



# **SWIFT INSTITUTE**

**SWIFT INSTITUTE WORKING PAPER NO. 2020-002**

## **CENTRAL BANK DIGITAL CURRENCIES AND INTERNATIONAL PAYMENTS**

CHUSU HE

ALISTAIR MILNE

MARKOS ZACHARIADIS

**PUBLICATION DATE: MAY 2022**

*The views and opinions expressed in this paper are those of the authors. SWIFT and the SWIFT Institute have not made any editorial review of this paper, therefore the views and opinions do not necessarily reflect those of either SWIFT or the SWIFT Institute.*

# Central Bank Digital Currencies and International Payments

Chusu He\*, Alistair Milne†, Markos Zachariadis‡

May, 2022§

## Table of Contents

1	Introduction.....	7
2	International payments and CBDC design choices .....	10
	2.1 Frictions in international payments.....	10
	2.2 CBDC design choices and international payments .....	17
3	Competition and innovation in payments .....	21
	3.1 A decade of change in payments technologies and regulation.....	21
	3.2 Platforms and network externalities as barriers to CBDC adoption.....	23
4	Four international payment scenarios: how CBDC can help improve .....	26
	4.1 Overview.....	26
	4.2 Small business payments.....	29
	4.3 Larger corporate transactions.....	31
	4.4 International retail purchases.....	31
	4.5 Remittances.....	33
5	Using CBDC to redesign international payments architecture .....	33
6	Conclusions.....	40
	References.....	44
	Appendix A. Interview design and interview questions. ....	47
7	The six page interview document .....	48
	7.1 Introduction.....	48
	Part A. CBDC design choices and international payments .....	49
	Part B. Scenarios of CBDC implementations for international payments .....	50
	Part C. General questions on the impact of CBDC on international finance.....	52
	Typology of key design choices for CBDC.....	53
	Appendix B. Central bank work on CBDC .....	55
	Some leading CBDC initiatives .....	58

---

\* School of Management, University of Bath, email: [ch704@bath.ac.uk](mailto:ch704@bath.ac.uk), Orcid: <https://orcid.org/0000-0002-2464-9280>

† School of Business and Economics, Loughborough University, email: [a.k.i.milne@lboro.ac.uk](mailto:a.k.i.milne@lboro.ac.uk), Orcid: <https://orcid.org/0000-0002-4135-3983>

‡ Alliance Business School, Manchester University, email: [markos.zachariadis@manchester.ac.uk](mailto:markos.zachariadis@manchester.ac.uk), Orcid: <https://orcid.org/0000-0002-6534-781X>

§ This paper has been supported by the SWIFT Institute, under their grant agreement 2020-002. SWIFT has facilitated our work through providing introductions for some of the interviews reported in this paper and through feedback on the research design. We would also like to acknowledge the generous amount of time provided to us by the twenty-two individuals who made themselves available for our interviews. We are fully responsible for the views and the analysis presented here.

## Executive summary

This paper – drawing on interviews with twenty-two senior payments professionals – documents the business processes employed in the execution of international payments and discusses how international payments might be improved through the adoption of central bank digital currencies (CBDC). This was a substantial exercise resulting in a lengthy research paper. This executive summary presents the key insights.

The motivation for this research is the focus of the industry on reducing costs, increasing speed, widening access and improving transparency of cross-border payments. An April 2020 report of the Financial Stability Board for the G20 (FSB, 2020) identifies some of the issues that need to be addressed: “fragmented data standards or lack of interoperability; complexities in meeting compliance requirements, including for anti-money laundering and countering the financing of terrorism (AML/CFT), and data protection purposes; different operating hours across different time zones; and outdated legacy technology platforms”.

To many observers technology has developed to the point where an international payment, to any destination, can and should be as straightforward as sending an email. This perception is reinforced by the observation that instant global payments can be made already using cryptocurrencies such as Bitcoin. So, it should be easy to do the same using CBDC, the fiat equivalent of cryptocurrencies.

A July 2021 report by the BIS, the World Bank and the IMF to the G20 (BIS et al., 2021) discusses the technical aspects of this. They consider arrangements for direct exchange of CBDCs of different fiat currencies, referring to these multiple CBDC exchanges as mCBDC. They consider several possible forms and applications of mCBDC in international payments.

Our focus on business processes highlights a different question, not addressed by (BIS et al., 2021). *What is the nature of the CBDC opportunity in international payments?* Is it:

- a) *Enhancement*: One of several current incremental technology developments, supporting gradual improvement in arrangements for making international payments, without fundamentally changing underlying business processes

OR

- b) *Transformation*: An opportunity for fundamental redesign of the architecture of international payments, radically simplifying business processes so that international payments can be made as directly and efficiently as domestic payments?

It seems that many discussing the problems of international payments are unaware of the complexities of the supporting business processes. In consequence, this central question has been largely overlooked. Yes, sending an international payment could become as easy as sending an email, but this would require substantial change in the way international payments are conducted, simplifying the underlying complexities of business processes.

What are these complexities? From the customer's perspective, an international payment is straightforward. It is the debiting of the sender's account followed by the crediting of the recipient's account in a different currency and different country. Underlying this though are many operations, as transactions move through accounts on intermediary balance sheets.

As an example, consider a domestic bank processing an international payment on behalf of a customer (see Figure 2 of the paper). This domestic bank accesses an international bank that in turn holds a foreign currency account with a correspondent bank in the destination country. Money is not itself transferred internationally. Instead, the payment is executed utilising a credit balance on an account held by international bank with its correspondent. Exchange of money from one currency to the other only takes place later and to the extent needed; for example, whenever the international bank uses foreign exchange transactions to restore its credit balance with the correspondent

There are several supporting settlement transactions: (i) first, at the time of the payment, two independently conducted single currency domestic settlements, for debiting the sender's account and for crediting money to the recipient's account; (ii) then later, if required, further settlement of the foreign exchange transactions used to restore credit balances with the correspondent.

The interviews reported here provided insight into other payment scenarios and their supporting business processes. International bank payments, of the kind described in the previous paragraphs, are mostly used by smaller companies and for person-to-person money transfers. Payments by larger companies can be much simpler, as they often already hold accounts in both jurisdictions. This eliminates the need to use an international bank and correspondent bank as middlemen for international payments. They still require an international bank, but only for multiple currency cash management, helping them with foreign exchange transfers to correct cash imbalances between currencies and jurisdictions.

Separate arrangements, operating in parallel to international bank payments, address other specific needs. Specialised non-bank financial institutions provide migrant remittances, often beginning with a deposit of physical cash and ending with a physical cash withdrawal. Most international retail payments, by tourists and travellers or for international online purchases, take place under the further arrangements of international card schemes, such as Visa and Mastercard, with payment passing through the balance sheets of their own chains of participating bank and non-bank intermediaries.

Technology is addressing the inefficiency of international payments, albeit slowly. The speed and transparency of international bank payments has been substantially improved by SWIFT gpi. Non-bank alternative foreign exchange providers are capturing an increasing share of international payments. While substantially improving services, these use similar business processes as the incumbents they challenge, with payments passing through several intermediary balance sheets. Their competitive advantage comes from better interfaces, low operating costs from employing specialised technology unencumbered by legacy, and operational integration with domestic faster payment schemes to support rapid completion of payment instructions.

Turning to the role of CBDC in improving international payments, the research adopts a broad definition. CBDC is taken to be any widely held electronically recorded central bank liability available for transfer, whether recorded on a distributed ledger or a more conventional database. This could be a 'retail CBDC' held by citizens, residents and domestic companies and potentially also by others. Or it could be a 'wholesale CBDC', used in larger value transactions and held by non-bank financial institutions, banks and possibly also large non-financial corporations.

We obtain the following findings:

- The most direct way of using CBDC to improve international payments is allowing *wholesale* CBDC to be accessed and used for settlement by a wide range of international intermediaries, e.g. non-bank payment service providers and foreign banks. This will avoid the need for a correspondent bank in payment transmission, in turn removing substantial barriers to entry in international payments, without any transformative change in international payments processes. The resulting increase in competition can then reduce the cost and opacity of international payments across all international payment scenarios.

This must though overcome two barriers. Central banks worldwide will be cautious about allowing foreign intermediaries access to their balance sheet. Also, wholesale CBDC accessed by foreign intermediaries must support the routing payments through the domestic payment scheme of the recipient, ideally on an immediate 24/7 basis. i.e. interoperability with domestic payment schemes, especially domestic faster payment schemes.

- Without a transformative redesign of international payments processes, the introduction of retail CBDC can only have only a limited impact on international payments, supporting improvements in some specific payment scenarios. It could be used by tourists or travellers as a cheaper and more convenient alternative to acquiring and holding physical currency. Retail CBDC, if it promotes financial inclusion, reduces costs of remittances by removing the reliance on local agents for making payments of physical currency to the recipient. Retail CBDC, if accompanied by the development of comprehensive domestic identity solutions, can also reduce the burden of KYC and AML monitoring in international payments.

The reason for this limited impact is that, without a transformative change in international payment processes, direct use of retail CBDC to execute an international payment will not be possible. Under current business processes, international payments (exceptions are those made using cryptocurrencies and physical cash e.g. US dollar bills) take place on the balance sheet of financial intermediaries. Holding retail CBDC and using it to make an international payment is no different than holding and using commercial bank money – it still has to be exchanged and then transferred as claims on financial intermediaries.

- It is possible that over a longer time horizon the emergence of retail CBDC could result in a transformation of business processes for international payments. We discuss one possible radical change of this kind. Suppose many households and corporates in both sending and receiving countries hold CBDC. In this case a market could arise for direct CBDC exchange without, unlike today, the payment having to pass through any intermediary balance sheets. Intermediaries would still be used, but they would be brokers, not dealers, helping customers find a counterparty with a 'double co-incidence

of wants' in foreign exchange, wanting to acquire the customer's CBDC in exchange for their own. Just as with exchange of cryptocurrencies transfer of ownership would then be immediate, with no subsequent settlement, and international payments would indeed be as easy as sending an email.

- A market for such real time exchange of retail CBDC, if it ever develops, is some way in the future. However, if the authorities wish to encourage a movement in this direction, they could support the development of a spot market for real time exchange of wholesale CBDC amongst large corporates and financial intermediaries. Our interviews indicate that there could be demand for such exchange in the relative near-term, allowing intermediaries and large corporates to manage their liquidity on a global real-time 24-7 basis. The reduction in costs of liquidity provision could then in turn support further efficiency gains across the full range of international payments scenarios. The existing T+2 settled foreign exchange markets (really a short term-forward market) could run alongside this true 24-7 spot market exchange, to support leveraged position taking and foreign exchange risk management.

Our analysis has one further implication. Policy needs to clearly distinguish two different goals: (i) near-term practical improvements in the cost and performance of existing international payment services; (ii) medium- and long-term reshaping of the architecture of international payment services to provide new and improved services that cannot be supported by existing arrangements. In terms of policy goal (i), the most obvious and immediate ways in which CBDC can be helpful are, in our analysis: providing wider intermediary access to central bank money in the form of wholesale CBDC; and interoperability and compatibility of wholesale CBDC with existing *domestic* payment systems; along with comprehensive globally accepted identity solutions.

These relatively mundane nitty-gritty enhancements to existing arrangements matter more, for near-term improvement to international payments, than the interoperability CBDCs being explored through current experiments with mCBDC, interoperability that is only needed in the context of longer term transformative change, with the emergence of widespread retail holding of CBDC and the opportunity this creates for redesign of the business processes of international payments.

## 1 Introduction

Central banks worldwide are examining closely the new digital monetary technologies with many of them considering launching their own central bank digital currencies (CBDC). A few have already implemented forms of CBDC (predominantly in the pilot stage) that can be used as alternatives to central bank notes in daily payments, for example the e-CNY in China). Many more – including the ECB, Bank of England, and the Federal Reserve – have initiated projects assessing the feasibility of creating their own digital currency and are publishing interim research and policy papers on what this would entail.

Our paper investigates the implications of the introduction of CBDC for international payments, with a focus on the impact on the low value payments made by small businesses, on merchant expenditures by consumer and travellers and on person-to-person international remittances. The investigation has been based on both desk research, with an extensive review of the research and policy literature, and twenty interviews with twenty-two payments professionals.

To conduct this investigation in a structured way, we had from the outset to deal with three broad issues. First, what counts as a ‘central bank digital currency’. Here we have consciously avoided the perspective of some technological purists: those who consider that an electronic form of money only qualifies as a digital currency if it is held on a distributed ledger i.e. multiple decentralised records of holdings reconciled through a ‘consensus process’. This is the form of record keeping often referred to as a ‘blockchain’ or more broadly a ‘distributed/shared ledger system’. We do not wish to limit the scope of our inquiry, hence, for the purposes of our investigation, CBDC is any widely held electronically recorded central bank liability available for transfer, whether recorded on a distributed ledger or on a more conventional database. This could be a ‘retail CBDC’ held by citizens and domestic companies and potentially also by non-citizens and overseas companies. Or it could be a ‘wholesale CBDC’, used in larger value transactions and held by non-bank financial institutions as well as banks and possibly also some large non-financial corporations.

Secondly – this is a principal contribution of our analysis compared to much other current discussion on CBDC – we pay close attention to the often quite complex current arrangements for the execution of both domestic and international payments, involving several stages of processing and a number of different intermediaries. A consistent theme of both our desk review and interview findings is that a proper understanding of the impact of CBDC on international payments must be based above all on understanding these processes and in particular on the central role of settlement in central bank money in payments processing.

This leads us to focus on the following issue: what is the nature of the CBDC opportunity in international payments?

- a) Is the creation of CBDC one of several current incremental technology developments, supporting gradual improvement in arrangements for making international payments? OR
- b) Is the creation of CBDC an opportunity for fundamental and transformative improvement in the way international payments are handled?

The answer obtained in this paper is (a); the creation of the CBDC is most obviously an opportunity for incremental improvements for international payments, rather than a fundamental transformation. The introduction of CBDC – along with other accompanying technological innovations – can promote greater efficiency in the conduct of many aspects of domestic and international payments without necessarily disrupting, but rather co-existing with the extant payments architecture. This is especially through the access it provides to

settlement or directly held money, allowing the firms involved to address operational inefficiencies and improve service quality. It can also reduce barriers to entry, promote greater competition in the different component services underlying an international payment and with appropriate supplementary measures on digital identity improve the transparency and convenience of payment services.

It may also be (b); a transformative change in the existing architecture is also possible, based on a widespread adoption of CBDC, but this requires substantial and costly changes in order to support institutional arrangements along with new financial infrastructures for direct exchange of CBDC. This could lead to financial intermediaries, non-financial companies holding and exchanging different national currencies directly and immediately with each other; and even support similar direct exchange amongst individuals (though from our research we've identified that this is unlikely in the near future). The development of such direct exchange could remove the need for many, though not all, of the supporting services currently required in international payments and further improve customer outcomes.

At the same time (b) is far from being an automatic consequence of the creation of CBDC. Existing arrangements work well enough in many situations. Where they do not, much can be done using digital technologies to reduce costs and increase the speed, reliability and transparency of both domestic and international payments without issue of CBDC. The launch of a retail CBDC brings with it commercial risks, especially in advanced countries where most domestic payment needs are already met. A retail CBDC may simply fail to attract a sufficient critical mass of domestic users, especially when alternative, adequate arrangements for executing domestic payments already exist.<sup>5</sup>

Thus, a future of radical change in international payments based on direct exchange of CBDC is conceivable, but it appears from our research that this is highly uncertain for two reasons: first it requires world-wide adoption of domestic retail CBDC which may not be easily achieved; second, even where retail CBDC is used on both sides of the payment transaction, substantial policy intervention is needed to develop new arrangements for the foreign exchange of retail CBDC, interventions with uncertain overall economic benefits. In our assessment the most that can be done along these lines in the foreseeable future, is supporting the direct real-time exchange of wholesale CBDC by financial intermediaries and larger non-financial companies, in order to reduce entry barriers and promote competition in both the foreign exchange and final settlement of international payments.

Further international finance aspects of CBDC lie outside the main scope of our research. The introduction of CBDC could conceivably impact on dominance of the dollar as an international reserve currency. From this perspective the push to develop CBDC can be interpreted as geopolitical: driven by a desire to challenge and also defend the existing global financial order. Widespread international holding of CBDC might also weaken domestic monetary sovereignty, especially in smaller countries with weak economies and financial systems.

Our analysis suggests some caution about any sweeping statements on the impact of CBDC on international financial order. We find that the impact of CBDC on international payments depends critically on detailed design choices. This is equally true with respect to the

---

<sup>5</sup> The battle of analog video recording formats of the 1970s and 1980s provides some parallel ([https://en.wikipedia.org/wiki/Videotape\\_format\\_war](https://en.wikipedia.org/wiki/Videotape_format_war)). Betamax launched first and offered some advantages in terms of a smaller cassette size with better picture and sound quality. Ultimately though the competing VHS format triumphed. The greater length of recordings together with lower cost of the recording machines led to VHS rather than Betamax achieving critical mass of users and widespread adoption.

potential further impacts of CBDC on international financial arrangements. For example, if central banks choose to limit international access to retail CBDC the implications for international financial arrangements will also be limited. On the other hand, it is possible that the major countries seize an opportunity created by CBDC, using it to aggressively compete for greater use of their fiat as an international store of value and medium of exchange. In this scenario – which is far from certain and depends on international politics as much as financial technology – then there can be major implications for the international financial order. In short, there are a lot of ‘ifs’ for such an impact to arise. Assuming that CBDC must substantially alter international financial arrangements appears at best a rather crude and superficial assessment.

The research methods used in this paper are desk research supplemented by hour long interviews with payments professionals and well-informed commentators on digital payments technologies. We conducted twenty interviews across six different categories of professional backgrounds (all under ‘Chatham house rule’ i.e. an understanding that they were speaking as individuals, not representing their organisations, and that we would not attribute views to any individual or organisation). The interviews were all ‘one to one’, except for one interview with a payment service provider where we interviewed three employees together. Table 1. Provides a breakdown of the interviews according to the main professional experience of those interviewed.

**Table 1: Breakdown of Interviews**

<b>Category (by main professional experience)</b>	<b>Number</b>
(i) International banks	5
(ii) International card schemes	2
(iii) Non-bank payment service providers	3
(iv) Regulators and infrastructure providers	7
(v) Payment technology consultants	3
Total	20

The three co-authors have a combined prior experience of more than 50 years of research on payments and financial infrastructures. The analysis draws on this experience. As this experience has taught us only too well, detail matters considerably in payment arrangements and in most cases answers cannot be binary (yes/no) but most often “it depends”. Thus, we have made free use of insights that emerged from the interviews throughout the drafting of the document. The paper contains different sections on the challenges of international payments and CBDC design choices, on the economics of payments innovation, on the insights from our interviews on specific international payment scenarios and on potential radical change. But the interviews have provided essential insights throughout the paper.

The paper is arranged as follows. Section 2 discusses the business and policy context, summarising the processes involved in international payments and reviews concerns about high costs and frictions. It also reviews the current interest in CBDC, distinguishing wholesale from retail CBDC and providing some initial discussion of their implications for international payments. Section 3 is a brief summary of the economics of competition and innovation in payments, highlighting both the rapid rate of current technological change but also the importance of network externalities in determining which innovations are actually adopted in practice. Section 4 summarises the findings from our interviews, on the impact of CBDC on four different international payment scenarios. Section 5 discusses the possibility of radical change. Section 6 concludes. Appendix A provides detail on our research methodology and provides the questions used in our interviews. Two further Appendices B and C provide some background information on three leading CBDC initiatives.

