as follows: "To what extent if any will technological choices on access to the ledger (or ledgers) of central bank money limit functionality? How might such limitations arise?"

My answers. I am an economist not a technologist so you will certainly want to consult with those who have deeper understanding of these technologies than I have. However, it is my understanding the supporting digital and cryptographic technologies are sufficiently powerful and flexible that technological choices with regard to supporting central bank e-money need not limit services or functionality in any way.

Decide what you want first. Then decide how to implement those decisions from a technological perspective.

As discussed in Chapter 6, the technology used to power CBDC should be chosen on the basis of what best meets our design principles. It will therefore be necessary to understand the potential of a range of different technologies, and the trade-offs each of these presents.

27 *The paper describes a core ledger, operated by the Bank, which supports a range of Payment Interface Providers through an API layer. What are the advantages and disadvantages of this architecture? What are the alternative architectures that we should consider?*

Your framework is already a little overengineered. No API layer is required. See my discussion of the architecture above.

28 *What are the main trade-offs that arise in deciding on a technology approach? What should we be prioritising in these trade-offs?*

None. There are no tradeoffs and no need to prioritize.

29 *The core ledger for this model of CBDC could be centralised, or operated through a consensus-driven distributed approach. Which is the optimum approach, and why?*

This is not a binary choice. There are many intermediary 'semi centralised' possibilities and many aspects of centraliation. -See M5 for fuller discussion. Ultimately though I think this is a secondary question, think about the functionality first, then design the supporting technology to best ensure safety, security and integrity which will be paramout.

30 *What are the merits, or challenges, of either 'token-based' or 'account-based' approaches to a CBDC ledger? Are there particular use cases that are better supported by either approach? Are there alternative approaches?*

See M1. The distinction between 'token-based' and 'account-based' is a false one. All electronic money is account based. The policy issue is whether personal identity is linked with the accounts (identified) or not (token). This is a practical choice that can apply to some accounts not all. There is a case for allowing some accounts, not all, to operate without a link to personal identity with some limits on usage e.g. maximum levels on value and on transaction (e.g. this might apply to the underlying value of smart card replacements for bank notes).

My further advice, since most accounts and all those of significant value are likely to be identity linked, The Bank 's e-money plans will need to be effectively integrated into UK government policies on e-identity and e-government. Agreed basic principles at national level are required.

31 What are the key use-cases for programmable money?

None that need concern the Bank. Provide the underlying irreducible core for transfer of central bank e-money. Private competition will determine if there is a demand for programmable money.

32 What architecture choices would best support programmable money functionality in a CBDC? Would it be preferable to build this functionality into the core ledger, via a separate module, or to enable the functionality to be provided by third parties? Are there alternative approaches?

Not part of the responsibilities of the bank.

33 How could CBDC support offline functionality? Are there technology solutions that can enable this without exposing any party to credit risk?

Another key question that I have already touched on in passing. My only though, and it is nor really a technological one, is that offline payments should be allowed up to a small minimum (but with the commercial bank taking the credit risk). in the event of severe infrastructural problems cause by say a major terrorist attack, these limits could be raised with HMT absorbing some of the risk.

But I should be frank about not having thought through this through in any detail. Identity solutions are also relevant, credit exposure to a known individual is more acceptable that to an anonymous recipient.

34 What dependencies would CBDC have on other innovations, such as digital identity solutions?

Identity is key. Access to central bank e-money must be designed to be robust to innovation and changes in identity solutions, which I envisage being provided through a parallel ledger.

35 What other future technology and digital economy innovations should we be factoring into the potential design of CBDC? How might these impact the future demands placed on CBDC, and potential approaches to designing a CBDC?

Basically, none. You are allowing yourself to be waylaid by technological details. The appropriate focus is on the core responsibilities of the central bank as the provider of the unit of account and most trustworthy store of monetary value. All that is needed is a single platform, as described in my question 19 answer, that offers the irreducible minimum services in a way that all other payments technology solutions can use as a foundation for their own provision. Simplify and scale back your ambitions and then challenge private sector providers to come up with any payment solutions which is not fully supported by your new platform (I believe, though this is obviously for exploration, that my design sketched in the answer to Q19 can support any possible future technological development).