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Towards the holy grail of cross-border payments

Abstract

The holy grail of cross-border payments is a solution allowing cross-border payments to be immediate, cheap, universal, and settled in a secure settlement medium. The search for such a solution is as old as international commerce and the implied need to pay. This paper describes current visions how to eventually find this holy grail within the next decade, namely through (i) modernized correspondent banking; (ii) emerging cross-border FinTech solutions; (iii) Bitcoin; (iv) global stablecoins; (v) interlinked instant payment systems with FX conversion layer; (vi) interlinked CBDC with FX conversion layer. For each, settlement mechanics are explained, and an assessment is provided on its potential to be the holy grail of cross-border payments. Several solutions are suitable for improving cross-border payments significantly, and some could even be the holy grail.

Non-technical summary

The holy grail of cross-border payments is a solution which allows cross-border payments to be (1) immediate, (2) cheap, (3) of universal reach, and (4) settled in a secure settlement medium, such as central bank money. The search for the holy grail has been ongoing for many centuries. In 2020, improving cross-border payments was set as a key priority by the G20: the G20 asked the Financial Stability Board (FSB), working with the Committee on Payments and Market Infrastructures (CPMI) and other standard-setting bodies to co-ordinate a three-stage process to develop a roadmap to enhance cross-border payments. The conclusion that it is time again for forceful measures to improve cross-border payments resulted from several considerations, namely that (i) globalisation and thus volumes of cross-border payments have continued (and indeed are forecasted) to increase; and (ii) the fact that although digitalisation has made instant cross-border communication quasi cost-free, there has not been a striking decline in the costs associated with executing cross-border payments.

This paper argues that after more than thousand years of search, the holy grail of cross-border payments can be found within the next ten years. To this end, section 2 of the paper briefly recalls a few historical elements involving the search for efficient cross-border payments and identifies a number of universal challenges across time. Through a series of financial accounts, the paper then reviews several options for enhancing cross-border payments with a view towards reaching the holy grail. Section 3 covers correspondent banking, both in its current implementation, as well as a modernised version. Section 4 reviews emerging Fintech solutions, which have already delivered in terms of offering cheaper than ever cross-border payments for certain currencies and use cases. Section 5 discusses Bitcoin, which is distinct from the alternatives as it relies on a completely different settlement asset which is not linked to any fiat currency. Section 6 turns to global stablecoins such as the one envisaged initially by Facebook (Libra/Diem). Section 7 unpacks the case of interlinking domestic payment systems through a cross-system and FX conversion layer. Finally, section 8 analyses the case of central bank digital currencies (CBDC), again interlinked cross-border through an FX conversion layer. Each of the arrangements covered in sections 3 to 8 are assessed in terms of their actual or potential efficiency, architectural parsimoniousness, competitiveness and, relating to that, preservation of monetary sovereignty. Section 9 concludes that the interlinking of domestic payment systems and the future interoperability of CBDCs are the most promising avenues, albeit subject to strong progress being made on the AML/CFT compliance side to ensure straight-through-processing (STP) for the large majority of cross-border payments.

1. Introduction

Cross-border payments consist of transactions where the payer and payee (and typically their financial institutions) are located in different jurisdictions (e.g. Bech, Faruqui and Shirakami, 2020).[1] They are more complex than domestic payments as they often involve different national legal and regulatory frameworks, more than one currency, multiple time zones, and often need to be facilitated through several intermediaries and financial market infrastructures (CPMI, 2020).

In parallel to domestic payments, cross-border flows can be broadly segregated into two subclasses. First, **cross-border retail payments** include payments between non-financial corporates, businesses serving their customers following a sale or purchase of goods, or payments disposed for other reasons (money sent by international migrants to their families, fund transfers to students abroad, etc. (CPMI, 2018). Although cross-border retail payments consist often of smaller-value transactions, they are generally of high-volume (Bank of England, 2021). Second, **wholesale cross-border payments** are high-value transactions. Whilst large-scale international payment flows among commercial banks can be made on behalf of their clients (including for the purposes of settling retail payments), they can also take place between financial institutions on their own accord typically relating to a variety of FX operations. The current paper focuses on cross-border retail payments, although some of the solutions also cover the case of wholesale payments.

A second important distinction for all cross-border payments is the one **between those involving a cross-currency FX conversion and those which do not**. In the former case, another party offers an FX conversion service, while in the case of the latter, the payment results in a change of the cross-border currency position of the payer and/or payee. In describing both examples, we argue that cross-border payments with currency conversion is the superior alternative from a policy perspective, at least for those jurisdictions with stable currencies.

The holy grail of cross-border payments is a solution which allows cross-border payments to be (1) immediate, (2) cheap, (3) universal, in the sense of covering ideally every addressable party in the world, and (3) settled in a secure settlement medium, such as central bank money. Unlike settlement

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[1] Whilst still a cross-border payment, the accounts of the payer and payee are debited and credited (respectively) in a different currency in a cross-currency payment.

in commercial bank money – which by definition implies the potential for liquidity and/or credit risk to arise for end-users – both forms of risk do not apply when transactions are settled in central bank money (see Bindseil, 2019, Chapter 2).

In 2020, improving cross-border payments was set as a key priority for the G20: the G20 asked the Financial Stability Board (FSB), working with the Committee on Payments and Market Infrastructures (CPMI) and other standard-setting bodies to co-ordinate a three-stage process to develop a roadmap to enhance cross-border payments. The FSB (2021) explains on its website about its work in 2020/2021 that:

> *"Cross-border payments sit at the heart of international trade and economic activity. However, for too long cross-border payments have faced four particular challenges: high costs, low speed, limited access and insufficient transparency. Faster, cheaper, more transparent and inclusive cross-border payments would have widespread benefits for supporting economic growth, international trade, global development and financial inclusion. Given the cross-border nature of these issues, coordinated international action will be central to addressing these issues, and we will also need close collaboration with the private sector."*

The conclusion that it is time again for forceful measures to improve cross-border payments resulted from several considerations. Globalisation and thus volumes of cross-border payments have continued (and indeed are forecasted) to increase (e.g. Bank of Canada, Bank of England and Monetary Authority of Singapore, 2018; FSB, 2020a; Bank of England, 2021). Moreover, digitalisation has made instant cross-border communication quasi cost-free, implying that international electronic payments should have enormously benefited from this. However, there has not been a striking decline in the costs associated with executing cross-border payments (ECB, 2016; International Monetary Fund, 2017; CPMI, 2018, 2020; ECB and BoJ, 2019). Two main reasons have been identified for this. First, intermediaries continue to struggle to ensure compliance with AML/CFT regulations and fear the legal and reputation risks of non-compliance. Second, although payment service providers have improved the "front-end" of completing cross-border payments in the form of enhanced user convenience, the

"back-end" of facilitating payments, through payment and market infrastructures, continue to face many challenges (CPMI, 2018, 2020).[2] In this context, the FSB (2020a, p. 14) notes that:

> *"The cost elements that affect the supply side include operational cost, financial regulatory compliance cost, network cost, correspondent cost, FX cost, and liquidity cost and costs resulting from ensuring adequate transparency in order to help protect cross border payments from money laundering and the financing of terrorism and proliferation (AML/CFT). These cost elements can lead to high barriers of entry and an unwillingness to do business with less profitable customers. Smaller banks and non-bank PSPs may need to rely on other banks in foreign jurisdictions, with accompanying additional liquidity and credit risk. Others may not be able to find correspondents or bank partners at all. A further cost component for multinational PSPs offering services in various countries and currencies is the need for liquidity access in several currencies and the related FX risk. Likewise, effective screening processes are costly."*

The chief organization for improving the effectiveness and efficiency of AML/CFT standards is the Financial Action Task Force (FATF), which also leads (together with the Basel Committee on Banking Supervision – BCBS) the crucial work on building block 5 ("Applying AML/CFT rules consistently and comprehensively") of the G20 work on improving cross-border payments. This paper does not further discuss how to improve the efficiency and effectiveness of AML/CFT compliance but assumes further progress in this field.