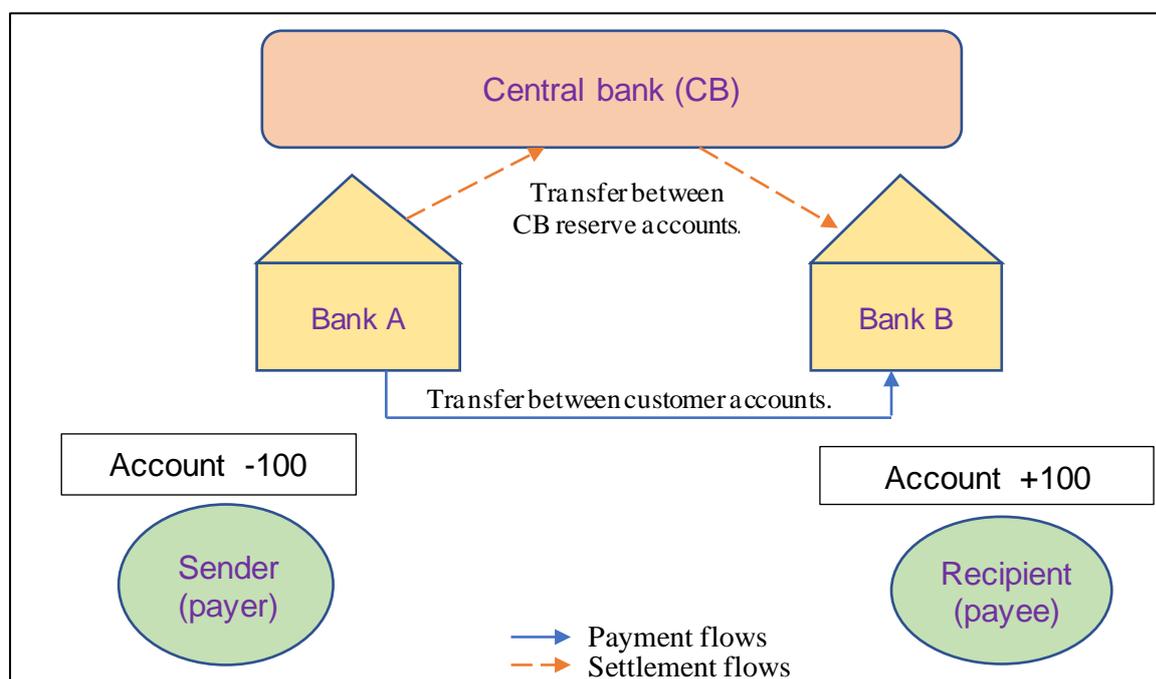
## 2 International payments and CBDC design choices

Interest in financial technologies has exploded in recent years, driven by the emergence of private digital currencies (cryptocurrencies and stablecoins) and perceived potential from employing new technologies in payments. This section is preliminary 'setting of the scene', before presenting our own research. It reviews: (i) the challenge of lowering costs and increasing speed and transparency in international payments; and then (ii) the rapid increase of interest in issue of central bank digital currencies (CBDC) and their potential use in international transactions.

### 2.1 Frictions in international payments.

To understand the frictions in international payments it is necessary, first, to understand the institutions involved and how they 'settle' payment transactions through the exchange and transfer of central bank money.

We begin by comparing two figures, Figure 1 and Figure 2, in order to illustrate the complexities of current international payments arrangements. Figure 1 represents the execution and settlement of a domestic payment; Figure 2 the more challenging case of an international payment.



**Figure 1: Execution of a Domestic Payment**

Figure 1 is a stylised, albeit not exhaustive, illustration, presented in order to highlight the contrasts between domestic and international payments. Customers are usually unaware of the need for a supporting settlement. From their perspective the €100 simply move from the payer's to the payee's account. But this money is a bank balance sheet liability and so in order to settle the transaction, an equivalent amount of monetary assets must transfer from the reserve account of the sending bank to the reserve accounts of the recipient bank.

In practice, while still relatively simple, domestic payment operations are a little more complicated than shown in Figure 1:

- The payment and settlement flows need not precisely match in timing and magnitude. Lower value payment schemes use ‘deferred net settlement’ or DNS. These schemes maintain a running total of settlement obligations between banks and then settle multiple customer payments with batch transfers of central bank reserves at specified times during the day. These customer payments are to a large extent offsetting, so reducing their need to hold central bank reserves ready for settlement, but at the cost of some exposure to interbank credit risk.
- Central banks also support high value payment schemes using ‘real time gross settlement’ or RTGS. Here the settlement (reserve transfer) and custom payment (deposit transfer) are matched in timing and value. But the largest payments, arising from financial market transactions, can be constrained by reserve holdings, in turn create sequencing problems with the possibility of a gridlock if banks are all waiting for other banks to initiate other RTGS payments. Central banks address these liquidity problems through providing banks with ‘intraday’ credit that must be repaid by the end of RTGS operating hours and sometimes also with approval for a limited amount of payments netting. Typically, this provision for liquidity is reserved for domestic banks operating in the local domain or for institutions they oversee in some way or for whom there is a reciprocal arrangement with another central bank<sup>6</sup>.
- Holding a reserve account with the central bank requires a domestic banking license and compliance with all the requirements of domestic bank supervisions and regulation. Many intermediaries, for example e-payments institutions, smaller credit card companies and cooperative institutions, participate indirectly in domestic settlement through an ‘agency relationship’ with a domestic bank, i.e. instead of holding a reserve account with the central bank they hold an account with an agent bank and settlement takes place through a debit/ credit to this account and a corresponding debit/ credit to the agent bank’s reserve account (in much the same way as foreign banks use correspondent banks in international payments).
- Below in Section 3 when we discuss payments innovation, we contrast three broad payment scheme ‘architectures’: (i) bank payment schemes, (ii) card payment schemes with funds eventually credited to merchant bank accounts; and (iii) e-money payments. All of these fit into the schema of Figure 1, but in slightly different ways. The figure represents the usual arrangement for bank payments. Card payments are similar, but final settlement including crediting the recipients account – especially with credit card payments – can be more substantially delayed. Payments employing an e-money scheme are often between accounts held with the same e-money provider. In this case – and also in the case of a payment between two customers of the same bank – no settlement is necessary, but settlement is still required for transferring funds between e-money and bank accounts. Notice also that there is something of an overlap in the services provided by deferred DNS bank payment schemes and real time RTGS bank payment schemes. Many countries have now developed ‘faster payment’ schemes which allow payments to transfer between accounts at two different domestic banks digitally within minutes. These are still though DNS schemes, the banks involved carry out settlement subsequently. In countries where such retail faster payment schemes are not yet universally available (the US is an example), the RTGS system is sometimes instead used to facilitate retail payment transfer in near-real time between different institutions, with the retail customer paying a transaction fee.
- While not shown in this diagram, there are often transaction fees and charges associated with such services. These vary considerably from country to country and from customer to customer. In some countries, e.g. the UK, personal customers enjoy ‘free in credit’ banking, meaning no charges for payments provided they maintain a positive credit balance in their account. In other countries retail customers

---

<sup>6</sup> One can refer to the Nordic example here where arrangements are reciprocal.

must pay modest transaction fees. Merchants who receive card payments from retail customers pay fees, which are particularly large on credit card payment with their further associated services and in the newly emerging 'buy now pay later products'. Small businesses payment charges are a major part of the revenue in small business banking.

A final central point, it is difficult to overstate the critical roles of both regulation and trust in payments. DNS requires trust in the ability of bank counterparties to settle their obligations. This in turn requires limited entry to payment schemes. Only adequately regulated and therefore trusted institutions can be eligible for holding reserve accounts at the central bank and participating directly in settlement. Issues of trust also arise in RTGS, since doubts about the ability of other banks to make anticipated payments can lead to other banks delaying or refusing payments and create a systemic breakdown of the system. Regulators like to ensure that there is a RTGS closure window, over the weekend, a window that can be used if necessary to manage the resolution of a distressed bank and the meeting of its payment obligations without systemic impact on other banks and the wider payment system. Regulation and oversight are also of course critical from the perspective of dealing with operational risk and ensuring data security. As we shall shortly discuss, many of the costs and frictions in international payments arise not because of inadequate technology but because of inadequate trust.

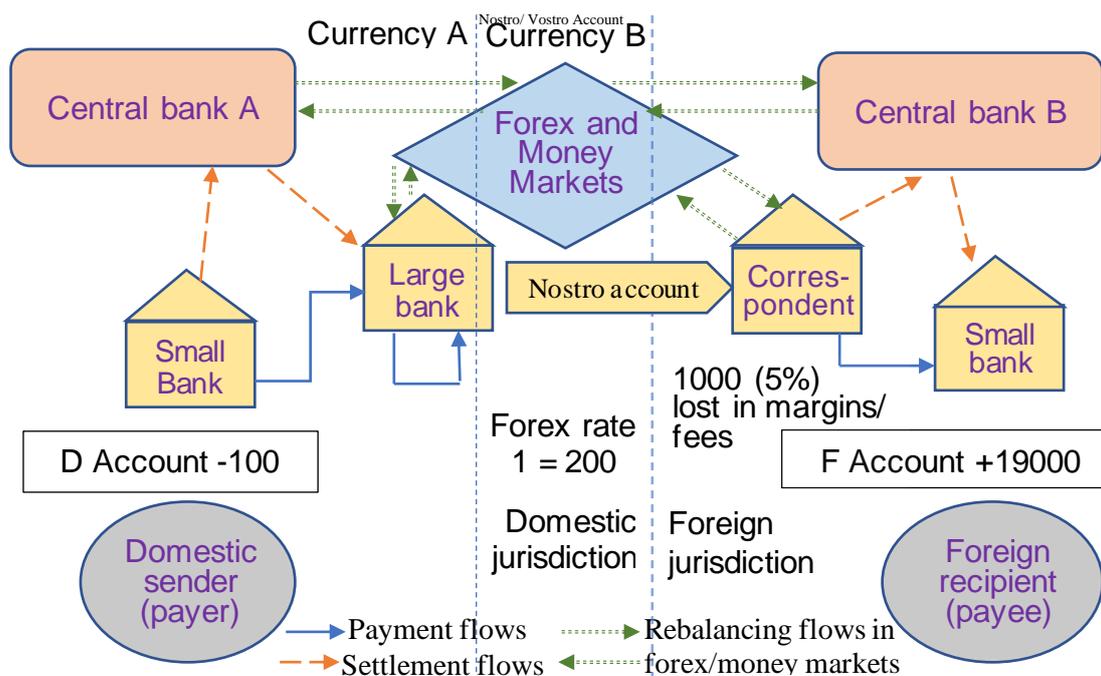
Figure 2 illustrates the additional complications involved in an international payment. Again, this is a stylised representation with many possible variations. It still though usefully highlights *three* features that distinguish international payments from domestic.

1. Additional fees which increase the cost of almost all international payment transactions relative to domestic payments.
2. The associated supporting foreign exchange and settlement is often not directly linked to customer payments (unlike settlement of domestic payments, where strict rules determine the scheduling of settlement either immediate real time gross settlement or deferred net settlement).
3. The operational and also legal and regulatory complications of a payment moving between two different jurisdictions and across multiple institutions.

The complications of this figure are required to capture the complexity of an international payment when compared to a domestic payment. The intermediaries are no longer tied into a single domestic system, with clearly established responsibilities and processes allowing them to trust each other and automate operations. Now they must engage in three different areas of operations: domestic payments within the sending country, foreign exchange and then domestic payment within the receiving country. On occasion, if there is no large domestic bank with a direct relationship to the receiving country, the transaction is even more complex than shown here. It can then be necessary to involve a second large bank in a third jurisdiction, in order to provide access to the foreign jurisdiction.

In Figure 2, just as in Figure 1, payment transfer requires supporting settlement, with a debiting of a reserve account held with the domestic (sending) central bank and the crediting of a reserve account held with the foreign (receiving) central bank. However, in contrast to domestic payments (i) relatively few 'large' banks are set up to engage in international payments, so smaller banks often rely on a domestic large bank for international payment processing; (ii) even these large banks will not usually have reserve accounts with the

central banks in both jurisdictions, instead relying on a correspondent bank to handle the required reserve transfers in the foreign jurisdiction;<sup>7</sup>



**Figure 2: Money and Foreign Exchange Markets**

A further central feature of this payment, illustrated in Figure 2, is that there is typically no international payment of money matching the domestic payments (out of the customer's account with the small domestic bank to the large international bank; from correspondent bank to the recipient's account with the small foreign bank). This instead depends on the financial obligations, recorded in 'nostro/vostro' accounts held between banks and their correspondent (nostro and vostro are the Italian words for ours and yours, these accounts are at the same both our account held with you and your account held with us). In Figure 2 the large bank holds a nostro account in the foreign jurisdiction currency B with the correspondent. The payment is made through drawing down a balance or sometimes on a line of credit on this account. As one informant put it to us "The surprising feature of international payments is that they do not really exist".

There are other possibilities than that illustrated in Figure 2. Instead of using a nostro account held with a correspondent, the payment may be financed out of a vostro account in the domestic currency A held at the large bank by a recipient bank in the foreign jurisdiction. Another possibility is an international bank establishing a local subsidiary (as opposed to having an account with a local correspondent). This is a logical step – if there are sufficient international payments to justify the set up costs of obtaining direct access to local clearing and central bank liquidity. In addition, many payments (in particular remittances) are made by money transfer operators who are typically present in many markets. In this scenario, many of the payments are "self-cleared" as an internal book transfer for the institution internally. Technically, these payments may still be considered to be "correspondent banking" but not according to the typical usage of the term in the payments literature.

<sup>7</sup> This would usually require two separately licensed and regulated subsidiaries since, with the principal current exception of Switzerland, central bank rules and regulations prohibit branches of foreign banks from holding central bank reserves or directly accessing domestic payment schemes.

Domestic settlements of payments, even when deferred, take place fairly soon after the payment is initiated, often only a few hours after the initial payment instruction. Domestic money markets and central bank collateralized lending provide the necessary liquidity. Interbank exposures are generally fairly quickly extinguished.

International payments rely to a greater degree on intermediary bank balance sheets and relatively longer lasting interbank exposures. Processing of international payments results in the building up or running down of liabilities, in this case between the large bank and the correspondent. Typically, the correspondent would generally expect a client to keep their 'nostro' account topped up enough for the correspondent to apply a debit to make the onward payment. The correspondent may give credit, sometimes intraday sometimes longer, in which case it would allow the previous institution to go overdrawn to make the payment. The previous institution would still be expected to top up the account at some point by whatever means of rebalancing works. There are many possibilities: it could exchange another currency for the required foreign exchange and transfer to the correspondent; it might do a foreign exchange deal directly with the correspondent; it might sell a financial asset to the correspondent bank or another foreign counterparty.

Any supporting foreign exchange transaction will also depend on the foreign exchange regime. If the recipient jurisdiction operates a fixed regime, pegging its currency to say the US dollar, then the transfer of dollars would result in the central bank of the recipient country acquiring additional foreign exchange reserves in exchange for supplying the domestic currency. With a floating exchange rate international investors would have to be persuaded to hold more funds in the sending country (replenishing the reserves with the domestic central bank) and less in the receiving country.

Despite these additional settlement processes, from the perspective of the two customers, an international payment remains fairly simple – appearing little more complicated than an email. A debit from one account (here in Figure 2 - 100) and a credit to another account (here + 19,000, assuming a market exchange rate of 200:1). The customer experience is though very often disappointing, compared to that of a domestic payment, with comparatively high fees and charges and what can still be unpredictable and opaque processing.

High costs and processing problems result from the complexity illustrated in Figure 2:

- (a) The requirement for several intermediaries, each playing a role in this payments chain and each adding their own mark-up, results in quite substantial costs and fees. Here the current central market exchange rate is assumed to be 1 = 200, with total margins and fees deducted from payment of 1,000. In this example these margins and fees can be charged on the two customers in three ways: a deduction before the payment is sent, a margin on the foreign exchange rate and a further deduction before the credit is made to the holder of the account.

To make the example more concrete, the 1,000 deduction might consist of a 1% or 1 initial deduction by the small bank from the payer so only 99 forwarded for exchange; an exchange rate of 1 = 196, 2% below the current mid-market rate of 200, so 99 becomes  $99 \times 196 = 19404$  then a further 404 deduction (2.08%) so the payee receives 19,000). The exchange rate of 196, rather than 200, is what is reported to the payer and payee, but this deduction could in turn be shared in different ways between the large bank, the correspondent bank and (if an actual foreign exchange transaction is required rather than just a book entry) any counterparties in foreign exchange markets.

- (b) As discussed below in Section 3, every payment is accompanied by accompanying information, the required information for the transaction itself together with other contextual information. Incompatibility and error in these information flows, or failure

to comply fully with requirements for identification of customers and to report potential AML breaches (suspicious transaction reports) and compliance with international sanctions can lead to a suspension of processing and the need for a manual intervention.

- (c) These informational frictions are exacerbated by system incompatibilities between jurisdictions, both between the payment schemes in the two jurisdictions (for example differences in RTGS opening hours; the absence of a retail instant payments solution) and also between the systems of the individual banks. Messaging and payments standards such as ISO20022 (in which SWIFT is the registration authority and also plays a leading development role of the financial repository) address some of these incompatibilities. Nonetheless adopting standards is a substantial investment and many inconsistencies remain and it will take time to resolve them.
- (d) Another reason for this is market power rooted in lack of competition. A particular concern is that the high costs of AML and sanctions compliance have resulted in a “de-risking” of correspondent banking, with many institutions forced to withdraw from providing correspondent banking services, leaving the few that remain with substantial market power and an ability to impose comparatively large margins for their services. For major currencies with many competing correspondent banks, this is not such a major concern. But for many low- and middle-income jurisdictions de-risking leaves few remaining correspondent banks, undermines competition and is thus a substantial cause of high charges for international payments.<sup>8</sup>
- (e) For less active ‘corridors’ (bilateral currency exchanges) the sending bank (‘large bank’ in Figure 1) may not have a corresponding banking relationship; so, further banks may be interposed in the chain to provide that relationship, sometimes even two banks with potential multi-currency exchanges.
- (f) Finally, there are the concerns over lack of transparency: even a minor error in instructions can lead to delay or interruption in an international payment transaction with a more pronounced impact if there is no mechanism for communicating this back to the sender and requesting if necessary further action.

Figure 2 omits the detail of foreign exchange market operations, which vary considerably. For the major internationally traded currencies, in particular the 18 currencies<sup>9</sup>, whose foreign exchange trades can be settled through CLS bank, there are many buyers and sellers with comparatively liquid markets for exchange against the dollar. A bank might need two transactions in the two currencies, each against the dollar, to rebalance its foreign exchange exposures, but the low margins mean these foreign exchange transactions do not contribute substantially to the costs of international payment.

At the opposite extreme are some very illiquid currencies, those of some small low-income countries with little private foreign exchange trading. All foreign exchange transactions in or out of these currencies are instead conducted on the books of the central bank at central bank determined exchange rates. For these currencies there can be limited current and capital account liberalization, so foreign exchange transactions may also require first a request with details of the transaction purpose, causing a delay until approval is given. The foreign exchange risks of holding such currencies are much more substantial and much more difficult to manage than those from holding actively traded international currencies, especially if there are concerns about the economics and financial situation of the domestic

---

<sup>8</sup> See (Casu and Wandhöfer, 2018; Rice, von Peter and Boar, 2020) for more detailed discussion.

<sup>9</sup> According to <https://www.cls-group.com/products/settlement/clssettlement/currencies/>: Mexican peso, Canadian dollar, Pound sterling, Israeli shekel, Japanese Yen, Korean won, Danish krone, euro, US dollar, Hong Kong dollar, Hungarian forint, Singapore dollar, Norwegian krone, Australian dollar, New Zealand dollar, South African rand, Swedish krona, Swiss franc.

economy. Hence the costs of conducting foreign exchange transactions and managing foreign exchange risk add to the costs of international payments to and from these currencies. Many other currencies are in an intermediate position, possibly with direct trading but without having a deep and liquid foreign exchange market or settlement available through CLS bank.

An April 2020 report of the Financial Stability Board for the G20 (FSB, 2020a) reviews the causes of the high costs, low speed, limited access and insufficient transparency in cross-border payments. They summarise the underlying problems, all rooted in the complexities illustrated by Figure 2, as follows: "... fragmented data standards or lack of interoperability; complexities in meeting compliance requirements, including for anti-money laundering and countering the financing of terrorism (AML/CFT), and data protection purposes; different operating hours across different time zones; and outdated legacy technology platforms." (p. 1).

Following this report: the BIS Committee on Payments and Markets Infrastructures conducted a detailed analysis identifying 19 "building blocks" required for improving cross border payments (CPMI, 2020); and the FSB then published in Oct 2020 (FSB, 2020c), a 'road map' for reform followed by an FSB consultative document (FSB, 2021) that proposes measurable targets for monitoring progress.

FSB (FSB, 2020b) notes the rapid rise in all forms of cross-border payments over the past decade, with increasing trade, travel and international migration; but at the same time a 20% fall in the number of correspondent banking relationships between 2011 and 2018 leading to limited choice and reduced competition in payments execution. In the case of remittances average costs are still around of 6.38%.<sup>10</sup> For other payments there are no standard statistics on costs and timeliness of international payments. Still, a variety of anecdotal evidence suggests that for many payment corridors and types of transaction substantial frictions remain.

It would be incorrect to suggest that there has been no progress at all in addressing the concerns over cost, timeliness, risk and opacity in international payments. Internet communication has supported the emergence of a range of alternative foreign exchange providers, unencumbered by legacy, competing with banks in retail international payments (this is discussed further in Section 3). The card schemes such as Visa and Mastercard are increasingly accepted for international payments, supporting retail purchase and subsistence and other traveller expenditures. Other payment service providers, notably PayPal and AliPay, compete with the card schemes in making international online customer payments to merchants. SWIFT has established their SWIFT gpi service, a new communication standard for cross border payments across correspondent banking networks, developed to "*meet the industry's needs for speed, traceability and transparency. It allows banks to provide their customers with a transformed payments experience, enabled through easy to use and simple to set up digital tools.*"<sup>11</sup> While it is true that some international payments remain slow and expensive, this is no longer true of the majority of these payments. For example, on average, 91% of international payments take less than a day, albeit these are predominantly from popular 'corridors' between developed financial markets.<sup>12</sup>

---

<sup>10</sup> (World Bank, 2021)

<sup>11</sup> For more information on SWIFT gpi see here: <https://www.swift.com/our-solutions/swift-gpi/about-swift-gpi>.

<sup>12</sup> See (CPMI, 2020) Box A, pg 6.

It would also be incorrect to suggest that all frictions in international payments are now being adequately addressed. The FSB road map emphasises the benefits of a co-ordinated implementation of change to several aspects of international payments:

- (i) ensuring a consistent jurisdictional treatment of international payments with co-ordination of regulatory, supervisory and oversight frameworks, for example with more consistent application of anti-money laundering and terrorist financing (AML/CFT) rules
- (ii) enhancement of existing payment infrastructures, with greater use of payment versus payment (PVP) to remove counterparty risk in payments settlement; reciprocal liquidity arrangements, extension and alignment of key payment systems and interlinking of payment systems for cross-border payments
- (iii) adopting harmonised messaging and API standards with global unique supporting identifiers. This report also emphasised the need for a shared vision of the future development of cross-border payments and encouraged the adoption of new technologies such as multilateral platforms, stablecoins and issue of CBDCs to support and enhance cross-border payments.

## 2.2 CBDC design choices and international payments

This subsection reviews the key design choices in introducing CBDCs and how these are relevant to international payments. As discussed in our introduction, we do not wish to limit the scope of our inquiry. Thus, we define CBDC as any widely held electronically recorded central bank liability available for transfer, whether on a distributed ledger or a more conventional database. This broad definition of CBDC avoids being constrained by particular technical choices for recording and transferring of CBDC.

This definition also implies that there is no real distinction between CBDC and the widening of access to accounts in central bank reserve money beyond domestic commercial banks. CBDC and widening of reserve access are two different ways of describing the same thing. Technicalities will though of course matter, especially for retail CBDC. No central bank will wish to have responsibility for retail customer account management. So, the technical design must allow third party account providers – which could be commercial banks but also non-bank payment service providers – to offer the customer interface. At the same time CBDC is always a liability of the central bank, not a liability of the account provider, so the technical design must also ensure that account holders are able to assert their rights as holders of central bank liabilities. For example, in the event of the financial failure of the third-party account provider CBDC account holders should get full and immediate access to their central bank money.

Keeping this definition of CBDC in mind we first summarise the growing interest in CBDC and then discuss some of the key design choices. Appendix B summarises the CBDC work of central banks around the world, distinguishing two main phases of activity. The years 2013-2019 saw a number of technical experiments with CBDC by the Bank of Canada and the Monetary Authority of Singapore, while the Swedish Riksbank also engaged in extensive investigation of the possibility of a central bank issued digital substitute for cash (motivated by the particularly marked fall in cash in circulation in Sweden).

Central bank interest has accelerated markedly in the past two years 2019-2021, with the establishment of the Bank for International Settlements (BIS) Innovation Hub and of the central bank CBDC working group, with administrative support from the BIS; co-ordinating the work of the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, the Sveriges Riksbank and the Swiss National Bank. Several central banks have now published extensive reports on CBDC, addressing design choices but also issues

such as implications for systemic risk, the supply of bank credit if monetary deposits move out of commercial banks into CBDC and for monetary policy transmission.

Interest in CBDC is by no means restricted to these major central banks. Most central banks worldwide are now working on CBDC. The BIS is monitoring developments worldwide, with regular surveys of central bank work on CBDC.<sup>13</sup> Some central banks have also recently launched retail CBDC – notably the e-CYN project of the People’s Bank of China and the Bahamian Sand Dollar, both summarised in our Appendix B. Other central banks in low and middle income countries have also announced that they intend to launch retail CBDC. At the same time widespread holding of retail CBDC in the major countries still appears to be some years distant.<sup>14</sup>

Particular attention has been paid in the technical work on CBDC, on multicurrency CBDC or ‘m-CBDC’ with operational linkages that allow for the simultaneous transfer, on a payment versus payment basis so eliminating counterparty risk, of two different CBDCs. The most recent work of this kind are the ongoing Inthanon-Lionrock experiments, now referred to as m-Bridge, most recently reported by (BIS Innovation Hub, 2021). What this proof of concept demonstrates is the possibility of foreign exchange conversion of CBDC from one CBDC and also CBDC exchange on a ‘payment versus payment’ PVP basis which would eliminate counterparty risk. The foreign exchange rate is the best current available market rate (what they refer to as the FX Board Rate”) or an agreed rate.

(BIS Innovation Hub, 2021) also notes some related technical initiatives, for example direct transfer of CBDC (settlement money) between the Arab Emirates dinar (the AED) of the United Arab Emirates and the Saudi Riyal (the SAR) of Saudi Arabia, without any foreign exchange conversion. In terms of Figure 2, this is possible because both currencies are firmly fixed against the US dollar, so the two central banks, at least for these limited experiments, are willing to accept each others’ CBDC as final settlement in international payments.

Turning to the key design choices, a central distinction is then between:

- a widely held *wholesale CBDC*, held by domestic non-bank financial institutions (thus differentiating it from central bank reserves which are held only by banks), and possibly also by foreign financial institutions and some large financial companies; and
- a *retail CBDC* widely held by persons and non-financial companies, and potentially available globally to non-residents.

The implications of these two forms of CBDC for international payments are quite different. A wholesale CBDC, especially if made available to international institutions, can support the existing role of intermediaries in international payments. CBDC is settlement money. So, a wholesale CBDC – if held cross border by the large bank in Figure 2 or by other competing international banks and non-bank payment providers – could make it unnecessary to use a local correspondent to complete an international payment. Further systems development would though still be required. As illustrated by Figure 2, interoperability would still be

---

<sup>13</sup> The most recent survey Boar and Wehrli, 2021 found that 86% of central banks are actively researching CBDC potential, 60% were experimenting with the technology and 14% were deploying pilot projects. The BIS also maintain a data base, updated every three months, on central bank CBDC activities and publications (BIS, 2021). There are several other useful sources of updated information on CBDC developments, for example, the lively webpage “The Global Fintech Intelligencer” (Kiff and Dav, 2021).

<sup>14</sup> For example the ECB, whose plans for CBDC are more advanced than those of most other central banks, have not yet made a final decision to launch a ‘digital Euro’. If they go ahead this will not be until 2026 (Panetta, 2021)).

needed with domestic payment schemes to route a payment from the wholesale CBDC account to reach the small bank and the account of the foreign recipient.

Retail CBDC has different implications for international payments. It can help with some of the different payment scenarios discussed in Section 4 below. It can lower the cost of person-to-person remittances payments, in cases where the recipient was previously unbanked but now, through retail CBDC is able to hold digital money. It is then no longer necessary to 'cash out', receiving payment in physical notes and coin from a local remittance agent. Retail CBDC available to international visitors on a stored-value card or on a phone-app could also offer low-cost payment execution for tourists and other international travellers. But for other international account to account payments, retail CBDC may make little difference. The payment will have to be routed to a CBDC account rather than a bank or e-money account, but – assuming the architecture of international payments remains as illustrated in Figure 2 – the operational processes involved are largely unchanged. There is though a possibility of using retail CBDC to redesign the architecture of international payments. We discuss this possibility in Section 5 below.

It is clear that any CBDC wholesale or retail will be 'permissioned' with most holding and transactions by authorised users whose identities have been verified and are approved to open account. Central banks will want to ensure that use of CBDC complies with all regulatory requirements for know your customer (KYC), anti-money laundering (AML) and enforcement of political sanctions. One exception is likely, with limited usage subject to strict value limits without such identity linkage (for example this is an option for Bahamian Sand Dollar and the e-CNY).

A further point, while quite obvious, deserves emphasis. It matters considerably for international payments who is able to hold CBDC. Suppose holding of CBDC is restricted to within national boundaries, with only local regulated financial intermediaries and locally incorporate companies allowed to hold wholesale CBDC and only residents and citizens allowed to hold retail CBDC. The impact on international payments will be relatively limited. The large bank in Figure 2 will not be able to hold wholesale CBDC and use this holding, but instead still relying on a correspondent bank to complete an international payment – a similar correspondent banking issue as in current payment rails. There will be no possibility of direct exchange of retail CBDC if these are not held outside national borders.

This point about national versus international held CBDC highlights the central challenges of trust and regulation, which lie behind the costs and complexities of international payments operations illustrated in Figure 2. Suppose central banks fully trusted overseas institutions and allowed them unrestricted access to wholesale CBDC and to their domestic payment schemes, in order to route payments to final recipients. This could address many of the problems of international payments. Rather than relying on a local correspondent, the large bank of Figure 2 could hold local CBDC and directly remit to recipient accounts.

Central banks will not though allow overseas institutions unlimited and unrestricted access to central bank money and domestic payment schemes. Aside from anything else, they will be concerned about prudential risk, that financial distress at these institutions might then disrupt their payment systems. But central banks could consider more limited access – for example without requiring a full local banking license they could offer CBDC and domestic payment scheme assets to all international institutions through the establishment of a non-bank subsidiary as a local payment service provider, with all local currency monetary liabilities including to the overseas parent, fully reserved in CBDC. Such 'ring-fencing' could eliminate prudential concerns of overseas access with relatively light supervisory requirements.

A further design choice, which could impact the use of CBDC in international payments is the extent to which a CBDC is interoperable with domestic payment schemes, especially those for interbank transfers. As indicated in Figure 2, a critical challenge in international payments is the ability to route the payment through to the final recipient. For this to be processed automatically without manual intervention requires integration into a domestic payment system. Under current arrangements of Figure 2, connecting to these systems is the responsibility of the correspondent bank. If wholesale CBDC, as we argue, can replace the need for using correspondent banks then holders of wholesale CBDC must be able to route payments from their wholesale CBDC accounts to final recipients, using wholesale CBDC for settlement.

Similar design choices about interoperability with domestic payment schemes arises for retail CBDC, though this choice is less directly related to international payments. A retail CBDC could be limited to payment to and from other CBDC accounts, plus the opportunity to move funds in and out from a holder's bank account i.e. much like most e-money operates today; or it could offer all the functionality of a domestic bank account, with the possibility of making and receiving payments through all domestic bank payment schemes including ATM withdrawal. Where this principally matters in relation to international payments is when crediting of the payment to the final recipient. Interoperability with domestic payment schemes will make this easier, not requiring correspondent or overseas bank to use a further CBDC payment system for payment routing. More broadly retail CBDC interoperability will increase the demand for holding retail CBDC and enhance the prospects for its widespread adoption, which will in turn facilitate its use in international payments.

Finally there is the possibility of interoperability of different CBDCs from different countries, with the m-CBDC experiments exploring what may be possible. (BIS Innovation Hub, 2021) claim that the m-bridge yields major benefits in terms of speed of execution cross-border payments, reducing transactions times from 3-5 days to 2-10 seconds. This though, in terms of our Figure 2, is a somewhat misleading statement, comparing 'apples' (a transfer of central bank money) with 'oranges' (the debiting of an account of one account a holder and the crediting of an account of another account holder in a different jurisdiction). Applied to Figure 2, the m-bridge would allow the large bank, when it rebalances its foreign exchange position, to do so near instantaneously, rather than relying on the T+2 settlement through CLS or potentially longer settlement times outside of the 18 CLS currencies.

It is unclear that using the m-bridge instead of CLS to settle foreign exchange transactions, would make much difference at all to the customer experience of payments, when executed using the processes illustrated in Figure 2. In the arrangement shown there, based on trust between the large bank and its correspondent, the correspondent bank will expect the large bank in the chain to maintain their account (at the correspondent bank) credited so that a debit is possible in order to make the onward payment to the payee (end customer). In some cases, payments can be made onto the final recipient in anticipation of an eventual deferred net settlement of the payment from the larger bank. In this scenario, the correspondent bank may provide credit (sometimes intra-day sometimes longer), that will allow the other institution to go overdrawn and fulfil the payment until they credit their account. The m-bridge may shorten the timeline for an eventual deferred net settlement (between the large bank institution and corresponding bank) when it eventually takes place, but does not directly affect the timing of the crediting of funds to the recipient's account. The m-bridge would though make a material difference if all international payments – both low value and high value – were to shift from deferred net settlement to real time gross settlement – one possible radical redesign of international payments architecture that we consider below in Section 5.

### 3 Competition and innovation in payments

This section is a summary of recent development in payments competition and innovation. It draws on relevant work on both the economics of networks and on the economics of money, as well as applied and policy studies on payments by consultants and competition economists.<sup>15</sup>

Two main points are made here. CBDC is just one of many recent developments in payments technologies. Arguably several of the benefits of CBDC, in terms of providing reliable and predictable real time international payments at low cost, could also be achieved in other ways. For example: through greater global standardisation of payment schemes to reduce the need for “exception processing” (manual intervention to deal with situations that cannot be automatically processed); or through the development of widely accepted and ideally globally accepted identity solutions for both corporates and individuals that can be used to automate processes such as AML reporting and also operational risks.

Secondly, while the technical innovations in payments have the potential to dramatically reduce costs and improve customer experience, in both domestic and international payments, adoption of these innovations should not be taken for granted. There must be incentives for individuals and for financial intermediaries to shift from existing arrangements and replace them with new payment arrangements; and the incentives can be strong to remain with existing platforms that already have an existing installed base, i.e. senders and recipients of payments already connected to these platforms, not to adopt the new approach.

#### 3.1 A decade of change in payments technologies and regulation

Three major developments have impacted the payments landscape in recent years:

- 1) The continuing advances in communication technologies, supporting rapid growth of mobile, online and faster payments and also the use of APIs to support open banking
- 2) The payments applications of public-key cryptography, notably in exploration of the use of distributed ledgers to secure cryptocurrencies and stablecoins
- 3) The evolution of payments regulation and payments architectures in response to these new technological developments.

Little more than a decade ago, payments services were almost exclusively provided by regulated commercial banks, through their roles in distributing and redepositing of bank notes; in operating domestic interbank payment schemes both retail and large value; and in developing and participating in the various domestic and international card associations. These payments were made along three principal payments ‘rails’ (cash, bank transfers, card) which were all bank dominated.<sup>16</sup> International payments were also bank dominated, principally conducted through interbank payment transfer supported by SWIFT network messaging and by the global card schemes.

These bank orientated payment arrangements are themselves the outcome of a half century of evolution from paper-based to computerised banking, with developments including: (i)

---

<sup>15</sup> This section draws on the analysis provide in (Milne, 2018).

<sup>16</sup> This division of retail payment schemes between interbank, cash and cards schemes is a standard one familiar one to all payments professions. The rules and operational process differ in fundamental ways between the three. Careers are typically pursued within one of the three silos. (OXERA, 2020) provide an insightful review of developments in EU retail payments, distinguishing these three traditional forms payment scheme and highlight the recent challenge from non-bank e-payment schemes.

automated clearing arrangements to support batch payments, standing orders and direct debits; (ii) the rise of card based payments both at point of sale and in remote transactions, with accompanying security developments such as the chip and pin standard (iii) the movement of large value payments to real time gross settlement subject to central bank oversight, in order to accommodate the major increase in volume and value of payments from capital, foreign exchange and money markets.

International payments have evolved along similar lines, with the adoption of computerised and then internet-based processing (with SWIFT's standards and secure communications playing a central role) and the creation of the CLS bank to provide payment versus payment (PVP) functionality in foreign exchange settlement.

The application of communication technologies and of public-key cryptography and the accompanying changes in payments regulation of the past decade have disrupted this landscape. Four trends are critical to understanding the role of innovation in international payments:

1. Changing expectations of customers and clients: Consumers are looking for payments services that match their growing use of mobile and internet communication and rising participation in virtual commerce, social media and international travel; with the convenience of a social media posting or private message. Businesses are looking for transparency and near real-time transfers.
2. The emergence of many non-bank payment service providers offering services in both person to person P2P and consumer to business C2B internet payments, in 'alternative' foreign exchange, in emerging market mobile payments, in merchant servicing and other elements of payments processing.
3. The explosion in trading and market values of cryptocurrencies and other crypto assets and the associated emergence of institution free 'decentralised finance' of DeFi. It is too early to judge whether these will be a fundamental disruption of conventional finance. They are though creating widespread awareness that the payments status quo is far from the only possible architecture.
4. Increasing attention of policy makers and financial authorities to payments. As well as the work of central banks on CBDC and the G20 and other initiatives on international payments, there are many further efforts supporting competition and innovation in domestic payments:
  - dismantling barriers to entry (for example in the EU payment services directives; and in the Bank of England's widening of access to reserve accounts to non-bank PSPs)
  - promoting 'faster payments' (the most recent being the FedNow in the US, following similar initiatives in other countries)
  - the upgrading of domestic payments clearing and settlement to simplify and reduce costs of access (e.g. the Australian New Payments Architecture).

A theme running across these innovations is increasing interest in the possibility of holding of money on a single platform – whether an e-money like MPesa, AliPay, Paypal or Wise; a stable coin like the proposed Facebook Diem or a CBDC. These arrangements are in sharp contrast to the holding of commercial bank money as developed over the past two centuries. Commercial bank money is multiplatform, each supported by its own operational arrangements and often hindered by inherited legacy infrastructures. Therefore, these new single platform-based forms of money can potentially offer better operational performance than bank based money.<sup>17</sup>

---

<sup>17</sup> The term 'tokenisation' is frequently used to refer to the recording the holding of assets on a single platform. In our opinion though this is a confusing terminology best avoided,

### 3.2 Platforms and network externalities as barriers to CBDC adoption

The dynamics of payment instruments are characterised by what economists refer to as network externalities. The decision to adopt any form of payments depends on the adoption decisions of others (their usefulness depends on others also adopting).