Under such an assumption, this paper argues that after more than thousand years of search, the holy grail of cross-border payments can be found within the next ten years. To this end, section 2 of the paper briefly recalls a few historical elements involving the search for efficient cross-border payments and identifies a number of universal challenges across time. Sections 3-8 each present and review one option for enhancing cross-border payments towards reaching its holy grail. Section 3 covers correspondent banking, both in its current implementation, as well as a modernised version. Section 4 reviews emerging Fintech solutions, which have already delivered in terms of offering cheaper than ever cross-border payments for certain currencies and use cases. Section 5 discusses Bitcoin, which is

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[2] This contrasts with domestic retail payments, whereby both front and back-end arrangements have undergone significant changes (see CPMI, 2016b). For instance, "TARGET instant payment settlement (TIPS)" by the ECB, the "New payments platform (NPP)" by the RBA, and "RIX-INST" by the Swedish Riksbank, all allow domestic retail payments to be settled instantaneously in central bank money on a round-the-clock basis (see, for example, Bolt, Emery and Harrigan, 2014; Rush and Louw, 2018; RBA, 2019; Conesa, 2021; Renzetti et al, 2021; Riksbank, 2021).

distinct from the alternatives as it relies on a completely different settlement asset which is not linked to any fiat currency. Section 6 turns to global stablecoins such as the one envisaged initially by Facebook (Libra/Diem). Section 7 unpacks the case of interlinking domestic payment systems through a cross-system and FX conversion layer, which is also an option explored currently by the G20 work, notably in its building block 13 (see FSB, 2020b, p. 26). Finally, section 8 analyses the case of central bank digital currencies (CBDC), again interlinked cross-border through an FX conversion layer. Each of the arrangements covered in sections 3 to 8 are assessed in terms of their actual or potential efficiency, architectural parsimoniousness, competitiveness and, relating to that, preservation of monetary sovereignty. Section 9 concludes that the interlinking of domestic payment systems and the future interoperability of CBDCs are the most promising avenues.

2. Short history: the search of the holy grail since the Middle Ages

The process through which cross-border payments have been settled has evolved over the centuries (partially analogous to domestic payments, see Bindseil, 2019, 2021 and Russo, 2021). To a significant extent, medieval foreign trade and therefore cross-border payments were facilitated through the shipping of bullion, or via payment in gold coin (Einzig, 1962, p. 61-63). Nonetheless, payment through coins was inconvenient, costly and time consuming, as in many cases, it was necessary to pay a professional "moneychanger" to ensure that the type and quality of any coins tendered were of the required standard (Mueller, 1997, Chapter 1; see also Kohn, 1999).

Therefore, the first major financial instrument employed for the purpose of executing international transactions was the **bill of exchange**, which came into being in the Arab world during the early Islamic era (Geva, 2011). In short, a bill of exchange was a written order by the issuer (drawer), which instructed a counterparty (drawee) to remit an amount, either immediately through a sight-bill or by a fixed date via a term-bill. If the drawee failed to pay (known as a "protest"), the drawer would be entitled to seek compensation through the courts, which would immediately execute an order against the failing party (Kahn, Quinn and Roberds 2014; Bolton and Guidi-Bruscoli, 2021).

As denoted by Kohn (1999), the predominant function of bills of exchange was for remittance and trade finance, and provided a means of payment at a significantly lower cost than shipping bullion.[3] Yet even at this early stage (i.e. prior to the introduction of electronic messaging standards), financial institutions had established a system of mutual accounts through the introduction of **correspondent banking**, in which one bank (the correspondent) provided a service to another bank (the respondent) (CPMI, 2016a). In this way, banks were able to offer mutual extensions of credit to one another through "vostro accounts", that, from the point of view of the other respective bank, was recognised as a "nostro account" (e.g. De Roover, 1944; Harfield, 1951).

By design, bills of exchange through correspondent banking arrangements permitted traders to repatriate funds from one jurisdiction to another, which mitigated the necessity for the shipping of bullion to complete a payment. For instance, a London wool exporter could have originally accumulated deposits in Antwerp, whilst the Flemish wool exporter would increase their deposits in London (Desan, 2014, pp. 228-229). In the instance where, say, the London exporter was required to settle a net transfer of deposits to the Flemish wool exporter following a deficit in trade, the English exporter would purchase a bill of exchange from their bank in London in Pounds. This would be drawn on the correspondent bank (i.e. the Flemish bank) in foreign currency, which would act as the acceptor. After receiving the bill of exchange in the mail,[4] this enabled the correspondent bank to debit the vostro account of the London bank and ensured that the Flemish wool exporter received payment in the domestic currency.

Prior to the First World War, global trade and cross-border payments had increased remarkably, ushering in the first era of globalisation (Keynes, 1919, p. 11). Whilst bills of exchange continued to be employed as an instrument of cross-border remittance, electronic direct deposit transfers through correspondent banking arrangements began in the midst of the 19th century after the laying of the first transatlantic cable and gradually accelerated (Eichengreen et al, 2021).

Although the use of telex messages for international interbank communication fundamentally increased the degree of financial integration, security and a lack of automation remained an issue even in the post-war area (Köppel, 2011). This prompted 239 banks from 15 countries to form a cooperative utility, the Society for Worldwide Interbank Financial Telecommunication (SWIFT), to reconcile

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[3] Bills of exchange were also utilised for executing domestic payments, otherwise known as "inland" bills of exchange (Desan, 2014, p. 244).
[4] For estimates of postal times, see Mueller (1997, p. 295).

problems in communicating across borders and to establish a common messaging standard. By the time SWIFT became live in 1977, 518 institutions from 22 nations were employing the SWIFT MT messaging standard (SWIFT, 2021a). SWIFT has recently announced that by November 2025, it will fully adopt the ISO 20022 messaging standard for all cross-border payments (SWIFT, 2021b).

Despite numerous evolutions, many of the principal challenges associated with cross-border payments have been consistent across time, as briefly summarised in Table 1. The list of frictions in cross-border payments shown in this table is largely based on FSB (2020a, p. 18-20). In addition, the measures considered currently by the G20 to address such frictions are outlined and structured in building blocks in FSB (2020b).

Table 1: Universal challenges of cross-border payments

	2020	1200-1900
1. Data standards and formats vary significantly	Adoption of new more comprehensive ISO20022 messaging format vs different insufficient legacy message formats (as supported in building block 14 of FSB 2020b).	Variety of conventions for example for the specification of bills of exchange. Handbooks like Kruse (1782) contain hundreds of pages explaining the different standards for coins and bills of exchange across global trade and settlement places
2. Complex processing of compliance checks	AML/CFT and other compliance checks have been perceived as heavy by banks, also as their implementation across jurisdictions is heterogeneous, creating high costs and legal risks (discussed in building blocks 4-8 of FSB, 2020b)	Challenging compliance with usury prohibition in international bills of exchange in the Middle Ages and early modern times. See e.g. De Roover (1953)
3. Limited operating hours	If RTGS systems and correspondent banks have no overlapping opening hours, then the payment chain may be delayed awaiting the re-opening of a relevant system (covered in building block 12 of FSB, 2020b)	In the Middle Ages and in early modern times, documents or value tokens travelled slowly, so that daily operating hours per se did not matter. However, in case there were regular settlement days for bills of exchange (e.g. quarterly), then the combination of infrequent settlement days and slow travel of e.g. bills of exchange could lead to even longer settlement lags.
4. Legacy technology platforms	Payment systems may follow old standards and that are costly to modernise because they would require to be completely redone because of outdated standards or programming languages (building block 17 of FSB, 2020b explores the feasibility of new multilateral platforms for cross border payments).	Technology per se was not a relevant category before the second half of the 19th century. Outdated standards and conventions could be classified as "legacy systems" but would be covered under 1.

5. Funding costs	Inefficient payment and settlement typically requires higher liquidity (building block 11 of FSB, 2020b) proposes liquidity bridges to address these challenges.	Interest rates and access to credit and thus the costs of liquidity were often significantly higher than today and therefore the need for liquidity in early trade was at least as pervasive as today.
6. Long transaction chains	Several correspondent banks needed in an international payment chain before settlement, delaying settlement and making it more expensive as each intermediary requires to be compensated (including for compliance related work), and making the chain less traceable and more opaque.	Long payment chains were experienced with bills of exchange, which were often endorsed and passed on multiple times. However, this may also have been useful as in this way the bill could be used several times as means of payments. The key trick of the bill of exchange was that all signatures in the chain of endorsements remained liable, so that the credit quality of a bill of exchange did not deteriorate when being passed on. On the other side that meant contingent liabilities for all signatories.
7. Weak competition	The high costs and risks associated with AML/CFT regulation and fines applied to banks led to a withdrawal of many banks from this business ("de-risking"), providing the remaining actors more market and thus pricing power.	Cross-border payments were often dominated by relatively few internationally active banking houses (like the Fuggers, Medicis, or later the Rothschilds), having market power and the associated ability to accumulate significant wealth
8. Crime threat	Cyber-risk management creates significant costs and entry barriers and is perceived to be an increasing challenge and cost factor for any bank, payment system and market infrastructure.	Physical extortion of value token; robbery. Both in transport and in vault. Reduced significantly through reliance on bills of exchange.
9. Slow speed and high costs of shipment	Hardly relevant today as costs of international data transmission have collapsed over the last decades.	Highly relevant in the past when value tokens or paper credit had to travel physically over long distance.
10. Relevance and challenges of currency conversion	International payments are typically done in international currencies, implying local currency conversion relying on banks offering such services at a cost to the end user (taken up in building block 13 of FSB, 2020b).	Numerous coin types and qualities circulating in parallel. Heterogeneous coinage and Gresham's law as major driver of reliance on paper instruments and the emergence of early commercial and public giro banking.

3. Correspondent banking

3.1 Motivation and Design

As noted in section 2, correspondent banking arrangements have existed for many centuries and are still widely used for the purposes of completing cross-border payments. At the same time, correspondent banking is considered relatively expensive (ECB, 2016; Rice, von Peter and Boar, 2020). McKinsey (2018) estimates that a financial institution facilitating a cross-border payment will on average receive 20 US Dollars in fees from a single transaction, with a study of Oliver Wyman and J.P.Morgan (2021) approximating global costs of around $120 billion on an annual basis. In parallel, cross-border payments have become increasingly concentrated, as a result from "de-risking". For example, Accuity (2017) estimate that the number of correspondent relationships for cross-border payments denominated in US Dollars has fallen by 15 percent since 2013. Similarly, there has been a 23 percent decline since 2009 for international transactions denominated in euro (see also World Bank Group, 2018).[5]

The decline in correspondent banking services can be mainly attributed to the requirement for banks to comply with several layers of regulations and requirements, such as those associated with AML/CFT and KYC requirements (CPMI, 2016a; International Monetary Fund, 2017; ECB, 2020) and the associated high costs and legal risks. The settlement of cross-border payments also continues to be executed in a non-instantaneous manner owing to fragmented data and message formats[6] and different operating hours of RTGS systems and banks in different time zones. These factors often prevent intermediaries from performing the straight-though procession (STP) of payments (FSB, 2020).

In the case of large multinational companies or financial institutions, delays and the uncertainty about the timing of cross-border payments are problematic, whilst for smaller businesses and individuals,

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[5] As from the perspective of the respondent bank nostro account balances are effectively a claim on the correspondent bank, such an "IOU economy" generates financial instability risks. With the number of correspondent banking arrangements becoming increasingly concentrated, this in turn implies that contagion risks in the event of a financial crisis are escalated. For a survey of the problems associated with credit-interconnectedness, see Gai and Kapadia (2010).

[6] For instance, CPMI (2018) notes that under many messaging formats and communication networks, character limits and other restrictions may prevent the sending of data specifically associated with a payment, which lead to manual interventions and therefore a decline in efficiency (see also CPMI, 2020).

transaction fees are a key concern. These issues are exacerbated for end-users in emerging market and developing economies, due to e.g. higher ALM/CFT costs and risks, and less competition.

Initiatives have been launched to address some of the above issues. The CPMI (2018) suggests that through the wide-scale adoption of ISO 20022, payment service providers will be able to accomplish fully automated STP. Whilst the motivations for ISO 20022 originally stemmed from a desire for greater efficiency in cross-border payments, it has been increasingly adopted in systems for real-time instant domestic retail payments. In addition, ISO 20022 supports greater automation of several compliance checks as payment messages (when compared with other messaging formats) include additional information fields (RBA, 2019; Major and Mangano, 2020). Finally, banking, payment and settlement systems tend to evolve towards 24h operations, which would solve the issue of disjunct operating hours across time zones.

The commitment to improve correspondent banking has also been demonstrated by a number of the G20/FSB cross-border payments building blocks focusing on these issues (see CPMI, 2020 and FSB, 2020b). Building blocks 5/6/7/8 all aim at improving the efficiency of compliance checks. These are of course not only relevant for correspondent banking, but for any cross-border payment solution. For instance, building block 12 aims at "…ensuring overlapping of payment system operating hours across time zones". Likewise, building block 14 relates to the promotion of common message formats, such as ISO 20022 (CPMI, 2020, pp. 44-47).

Last but not least the SWIFT gpi initiative promises to improve speed, accountability and transparency of cross-border payments relying on correspondent banking (SWIFT, 2020, p. 6). "SWIFT gpi combines the traditional SWIFT messaging and correspondent banking system with a new set of business rules captured in a set of multilateral service-level agreements … between participating banks… SWIFT member banks who commit to gpi agree to provide same-day use of funds, transparency of fees, end-to-end payments tracking and unaltered transfer of remittance information. SWIFT value-added solutions include the gpi Tracker, Observer and Directory (all discussed in Chapter 3) and enable gpi banks to track payment progress in real-time, monitor SLA compliance and seamlessly interoperate with other member banks in the gpi ecosystem. Today, SWIFT gpi ensures that cross-border payments are fast, fully trackable in real-time and confirmation is delivered when the beneficiary account is credited. … Thousands of banks in numerous countries have already implemented SWIFT gpi, building on SWIFT's existing infrastructure" (SWIFT, 2020, pp. 9-10). SWIFT also shares the vision of the holy grail of cross-border payments, with gpi as major contribution to achieve it through correspondent

banking: "The SWIFT vision for the future is simple: to make real-time, 24/7 cross-border payments as seamless, convenient, cost-efficient and accessible as domestic payments" (SWIFT, 2020, p. 29).

3.2 Settlement Mechanics

The following systems of financial accounts illustrate the ("flow-of-funds") mechanics of cross-border payments. The approach to illustrate payment flows in closed systems of financial accounts is explained for example in Pantelopoulos (2021), or in Bindseil and Fotia (2021). To consider the settlement mechanics of a cross-border payment through correspondent banks,[7] suppose that the bank, Bank A1, of the importer (Firm A) must rely on an intermediary, Bank A2, to complete a cross-border payment. We are assuming that Bank A2 is already equipped with nostro account balances i.e. currency B deposits. Otherwise, it would be required to either (i) enter the (spot) FX market by attempting to offload currency A reserves for stocks of currency B; or, (ii) enter into an FX trade (e.g. spot, outright forward or swap) with another bank (see Pantelopoulos, 2021). The accounts below therefore illustrate only the simplest cases. Moreover, we only show the simplest cases because we assume a rather short chain of correspondent banking relations needed for settlement, which is less plausible for the non-major currency corridors.