These 'network externalities' generate a number of well-known phenomena:

- a. The central importance to digital payments of 'platforms'. The execution of digital payments, whether more traditional bank transfers or card payments, or newer innovations such as e-money, stablecoins and now CBDC – depend on payer and payee being connected to the same platform. The business models of many of the new payment service providers are based on providing platform connectivity.
- b. Critical mass – with sufficient early adopters of a payment platform, adoption of a new form of money or payment can then rise rapidly with new users attracting further users; but if early adoption is insufficient then initial adoption can stall and the innovation fail.
- c. Tipping points – one competing form of money or payment can rapidly replace another over a comparatively short period.
- d. Network based market power – control over a platform access to a network can be a source of market power, resulting in economic inefficiency, either from pricing substantially above marginal cost or by limiting competition in the supply of further services (so called 'downstream' services) that rely on access to the network (so called 'upstream services'). A relevant payments example is market power based on access to central bank money for settlement of retail payments transactions.
- e. Payment arrangements are often 'two-sided' platforms that need, in order to build critical mass, to attract both senders of money (e.g. consumers paying merchants for card schemes) and receivers of money (e.g. merchants selling goods and services for card schemes). The history of credit card schemes provides a well-known example, with the use of substantial financial and non-financial incentives to persuade card holders to use credit cards and build critical mass.
- f. It is also though increasingly common in digital payments to observe 'multihoming', especially when platform connectivity is provided through either a mobile app or desktop or notebook software. It is then relatively easy to choose from a menu of possible payment instruments to execute a particular payment.

The distinctive role of money and payments, distinguishing them from other networks, are their roles in providing the standard monetary functions. As described in many textbooks, these are: 'unit of account', 'medium of exchange' and a 'stable store of value'.

The provisions of these functions are inseparably intertwined with the provision of credit and the need for intermediaries such as banks:

- *In a theoretical world* of complete trust and costless record keeping, there is no need to for money. Nor is there any need for banks or for other payments and credit intermediaries. All economic and financial exchanges can be financed using interest bearing IOUs (denominated in the unit of account) between buyers and sellers.

---

because exactly same word is used with several different inconsistent meanings, also to refer to anonymous or pseudonymous holding of money or financial assets (for example casino chips), for low value physical representations of money and also, mistakenly, to suggest that tokenisation is inconsistent with holding money or financial assets in account form. See (Milne, 2018; Garratt *et al.*, 2020).

- *In practice money and intermediaries are crucial.* Instead of bilateral IOUs, which are only possible with a relationship of complete trust, buyers and sellers hold different forms of money (nowadays predominantly claims on financial intermediaries or the central bank) along with arrangements to access debt from intermediaries for payments. In consequence every buyer and seller must face a trade-off between holding balances of liquid but idle money against the costs of facing binding limits on credit that constrain the ability to pay or the inconvenience and cost of accessing short-term debt in order to complete payments.
- *Intermediary money requires settlement.* As described above, in relation to Figures 1 and 2, transferring money that is a claim on one financial intermediary, to create a claim on another intermediary, requires a matching settlement with a transfer of a settlement asset, usually in the form of central bank money. Financial intermediaries then face a similar trade-off as their customers, a trade-off between a loss of income resulting from holding balances at the central bank instead of higher interest assets versus the potential costs of emergency access to money through borrowing or asset sales. Commercial banks are able to use netting of payments and short term intraday and overnight credit from the central bank to maintain a much less liquid asset portfolio while still honouring payments obligations for their customers.
- The need for a matching settlement in turn requires *a legal framework that specifies, unambiguously, when a payment is final*, no longer relying on promises of future payment or settlement. Payment finality is crucial for money received to then be legally valid for use in a future payment. Finality is also crucial for dealing with monetary claims, in the event that it is necessary to resolve a failing bank or payments intermediary.

All this means, especially in the context of international payments as illustrated in Figure 2, that a large number of institutions are involved both in payment processing and in the provision of supporting credit and liquidity to allow commercial bank money to pass from one holder to another.

As noted, one of the promises of new technologies of money and payments, including stablecoins, e-moneys and CBDC, is simplifying these processes through disintermediation of commercial banks. Instead of holding money with commercial banks, all money holdings could be recorded on a single shared ledger, an essentially single closed system with no need for subsequent settlement when money is moved. This could be based on some form of distributed ledger technologies such as those emerged to support cryptocurrencies, but could equally well be based on more traditional centralised ledgers such as those used in e-moneys such as PayPal and Alipay.

Such a shift would be considerably simpler from an operational perspective than existing arrangements. In the context of using CBDC in international payments, all that would be required is an efficient mechanism for connecting the different national ledgers i.e. a reform along the lines discussed in Section 5 below with technical support of the kind explored in the recent experiments with m-CBDC.

Adoption of such radical reform is though not straightforward, because of the reliance on intermediaries as well as the network externalities of money and payments.

1. The essential role of credit in payments. It is inefficient for everyone making payments to pre-finance and hold sufficient balances to cover all possible payment needs. Many senders of money – both companies and households making retail payments and larger companies and financial institutions – may prefer to use credit

- card and bank accounts supported by pre-committed credit (overdrafts or lines of credit) for them to make payments as and when they think they are necessary.<sup>18</sup>
2. The requirement for accompanying transaction information to support information processing services. The potential for full automation of digital payments is not achieved just by holding money on single shared ledgers, it also requires integration of the payment process with accompanying transaction information, allowing integration into supporting business and accounting systems.
  3. The need to establish identity, document transactions, prevent fraud and maintain security. Banks have an essential role in payment systems in managing and verifying identity, in combating fraud and in preventing unauthorised access to their systems, as well as in providing account servicing information in the form of statements of account positions and notifications where customers actions are required (for example obtaining additional credit to complete payments) to manage account balances.

The key point is that these three aspects of payments – credit provision, the processing of supporting information, and the management and verification of identity and accounts – are all built into existing bank payment arrangements. These arrangements are not standing still either. The technical progress in payments of the past decade is leading gradually to greater automation and improved payment services. Introducing direct holding of money in the form of CBDC requires replicating all these supporting services, otherwise the incentives to hold and use CBDC will be limited.

In short it is usually easier to adopt innovations which represent a relatively small incremental change from existing operational arrangements. Radical innovation changing the operational architecture requires a co-ordinated change which is much more difficult. In the context of international payments, adoption of wholesale CBDC, if this can be held by overseas banks and non-bank payment service providers is just such an incremental change. It will support greater competition in the provision of international payment services. If wholesale CBDC is also interoperable with domestic payment schemes and can be used to make instantaneously settled domestic transfers of account money<sup>19</sup> then it will allow international intermediaries to complete payments without relying on a correspondent bank. Retail CBDC can also be a useful incremental innovation in some specific international payment contexts, but its widespread adoption in international payments requires, as we discuss further in Section 5 below, a co-ordinated change in payments architectures.

---

<sup>18</sup> Some may point to a counter example, the emergence of new smart-contract based mechanisms of decentralised credit without financial intermediaries that have emerged in the Ethereum based ‘decentralised finance’ of DeFi, see (Schär, 2021). But these are always secured credit, lending of the cryptocurrency Ether against tradeable crypto assets, with the smart contracts fully determining payments of interest and principal with where necessary sale of the collateral securing the debt. They are thus free of credit risk. In contrast, the provision of credit for payments amongst firms and households in daily economic exchange is inherently credit risky.

<sup>19</sup> In this case, an institution would still need to hold a wallet in the domestic system (or a wallet from which it could access the domestic infrastructure). This means that the institution will have substituted an account with a correspondent for a wallet held at the central bank or at a correspondent (alternatively, they could also be a member of the local system).

## 4 Four international payment scenarios: how CBDC can help improve

We now review the evidence collected from our interviews, and the extent to which this bears out the analysis provided in Section 2 of the various opportunities for improving international payments from the creation of CBDC. We then look at the impact these can have on four specific examples of international payments, focussing on opportunities for reducing costs, risks and delays in existing payment processes.

### 4.1 Overview

A first point of agreement across all our interviews is that there are several reasons for the high costs, occasional long processing times and uncertainties in international payments. CBDC is certainly relevant. Wholesale CBDC could for example allow increased access of foreign banks and payment service providers to domestic central bank money, hence removing dependence on domestic banks as correspondents. Other frictions though have little to do with access to central bank money, whether this is through retail or wholesale CBDC. Efficient payments processing requires addressing basics like the adoption of adequate agreed messaging formats. These formats must reflect the global trend towards enriched payment schemes, allowing the transmission of all the supporting information accompanying a payment.

Even with the ISO20022 standard increasingly being adopted and allowing payment messages to carry all the required information in a standardised way, there is still residual fragmentation, with variations of interpretation in different jurisdictions. Adoption of ISO20022 is also a major co-ordinated investment that will not happen across the world all at once, making it inevitable that international payments have to cope with incompatible legacy arrangements for years to come. The requirements of anti-money laundering and sanctions screening are a further major impediment. These frictions then generate the further concerns about lack of transparency of international payments processes, the inability of senders of money to monitor the stages of processing and the lack of assurance to both senders and recipients about when money will be received.

That said the actions of central banks are acknowledged to be of great importance. They play a lead role in modernising domestic payments arrangements. This, alongside the initiation of CBDC projects and established international collaboration between central banks to promote globally co-ordinated responses can deal with a wide range of payment frictions.

A second point emerging from our interviews is that there is a divergence of professional views about the nature of the opportunity for international payments from the emergence of CBDC. For most of those we interviewed, with an extensive professional background in payments processing, the opportunities from the emergence of CBDC are principally about gradual and incremental improvement in existing payment processes. A smaller number – two of the three independent payments consultants and one payment service provider – highlighted the opportunity for more fundamental change.

This division was anticipated in our interview design which we follow in this write up. We focus in this subsection on the opportunities for incremental improvements and how this relates to CBDC design choices. The possibility of more fundamental change is discussed in Section 5 below on the possibility of fundamental change in international payments architecture.

A third point about design choice, is that for the large majority of our interviewees it is the introduction of wholesale rather than of retail CBDC that has the most obvious direct impact on international payments. Wholesale CBDC, by widening access to central bank accounts,

can make a substantial difference across a wide range of international payments. This impact can arise in two different ways:

- First by overcoming the limitations on opening hours of existing RTGS systems. Assuming wholesale CBDC can be transferred 24/7 it can allow banks to complete the settlement of international payments in real time (a current constraint mentioned by several of our interviewees as well as in the FSB report for the G30 (FSB, 2020a).
- Second by lowering barriers to entry. Provided wholesale CBDC is integrated with domestic large value payment systems, it can give foreign banks and payment service providers access to central bank settlement, in turn allowing them to compete in the final leg of domestic payment on a 'level playing field'.

There are alternatives to wholesale CBDC for achieving these two outcomes. RTGS systems could shift to 24/7 operation. Foreign banks and non-bank payment service providers might join existing RTGS arrangements. Still, introducing a wholesale CBDC operating in parallel with existing RTGS can be one way of achieving these two outcomes without completely redesigning existing arrangements. In particular routing a payment from a wholesale CBDC account through a domestic payment scheme should be possible because CBDC is settlement money, hence even at night time and weekends it should be possible to execute and settle a payment originating from a wholesale CBDC account.

Although retail CBDC is not so directly relevant to most international payments, discussion of retail CBDC was still a major point of interest to our interviewees. To some, establishing a retail CBDC means creating a state-owned competitor with existing private sector payment solutions. As one experienced payments practitioner stated to us "A retail CBDC is basically a central bank setting up an e-money system similar to those already created by private players. It is a digital payments solution not a new form of money. Is the government going to think about CBDC for five years then launch something that everyone is going to use in preference to private sector payment solutions? If satisfactory private solutions already exist, that seems unlikely to me."

This view oversimplifies because from the perspective of risk and regulation an e-money and retail CBDC are clearly not the same. As central banking discussions emphasise, a key difference is the default risk of private sector e-money as well as potential competition concerns connected to platform-based solutions. It is not an insured deposit and, as a result, there is at least theoretically a risk of the provider failing with assets falling below deposits and some customer balances being lost. Even without failure there could be a 'run' with customers withdrawing deposits because of the fear of failure. This is not a concern for retail CBDC because it is held as safe central bank money, free of default risk. It is worth also noting that a wholesale CBDC, used as an e-money reserve asset, would remove the theoretical default risk and make e-money also equivalent to an insured bank deposit or retail CBDC.

Despite this oversimplification, this statement contains an important kernel of truth. Creating a retail CBDC does not of itself change the arrangements for processing an international payment. Whether the money comes from a bank account, an e-money account or a retail CBDC account, under current processing arrangements an intermediary must still conduct the foreign exchange, and once the foreign currency is acquired it must pass through domestic payments systems to reach an e-money, bank account or retail CBDC account held by the recipient (Figure 2). It is also unclear that customers are concerned about the default risk of private sector e-money. Solutions like Wise are widely used despite this risk. Even if customers do recognise the default risk of private sector e-money, from their point of view there is no obvious difference between an insured bank deposit and a retail CBDC. They are both safe forms of money that can be easily used in most payment contexts, including international transactions.

Introducing retail CBDC may still have *indirect* impacts on international payments:

- (i) In low- and middle-income countries, where a large proportion of the population rely on cash for income and payments, introducing retail CBDC can promote the holding of account-based money. The resulting increase in financial inclusion may facilitate the processing of some international payments because a digital payment can be routed directly to the recipient, not to a local agent for exchange into physical cash.
- (ii) Many of those we interviewed highlighted identity, or more precisely the weakness of existing digital identity solutions, as a central issue in improving the efficiency of international payments. A fully functional retail CBDC, envisaged as something useable in all payment situations including international transactions, might be allied with the development of such a comprehensive digital identity solution for citizens. A globally recognised and comprehensive digital identity solution of this kind would then in turn also remove many of the frictions involved in the sending and receiving of international payments. Bank and other payment service providers could more easily check that the payment instructions take the money to the correct recipient. Comprehensive identity solutions could also substantially reduce the significant costs for banks and payments service providers of complying with anti-money laundering regulations and sanctions requirements.

In both these cases –promoting financial inclusion and developing a comprehensive digital identity solution – the role of retail CBDC is indirect. These goals could be pursued independently, without creating a retail CBDC at all. On the other hand, a retail CBDC project might usefully promote both financial inclusion and comprehensive digital identity. A possibility for which retail CBDC would be fundamental, as we discuss below in Section 5, is that retail CBDC might form the basis for an entirely new architecture of international payments with direct exchange of retail CBDCs issued by different countries and no need for international payments to be held on the balance sheets of commercial bank or non-bank payment services providers at all. While this is certainly conceivable, our assessment there is that this is not a realistic prospect in the foreseeable future.

As discussed in the next subsection, retail CBDC could also fill some specific gaps in international payments. One example is payments by an international visitor if their domestic bank cards are not accepted for all local transactions, requiring them to acquiring physical cash which cannot be easily returned if unspent. Here though other solutions based on private e-money or card payments might also suffice. These may even have advantages. For example, refund arrangements are designed into card payment schemes. Retail CBDC may need to set up similar arrangements with merchants to compete with card schemes.

A number of interviewees agreed that interoperability was important in order for a retail CBDC such as the ‘digital Euro’ to have an impact on international payments. Interviewees were not though of one mind as to what form of interoperability was required. Interoperability between different retail CBDC systems, e.g. a co-ordinated exchange of digital Euros for digital dollars between two holders, is technically feasible, as demonstrated by the m-CBDC experiments of the BIS Innovation Hub. This though does not deal with the necessity for agreement on message formats and information exchange. As one of our interviewees stated “you haven’t got the message format, so there’s a bigger set of technical requirements that have to be done because there’s nobody unifying it, like there isn’t a card network”.

Our questioning raised the separate aspect of interoperability, the possibility of using retail CBDC in domestic bank payment ‘faster’ payment systems, a feature that may be included in the design for the digital Euro. But none of our interviewees saw this as of general relevance to current processing of international payments because it does not deal with the need for foreign exchange.

Some interviewees also emphasized the need for offline functionality, which can support smooth 24/7 transaction and is particularly important for countries without stable internet/electricity supply. However, such a feature imposes credit risk if there is a shortfall in the payer's account. This is something else already allowed for in existing card and bank retail payment schemes, that would have to be allowed for in the design of a retail CBDC.

Other design choices addressed in our interviews were between 'direct' and 'indirect' architectures, whether access would be 'permissioned' or 'permissionless' and also whether distributed ledger technologies were essential aspects of CBDC. There was consensus amongst all interviewees that any retail CBDC would have to be held indirectly – no central bank wants to be operating a retail banking service – and also that any CBDC whether retail or wholesale would also be permissioned. Only a few highlighted the role of decentralisation using distributed ledger technologies, for most a centralised ledger could equally well be used to provide either wholesale or retail CBDC. There was mention of the use of distributed ledger technologies to facilitate automated payments processing through 'smart contracts'. Most importantly to our analysis, no interviewee identified any clear reasons why these choices would make any difference to international payments.

We now summarise the findings from our interview responses on the possible impact of CBDC in four specific international payment scenarios: small business payments, larger corporate transactions, international retail purchases and remittances.

Our interviews and bank websites reveal that the 'cut off' between small and larger corporate businesses varies somewhat from one bank to another. In general, any firm with revenues in excess of around \$5mn per year could expect to be able to bargain for more favourable treatment of international payment transactions with negotiated charges depending on the volume and size of their payment transactions and the associated supporting services provided.

## 4.2 Small business payments

There was extensive discussion of small business payments in our interviews. Our overall understanding, from the interviews and other sources is as follows. Small business payments are generally of low value in the hundreds or thousands of dollars not hundreds of thousands. Domestically, these small business payments are processed using the same payment arrangements as retail household payments, as retail bank payments or sometimes as card payments. Both cost and speed of payments are of particular importance for small businesses. Typically, their operating margins are tight, so paying one or two percent for payment processing has a substantial impact on their bottom line. Small business also often have limited options for borrowing funds, meaning that delays and uncertainty about the timing of payment receipts can cause them substantial problems in cash flow management.

These concerns of small businesses about high costs, timeliness and uncertainty of payment receipts are particularly pronounced for international payments. Most payments to international suppliers are bank to bank payments, conducted as illustrated in our Figure 2. There are increasingly alternative foreign exchange providers, competing with banks in international payments for small businesses as well as in international money transfers for households. Competition amongst banks and between banks and non-bank foreign exchange providers has lowered costs and provided greater transparency and predictability for many international small business payments. Still, as discussed above in Section 2.2, 'derisking' and the resulting reduction in correspondent banking services because of the associated regulatory risks limits the effectiveness of competition for many currency

corridors. As a result for some international payments by small businesses charges have risen rather than fallen despite the increasing application of new payments technologies.

To remove their dependence on correspondent banks, international banks and payment service providers need to be able to route payments into the account of the ultimate recipient of the international payment, i.e. to the payment recipient's account in the foreign currency B in the foreign 'Small bank' in Figure 2. This could be achieved with the wholesale CBDC that is made available to non-domestic financial institutions designed with interoperability that supports wholesale CBDC payment into existing domestic retail payments schemes. This could be direct interoperability with existing domestic payment schemes. Or alternatively it could be a tailored scheme for transfer wholesale CBDC B from Large bank to the foreign Small bank, which then converts this central bank balance from wholesale CBDC B to traditional central bank reserves and simultaneously credits the ultimate recipient's account.

Wholesale CBDC thus offers the possibility to tackle high costs and poor service quality in international payments through greater market competition in correspondent banking service provision. We expect the majority of central banks to be rather cautious about allowing international institutions direct access to their balance sheets. Concerns about financial stability mean that they will discourage international institutions, without a domestic banking license, from borrowing in domestic money markets or holding any illiquid assets such as loans using short term money market funding. Similarly, they will not want to extend intraday credit for large value real time gross settlement RTGS payments to international institutions as well as domestic banks. These are though not in our view compelling reasons for limiting wholesale CBDC to domestic financial institutions. Provided that foreign banks and non-bank alternative foreign exchange providers are restricted to holding positive wholesale CBDC balances and their customer obligations are fully reserved, then they will be able to provide their customers with international payments execution, moving central bank money freely to other wholesale CBDC account holders, without creating financial stability risks.