(i) Non-instantaneous correspondent banking

Firm A needs to import a good with a value, when expressed in B-currency, in the amount of **"a"**. Therefore, when expressed in A-currency, the value of the good is **βa,** whereby **β** is the **exchange rate**, with **β** being the **number of A-currency units needed to buy one B-currency unit**.[8] The positions X stand for stocks prior to any transactions, whereby X varies across the accounts (i.e. each X in the table is nominally different). Despite recent efforts, most cross border payments through correspondent banks are still not instantaneous. Also, the delivery of goods in international trade is not instantaneous. In the very first financial accounts below we will distinguish all of these steps – in total four – but

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[7] This is by no means an exhaustive outline. For example, banks may be equipped with subsidiaries or branches in foreign jurisdictions, which can alleviate the necessity for a bank to rely on a correspondent. As suggested by Jones (1993, pp. 13-14), multinational banks developed on a large-scale during the 1830's, as in being managed from their headquarters in London, many British institutions opened overseas branches in the colonies of Australia, the West Indies and Canada.

[8] We will follow this convention throughout the paper.

simplify later and focus only on the cross-border payments. Therefore, the financial accounts below show the cross-border payment flow process being split into two steps. Having only two steps relies on four assumptions: (i) the domestic payment systems and banks work instantaneously and have straight-through processing; (ii) they do so even for payments with international dimension, requiring that payment message formats are rich enough to contain all the necessary information for an international payment and are standardised for international automated processing, and that AML/CFT checks have been done in advance or are also automated to ensure (iii) the operating hours of the financial system in the two countries overlap at least briefly; (iv) also the export firm in country B "ships" the real good immediately when having received the payment, and once shipped Firm A can book the real goods as now being in its ownership (although physically they are still on their way, unless it is a virtual good, like a software delivered online, which could be delivered instantaneously). In reality, correspondent banking is still struggling with these four assumptions, implying that the case below only illustrates one of the various constraints which correspondent banking is still working on. If one changes any of the four assumptions, one needs to introduce additional steps in the flows of funds sequence, which extends the fundamental issue of settlement delays, and therefore adds settlement risks. In the accounts below, we show different flows of funds in different colors if they take place at different moments in time. As we need to distinguish (thanks to our simplifying assumptions) only two moments in which flows occur and accounts change, we will show those taking place first as **a** (or **βa** when they occur in A-country) and those taking place later as **a** (or **βa**):

- First **(a)**, the importer (Firm A) instructs its bank, Bank A1, to make the payment that will result in the account Firm B, the exporter, with Bank B2 be credited. Bank A1 debits the deposit given that the RTGS systems of nation A and nation B do not open at the same time (but have overlapping hours). Also, Firm A has some temporary "IOU" style claim on Bank A1 in the sense that it has seen its deposit account being debited, without the promised service (ensuring that the account of Firm B with Bank B1 is credited) has taken place. It is assumed that Bank A1 makes immediately an instantaneous payment in central bank money via the domestic payment system to Bank A2 and transmits in relation to the payment sufficient information explaining to Bank A2 on why it makes this payment and what is expected as matching international payment. To deliver on the latter, Bank A2 immediately sends related instruction to Bank B2 in country B. However, then nothing else happens for the time being as in B-country the systems of banks and the domestic payment system are closed.

- Second **(a)**, with the payment systems of the two countries now simultaneously open, and assuming that in the domestic banking system of country B, like in A, everything can be settled instantaneously and simultaneously (the ideal case), settlement is completed through Bank B2 debiting the vostro account of Bank A2, transferring central bank money via the domestic payment system to Bank B1, together with the necessary instruction to credit the deposit account of Firm B. By assumption, Bank B1 has straight through processing and immediately credits the deposit account of Firm B, and Firm B's IT systems immediately recognise this incoming payment and trigger the shipping of the export good. Also Firm A is still operating (we assumed at least short overlapping operating hours) and therefore can now record in its accounts ownership of the good it is importing, and therefore the IOUs withing country A (between the Firm A and its Bank B1, and between BanB1 and Bank B2) all vanish.

Table 2a: Non-instant cross-border payment through correspondent banking

Country A - in A-currency					
Firm A (importer)					
Real goods	X	$+\beta a$	Equity	X	
Temp IOU claim on Bank A1	X	$+\beta a$			
Claim on Firm B	X				
Account Bank A1	X	$-\beta a$			
Bank A1 (a domestic bank servicing firms and households)					
Deposits with central bank	X	$-\beta a$	Deposits Firm A	X	$-\beta a$
Temp IOU claim on Bank A2	X	$+\beta a$ $-\beta a$	Temp IOU claim of Firm A1	X	$+\beta a$ $-\beta a$
Bank A2 (an internationally active correspondent bank)					
Deposits with central bank	X	$+\beta a$	Deposits	X	
Nostro B2	X	$-\beta a$	Temp IOU Liability to Bank A1	X	$+\beta a - \beta a$
Central Bank A					
Other assets	X		Deposits Bank A1	X	$-\beta a$
			Deposits Bank A2	X	$+\beta a$
			Banknotes issued	X	
Country B – in B-currency					
Central Bank B					
Other assets	X		Deposits Bank B1	X	$+a$
			Deposits Bank B2	X	$-a$
			Banknotes issued	X	
Bank B2 (an internationally active correspondent bank)					
Deposits with central bank	X	$-a$	Deposits	X	
Other assets	X		Vostro A2	X	$-a$
Bank B1 (a domestic bank servicing firms and households)					
Deposits with central bank	X	$+a$	Deposits Firm B	X	$+a$
Other assets	X				
Firm B (exporter)					
Real goods	X	$-a$	Equity	X	
Account Bank B1	X	$+a$			

(ii) Modernised correspondent banking (instantaneous)

If one could assume that the ongoing efforts to improve correspondent banking are proven to have been successful at some point in the future and not only the four assumptions stated above are fulfilled, but in addition that the two banking and payment systems become operational 24/7, then everything can be settled instantaneously, avoiding settlement risk and reducing settlement costs for the benefit of international trade. This is illustrated in the financial accounts below.

Table 2b: Instant cross-border payment through correspondent banking

Country A - in A-currency			
Firm A (importer)			
Real goods	X + β a	Equity	X
Account Bank A1	X - β a		
Bank A1 (a domestic bank servicing firms and households)			
Deposits with central bank	X - β a	Deposits Firm A	X - β a
Other assets	X		
Bank A2 (an internationally active correspondent bank)			
Deposits with central bank	X + β a	Deposits	X
Nostro B2	X - β a		
Other assets.	X		
Central Bank A			
Other assets	X	Deposits Bank A1	X - β a
		Deposits Bank A2	X + β a
		Banknotes issued	X
Country B - in B-currency			
Central Bank B			
Other assets	X	Deposits Bank B1	X + a
		Deposits Bank B2	X - a
		Banknotes issued	X
Bank B2 (an internationally active correspondent bank)			
Deposits with central bank	X - a	Deposits	X
Other assets	X	Vostro A2	X - a
Bank B1 (a domestic bank servicing firms and households)			
Deposits with central bank	X + a	Deposits Firm B	X + a
Other assets	X		
Firm B			
Real goods	X - a	Equity	X
Account Bank B1	X + a		

3.3 Can modernised correspondent banking be the holy grail of cross-border payments?

Correspondent banking has been for many decades the predominant solution to cross-border payments. This means it was the most efficient available solution, even if it seems to have remained slow and costly relative to an ideal state. A modernised system of correspondent banking can certainly move closer to accomplishing the holy grail of cross-border payments:

- First, compared to other options discussed in this paper, **correspondent banking is a well-tested method for the settlement of cross-border payments**, given its historical and contemporary role in serving global trade, finance and remittance. Modernising it allows to re-use the current network of interbank and client relationship and the established KYC and compliance processes and expertise.

- Second, **the use of correspondent banks avoids the drawbacks of cross-border payments being completed through a single provider in a closed-loop system** (such as that under a global stablecoin framework, leading to fragmentation and/or market power). Reducing legal risks through a better co-ordinated and implemented set of AML/CFT rules could attract banks to return to offering correspondent banking services and enhance the competitiveness of this activity.

- Third, **monetary sovereignty would not be undermined** as the current system of nationally regulated banks providing key cross-border payment services with the help of domestic infrastructures would continue to prevail.

- Fourth, **correspondent banking has universal reach**: Provided my counterparty has a bank account (as the majority of people in the developed world have), my bank will find a path to make that payment, even if it requires multiple intermediate steps.

- Finally, correspondent banking may continue to remain the only feasible solution for low-volume cross border payment corridors, and in case theoretically better solutions are not being established because of their high fixed costs, a lack of political will, legal hurdles or any other impediments.

Whilst there are many positive aspects to modernised correspondent banking, several issues will continue to linger:

- **It will still remain a layered network**, and therefore will retain shortcomings related to completing payments through multiple intermediaries.

- Even in the instance where payments can be completed instantaneously, **existing claims and liabilities in respective nostro and vostro accounts will continue to be denominated in commercial bank money**, thereby potentially posing financial stability risks. It will continue to rely on a complex network of claims and liabilities ("IOUs" between banks) which are not cleared regularly with one single medium of exchange. At the same time, banks tend to be well-supervised everywhere compared to alternative arrangements such as stablecoins, and they typically benefit, as long as they remain solvent, from a lender of last resort (LOLR). Also, settlement in commercial bank money is not per se problematic, at least not for low-volume cross-border payment corridors.

- While being less vulnerable to the abuse of market power and/or fragmentation related to closed-loop global stablecoin solutions, **it is still by nature an approach which has been and will continue to be significantly concentrated amongst a few participants**. Correspondent banking benefits from network effects, in which the large players can offer better services than small players. This will continue to prevail even if some banks return to offering correspondent banking services because of lower compliance costs and risks. Dominant correspondent banks will inevitably exploit their market power through higher than competitive fees.

In conclusion, correspondent banking continues to demonstrate its viability by being the predominant solution of cross-border payments. Although current initiatives to improve it are credible, achieving the holy grail through such an avenue may remain elusive as it will (i) remain by nature a somewhat inefficient approach in terms of a multiplicity of "IOUs" and lengthy transaction chains , (ii) rely extensively on commercial bank money settlement, (iii) pose financial stability vulnerabilities and (iv) result in continuing market power of the leading correspondent banks.

4. Cross-border payment FinTechs present in multiple countries

4.1 Motivation and design

What we call here cross-border payment FinTechs tend to be e-money institutions or payment services providers more or less specialised in cross-border payments. These include both broad retail payment services providers like PayPal (which has so far not been very ambitious in terms of offering cheap cross-border retail payment services) and various newer, smaller companies rapidly building up a customer base, such as Wise, Skrill, Revolut and others. Last but not least, some specialised banks like

Western Union and MoneyGram have been offering similar services for a long time, but would typically not be given a "FinTech" label (as they are more traditional banks and operate with a branch network that allows to offer operations without internet access and even with cash pay-ins and out). According to Bech and Hancock (2020), these service providers would generally have to be classified as closed-loop solutions:

> *"The second model is a closed loop. This is sometimes known as an in-house or intragroup transfer system because there is a single central PSP that provides services to both the payee and the payer. Western Union and MoneyGram have a long history of providing remittances via closed-loop systems; they have a physical presence in each of the jurisdictions they serve and do not require users to open an account. More recently, AliPay and WeChat Pay have been very successful using a closed-loop model for domestic payments in China. Nevertheless, this is unlikely to be a feasible global solution. It would require payees and payers around the world to all use the same PSP, which would be a coordination challenge and lead to concentration risk. Closed loops are mainly improving particular niche cross-border payments. AliPay and WeChat Pay are increasingly partnering with overseas payment operators to allow Chinese travellers to use their mobile payments application whilst abroad. Other fintech firms, such as Revolut and Transferwise, provide services in currency pairs for which there is high turnover, using incoming payments to fund outgoing payments in the same currency to minimise costs."*

Looking at the corridors served by the firms mentioned, it could appear that they actually go beyond "niches" and actually also their closed-loop character may not be as deep and therefore be somewhat less a problem from an economic perspective. That these providers serve more than niches is also suggested by the remittance costs tracker offered by the Worldbank (https://remittanceprices.worldbank.org/en), where such type of companies appear to perform particularly well, and better than e.g. correspondent banking (while e.g. stablecoin based solutions are not identified yet as offering competitive services). For example, by querying the tracker for the best providers for remittances from Germany to India for a payment of EUR 140, the fee-ranked list suggests first Fintechs named Skrill, RemitMoney, Kotak Click2Remit, Remitly, WorldRemit, Azimo. Only then follow some banks offering correspondent banking services. Payment instruments, i.e. the sources of the funds to be transferred, would be amongst three types in particular, bank accounts, debit cards, credit cards. Total fees in euro (including charges in the form of deviations from the mid-market rate)

range between EUR 0.74 and 4.12 for the mentioned Fintech providers, while the cheapest bank offer would be for a fee of EUR 4.79. Of course, the transferred amount is small relative to many other cross-border payments, and the gap between Fintechs and correspondent banking is likely to be smaller for larger amounts, and very large amounts are actually not yet offered by FinTechs. Speed of the payment would be below one hour for some of the providers, while for others (including banks) it would be 2 days. The World Bank tracker does not offer rankings for remittances between industrialised countries. However querying individual providers for a 140 EUR transfer from Germany to the US would reveal fees similar to the ones from Germany to India, with however an additional provider (Wise) offering the cheapest price (which was not identified by the World Bank comparison tool). According to Bhattacharyya (2021), who focuses amongst others on the example of Wise, "Wise's cross-border payment system for businesses operates in a similar fashion to its consumer-to-consumer international money-transfer offering. The company has a network of local accounts around the world, and recipients are paid from Wise's local account and the money never crosses borders. This makes sending money cheaper and faster than traditional foreign-exchange methods, with time frames ranging from instant 30% of the time to a maximum of two days. Wise also has bank clients with which it partners to offer foreign-exchange services".[9] The scope of Wise payments would currently be extended into business to busines payments although currently the maximum limit for payments was still one million USD. The reason for the high efficiency of the FinTechs entering the retail cross-border payment market may relate to their lean set up (no branches; only internet access; fresh organisational set up); their specialisation (compared to e.g. universal banks), possibly their lighter regulatory treatment, their innovative technologies, or their aggressive market entry to gain a customer base. Actually, the financial technology they rely upon does not seem to be extremely innovative, and this is also not pretended by these companies. The companies rely on the internet for their client relationships and have no branches – but in contrast to stablecoins, they do not pretend that e.g. a reliance on DLT or blockchain are crucial to their transfer and settlement model, and actually do not seem to apply such technology. The legal type (bank, e-money institution, etc.) of FinTech payment companies will of course depend on the frameworks available in the jurisdictions in which they operate, but often these would be treated as specialised payment services providers or e-money institutions with a lighter

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[9] That "money never crosses borders" is not really specific to the cross-border payment solution offered by Wise or by other FinTechs.

regulation than banks in view of the absence of risky assets and an assumed matching of payment liabilities with very low risk and fully liquid assets.