What about the impact of retail CBDC on international payments by small businesses? There was relatively little discussion in our interviews on this compared to the discussion of how wholesale CBDC might affect the payments processing illustrated in Figure 2. Some respondents suggested a simplification of international payments if both the domestic customer (holding the 'Currency A account' in Figure 2) and the foreign recipient (holding the 'Currency account B' in Figure 2) held retail CBDC accounts directly with their respective central banks. This could remove their dependency on international banks and on a correspondent bank with access to domestic payment schemes for routing international payments into a domestically held bank account.

We address this possibility in Section 5 below. The key point is that having both payer and payee holding a retail CBDC does not of itself change matters very much. There still needs to be a foreign exchange transaction. There are currently no markets for direct exchange of one retail CBDC against another, so the payer holding CBDC would still have to transfer their CBDC to a large bank who participates in foreign exchange markets. Once exchanged then the large bank still needs to find a way to route the payment to the retail CBDC holding of the payee, which is little different from routing to a bank account. However, it is conceivable, as discussed in Section 5, that central banks could support the development of a bilateral market in direct exchange of their two retail CBDCs. In this situation, which requires more than just payer and payee holding retail CBDC, there could be much reduced reliance on foreign banks and their correspondents for international payments. In our judgement this is a possibility, but it is still a decade or more away from practical implementation.

As highlighted by a couple of our interviewees, another way that retail CBDC could also make a difference for small business payments is if the creation of retail CBDC is

accompanied by the development of global identity standards. Including standard digital identities in invoicing and payments would lower the costs of compliance with AML and sanctions reporting and also substantially reduce the delays that arise when there are mistakes in payment instructions for example due to incorrect account numbers. The established global Legal Entity Identifier (LEI) could potentially be developed to play this role for small business payments, especially if it provided standardised links to account data required for payments processing.

### 4.3 Larger corporate transactions

This scenario was discussed in less detail than the other three. One reason for this was the issues overlap with the case of small business payments, especially for smaller payments moving from between large and smaller businesses. A chain of intermediaries can still be required resulting in the same payment frictions. The arguments under Section 4.2.1 that foreign banks and payment service providers having access to wholesale CBDC can lower barriers to entry and hence costs and improve the service remain valid.

A second reason is that many international payments by large banks are larger value, perhaps \$100,000 or more. Fees are typically not a concern for these transactions. Banks charge corporate clients a lower rate at near cost for these larger international transactions because the value proposition of corporate clients for the bank is the entire corporate relationship and the opportunity this offers for providing a range of banking services including credit. The high cost of switching banking service provider reinforces these existing corporate banking relationships and there is no need to seek to profit from each individual transaction.

The final reason that this scenario attracted relatively little discussion is that for the very largest corporate customers, the principal challenge is not so much international payments as international liquidity management. They will keep balances in many currencies, effectively internalising the role of Large bank from Figure 2 in exchanging and transferring foreign currencies. On occasion they will need to balance liquidity, with a larger movement of funds from one currency to another, as determined by their corporate treasury. However, this does not affect the execution of individual payments to and from their international suppliers and customers. Possibly, the holding of wholesale CBDC extended to large non-financial corporates could be of interest to some of these large businesses, especially if this eases their ability to lend and borrow in wholesale money markets. Again, this is not of direct relevance to the international payments arising in their day-to-day business.

### 4.4 International retail purchases

Our third scenario concerns cross-border retail purchases, either by international visitors purchasing goods and services face to face, for example from a shop, hotel or restaurant; or for purchases online from an overseas merchant. As we learned from our interviews, these payment needs are, currently, largely provided by the global card schemes such as Visa and Mastercard, with the schemes offering guarantees of payment and crediting funds to the recipient some days after the initial transaction. The card schemes can impose substantial merchant fees, a rate of 2.5% is quite usual for credit card payments. In return merchants obtain substantial benefits: the ability to accept payments from customers who might otherwise be turned away; second the insurance, knowing that if they follow scheme procedures even if the payment turns out to be fraudulent (for example a stolen card) they will still get paid.

Card schemes have a penetration rate around the globe, offering great convenience to cardholders. One interviewee gave a striking example, that of a private plane refuelling at a

remote airport somewhere in central Africa, using a Visa card and paying a 2.5% fee for a payment of several hundred dollars because this was the only acceptable medium of exchange for this transaction. However, this example, in which the merchant fee was paid by the purchaser, is the exception not the rule. For most card payments merchants choose not to pass on the merchant fee to the paying customer so that the payers are unaware of this transaction cost of card payment.

Consider first the potential role of retail CBDC. Central banks tend to define retail CBDC as a digital equivalent of cash that incurs no transaction costs to retail customers. This low-cost feature, however, doesn't distinguish retail CBDC much from card payments from the retail customers' perspective because customers do not bear card payment costs in most cases. Besides, customers also benefit from the opportunity in a card purchase of refund through chargebacks (in the case of credit cards) additional transaction benefits from insurance services in case of problems with the transaction as well as a period of interest free borrowing and rewards. As a result, customers can have little incentive to shift from higher cost cards to lower cost retail CBDC for making a merchant payment.

Merchants maybe more motivated to promote adoption of retail CBDC if the merchant fee is sufficiently lower than those in card schemes. In principle, a retail CBDC could serve as a low cost guaranteed form of payment in a domestic retail transaction. Like a card payment, a CBDC payment provides to the merchant a guarantee they are getting good money. Unlike a card payment this does not require any institutional guarantee and so does not have a charge built into the merchant fee to compensate for the costs of providing this guarantee. Such a low-cost guarantee based on domestic retail CBDC might also be possible in international payments if the payment provider handling the payment can acquire CBDC and route it to a domestic retail CBDC account. This though will be subject to central banks' discretion on whether and to what degree they are willing to open the central bank balance sheet to foreign entities.

All these possibilities are conditional on retail CBDC achieving widespread adoption in the jurisdiction receiving the international payment. The strength of the 'installed base' in existing card payment schemes suggest that retail CBDC may struggle in many countries to achieve a critical mass of retail merchant transactions. The exception are countries where card schemes have made little inroads in supplanting cash payments or in supporting online payments, explaining why the push for retail CBDC is strongest amongst low- and middle-income countries. Even then retail CBDC could struggle, in jurisdictions where other e-money solutions have already established themselves, such as M-Pesa in Kenya or Grab or GoJek Pay in South East Asia. An informative test case will be the competition in merchant payments between the e-CNY and its e-money competitors AliPay and WeChat Pay in China. As discussed in the Appendix, the e-CNY is being designed without any charge to the retail customer, hence giving it one advantage over these domestic e-monies.

Some of our interviewees referred to the rise of bank based alternatives to card scheme payments, specifically the possibility of faster payment bank account to bank account solutions installed on smart phones and also the 'European Payments Initiative'<sup>20</sup> to provide a "comprehensive payments solution for Europe", not just for the Eurozone but also for other non-Euro payments in the EU, which could provide low cost payments both in retail purchase and for "peer to peer" transactions between individuals. In those jurisdictions where these bank-based solutions become established, a retail CBDC could still establish a toe-hold in retail merchant transactions, for example for customers who for various reasons find it difficult to open a bank account. However, this can happen only if retail CBDC is designed from the outset to be interoperable with these bank-based payments solutions, and

---

<sup>20</sup> <https://www.epicompany.eu/>

can be used to initiate retail CBDC to bank account payments, in the same manner as bank account to bank account payments.

A scenario related to international retail purchases is a retail CBDC solution made available to international travellers (as is happening with the China e-CNY experiment for the 2022 Winter Olympics). Though this is essentially a domestic transaction, it could fill a gap in payment services, allowing small firms to accept payments from tourists and travellers as an alternative to card payments. General usage of this kind will also be promoted by interoperability with existing domestic bank payment schemes. As discussed in Section 5, without a fundamental change in the architecture of international payment processing, direct exchange of one retail CBDC with another seems an unlikely development.

#### 4.5 Remittances

Our interviewees with direct experience of providing international remittance services confirmed that much of the cost is associated with ‘cashing out’, when recipients are paid by a remittance agent in cash rather than the payment going into a bank or e-money account. The development of retail CBDC as a state supported e-money in low- and middle-income countries can help remove this element of cost. Further costs can arise with ‘cashing in’ when the senders of remittances wish to pay using cash rather than from a bank account.

AML and sanctions reporting require that remittance firms establish the identity both of those making the payment and those receiving payment, particularly challenging for cash payments. Where a payment originates from a bank or e-money account they can rely on the bank’s identification of their customer. Some of our interviewees emphasised the need for global identity solutions to facilitate digital transformation of international payments. This suggests that a more significant cost reduction in remittance payments could be achieved if the creation of retail CBDC is supported by globally accepted identity solutions, unambiguously identifying both the sender and recipient of an international remittance payment and hence reducing the currently substantial burden of compliance with AML and sanctions of politically exposed individuals.

With respect to wholesale CBDC, our interviews suggest, if anything, more pronounced impacts on the competitive landscape and hence costs of remittances than costs of small business payments. Typically, in the main remittance ‘corridors’, i.e. for a particular currency pair, e.g. US dollar to Mexican peso, the balance of flows is largely in one direction, from the country hosting international migrants to their country of origin. This means that a payment service provider offering a remittance service needs more than just customer access. They also need to conduct supporting foreign exchange transactions in order to acquire the domestic currency. The barrier to entry and resulted additional markup costs from reliance on a commercial bank to conduct this foreign exchange transaction and provide domestic can be reduced by payment service providers having access to Mexican wholesale CBDC, albeit at the expense of having to prefund payments.

### 5 Using CBDC to redesign international payments architecture

Is our discussion so far missing the possibility of more transformative radical change? The prospective issue of central bank digital currency has triggered an enormous volume of commentary. Some view CBDC as a transformative step, as important a monetary development as the creation of the first coinage in Lydia (east Anatoli in modern Turkey), the first European bank notes in the 17<sup>th</sup> and 18<sup>th</sup> centuries or the breakdown of metallic monetary standards in the 20<sup>th</sup> century.

The 'vision' is that of direct decentralised exchange of retail- CBDC, much as coins were directly exchanged in classical antiquity or in renaissance Europe. This is viewed as part of a broader global shift to decentralised peer-to-peer financial exchange, removing the role of institutions and supporting a transformative revolution in domestic and international payments. Specifically, it is claimed that "The use of CBDC in cross-border payments would enable instantaneous payments irrespective of location."<sup>21</sup>

Policy makers are seriously exploring the opportunity for such direct exchange in cross-border payments, as outlined in a recent BIS-IMF-World Bank stocktake.<sup>22</sup> The most recent report on central bank collaboration in the development of multiple-CBDC interoperability finds that "**The prototype demonstrates a substantial improvement in cross-border transfer speed from multiple days to seconds**, as well as the potential to reduce several of the core cost components of correspondent banking. It thereby demonstrates the potential of faster and lower cost cross-border transfers for participating jurisdictions."<sup>23</sup>

The large majority of our interviews were with payments professionals. Their views are in sharp contrast to these radical visions. Is this lack of imagination, professionals who spent their careers doing things in a certain way unable to envisage an alternative? Or is this an awareness of practical realities that these more visionary statements about the impact of CBDC neglect?

Our desk research, and some of our interviews, suggest that an alternative outcome of much more radical change is at least conceivable. A 'new world' with real time payments at both domestic and global level based on central bank digital currency is possible. This though requires a substantial shift in the role of banks and other intermediaries in international payments arrangements, both in retail and large value transactions. The changes involved are far more than just technology adoption, they are a fundamental redesign of the institutional architecture of international financial transactions.

Given the problems of high cost and poor quality of service in international payments, profound changes certainly merit consideration. There will have to be extensive discussion and elaboration before anything along these lines can be introduced and it is far from certain whether such developments towards decentralised peer to peer exchange will work as well in practice as their many proponents theorise. Our goal in this sub-section is to identify some of the issues involved.

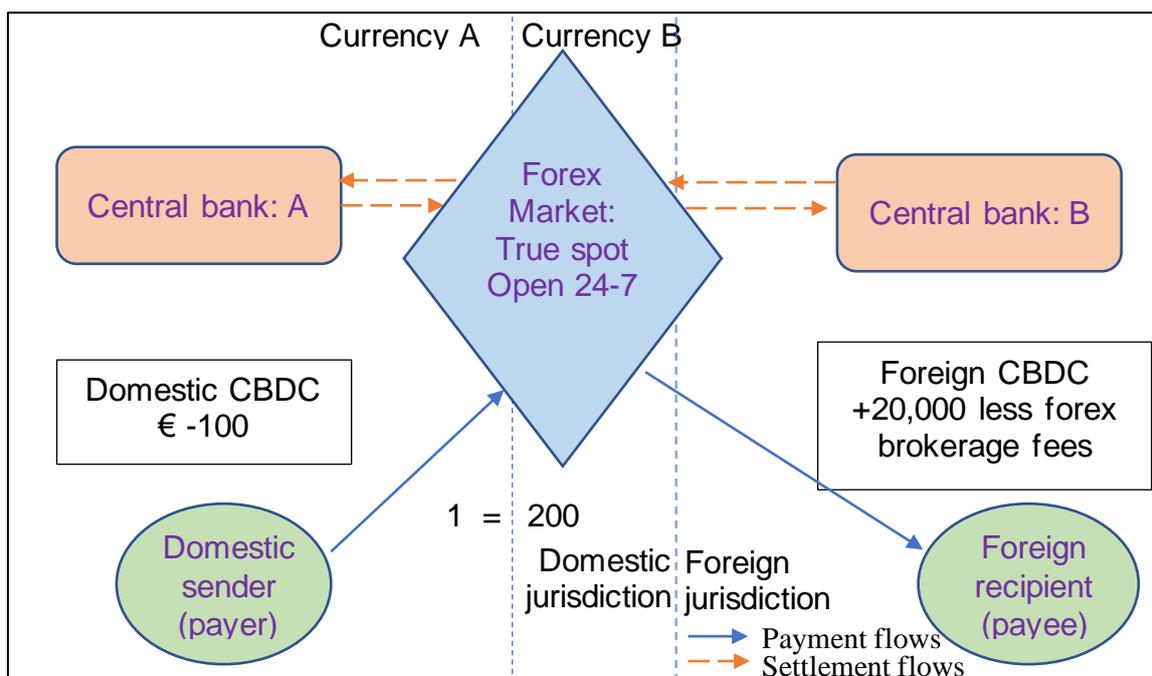
Figure 3, below, suggests one such potential redesign of international payments. It can be contrasted with the existing arrangements illustrated in Figure 2 above.

---

<sup>21</sup> (Accenture, 2019, page 11)

<sup>22</sup> (BIS, IMF and World Bank, 2021, Section 2, pages 5-12).

<sup>23</sup> (BIS Innovation Hub, 2021, pg 7).



**Figure 3: A possible retail CBDC-based real-time international payments architecture**

This figure illustrates arrangements that might, using retail CBDC, support near real-time direct international transfers of value. Such near real-time transfer could potentially reduce much of the complexity and hence the high costs of the current arrangements illustrated in Figure 2.

Figure 3 assumes widespread retail adoption of CBDC in both the sending and receiving country. The payer holds their 'domestic' CBDC which they wish to use for the international payment while the payee is happy to receive payment in their own 'foreign' CBDC. As we now discuss, even when sender and recipient both hold the CBDC of their own jurisdiction, direct international transfer of CBDC is still a difficult challenge.

Having payer and payee hold their money as CBDC eliminates the need for settlement, either in the domestic or foreign currency. It does *not* eliminate the need for the accompanying foreign exchange transaction. The domestic CBDC must still be exchanged for foreign CBDC transferred to the recipient. For this to be a near real-time direct exchange requires payer and payee to have access to a market for CBDC foreign exchange, operating continuously 24/7 with immediate settlement. It also requires supporting operational systems for the simultaneous debiting of CBDC holdings of the payer (here –100) and crediting of CBDC holdings of the payee (here +20,000).

How might access to the foreign exchange market, shown in Figure 3, work? There are a range of possibilities. Here are two polar cases:

- Polar Case 1.** A fully liberalised market for exchange of CBDC, in which neither country places any restrictions of any kind on who holds their CBDC; and where there is substantial demand for small value transactions between the two jurisdictions
- Polar Case 2.** A fully controlled one-sided market for CBDC exchange, that of a small country which limits holdings of CBDC to its own citizens and residents and whose central bank acts as the market maker, offering two-way exchange against an international CBDC at a posted exchange rate.

Other arrangements than these two polar cases can be envisaged, but these capture much of what would be involved.<sup>24</sup> The market could be facilitated either through a liberalised market with multiple participants or through exchange on central bank books. Some blend of the two is also possible, with the central bank participating actively in a real-time market. We suppose that much of the exchange would still be brokered, with banks or other non-bank foreign exchange service providers providing retail customers with CBDC account connectivity and transaction execution at best available market prices. Hence for most retail clients the 20,000 credited would have some brokerage fees deducted. There would though be little or no barriers to entry in this form of brokerage so these fees would be an order of magnitude smaller than the 5% of Figure 2, perhaps as low as 0.1%.

However if implemented, this shift from indirect intermediated deferred international payments (the current architecture of Figure 2) to direct near real-time international payments (a new architecture as in Figure 3) must address the fundamental requirement of liquidity provision. For the payer in the domestic country to access the foreign CBDC they must find a counterparty to give them the foreign CBDC. It will be a matter of rare chance that there is someone else arriving at the market with the foreign CBDC, at the exact same time and requiring exactly the same amount of the domestic CBDC in order to complete a payment in the other direction.

The fundamental role of banks and payment intermediaries under the current architecture of international payments (Figure 2) is not payments processing but the commitment of their balance sheets to provide liquidity, bridging these differences in both timing and amount in the need for foreign exchange. Whenever a bank or a non-bank payment service company takes a payment from an account in a domestic currency and passes it on to a correspondent bank to make payment in a foreign currency, they are taking a foreign exchange position.

As discussed in Section 2, for more active corridors of exchange with multiple payment flows in both directions, this liquidity can be provided at low cost. The net aggregate exposure for payments intermediaries is quite small compared to the value of transactions. Only occasional rebalancing transactions in foreign exchange markets are then required to limit foreign exchange risk. For other less active corridors supporting foreign exchange transactions must take place more often and the costs of liquidity provision are higher.

Direct near real-time 'peer to peer' payments as in Figure 3 still require the provision of liquidity – but this will have to be provided in quite a different way than in Figure 2: not through the commitment of intermediary balance sheets but through a liquid real-time market in direct exchange of CBDC (Polar case 1), through a central bank using its balance sheet to ensure immediate real time exchange (Polar case 2) or through some combination of the two. Moreover, for this liquidity provision to be effective, further supporting arrangements not captured in Figure 3 will then be required. Possibilities include the following:

- A purely market-driven evolution. The provision of liquidity in a liberalised market for CBDC exchange (polar case 1) requires trading intermediaries committing their

---

<sup>24</sup> Our analysis remains very mainstream. The radical visionary response is to point to the software-based provision of liquidity in the rapidly evolving world of decentralised finance or DeFi operating on Ethereum and other blockchain platforms. For example Uniswap (<https://uniswap.org/>) and Sushiswap (<https://sushi.com/>) provide liquidity pools for decentralised exchange between different cryptocurrencies. We may be missing something here, but we have found no coherent explanation of how mechanisms of these kind could provide liquidity for exchange of retail CBDCs. We therefore believe that retail exchange must rely on the established mechanisms we refer to here of traders and/or a market maker posting to a limit order book.

capital to taking foreign exchange positions. If there are enough underlying retail buyers and sellers for a particular currency pair, then the commercial incentives could be sufficiently strong to lead to the emergence of trading platforms for direct exchange of the two retail CBDCs and for sufficient participation of trading intermediaries to ensure 24/7 liquidity. The role of central banks and regulators will be limited to ensuring a supportive regulatory framework that allows this market to flourish.