4.2 Settlement Mechanics

The settlement mechanics of Fintechs offering retail payments cross-border payments are not necessarily identical, and one Fintech covering various currencies may also have established different settlement arrangements in different countries, without this necessarily making an obvious difference to customers. On the payer side, at least two options would be possible:

- the payer needs to establish an account with the Fintech provider and must first load funds to the account via a direct debit of their bank account or a funds transfer from it. Then the payer can trigger a payment up to the pre-funded amount.
- Alternatively, the payer triggers a fund transfer in one go together with the cross-border payment order, e.g. through a fast payment order, that is triggered by the FinTech through an application programming interface (API) allowing the Fintech to act as a payment initiator with the consent of the payer. This is more efficient for the user but requires open banking and an instant payment system.

On the payee side, again different options would be possible:

- First, the payee receives a notification via email or SMS that they are receiving a payment via a Fintech platform and needs to register first before the receipt of the payment is possible. If already registered, then the payment can come in directly on the bank account. This approach has the advantage that the payer does not need to know nor to reveal to the Fintech the bank account details of the payee (as a very minimum, the payer just needs to know the "proxy", which is the email address or the phone number of the payee). Only the payee would have to provide them to the FinTech if they are willing to accept the payment via this channel. Two sub-cases exist: the payee needs to register with their bank account details and the money once coming in is directly paid into the bank account. Alternatively, the money is only transferred on the account of the payee with the Fintech, and then the payee needs to trigger the transfer to any bank account (e.g. their own bank account or that of someone else).

- Alternatively, the payee could directly receive the payment in their bank account (without ever registering with the Fintech), but this requires that the payer knows and registers correctly all the bank details and other relevant information of the payee with the Fintech.

In both currency areas, the Fintech may or may not have a banking licence or other way to access central bank money. If it has no account with the central bank, it would use instead a commercial bank account. Table 3a assumes that the Fintech has in the country of the payer (country A) a licence giving it access to central bank money while in the country of the payee (country B), it has only a commercial bank account. We also assume that the payee is already registered, and that the money is paid in and out in both currencies through instant payments (including in the payer's currency through an API). We assume that the payment is a remittance and that the value to be received in B currency is **"a"**. Moreover, we assume that the payment stays on the account of the Fintech in both countries only for a few moments, but enough to show it in the accounts below. Therefore, we can think of **a, a, a** as occurring sequentially all say in less than an hour, in line with what the best FinTechs achieve according to the WorldBank tracker.

Table 3a: Instant cross-border payment through a Fintech payment services provider

Country A - in A-currency			
Household A			
Account Fintech	X + β a - β a	Equity	X - β a
Account Bank A	X - β a		
FintechX – subsidiary A			
Deposits with central bank	X + β a	Deposits Household A	X + β a - β a
		Liability to FintechX – subsidiary B	X + β a
Bank A			
Deposits with central bank	X - β a	Deposits	X
		Account Household A	X - β a
Central Bank A			
Assets	X	Deposits Bank A	X - β a
		Deposits FintechX subsidiary A	X + β a
Country B - in B-currency			
Household B			
Deposit FintechX-B	X + a - a	Equity	X + a
Deposits Bank B2	X + a		
FintechX subsidiary B			
Deposits with Bank B1	X - a	Deposit Household B	X + a - a
Claim on FintechX – subsidiary A	X + a		
Bank B1			
Deposits with central bank	X - a	Deposits FintechX B	X - a
Bank B2			
Deposit with central bank	X + a	Deposits Household B	X + a
Central Bank B			
Assets	X	Deposit Bank B1	X - a
		Deposit Bank B2	X + a

A further streamlining can be achieved if the payer and payee never actually hold balances with the Fintech, but the money is directly transferred from the payer's bank account. This is illustrated below and we assume that the entire process takes place simultaneously:

Table 3b: Instant cross-border payment through a Fintech payment services provider which is not collecting deposits of clients during the cross-border payment process

Country A - in A-currency			
Household A			
Account Bank A	X - β a	Equity	X - β a
FintechX – subsidiary A			
Deposits with central bank	X + β a	Liability to FintechX – subsidiary B	X + β a
Bank A			
Deposits with central bank	X - β a	Deposits	X
		Account Household A	X - β a
Central Bank A			
Assets	X	Deposits Bank A	X - β a
		Deposits FintechX Subs A	X +β a
Country B - in B-currency			
Household B			
Deposits Bank B2	X + a	Equity	X + a
FintechX subsidiary B			
Deposits with Bank B1	X - a	Liabilities	X
Claim to FintechX – subsidiary A	X + a		
Bank B1			
Deposits with central bank	X - a	Deposits FintechX B	X - a
Bank B2			
Deposit with central bank	X + a	Deposits Household B	X + a
Central Bank B			
Assets	X	Deposit Bank B1	X - a
		Deposit Bank B2	X + a

It is useful to recall that FintechX is in fact one global company, i.e. one can take a consolidated approach to its balance sheet, which would be as follows under the model where funds are first loaded on the accounts of households with the Fintech. We assume moreover that the holding company is in B-country and therefore has accounts in B-currency.

Table 3c: Consolidated account of the Fintech

FintechX consolidated view (B-currency)			
Deposits with central bank (A)	X + a	Deposits Household A	X + a - a
Deposits with Bank B1	X - a	Deposit Household B	X + a - a

In the model in which the funds do not go through the deposit (liability) accounts of the Fintech, obviously the only change occurs on the asset side of the Fintech.

Table 3d: Consolidated account of the Fintech if it does not collect customer deposits during the cross-border payment process

FintechX consolidated view (B-currency)			
Deposits with central bank (A)	X + a	Liabilities	X
Deposits with Bank B1	X - a		

4.3 Can FinTechs with presences in multiple countries be the holy grail of cross-border payments?

Over recent years, cross-border payment FinTechs have been able to offer to an increasing extent cheaper and faster retail cross-border payments than banks and any other competitors. They have added competition and as a consequence have contributed to an overall decline in cross-border payment fees in the segments they serve. This achievement has also been recognized by the World Bank, as its official tracker of executable cross-border payment service offers seems to confirm the supremacy of their offers. Their strengths relate to:

- Specialization to one (or few related) financial service(s), allowing to focus on delivering the best services where they have comparative advantages, and avoiding to the extent possible organizational and regulatory burden.
- Systematic use of new technology (internet access; remote user identification; no branches).

However, it may be too early to conclude that this supremacy is uncontestable:

- some of their very attractive offers might be unsustainable in the long run, as if it were to be part of their aggressive strategy to increase their customer base, future fee increases would be more or less unavoidable if they were to maintain profitability.

- As noted by Bech and Hancock (2020), they are in some sense non-interoperable closed loop solutions, like stablecoins. However, if on-boarding costs of clients are low, then the market power of dominant providers may remain relatively limited. Also, in contrast to stablecoins, they rely to a much larger extent on existing providers and infrastructures (banks and payment systems), i.e. they are less deep than stablecoins in terms of the closed loop they bring.

- It needs to be confirmed that the "one function – one risk - one set of rules" principle is effectively applied to these Fintechs in the domain of AML/CFT rules, relative to banks.

- So far the reach of Fintech solutions may be more limited, e.g. compared to correspondent banking, in view of a more siloed approach.

In any case, as mentioned, Fintechs have already contributed to improving cross-border payments.

5. Unbacked crypto-assets such as Bitcoin

5.1 Motivation and design

The FSB (2020a, 2020b) does not even consider unbacked crypto-assets such as Bitcoin as a suitable means of cross-border payments. In the following, we will refer only to Bitcoin as being the most prominent unbacked crypto-asset, but most of the analysis would apply equally to other unbacked crypto-assets. A growing community of Bitcoin supporters and investors argue that Bitcoin is the solution for cross-border payments – most recently for example in the context of payments to support Ukraine in the context of the Russian invasion. Already in the Bitcoin Whitepaper, Nakamoto (2008, abstract) portrays that Bitcoin would be "A purely peer-to-peer version of electronic cash" which "would allow online payments to be sent directly from one party to another without going through a financial institution." The global nature of Bitcoin, and with it the disintermediation of financial intermediaries and existing payment infrastructure, enabled supporters to conclude that it would also be an obvious candidate for cross-border payments as national and regulatory borders would not matter for a computer network in which location would be negligible.[10] The vision of Bitcoin as a solution to international payments was advocated for example by El Salvador's President Bukele, who passed legislation making Bitcoin legal tender in El Salvador. As reported for example by the New York

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[10] For a critical review of Bitcoin, see, for instance, BIS (2021) and Taleb (2021).

Times (7 September 2021, "In Global First, El Salvador Adopts Bitcoin as Currency", by O. Lopez and E. Livni):

> *"President Nayib Bukele, a tech-savvy millennial, has promoted the digital currency's adoption, pitching it as a way of bringing more Salvadorans, about 70 percent of whom don't have bank accounts, into the formal economy. Using the cryptocurrency would make it faster and cheaper to get remittances from abroad, he argues, and could free the indebted nation from the hold of the traditional global financial system."*

Furthermore, according to Bloomberg News, on the basis of an interview conducted with the President of the Central Bank of El Salvador (10/19/2021, "Bitcoin Is Part of the Pitch as El Salvador Courts IMF Deal", by M. Vizcaino and M. D. McDonald):

> *The cryptocurrency will lose its reputation as a speculative asset and prove its use as a legitimate payment system, central bank President Douglas Rodriguez said in an interview Monday. … "We don't see any risks. Perhaps, upside risks," Rodriguez said in a virtual interview from San Salvador. Bitcoin will "become a payment system, a system for financial inclusion."… "We've explained openly to the IMF: For us, Chivo and Bitcoin is simply a payment method" … Businesses in the capital of San Salvador, from Starbucks and McDonald's to local electronics stores, have begun to accept it in exchange for goods. Rodriguez reiterated that use of the cryptocurrency was optional and expected it to be used alongside the U.S. dollar. The next step for the government is providing Salvadorans living in the U.S. with identification numbers, a requisite for opening a Chivo account, he said. Doing so could offer a cheaper way for those living abroad to send money back to El Salvador, Rodriguez added.*

There are also many reports about Bitcoin supporter's quasi-religious belief that Bitcoin is actually "a new messiah" (e.g. Orcutt, 2017).

The design of Bitcoin has been described elsewhere in detail, such as in the initial White Paper by Nakamoto (2008). Also, a number of other crypto assets (like Ethereum) have been perceived as suitable means of payments, including for cross-border payments. The settlement mechanics described in the following section would also apply to those.

5.2 Settlement mechanics

The particularity of a cross-border payment in Bitcoin is its reliance on an independent third asset; i.e. it is neither in the currency of the payer, nor in the currency of the payee. Also, the value of Bitcoin in both currencies is permanently fluctuating. Six cases may be distinguished, along two dimensions: whether or not the payer and payee hold Bitcoin permanently (versus using Bitcoin only temporarily as a cross-border means of payment); whether or not Bitcoin service providers are used, and whether they are brokers or principals.

Table 4: Bitcoin cases considered

	No bitcoin service providers used	Bitcoin service providers as broker	Bitcoin service providers used as Bitcoin deposit issuer
Firms/households hold Bitcoins permanently	(i)	(ii)	(iii)
Firms/households use Bitcoin only for cross border payments; no permanent positions	(iv)	(v)	(vi)

(i) If payer and payee are holding permanent Bitcoin positions and do not use service providers

This case comes probably closest to the initial vision of Bitcoin. A Bitcoin holder may have built-up her position (i) by having received Bitcoin-transfers, (ii) through mining, or (iii) through exchange via fiat currency using a service provider, which does not matter for the following. For example, a household in A-country purchases a good via e-commerce from a B-country company which also accepts Bitcoin payment. Then, the value of the good in B-currency of "**a**" is added at the moment of payment in the Bitcoin position of the B-company. Upon receipt, the price of Bitcoin will fluctuate further and will generate accounting gains and losses on the books of the B-country e-commerce vendor. The financial accounts below illustrate only what happens at the moment of the transfer of the Bitcoins, and the subsequent changes of the Bitcoin positions because of valuation changes or rebalancing of positions are not shown. Only the pseudo-account of the Bitcoin network is denominated in Bitcoin (the Bitcoin network does not really have a balance sheet). **The payment in Bitcoin terms is for a value of αa Bitcoin where α is the inverse of the price of a Bitcoin** at the moment of the transaction (since the settlement in the Bitcoin network occurs only around every ten minutes, valuation effects are already

materializing at the moment of settlement, making Bitcoin payments actually more complicated than what is portrayed below). Regarding the exchange rate between A-country and B-country: **β is once again the number of A-currency units needed to buy one B-currency unit**.

Table 5a: Payment in bitcoin, Case (i)

A-country (in A-currency)			
Firm (or household) A			
Real goods	X + β a	Equity	X
Bank deposits	X		
Bitcoin	X - β a		
Bitcoin network (in Bitcoin)			
Minted bitcoins	X	Bitcoin of firm A	X - α a
		Bitcoin of firm B	X + α a
		Other bitcoins	X
B-country (in B-currency)			
Firm (or household) B			
Real goods	X - a	Equity	X
Bank deposits	X		
Bitcoin	X + a		

The striking feature of payments in Bitcoin is that, as pledged by Nakamoto (2008), no financial intermediaries need to provide their balance sheet for Bitcoin transactions to happen, nor are any traditional infrastructures, intermediaries, or payment systems required. The payment occurs directly in a third asset and can be completed relatively soon in accordance with the frequency of its settlement cycles.

Bitcoin has scaling and speed issues that have been acknowledged for some time (e.g. McCorry et al, 2016; see also BIS, 2018, Chapter V). Therefore, initiatives have aimed at establishing blockchain networks ("side-chains") linked to Bitcoin which would allow for immediate small payments. One prominent such network is the Lightning Network (Poon and Dryja, 2016, p. 1), which promises that "The bitcoin protocol can encompass the global financial transaction volume in all electronic payment systems today, without a single custodial third party holding funds or requiring participants to have anything more than a computer using a broadband connection". To achieve this, a decentralized system would let micropayments take place over a specific network with a transfer of value outside the proper Bitcoin blockchain, to be eventually settled (after netting and only occasionally) on the Bitcoin blockchain. As highlighted by the authors (p. 4), "[t]his permits the financial relationships between two parties to be trustlessly deferred to a later date, without risk of counterparty default.

Micropayment channels use real bitcoin transactions, only electing to defer the broadcast to the blockchain in such a way that both parties can guarantee their current balance on the blockchain; this is not a trusted overlay network —payments in micropayment channels are real bitcoin communicated and exchanged off-chain." GCEX et al (2021, p. 10) make similar proposals and note that "A number of Layer 2 solutions like Bosonic are emerging. These are separate domain specific blockchain networks linked to general purpose networks like Bitcoin and Ethereum. Trades are executed and net cleared on Layer 2, then settled at a convenient time slot by the custodian on Layer 1." We associate all such solutions to the one shown in the accounts above. The accounts could also be unfolded further as two-layer solution to show separately the lightning network.