- When, as is likely, commercial incentives for private liquidity provision need reinforcing, then the central banks concerned might reach a bilateral agreement on the creation of a real-time limit-order book for exchange between their two CBDCs, licensing domestic intermediaries to act as market makers. These market makers would be obliged to post sufficient limit orders to ensure retail holders can always make immediate low value exchange at a current market.
- In a controlled market (polar case 2) the central bank provides liquidity to support retail transactions in their own CBDC. This will be comparatively straightforward for smaller low and middle-income countries with fixed exchange rates. This though does mean that these central banks will end up acquiring holdings in the CBDCs issued by other central banks. Hence co-operation between central banks, allowing central bank holding of each other's CBDC, will be essential. This might be facilitated through regional co-operation agreements, allowing central banks of neighbouring countries to build up holdings in each other's CBDCs. They will not though want to become major creditors of their neighbours, with the threat of financial losses in the event that a fixed exchange rate regime collapses; nor will they be comfortable with a large proportion of their domestic CBDC going to neighbouring countries with a corresponding requirement for monetary expansion to maintain domestic access to CBDC.
- Other low and middle-income countries, with managed floating exchange rates, might also introduce a controlled market in exchange of retail CBDC (polar case 2) but limiting this market to exchange against the retail CBDC of major international currencies. This largely removes concerns about excessive risk exposure from holding the CBDCs of other central banks; but it still leaves potential policy concerns, unrestricted ability of citizens and residents to exchange domestic CBDC into an international CBDC could facilitate capital flight and dollarization of the local economy. So, this exchange might be largely limited to inward CBDC payments.

Taking stock, what we have presented in Figure 3 is the possibility of a real-time direct exchange of CBDC. The recent work undertaken by a number of central banks worldwide on 'm-CBDC' i.e. operational bridges between multiple CBDC ledgers, addresses part of what is required for such a change in international payment architecture, the supporting operational systems which would allow such real-time exchange and settlement. These experiments assume that two counterparties have already agreed on how much CBDC to exchange and on the exchange rate or to use a current market exchange rate. They show that it is then possible to ensure that this exchange take place without counterparty risk, on a simultaneous "payment versus payment" or PvP basis. There are though massive remaining challenges involved in a successful shift from existing arrangements based on bank intermediation (Figure 2) to direct international exchange of retail CBDC (Figure 3).

These m-CBDC bridges will require extensive supporting institutional arrangements, based on some combination of regulated market intermediaries and central bank balance sheet interventions to build the necessary trust between central banks, households, companies and intermediaries that will allow real time direct exchange of CBDC to work in practice. The existing arrangements for international payments, relying on bank balance sheets, while costly and often slow and unpredictable, do at least work. They attract sufficient transaction volumes to be viable. Who will jump to an untested and untried system, however

technologically impressive, if they are not confident that others are also using it? Central banks can be expected to continue making positive noises about transacting directly in the CBDCs of other central banks (they will not be so rude as to express publicly any concerns), but: they will be cautious about widening access to their own CBDC beyond their citizens and residents, even to other central banks; and they will want to proceed very carefully when acquiring CBDC exposures to other central banks. Building the required trust is a substantial undertaking that will take some time.

We can though also envisage an intermediate stage of development, employing m-CBDC operational linkages at a wholesale rather than at a retail level, to support real time wholesale foreign exchange and settlement. This could allow a wide range of financial and non-financial institutions— commercial and investment banks, non-bank payment service providers, foreign exchange dealers, hedge funds and other trading intermediaries, and asset managers – along with larger corporates, to hold and exchange wholesale CBDC on a real-time immediate settlement basis.

This would be something of a ‘half-way house’ between the current arrangements of Figure 2 and the futuristic arrangements of Figure 3. Once again, the critical issue is not technological. The issue here is whether there is sufficient demand for such real-time settled foreign exchange amongst financial intermediaries and larger corporates to create a viable liquid market for 24-7 real-time foreign exchange. Just as described above for direct exchange of retail CBDC, commercial incentives may not be enough on their own for the emergence of such a market (a related point raised by one of our interviewees is that the CLS bank initiative “CLS-Now” to offer real-time settled foreign exchange transactions which went live in July 2019 has attracted little trading volume). This could require central banks who have issued wholesale CBDC, agreeing to support real-time bilateral limit-order books for the true spot transactions.

There are range of potential benefits from such a true-spot market in foreign exchange, if it proves viable.

1. The existing foreign exchange dealers could continue offering wholesale foreign exchange to their clients. They would now though be able to do this in a different way, as brokers providing best execution in the true spot market. As brokers they would be operating in exactly the same way as investment banks currently act as brokers for equity trades. They would transmit client orders for market execution, but would not take any client positions on their own balance sheet. This substantially reduces their own capital needs. Other intermediaries, such as high frequency traders, could instead absorb market risks.
2. Such brokered exchange with immediate real-time settlement removes the opaqueness allowed through the manipulation of global foreign exchange markets by dealers at the expense of their clients. Trades would always be at an identified time and price conducted on the client’s behalf. Clients and regulators would be able, retrospectively, to analyse trading data to ensure brokers have met with their best execution obligations.
3. A true spot market eliminated with real time settlement, supported by m-CBDC linkage, removes counterparty risk. Funds must be available in advance, with no post trade financing or settlement risks. This in turn makes it possible to open the true spot market to a much wider range of participation than is possible in current T+2 settled markets. This reduction in entry barriers can in turn support greater competition in international payments between both bank and non-bank payment service providers and allow even relatively large transactions to be executed and settled in retail time without the support of bank balance sheets.
4. Treasuries of banks, non-bank intermediaries and global corporations would be enabled to source large amounts of currency on short notice. For one of our

interviewees, this would be a beneficial shift. This interviewee, who works for a non-bank international payment service provider, believes this would help them manage their liquidity globally on a real time basis, moving funds in a 24-hour cycle: starting with holding Asian currencies at the beginning of the day, to manage cross border payment flows within Asia and from Asia to the rest of the world; then moving on to hold European currencies in the middle of the day; and, after that, currencies from the Americas before then moving liquidity once again on to Asia. From their perspective current arrangements are inefficient. Because of  $T+2$  rather than immediate real time settlement, liquidity is trapped within currencies.

The major question mark about such true spot exchange with real-time settlement is whether there will be sufficient participation and sufficient liquidity to make a true spot market in foreign exchange viable. The arrangements for liquidity provision in global foreign exchange rely on delayed  $T+2$  settlement, allowing the dealers and other market participants who provide market liquidity to freely buy and sell foreign exchange throughout the trading day, only having to settle a much smaller net position. The need to prefinance trading in the true spot market will discourage traders taking positions and providing liquidity directly in this market.

What this suggests is the desirability of two parallel foreign exchange venues for large value forex transactions, alongside the true spot market with immediate real-time settlement a parallel market with  $T+2$  settlement (what we currently call the spot market, but which is fact a short-term forward market). The  $T+2$  markets need not cover all bilateral currency pairs, it would be enough for them all to operate against an accepted numeraire such as the US dollar. Hedge funds and other trading intermediaries could then provide spot liquidity by transacting simultaneously in the two markets. They would profit from their commitment of capital and their understanding of economic and financial information order flow and their impact on the spot market over the two-day horizon between  $T$  and  $T+2$ .

## 6 Conclusions

This paper reports an investigation of the potential impact of central bank digital currencies on international payments. This investigation was pursued through desk research, with a detailed review of both current policy initiatives and of the economic theory of competition and innovation in money and payments, alongside interviews with twenty-two payments practitioners.

We provide a review of the economics of competition and innovation in money and payments, stressing the point that these are network goods and therefore greatly affected by 'network externalities', i.e. that adoption and usage depends on the adoption decisions of others. The increasing importance of accompanying information flows in payment intensifies these network externalities. There can be substantial and rapid switching of technologies but also sometimes inertia with externalities discouraging the adoption of superior solutions. Network externalities also generate concerns about barriers to entry and market power and create stubborn problems of technical compatibility which require overcoming challenges both of co-ordinated change and sometimes overcoming vested interests if they are to be properly addressed.

Building on these initial insights, our desk research and interviews support three further broad sets of findings.

### *International payments processes are complex.*

The first set of findings are about the complexity and role of various intermediaries supporting the execution of international payments (as illustrated in Figure 2 of Section 2). From a customer perspective, an international payment seems very simple. The sender's account is debited, and all going well, the recipient's account is then credited net of any charges and costs of foreign exchange. Underlying this apparent simplicity, are complex operational processes conducted in successive stages.

As discussed in relation to Figure 2, digital payments today are all transfers of monetary claims, such as bank deposits or sometimes an e-money. This means that all international payments require settlement in central bank money, not once but three times: in the initial domestic stage of the payment taking money out of the senders account, in foreign exchange and in the final stage crediting money to the recipient's account. For the overwhelming majority of international payments, the value involved is relatively low and settlements are delayed net settlements DNS, not real time. Many payments are netted together and settled as a single 'batch'. The required settlements take place some time after the debiting of the sender's account, with some settlement even after the crediting of the recipient's accounts.

When it comes to the settlement of the foreign exchange leg of international payments (in contrast to the two domestic settlements) there is not even any fixed time period for this delayed settlement. As illustrated in Figure 2, banks build up or run down their holdings of foreign exchange, transacting in foreign exchange markets only as required to rebalance their foreign exchange exposures. This is a key fundamental role of large banks in international payments, using their balance sheets to provide supporting guarantees of eventual final transfer of value in foreign exchange settlement, and in this way bridging gaps in both the timing and quantity of international payments.

A further complication is that the supporting transfer arrangements (or payment schemes) within each jurisdiction have developed independently. An international payment while also digital is inherently problematic because it requires co-ordinating a transfer through two different schemes, one for the jurisdiction of the sender, the other for the jurisdiction of the

receiver of money. This in turn means that there is usually a reliance on a correspondent bank, to provide access to the payment schemes of the recipient jurisdiction and also to enable settlement on the banks of those jurisdictions central banks.

*The introduction of CBDC, particularly wholesale CBDC, can support continuing gradual improvement in international payments.*

Our second set of findings are about the impact of technological innovation, including the introduction of CBDC, on these operational processes and on customer outcomes, both costs and service quality. Our review of the economics of innovation in money and payments and our interviews have both highlighted the importance of network externalities in digital payments. We have well-established arrangements that already have critical mass. The prospect is therefore for incremental improvement, not radical shaping of payment processes, driven by a number of parallel developments.

We find that it is the introduction of wholesale CBDC, not retail CBDC, that will have the main impact on international payments. Wholesale CBDC, made available to foreign intermediaries including both international banks and competing payment service providers, will lower barriers to entry both in the provision of settlement in central bank money and in routing of payments within the recipient jurisdiction. This reduction in barriers to entry will come from: technical standardisation, reducing technical incompatibilities and hence lowering the costs of connecting to local payment systems; and from facilitating 24/7 round the clock payments settlement. Barriers to entry will be reduced most fully with a wholesale CBDC design that allows foreign intermediaries holding CBDC to initiate domestic payments to retail accounts, ideally instant payments with immediate real time settlement.

Retail CBDC can also have an impact, but in more specific situations. One is in lowering remittances costs by increasing financial inclusion. Another is offering a retail CBDC on phone or card to international visitors, providing an alternative to existing payments based on international card schemes that could be accepted at low cost by a wide range of small merchants. A broader impact that may be associated with the introduction of retail CBDC (but could also be pursued independently) would be establishing globally accepted digital identity schemes, thus directly reducing the costs of compliance with AML and political sanctions reporting, which currently serve as substantial barriers to entry in international payments services.

Technological developments will also, incrementally, address existing concerns about cost and service quality in international payments. The upgrading of domestic payments architectures and accompanying adoption of the ISO20022 global standards framework for payment schemes is eroding technical incompatibilities between arrangements in different jurisdictions. ISO20022 is also supporting much greater accompanying information flows alongside payments instructions. This, together with the SWIFT gpi service for supporting transparency of execution in international payments, is now offering the opportunity for payment service providers to build better customer solutions with much improved oversight of payments processing, what has 'happened' to their payments and the required actions to deal with any processing delays. This can also support integration in business supply chain and international trade operations and finance. Wholesale CBDC with direct holding of central bank money by intermediaries will complement these developments, but improvement can take place even where introduction of wholesale CBDC is delayed.

*Radical change is possible but not inevitable.*

Our third set of findings are about the possibilities of radical change in money and payments, based on the emergence of new digital forms of money. Given the great excitement about digital money and the impact of introducing CBDC, the view that emerges from our analytical framework (Section 3, emphasising network externalities in payments) and from our interviews (Section 5) are strikingly conservative. We have ended up with a much more

cautious view. Gradual incremental improvements in the cost and service quality of international payments, based on access to CBDC and the adoption of other technology innovations. This is very far from the dramatic picture of radical change in domestic and international payments expressed in many other discussions of the emergence of new digital forms of money.

What explains this difference? Much of the expectation of radical change rests on an assumption that digital innovation will create opportunities for direct exchange of digital currencies, replaying the existing complexities of both domestic and international payments with simple direct exchange. While this is not impossible, the expectation that all this requires is the creation of a new digital form of money is somewhat naïve. The central importance of accompanying information mean that digital payments are, inherently, much more than just a transfer of value. Digital payments based on bank and card payment schemes, as well as those using new e-moneys, rely on established schemes or platforms each with a with large installed user base. These connect payers and payees in particular payment contexts. CBDC will not automatically attract users

Our analysis has distinguished two plausible variations on this theme. The first is that of widespread holding of retail CBDC, a direct money holding which when used in payments just like a bank note needs no further settlement, and directly transferred whenever an international payment is made. Nothing in our desk research or our interviews suggested that this is a realistic near-term prospect.

A more likely possibility is a radical simplification of wholesale transactions money and international foreign exchange markets, with large corporates, investment funds as well as investment banks, domestic and international commercial banks and payment service providers directly holding and exchanging wholesale CBDC. There could then be sufficient value from real time exchange of wholesale CBDC for the emergence of parallel foreign exchange venues, with a true spot market operating with immediate settlement alongside the existing  $T+2$  settled market that operates today. This could in turn facilitate real time global liquidity management, with funds being transferred around the world in different currencies at different times of the day according to when they are needed. Unsecured and secured money market transactions could similarly use wholesale CBDC for immediate real time realisation of money.

The evidence of our interviews though is that this would be a major and challenging change to the existing infrastructure for international foreign exchange. It is therefore not going to emerge automatically, even with widespread access to wholesale CBDC. Existing arrangements with delayed settlement, currently  $T+2$  in foreign exchange, are a market preference. While foreign exchange markets might follow the lead of securities markets and push for  $T+1$  settlement, this is inherently different from near-real time immediate settlement. The netting that is made possible by delayed settlement reduces substantially the liquidity that must be committed to supporting the final PvP exchange of foreign currencies. So, there is a trade-off in moving to near-real time settlement: greater simplicity and reduced risk exposure v. greater liquidity requirements and also the costs of changing operational systems. There is moreover a co-ordination problem. the two sides of the trade must agree on the same settlement window. It is not enough if some institutions see commercial benefits in changing their forex business model to near-real time settlement, all must change at the same time.

Global central banks may wish to promote a different outcome. Real time spot exchange of wholesale CBDC incorporating near real-time spot settlement, i.e. a true spot market, might, for example, help to reduce systemic risk exposure in short term secured and unsecured money markets. It could promote greater competition in the services illustrated in our Figure 1, helping small banks better access to foreign exchange services. Such development though

needs careful assessment. A reworking of the entire infrastructure of international payments is a far from trivial investment.

Such a radical redesign of international payment processing is relatively remote from the experience of most customers. While an evolution of wholesale CBDC in this direction of real-time spot exchange with immediate settlement could help further reduce barriers to entry and promote competition in international payments, the most obvious ways to improve customer outcomes are as discussed at length in our paper through improved interoperability and compatibility of processing systems, together with wider access to central bank money and comprehensive globally accepted identity solutions. This technical nitty-gritty appears to matter more for improving international payments than any grand redesign.

## References

- Accenture (2019) *The (R)evolution of Money II Blockchain Empowered Central Bank Digital Currencies*. Available at: [https://www.accenture.com/\\_acnmedia/PDF-105/Accenture-Revolution-of-Money-II-2019.pdf](https://www.accenture.com/_acnmedia/PDF-105/Accenture-Revolution-of-Money-II-2019.pdf).
- Andolfatto, D. (2015) *MacroMania: Fedcoin: On the Desirability of a Government Cryptocurrency*, *Macromania Blog*. Available at: <http://andolfatto.blogspot.co.uk/2015/02/fedcoin-on-desirability-of-government.html>.
- Bank of England (2020) *Central Bank Digital Currency: opportunities, challenges and design*. London.
- Bank of Japan (2020) *The Bank of Japan's Approach to Central Bank Digital Currency: 日本銀行 Bank of Japan*. Tokyo. Available at: [https://www.boj.or.jp/en/announcements/release\\_2020/rel201009e.htm/](https://www.boj.or.jp/en/announcements/release_2020/rel201009e.htm/) (Accessed: June 4, 2021).
- BIS (2020) "Central bank group to assess potential cases for central bank digital currencies." Bank for International Settlements.
- BIS (2021) *Updated dataset on CBDC projects around the world*. Available at: <https://www.bis.org/publ/work880.htm>.
- BIS, IMF and World Bank (2021) *Central bank digital currencies for cross-border payments: Report to the G20*. Basel. Available at: <https://www.bis.org/publ/othp38.pdf>.
- BIS Innovation Hub (2021) *Inthanon-LionRock to mBridge: Building a multi CBDC platform for international payments*. Hong Kong. Available at: <https://www.bis.org/publ/othp40.pdf>.
- BISIH Swiss Centre, SNB and SIX (2020) *Project Helvetia: Settling tokenised assets in central bank money*. Available at: <https://www.bis.org/publ/othp35.htm>.
- BoE (2021) "Bank of England Omnibus Accounts – Access Policy," 19 April. Available at: <https://www.bankofengland.co.uk/-/media/boe/files/payments/boeomnibusaccounts.pdf>.
- Brainard, L. (2021) *Private Money and Central Bank Money as Payments Go Digital: an Update on CBDCs*, *Board of Governors of the Federal Reserve System, Speech*. Available at: <https://www.federalreserve.gov/newsevents/speech/brainard20210524a.htm> (Accessed: June 4, 2021).
- Casu, B. and Wandhöfer, R. (2018) *The Future of Correspondent Banking Cross Border Payments*. 2017–001. SWIFT Institute Working Paper. Available at: [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3261168](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3261168).
- CBDC Working Group (2020) *Central bank digital currencies: foundational principles and core features*. Basel. Available at: <https://www.bis.org/publ/othp33.pdf>.
- CPMI (2020) *Enhancing cross-border payments: building blocks of a global roadmap*. 93. Basel. Available at: <https://www.bis.org/cpmi/publ/d193.htm>.
- ECB (2020) *High level task force report on a digital euro*. Available at: [https://www.ecb.europa.eu/pub/pdf/other/Report\\_on\\_a\\_digital\\_euro~4d7268b458.en.pdf](https://www.ecb.europa.eu/pub/pdf/other/Report_on_a_digital_euro~4d7268b458.en.pdf).
- ECB (2021) *Eurosystem report on the public consultation on a digital euro*. Frankfurt-Am-Main. Available at: [https://www.ecb.europa.eu/pub/pdf/other/Eurosystem\\_report\\_on\\_the\\_public\\_consultation\\_on\\_a\\_digital\\_euro~539fa8cd8d.en.pdf](https://www.ecb.europa.eu/pub/pdf/other/Eurosystem_report_on_the_public_consultation_on_a_digital_euro~539fa8cd8d.en.pdf).
- Finality Global Payments (2021) "The Finality Narrative," April. Available at: [https://www.finality.org/hubfs/Finality International Narrative Q3 20.pdf](https://www.finality.org/hubfs/Finality%20International%20Narrative%20Q3%2020.pdf).
- FSB (2020a) "Enhancing Cross-border Payments - Stage 1 report to the G20," 9 April. Available at: <https://www.fsb.org/2020/04/enhancing-cross-border-payments-stage-1-report-to-the-g20/>.
- FSB (2020b) "Enhancing Cross-border Payments - Stage 1 report to the G20: Technical background report," 9 April. Available at: <https://www.fsb.org/wp-content/uploads/P090420-2.pdf>.

FSB (2020c) *Enhancing Cross-border Payments: Stage 3 roadmap*. Basel. Available at: <https://www.fsb.org/2020/10/enhancing-cross-border-payments-stage-3-roadmap/>.

FSB (2021) *Targets for Addressing the Four Challenges of Cross-Border Payments Consultative document*. Basel. Available at: <https://www.fsb.org/2021/05/targets-for-addressing-the-four-challenges-of-cross-border-payments-consultative-document/>.

Garratt, R. *et al.* (2020) “Token-or Account-Based? A Digital Currency Can Be Both.” Federal Reserve Bank of New York. Available at: <https://libertystreeteconomics.newyorkfed.org/2020/08/token-or-account-based-a-digital-currency-can-be-both.html>.

Kavuri, A. and Milne, A. (2020) *Evolution or Revolution? Distributed Ledgers in Financial Services*. 4/2020. London. Available at: [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3527192](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3527192).

Kiff, J. and Dav, S. (2021) *The Global Fintech Intelligencer – Fintech perspectives from a bunch of policy wonks*. Available at: <https://theglobalfintechintelligencer.com/> (Accessed: June 7, 2021).

Koning, J. (2014) *Fedcoin, Moneyness blog*. Available at: <http://jpkoning.blogspot.co.uk/2014/10/fedcoin.html>.

Koning, J. (2016) “Fedcoin: A central bank-issued Cryptocurrency,” *R3 Report*, 15.

Linde, J. and Nessen, M. (eds) (2018) “Sveriges Riksbank Economic Review: Special issue on the e-krona,” in. Stockholm.

Milne, A. (2018) *Argument by False Analogy: The Mistaken Classification of Bitcoin as Token Money*. 3290325. Available at: [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3290325](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3290325).

Nessen, M. and Soderstrom, U. (eds) (2020) “Sveriges Riksbank Economic Review: Second special issue on the e-krona,” in. Stockholm: Sveriges Riskbank. Available at: <https://www.riksbank.se/globalassets/media/rapporter/pov/engelska/2020/economic-review-2-2020.pdf>.

OXERA (2020) *The competitive landscape for payments: a European perspective*. Available at: <https://www.oxera.com/publications/the-competitive-landscape-for-payments-a-european-perspective/>.

Panetta, F. (2021) “Preparing for the euro’s digital future,” *The ECB Blog*, 14 July. Available at: <https://www.ecb.europa.eu/press/blog/date/2021/html/ecb.blog210714~6bfc156386.en.html#footnote.4>.

Powell, J.H. (2021) *Federal Reserve’s response to technological advances driving rapid change in the global payments landscape*, Board of Governors of the Federal Reserves System, *Speech*. Available at: <https://www.federalreserve.gov/newsevents/pressreleases/other20210520b.htm> (Accessed: June 4, 2021).

Project Jasper (2017) *Phase 2: A Canadian Experiment with Distributed Ledger Technology for Domestic Interbank Payments Settlement*. Ottawa. Available at: <https://www.payments.ca/industry-info/our-research/project-jasper>.

Project Jasper (2018) *Phase 3: A collaborative research initiative between Payments Canada, the Bank of Canada and TMX group*. Available at: <https://www.payments.ca/industry-info/our-research/project-jasper>.

Project Ubin (2017a) *Phase 1: SGD on Distributed Ledger*. Singapore. Available at: <https://www.mas.gov.sg/schemes-and-initiatives/Project-Ubin> (Accessed: June 5, 2021).

Project Ubin (2017b) “Phase 2: Reimagining RTGS,” 14 November. Available at: <https://www.mas.gov.sg/-/media/MAS/ProjectUbin/Project-Ubin-Phase-2-Reimagining->

RTGS.pdf?la=en&hash=02722F923D88DE83C35AF4D1346FDC2D42298AE0 (Accessed: June 5, 2021).

Project Ubin (2018) *Phase 3: Delivery versus Payment on Distributed Ledger Technologies*. Singapore. Available at: <https://www.mas.gov.sg/schemes-and-initiatives/Project-Ubin> (Accessed: June 5, 2021).

Rice, T., von Peter, G. and Boar, C. (2020) “On the global retreat of correspondent banks,” *BIS Quarterly Review, March* [Preprint].

Riksbank (2017) *The Riksbank’s e-krona project: Report 1*. Stockholm. Available at: <https://www.riksbank.se/en-gb/financial-stability/the-financial-system/payments/does-sweden-need-an-e-krona/the-e-krona-projects-first-interim-report/>.

Riksbank (2018) *The Riksbank e-Krona project: Report 2*. Stockholm. Available at: <https://www.riksbank.se/en-gb/payments--cash/e-krona/e-krona-reports/e-krona-project-report-2/>.

Riksbank (2021) *E-krona pilot phase 1*. Available at: <https://www.riksbank.se/en-gb/payments--cash/e-krona/e-krona-reports/e-krona-pilot-phase-1-report-3/> (Accessed: June 4, 2021).

Schär, F. (2021) “Decentralized finance: On blockchain-and smart contract-based financial markets,” *FRB of St. Louis Review*, 2021 (Second Quarter), pp. 153–174. Available at: <https://research.stlouisfed.org/publications/review/2021/02/05/decentralized-finance-on-blockchain-and-smart-contract-based-financial-markets>.

World Bank (2021) *Remittance Prices Worldwide*. Available at: <https://remittanceprices.worldbank.org/en>.

## Appendix A. Interview design and interview questions.

It is difficult to use formal model building or statistical hypothesis testing in investigating the impact of a novel form of money such as CBDC on an industry scenario as complex as cross-border payments. Our research therefore employs qualitative research methods. Specifically, we explored the understanding developed in our 'desk analysis' of Sections 2 and 3 with semi-structured interviews. Our goal was to test and develop the analytical framework developed in our desk research, by obtaining the perspectives of professionals with a wide range of experience in international payments and payments technologies.

The research method can be described as a "grounded theory" approach in which a theoretical framework is developed inductively from data and thus 'grounded' in qualitative observations (Glaser and Strauss, 1967; Strauss and Corbin, 1990). Following this research tradition, the analysis of Section 3 was used as a framework for understanding both institutional and policy issues and interview data. The interview data were interpreted through content analysis or "coding" that allowed us to label and categorise data. This analytical process allowed us to refine our conceptualisation of the core issues around CBDCs. While the researchers already had prior knowledge about the various issues and discussions about CBDC and international payments, as set out in Section 3, both interviews as well as the coding process were performed with an 'open mind', so analysis and conclusions were shaped by the data, rather than forcing the results to fit within a preconceived framework.

The interviews conducted were designed to address three broad areas: 1) the CBDC design choices available to issuers and policy makers, 2) the impact of CBDC issuance based on specific international payments scenarios, and 3) broader monetary and economic issues that CBDCs could introduce. All questions during the interviews (from the more narrow to the more open-ended) were asked from an interview guide that was circulated in advance to the interviewees (see Appendix A.). Most interviews lasted between 50-60 minutes. All participants gave permission for recording of the discussions. These recordings were used to transcripts which were then returned to the interviewees for the record as well as to give them the opportunity to provide any additional response. This allowed the research team to capture the entirety of the discussions.

The data collection exercise lasted eight months, with desk analysis and interview design beginning in November 2020, Interviews from Feb – June 2021 and a further four months (between July 2021 – Oct 2021) of data analysis and write up of the results and the paper.

## 7 The six page interview document

### 7.1 Introduction

This interview is one of a series conducted February - June 2021 with payments professionals, regulators and central bankers. They form part of a research project investigating the implications of the issue of CBDC on the operation of international payments. This research is being conducted by Chusu He of University of Bath, Alistair Milne of Loughborough University and Markos Zachariadis of Manchester University. It is supported by the SWIFT Institute under grant agreement 2020-002. We expect the research to be published as a SWIFT Institute Working Paper in the summer of 2021.

The interview has three parts. In Part A we ask about your understanding of the design choices for CBDC, especially those that are likely to be most critical to use in international transactions. In Part B we then ask your views about four different scenarios in which CBDC might be adopted for international payments by households and corporates. In Part C, time allowing, we ask some more open-ended questions about impact on international finance. We would be grateful if you could read the following, describing the conduct of the interviews and write up the research. We will ask at the beginning of the interview if you have any concerns:

- The interview will take between 45-60 minutes. We plan to spend around 5 minutes on preliminaries, 15 minutes on part A, 30 minutes on part B and (assuming we keep to time) 10 minutes on part C.
- With your permission (we will ask for confirmation) the interview will be audio recorded and a transcript prepared. We will share the transcript with you, giving you an opportunity to add to or correct anything you have said. If you cannot grant permission for recording, for whatever reason, then the interview will be minuted (keep detailed notes) and we will share the minutes with you, again giving you an opportunity to add to or correct our record of your responses.
- All audio recordings, transcripts and minutes will be stored securely, in encrypted files. They will be seen only by the research team (three co-authors of the research) Chusu He, Alistair Milne and Markos Zachariadis who will also conduct the interviews.
- These files will be kept for a period of five years. This is to allow for the further process of any peer reviewed publication. Subject to agreement from the SWIFT Institute and all those we interview, we also plan to publish a more detailed interview summary, which can in turn be referred to in further published research, by ourselves or others. This is to make full use of the opportunity given by this work to share detailed professional understanding of international payments with researchers, practitioners and policy makers.
- We are not asking for you to share any commercially confidential information or to identify any statements you make with you as an individual or with your firm or employer. Any quotations or attributions in the research paper will use pseudonyms e.g. "Participant A." We would like to include a list of interviewees and their affiliations in the published paper; but if you prefer not to be included by name we can at your request instead use a pseudonym "International payments manager B at international bank X".
- We will share a draft of the final paper for your record and may ask you to kindly provide feedback or make any suggestions on our analysis and conclusions before publication.
- If you have any questions about the research, or the nature of your involvement, please do not hesitate to ask us before or at the start of the interview.

### **The definition of CBDC used in our research**

Debate on CBDCs is often marred by confusion about what CBDCs actually are; so it is important for the purposes of this research to offer a definition. For us, CBDCs are widely held accounting liabilities of a central bank: (i) exchangeable one for one into other money measured in the domestic unit of account; and (ii) with supporting digital transfer arrangements. This implies that a CBDC transfer, like a transfer of a bank note, achieves finality at the time of the transaction without any further process of settlement (they are “self - settling” or provide “atomic settlement”). “Widely held” is employed to distinguish CBDC from central bank reserves, which are normally held only by commercial banks. One for one exchangeability in the unit of account distinguishes CBDC from equity or foreign currency liabilities. The digital transfer arrangements distinguish CBDC from bank notes. This is a broad definition that includes all various forms of CBDC featured in recent discussions.

Having this in mind, one can envisage a variety of different forms of CBDC according to several further systems and design choices that we would like to discuss with you.

### **Part A. CBDC design choices and international payments**

The *design choices* listed in this part of the interview are described more fully in our CBDC typology, below. As you will see in the second part of the interview, we highlight three design choices that we believe are critical to international payments. We need to establish if our interviewees agree with our assessment.

QA1. Do you agree that the following CBDC design choices are the critical choices for their use in international payments?

- *Retail v. wholesale*
- *Direct v. indirect architecture*
- *Degree of interoperability*

QA2. Do you agree that the following CBDC design choices are important to their use in international payments?

- *Identity linked v. pseudonymous holding (e.g. how central is digital identity)*
- *Level and permissions for data access and data mobility across different entities and jurisdictions*
- *CBDC functionality (online/offline)*

QA3. Are there any other CBDC design choices that are relevant to their use in international payments? How important are they?

*e.g. Degree of access (e.g. who has access to the systems and under what terms?); Distributed (DLT) vs. Centralized ledgers; Interest bearing or non-interest bearing CBDCs*

## Part B. Scenarios of CBDC implementations for international payments

Scenarios. We now explore the impact of the issue of CBDC on four representative payment scenarios. There is overlap e.g. small business payments (QB1) merge into those of larger businesses (QB2), but we distinguish because they are served by somewhat different arrangements.

Our focus here is on the design choices for CBDC and how these might affect the impact of CBDC on international payments. Depending on design choices this could involve: (i) direct use of CBDC for the payment (ii) indirect use of CBDC by banks or non-bank payment service providers (PSPs).

We ask you to both give your perspective on both current processing arrangements (how payment operations are conducted, the 'pain points' in terms of speed, cost, transparency, certainty etc.); and how these might be changed by access to CBDC.

The following table summarises our initial understanding of where CBDC issue may impact on international payments, highlighting the wide range of possibilities depending on the design choices made.

<i>Retail v. wholesale</i>	<i>Direct v. indirect architecture</i>	<i>Degree of interoperability</i>	<i>Other CBDC design choices,</i>
What additional or improved international payments services are possible of (i) the sender / recipient hold CBDC themselves, or (ii) either or both hold a deposit with a PSP or bank which itself holds CBDC?	Is the impact of holding of CBDC on international payments strengthened by third party provision of CBDC services?  e.g. a PSP might facilitate direct PvP exchange of two CBDCs if it is able to offer both sides of the transaction, sender and recipient or their banks, direct CBDC holding in both currencies.	Is interoperability critical to using CBDC in international payments?  e.g. allowing the possibility of direct use of the CBDC for final payment and settlement, through the domestic payment scheme of the recipient's jurisdiction, so avoiding the need for a correspondent bank for settlement?	Are other design choices critical or important to use of CBDC in international payments  e.g. CBDC as a data carrier?

## **Part B (continued). Scenarios of CBDC implementations for international payments**

Please answer the questions in Part B. The first four questions have the same two-part wording, for each of the four proposed scenarios considered; for the second part we ask you to consider the design choices in the table on the previous page. The fifth and final question is a catch all: have our discussion missed anything important?

*QB1. A B2B payment by a smaller business to a supplier, cross-border and with currency exchange. What about payments from a customer or an importer?*

What are the concerns (cost, speed, etc.) for payers/payees under current arrangements? How might these be improved/ transformed by access to CBDC, allowing for possible CBDC design choices?

*QB2. A B2B payment by a larger business (mid sized revenues €5mn to €20mn, larger above this) to a commercial supplier or customer, cross border and with currency exchange.*

What are the concerns (cost, speed, etc.) for payers/payees under current arrangements? How might these be improved/ transformed by access to CBDC, allowing for possible CBDC design choices?

*QB3. Payments by an individual cross-border and with currency exchange for the receipt of goods or services, distinguishing payer present and payer remote.*

What are the concerns (cost, speed, etc.) for payers/payees under current arrangements? How might these be improved/ transformed by access to CBDC, allowing for possible CBDC design choices?

*QB4. Remittance payments, from an individual cross border and with currency exchange, to another individual with a bank or PSP e-money account, distinguishing different corridors as appropriate.*

What are the concerns (cost, speed, etc.) for payers/payees under current arrangements? How might these be improved/ transformed by access to CBDC, allowing for possible CBDC design choices?

*QB5. Underlying all these scenarios is the possibility that CBDC issue might support radical simplifications of the current complexity of international payments, disrupting the role of incumbent intermediaries and other service providers and replacing them with more direct exchange.*

To what extent do you agree that this is a possibility? How does this depend on CBDC design choices? Is there a greater or more limited role for smaller institutions?

### Part C. General questions on the impact of CBDC on international finance

We complete the interview (time allowing) with some final questions about the more general impact of CBDC on international finance. We would like to take the opportunity to obtain insight and clarifications into some of these broader issues/debates to have a more nuanced view on the impact of CBDCs.

What impact do you think the issue of CBDC, by central banks in major economies and in other jurisdictions, might have in the following areas of international finance. Again, please comment on how these outcomes might be affected by CBDC design choices

*QC1. Dollarization (i.e. an international currency becoming widely used in domestic transactions across different jurisdictions). Could issue of CBDC, whether a digital version of the US dollar or of other major currencies, facilitate 'dollarization' in cases where fiscal and monetary instability leads to a collapse of confidence in a domestic currency?*

*QC2. On the ability of residents and non-residents to circumvent exchange and capital controls applied in some low- and middle-income countries, so weakening the ability of these countries to regulate international transactions.*

*QC3. Transactions between clients and dealers in global foreign exchange markets (the client could be a commercial bank, a non-bank payment service provider, a foreign exchange trader, an asset manager; it could also be a large non-financial company). Could CBDC transform international financial markets?*

*QC4. "Offshore" money market and foreign exchange transactions, either: (i) by resident financial institutions (including subsidiaries of non-resident financial institutions), in the offshore market transacting in non-domestic currencies; or (ii) by non-resident institutions (including branches of non-resident financial institutions) transacting in either non-domestic or domestic currency. An important part of international financial transactions, notably in London, are offshore in a jurisdiction that can be different from that of either the legal residence of two parties to the exchange or the currency in which it is denominated. Will the issue of CBDC promote or discourage offshore financial transactions?*

## Typology of key design choices for CBDC

Those marked \*\* are those we consider most critical to international payments; and those marked \* are those we consider important to international payments. An objective of part I of the interview is to find out if our interviewees agree with these assessments.

- \*\* *Retail v. wholesale* – The distinction between retail and wholesale CBDCs has been one of the most prevalent in the existing literature. While retail CBDCs aim at providing access to the end customer (either consumers or businesses), wholesale CBDCs will be exclusive to financial Services institutions, such as banks and non-bank payment services providers, who will want to leverage the infrastructure to increase efficiency (i.e. reduce counterparty liquidity and credit risks and improve settlement efficiency) and provide better products and services. In general terms, r-CBDCs are a popular option amongst emerging economies who wish to increase financial inclusion, whereas, w-CBDCs are seen more favourably in advanced economics that wish to simplify payment infrastructure (including international payments) and reduce the number of intermediaries involved in the process. The distinction between r-CBDC and w-CBDC, however is not a binary one and there can be a number of in-between combinations that accommodate different groups or users.
- \*\* *Direct v. indirect architecture*. These design choices are confusing because of lack of established definitions in the literature and many extant works use such terms to describe different things. Our take of the direct architecture is that the CBDC will be a claim on the central bank who is the only responsible institution for the issuance, redeeming of CBDC as well as data management of the system. An indirect CBDC system is similar in terms of the claim on the central bank but allows financial institutions (e.g. banks) to play a role in onboarding customers and manage data access (e.g. secure authentication, checking of balances, initiate payments, etc.). This is a delegated management model similar to ‘hot wallets’ provided by cryptocurrency service firms. It is also possible to distinguish a ‘synthetic’ arrangement, e.g. and Adrian and Griffoli-Mancini (2019) which resembles the existing intermediation system where CBDC will be a claim on a financial institution (but where this claim is ‘100% reserved’ i.e. fully backed by central bank liabilities). This will also manage onboarding and data (both reference and transactional/payment). Similar distinctions are used elsewhere in the literature but with different terminology and definitions – for example Auer and Böhme (2020) describes our synthetic definition as ‘indirect’, collapse our direct and indirect into one level and introduces a further ‘hybrid’ level which is intermediate between our indirect and synthetic, with CBDC held on multiple ledgers.
- \*\* Degree of interoperability – Depending on their architecture and implementation CBDCs tend to be seen as separate channels of value transfer of payment rails. However, most often the success of new infrastructures depends on their ability to integrate and interoperate with existing, more established systems. Similarly, CBDC’s interoperability can be assessed based on their integration with a) domestic bank payment rails (e.g. PayUK schemes, CHAPS, etc. in the UK), b) existing card network rails and related systems (e.g. Mastercard, VISA, AMEX and relevant technologies such as terminals, gateways, etc.), and c) large value payment systems. Relevant to this discussion is CBDC interoperability with domestic and cross border infrastructures (single currency payments) and whether CBDC would be able to interface with foreign CBDC-based (or not) currencies on a multicurrency basis. In case of the later, questions regarding liquidity management and exchange rates will need to be resolved. This becomes even more complicated if one considers the various processes and systems involved in cross-border payments. For example, for large value

payment systems a payment-versus-payment process is commonly used which in turn would require a pre-funding arrangement (with pre-funded accounts). Additional steps in the payment chain would be complying with AML rules, sanctions, etc.

- \* Identity linked v. pseudonymous holding – One of the potential advantages of having a CBDC as a ‘bearer asset’ is the feature of ‘anonymity’. Thus far, this has been a popular characteristic among DLT-based cryptocurrencies but is quite unlikely it will be incorporated in CBDC solutions in the same way, albeit, some privacy in lawful exchange can be secured. In any case, a distinction between identity-linked and pseudonymous holding of a digital asset begs the questions of: how does one enter the system? What will be the KYC process to onboard users? Who will control this and will it be push (user initiating the registration) or pull (an intermediary issuing a digital wallet or smart card)? Answers to these questions will also influence or depend on the chosen design and architecture of a CBDC.
- \* *Level and permissions for data access* – As open finance is catching on around the world, there has been a need to address customer data access and portability across many banking services including payments. Implementation of open banking frameworks (regulated or not) have been quite challenging (see Zachariadis and Ozcan, 2017 and Ozcan and Zachariadis, 2020) due to the complexity of systems and protocols used internationally. It is evident that more integrated systems will be easier to manage and control access to data and so CBDCs would offer a possibility to implement open payments more systematically and successfully. The level of data access and permission (depending on the architecture of choice) can happen either at the central bank (issuing a direct API to consumer’s balances and transactional information) or at the level of the intermediary.
- \* *CBDC functionality (online/offline)* – As digital ‘bearer’ instruments may often rely on near-real time settlement that takes place across a network of settlement agents/nodes, access to the internet has been a key concern. Various models have been proposed to solve this issue including technologies that would allow the exchange of CBDC on an off-line basis between phones that can support ‘hardware money’ (with a chip or smartphone ‘secure element’ built-into the smartphone to prevent double spending).
- *Distributed (DLT) vs. Centralized ledgers* – To deal with issues around transparency, privacy, double-spending, and security, the idea to implement CBDC using blockchain-based on DLT-related innovations has been proposed. While the use of such technologies has been quite successful in the context of privately-issued cryptocurrencies available to the wider public, it is not necessary or straightforward that these will be ideal for the issuance of CBDCs going forward. In any case, one can easily see their relevance and there is a good amount of literature that advocates or criticises their use in this context.
- *Interest bearing or non-interest bearing CBDCs* – This distinction is mainly important from the point of monetary policy and financial stability. If CBDCs are interest-bearing and can be held without limits, this could affect holdings by institutional investors of other liquid, low-risk instruments (such as short-term government bills and repos backed by sovereign collateral). An interest-bearing CBDC could make monetary policy more effective as the pass-through of interest rate changes by the central bank would be more direct. On the other hand, if CBDC offers a direct alternative for deposits, banks would have less ability to independently set deposit interest rates. In case of a non-interest bearing CBDC like banknotes, this would not directly transmit changes in the key interest rate to holders, nor would it be likely to have large effects on money market interest rates.

## Appendix B. Central bank work on CBDC

This Appendix summaries the phases of central bank work on CBDC over the past decade.

The first phase focused on initial technical experimentation, exploring the possibilities for CBDC in a number of ‘proof of concept’ projects. This work was encouraged by the emergence in 2013 of widespread trading of Bitcoin and the first discussion of central bank digital currency using distributed ledger technologies (Koning, 2014, 2016; Andolfatto, 2015).

Singapore and Canada embarked on a series of technical experiment, the Monetary Authority of Singapore’s Project Ubin in 2016 <https://www.mas.gov.sg/schemes-and-initiatives/Project-Ubin> and the Payments Canada and the Bank of Canada collaboration on ‘Project Jasper’ <https://www.payments.ca/industry-info/our-research/project-jasper>. These demonstrated the technical feasibility of operating large value payments on a ‘distributed ledger’ without a central operator (Project Jasper, 2017; Project Ubin, 2017a, 2017b); and explored an integrated system for settling securities and payments (Project Jasper, 2018; Project Ubin, 2018).

In parallel with these technical experiments, the Swedish Riksbank launched its e-Krona project exploring the use case for CBDC as a cash substitute <https://www.riksbank.se/en-gb/payments--cash/e-krona/>, with the rather different motivation from other central banks of Sweden’s experience of rapidly falling values of cash in circulation. This is reported in (Riksbank, 2017, 2018) with further analysis in two special issues of their economic review (Linde and Nessen, 2018; Nessen and Soderstrom, 2020). Recently they have embarked on phase 1 of a pilot investigation with more detailed examination of the legal and technical requirements (Riksbank, 2021)

The second phase of increased central bank interest can be associated with increasing mainstream adoption of cryptocurrency technologies, including the potential issue of private ‘stablecoins’ competing with central bank money.<sup>25</sup> Their interest in digital payments has been further catalysed by the global pandemic and the major stimulus this has provided to digital commerce of all kinds. Notable developments in this second phase of widespread interest include:

- Sept 2019: the establishment of the BIS innovation hub to foster international collaboration on innovative financial technology amongst central banks (<https://www.bis.org/about/bisih/about.htm>).<sup>26</sup>
- January 2020: the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, the Sveriges Riksbank and the Swiss National Bank, together with the Bank for International Settlements (BIS) established a central bank CBDC working group to co-ordinate their work (BIS, 2020). They released a first overview of the issues in Oct 2020 (CBDC Working Group, 2020).

---

<sup>25</sup> (Kavuri and Milne, 2020) review many of these developments, including the June 2019 announcement by Facebook of the ‘Libra’ stablecoin, now repositioned as Diem, alongside the growing interest in the possibilities of using distributed ledger technologies to record and exchange holdings of money and securities. . Notable developments include: the June 2019 creation of Finality <https://www.fnality.org/home>, owned now by 15 major international banks, which expects to launch its first services in late 2021, offering its bank users 24/7 real time settlement in central bank money for liquidity management (Fnality Global Payments, 2021). Another initiative has been the 2020 announcement by SIX, the Swiss securities exchange, of the SIX digital exchange <https://www.sdx.com/> working with Hyperledger, Ethereum, R3 and others to create the world’s first regulated digital market infrastructure.

<sup>26</sup> In 2020 they co-operated with SIX in Project Helvetia <https://www.bis.org/about/bisih/topics/cbdc/helvetia.htm> demonstrating the ‘functional feasibility and legal robustness’ of settling securities transactions in central bank money held on a permissioned distributed ledger (BISIH Swiss Centre, SNB and SIX, 2020)

- March, 2020: the issue of a consultation document by the Bank of England (Bank of England, 2020): followed by subsequent April, 2021 announcement of the establishing a HMT-Bank of England taskforce on issuing CBDC  
<https://www.bankofengland.co.uk/news/2021/april/bank-of-england-statement-on-central-bank-digital-currency>.<sup>27</sup>
- October 2020: the Bank of Japan announcement of a three-phase program of work on CBDC to begin in 2021, beginning with the technical proof of concept experiments on the design of a general purpose retail CBDC, which could be followed up with a pilot development program (Bank of Japan, 2020).
- October 2020: the publication of the ECB task force report on a digital Euro (ECB, 2020), followed by a public consultation reported in (ECB, 2021). In July of 2021 the ECB then began two year investigative project to prepared possible issuance  
[https://www.ecb.europa.eu/paym/digital\\_euro/html/index.en.html](https://www.ecb.europa.eu/paym/digital_euro/html/index.en.html)
- May 2021: A commitment by the US Federal Reserve, announced in speeches by Chair Jerome Powell (Powell, 2021) and Governor Lael Brainard (Brainard, 2021), to examine closely the policy issues arising with new emerging forms of digital money – both the regulation and oversight of private digital money and the potential issue of a US dollar CBDC - and also to collaborate closely internationally on policy towards digital payments and CBDC. A range of policy work is now taking place across the Federal Reserve System, with a discussion paper to be published later in 2021 followed by a public consultation. A private sector consortium, the ‘digital dollar project’ is also investigating the potential issue of digital version of the US dollar.
- The first examples of ‘live’ retail CBDC available for use in day-to-day payments: including the Chinese e-CNY and the Bahamian ‘Sand Dollar’ (these projects are summarised below).

---

<sup>27</sup> Accompanied by a further announcement that non-bank payments service providers will be able to apply for holding so called ‘omnibus accounts’ at the Bank of England (BoE, 2021) . This will offer an alternative form access to central bank money for settlement alongside the established CHAPS RTGS scheme; an opportunity which Fnlity plan to exploit for the launch of their first services in Sterling later in 2021



## Some leading CBDC initiatives

	Chinese CBDC experiments	Bahamian Sand Dollar	Cambodian Bakong Project
Background	<p>In 2014, the People's Bank of China (PBOC) formed a study group to analyse digital currency, which then evolved into a digital currency research institute affiliated to PBOC in 2016. This institute is responsible to research under the project of Digital Currency Electronic Payment (DC/EP), to explore the design and development of Chinese CBDC, which is known as e-CNY.</p> <p>While e-CNY is technically ready for cross-border payment, its present main use case is for <i>domestic retail small value</i> payment, considering complicated issues over monetary sovereignty, FX policies and arrangements, regulatory and compliance requirements etc. (PBOC, 2021). However, PBOC is open to investigation and collaboration on CBDC cross-border payment (PBOC, 2021).</p> <p>China has carried out e-CNY pilots in more than 10 major cities/regions across the country and plans to put it in use for the 2022 Beijing Winter Olympics. 'As of June 30, 2021, e-CNY has been applied in over 1.32 million scenarios, covering utility payment, catering service, transportation, shopping, and government services. More than 20.87 million personal wallets and over 3.51 million corporate wallets had been opened, with transaction volume totalling 70.75 million and transaction value approximating RMB34.5 billion.' (PBOC, 2021) China smart phone internet users constitute 69.8% of the population. (CNNIC, 2021)</p>	<p>Defined as the digital version of legal tender (cash) and piloted in 2019, Bahamian Sand Dollar was officially launched by the Central Bank of The Bahamas as the world's first fully deployed CBDC in 20 October 2020, available to all (393 thousand) residents in the country.</p> <p>Bahamas has a 90% penetration for mobile devices.<sup>28</sup> The Bahamian dollar is pegged to the US dollar on a one-to-one basis.</p>	<p>The National Bank of Cambodia (NBC) started exploring the use of blockchain and DLT in payment system in 2016 and subsequently tested and officially launched the Bakong Project, a DLT-based interbank payment system, in 2018 and 28 October 2020. By July 2021, 25 banks and payment service institutions (PSIs) have participated in the network. The system is designed as an alternative to small value cash transactions.</p> <p>According to a report in 2020 by SORAMITSU<sup>29</sup>, a main contributor of the system, Bakong has 50 thousand users and 20 million dollars value in the system. The country has large unbanked population (78%), a large yet costly remittance market and very few credit cards and digital payment facilitates. Internet penetration in Cambodia stood at 52.6% in January 2021.<sup>30</sup></p>
Retail v. wholesale	E-CNY mainly serves domestic retail payments, but it differentiates personal and corporate wallets. Personal wallets are designed for natural persons and self-employed individuals, while corporate wallets are for legal persons and unincorporate institutions (PBOC, 2021). Because transaction and balance limits vary and the functions of wallets can be customized, there may be room for realizing some wholesale functions using e-CNY, though wholesale is not its main purpose.	Retail and wholesale <sup>31</sup> for domestic use only. Most public information is on retail Sand Dollar, which is hence the focus of this summary hereafter.	Retail
Direct v. indirect architecture	E-CNY adopts two-tier operation (i.e. indirect architecture), where PBOC issues e-CNY and authorized operators manage exchange and circulation. To encourage innovation in secure and effective operation, authorized operators are entitled to develop their own digital wallets to meet different use cases. Only commercial banks can possibly be franchised as authorized operators (PBOC, 2021).	Sand dollar adopts the indirect architecture, a partnership with the central bank as the sponsor playing a multi-purpose role (currency issuance, monitoring of holdings and sponsoring a centralised KYC/identity infrastructure). Its financial partners include four money	Bakong uses a two tier (indirect) architecture, where the central bank provides an interbank ledger of all transactions and each commercial bank and PSI provides access to transact on the platform to their users.

<sup>28</sup> <https://www.forbes.com/sites/vipinbharathan/2020/10/21/central-bank-digital-currency-the-first-nationwide-cbdc-in-the-world-has-been-launched-by-the-bahamas/?sh=9779a65506eb>

<sup>29</sup> <https://wiki.hyperledger.org/download/attachments/41589339/Bakong.pdf?version=1&modificationDate=1610634325000&api=v2>

<sup>30</sup> <https://datareportal.com/reports/digital-2021-cambodia>

<sup>31</sup> <https://www.sanddollar.bs/about>

		transmission businesses (MTBS) and three payment service providers (PSPs) <sup>32</sup> offering their own version of mobile wallets, and clearing banks and credit unions to support customer due diligence regime interoperability. The partnership also involves strategic and technology partners.	
Degree of interoperability	<p>The e-CNY system supports interoperability with traditional banking systems and digital wallets of different operators. People can transfer funds from a digital wallet to a bank account or another digital wallet (PBOC, 2021).</p> <p>PBOC does not charge authorized operators for exchange and circulation services, and the operators do not charge individual clients for the exchange of e-CNY either. This removes the friction from the transaction fee perspective and is in contrast to PSP (e.g. AliPay and WeChat Pay) e-money.<sup>33</sup></p> <p>In developing CBDC cross-border payment, PBOC will follow the principle of interconnectivity 'to enable interoperability between CBDC systems of different jurisdictions as well as between CBDC systems and incumbent payment systems' (PBOC, 2021).</p>	Transactions are initially limited to between wallets from the same operator. In the future wallet providers will be required to allow transactions between all Sand dollar wallets. Clearing banks and credit unions to facilitate interoperability between bank accounts and Sand dollar wallets and enable foreign exchange transactions via bank accounts. Sand Dollar charges a low merchant fee (lower than other electronic payments) to business users and no fee for personal wallet	Users can use cash to top up their Bakong account at a branch of a bank participant. Bakong allows money transfer between registered users in the system and withdraw money from a Bakong account to any bank account with a core banking ISO 20022 message.
Identity linked v. pseudonymous holding	<p>Authorized operators are entitled to develop 'different types of digital wallets for customers based on the strength of customer personal information identification' and provide corresponding e-CNY exchange services (PBOC, 2021). Wallets verified with stronger identity information are allowed higher per-transaction and daily limit values and a higher maximum balance. PBOC (2021) says e-CNY follows the principle of 'anonymity for small value and traceable for high value'.</p> <p>Rather than 'anonymity', 'managed anonymity' may more genuinely describe e-CNY. According to PBOC (2021), users can open least-privileged wallets without providing identities. It is said the least-privileged wallet can be opened with a mobile number.<sup>34</sup> However, it is compulsory in China to register mobile numbers under real identities, so the real identities are traceable. Other possible identity verification measures include uploading photos of ID card and bank cards and, more senior, in-person interview at a bank branch.</p>	<p>The wallets are segregated into three tiers depending on the strength of identity and legal status:</p> <ol style="list-style-type: none"> <li>1. Business wallet (balance limit S8,000 - \$1 million): must be tied to bank account and providing valid business license</li> <li>2. Personal wallet I (balance limit \$500): for unbanked/non-residents/visitors; identification not required; cannot be linked to a bank account</li> <li>3. Personal wallet II (balanced limit \$8000): government-issued identification as a requisite for enrolment; can be linked to a bank account</li> </ol>	All users must register with a phone number and provide selfie and ID card photo.

<sup>32</sup> <https://www.sanddollar.bs/keyplayers>

<sup>33</sup> Using PSP e-monies, merchants are charged a fee ranging from 0.6% to 1.2% of the payment value received; each individual person is bounded by a lifetime limit on the value that can be transferred out from the PSP system for free (0.1% of the transferred value exceeding this limit is charged as a service fee).

<sup>34</sup> [http://www.xinhuanet.com/fortune/2020-04/20/c\\_1125878094.htm](http://www.xinhuanet.com/fortune/2020-04/20/c_1125878094.htm)

		Minors can access Sand Dollar subject to their guardians' permission.	
Level and permissions for data access and data mobility (across different entities and jurisdictions)	E-CNY related information is protected by a firewall set by PBOC and are not allowed to be disclosed to third parties or other government agencies unless stipulated by laws and regulations (PBOC, 2021). Information will be used for anti-money laundering and countering the financing of terrorism (AML/CFT).  A user can open sub-wallets under the main wallet to manage funds for different purposes and better privacy protection.	The central bank aims to promote KYC documentation sharing by commercial banks to PSPs. Transaction data may be shared to support micro-loan application The central bank monitors transaction volume and frequency to detect personal wallets for business use. Wallet owners can access the full history of their transaction data, which is encryption protected by wallet providers. Transaction details are not available to back-office operators. The penalty for confidentiality breaches by wallet providers or others is \$50,000 or up to three years in prison, or both. <sup>35</sup>	Only NBC has access to all transactions; commercial banks can only monitor the transactions of their own users.
CBDC functionality (online/offline)	E-CNY will be designed to meet online and offline applications in all scenarios.	Sand Dollar supports offline transaction within a pre-set dollar value, which will be synchronized when devices are connected to internet. This is a critical feature because Bahamas Islands are prone to hurricanes which causes power suspension and damages of banks and ATMs. <sup>36</sup>	No official sources have mentioned the offline functionality.
Distributed (DLT) vs. Centralized ledgers	The e-CNY system uses distributed ledger technologies in the circulation layer to support collaboration between PBOC and authorized operators. It adopts a centralized structure in the transaction layer and all cross-operators transactions are transferred directly through PBOC. <sup>37</sup>	Media describe Sand Dollar as blockchain-based <sup>38</sup> because its technology partners are specialized in blockchain. Sand Dollar official website discloses no information whether the currency is pure blockchain based.	The system is based on a permissioned distributed ledger. <sup>39</sup>
Interest bearing or not	E-CNY is defined as a substitute for M0 and pays no interest (PBOC, 2021).	Sand Dollar doesn't accrue interest.	No official sources have mentioned this.
Other functions	E-CNY supports software wallet (based on mobile payment apps) and hardware wallet (e.g. prepaid IC cards, mobile phones, wearable objects). E-CNY allows setting payment caps and payment conditions (including programmable smart contracts).	Sand dollar supports software wallet (Android/iOS app) and hardware wallet (prepaid Sand Dollar Card).	Bakong is applicable for Mobile Phone and Tablet (Android and IOS), and Desktop application.

<sup>35</sup> <https://www.ledgerinsights.com/central-bank-of-bahamas-makes-progress-with-sand-dollar-cbdc/>

<sup>36</sup> <https://www.mastercard.com/news/perspectives/2021/the-bahamas-is-disaster-proofing-payments-with-its-first-ever-digital-currency/>

<sup>37</sup> <http://www.pbc.gov.cn/goutongjiaoliu/113456/113469/4294165/index.html>

<sup>38</sup> <https://www.reuters.com/article/us-cenbanks-digital-analysis-idUSKBN28S0KT>

<sup>39</sup> [https://bakong.nbc.org.kh/download/NBC\\_BAKONG\\_White\\_Paper.pdf](https://bakong.nbc.org.kh/download/NBC_BAKONG_White_Paper.pdf)