(ii) If Bitcoins are held permanently <u>and crypto asset service providers (CASPS) are custodians</u>

The financial accounts representation is the same as in case (i), since the Bitcoin flows do not affect the books of the CASPS. Compared to option (i), the main difference is that the CASPS may have facilitated the connection of the payer and payee with the Bitcoin network and may have provided KYC and ALM/CFT related functions, as required by authorities. However, as highlighted for example by GCEX et al (2021, p. 6), many "crypto custodians rely on omnibus accounts, where customer assets are commingled on a single address. It simplifies key management and allows cheap and fast off-chain transfers. Yet, it sacrifices transparency, as the customer no longer has an independent mechanism to monitor transactions, and fully relies on the custodian to act in an agreed manner e.g. no re-hypothecation. Omnibus accounts also introduce legal uncertainty under liquidation, i.e. are assets on or off the balance sheet. Lack of transparency introduces additional and often unnecessary custodial counterparty risk, which may be unacceptable." Also, ASIFMA (2018, p. 23) argues that "The identification and ring-fencing of users' digital assets is arguably far preferable, to ensure that the assets will not form part of the estate available to the liquidator in the event of the insolvency of the custodian." One can conclude that there is in fact a continuum between (ii) and (iii), as there is economic and probably also legal ambiguity if the arrangements offered by service providers are of a custodial or depositary nature. Indeed, GCEX et al (2021, p. 10) also refer to the case that "Exchanges accept deposits from customers and let them trade with those deposits. All trades are cleared on a much faster centralized ledger, and only when the customer wishes to withdraw funds, does the exchange transfer on-chain." This seems to be the arrangement of the Chivo Bitcoin wallet used in El Salvador, which to date has not revealed its custody arrangement.

(iii) If Bitcoins are held permanently and <u>CASPs are Bitcoin deposit issuers</u>

As also Poon and Dryja (2016, p. 4) note, the problem of the inefficiency of settling small payments on the Bitcoin blockchain is often addressed today by offloading transactions to a large custodian, which settles the payments between clients in its own books (like in El Salvador within the Chivo Wallet). But this requires trusting the custodian, accepting related risks and possibly to pay the custodian a fee. We assume that the payments all take place at the same time, i.e. the CASPs execute the payment in Bitcoin in the Bitcoin network at the same time as they debit/credit the accounts of their clients. The two CASPs need to exchange messages to inform each other about the actions of the payer and payee. As a result, the CASP in Country A needs to instruct the CASP in Country B to credit a specific client as a counterpart to the Bitcoins received in the Bitcoin network.

Table 5b: Case (iii) – one CASP per country issuing Bitcoin deposits

A-country (in A-currency)					
Firm (or household) A					
Real goods	X	$+ \beta\, a$	Equity	X	
Bank deposits	X				
Bitcoin deposits	X	$- \beta\, a$			
Bitcoin CASP A					
Other assets	X		Equity	X	
Bank deposits	X		Bitcoin deposits	X	$- \beta\, a$
Bitcoin	X	$- \beta\, a$			
Bitcoin network (in Bitcoin)					
Minted bitcoins	X		Bitcoin of CASP A	X	$- \alpha\, a$
			Bitcoin of CASP B	X	$+ \alpha\, a$
B-country (in B-currency)					
Bitcoin CASP B					
Other assets	X		Equity	X	
Bank deposits	X		Bitcoin deposits of firm B	X	$+ a$
Bitcoin	X	$+ a$			
Firm (or household) B					
Real goods	X	$- a$	Equity	X	
Bank deposits	X				
Bitcoin deposits	X	$+ a$			

In practice, a multi-country service provider may have a significant advantage to that as portrayed above. This case, which may illustrate the case of the Chivo-wallet when used for Bitcoin remittances between a US-resident with El Salvadorian passport and an El Salvadorian resident, is illustrated below:

Table 5c: Case (iii) – Single multi-country CASP issuing Bitcoin deposits

A-country (in A-currency)					
Firm (or household) A					
Real goods	X	+ β a	Equity	X	
Bank deposits	X				
Bitcoin	X	- β a			
Global CASP (assuming accounts in Bitcoin)					
Other assets	X		Equity	X	
Bank deposits	X		Bitcoin deposits Firm A	X	- α a
Bitcoin	X		Bitcoin deposits Firm B	X	+ α a
Bitcoin network (in Bitcoin)					
Minted bitcoins	X		Bitcoin owned by firm A	X	
			Bitcoin owned by firm B	X	
			Other bitcoin	X	
Country B - (in B-currency)					
Firm (or household) B					
Real goods	X	-a	Equity	X	
Bank deposits	X				
Bitcoin	X	+a			

Now the global Bitcoin service provider can internalize the Bitcoin payment and save the costs of actually settling it in the Bitcoin network itself. Compared to option (ii), the costs of executing the Bitcoin transaction are likely to be significantly lower and settlement will be faster. However, this comes at the price of moving away from the original idea of Bitcoin of a network without intermediation and with all transactions visible in the single blockchain. Indeed, in the arrangement of (iii), Bitcoin users actually are exposed to mismanagement or fraud of the service provider (i.e. they are exposed to credit risk, in addition to the Bitcoin related market risks). Moreover, they are indirectly subject to the regulations imposed on service providers, which can be positive or negative (depending on the perspective and the objectives of the legislator).

(iv) Bitcoins only used for cross-border payments; no permanent positions, no use of CASPs

This case is not really feasible in the sense that firms/households need to exchange domestic currency into Bitcoin for every use of the Bitcoin network for cross-border payment purposes, as a counterparty must be found. In theory this could be a "family/friend" counterparty who is willing to exchange Bitcoin and domestic currency in such a way to match the needs of the cross-border payer or payee. However, this seems rather inefficient and unsecure.

(v) Bitcoins only used for cross-border payments, no permanent positions, CASPs are custodians

In the following we assume that in one of the two countries (country A) the CASP is not a bank, while in country B, the bank is itself the CASP. This allows both cases to be illustrated simultaneously. We assume also that in both cases, the CASP is not a principal to the Bitcoin position of the client, but only an agent and custodian. Three steps need to be distinguished which can be close to simultaneous if the Bitcoin versus domestic currency conversion is to be straight-through.

- First, the firm in country A exchanges domestic currency against Bitcoin **(a)**.
- Second step, the payment in Bitcoin takes place **(a)**.
- Third, Firm B converts the Bitcoins received into domestic currency **(a)**.

Table 5d: Case (v) – If Bitcoin only used for the payment using CASPs as custodians

Country A - in A currency					
Firm (or household) A					
Real goods	X	+ β a	Equity	X	
Bank deposits	X	- β a			
Bitcoin	X	+ β a - β a			
CASP A					
Other assets	X		Equity	X	
Bank deposits	X	+ β a			
Bitcoin	X	- β a			
Bank A					
Deposits with central bank	X		Deposits Firm A	X - β a	
Other assets	X		Deposits CASP A	X + β a	
			Equity	X	
Bitcoin network (in Bitcoin)					
Minted bitcoins	X		Bitcoin of CASP A	X - α a	
			Bitcoin of Firm A	X + α a - α a	
			Bitcoin of Firm B	X + α a - α a	
			Bitcoin of CASP B	X + α a	
			Other bitcoin	X	
Country B - in B-currency					
CASP and Bank B					
Deposits with central bank	X		Equity	X	
Other assets	X		Deposits of firm B	X + a	
Bitcoin	X	+ a			
Firm (or household) B					
Real goods	X	- a	Equity	X	
Bank deposits	X	+ a			
Bitcoin	X	+ a - a			

(vi) Bitcoins only used for cross-border payments, no permanent positions, CASPs are issuers of Bitcoin deposits

The case combines (iii) and (v). Again, compared to (v), it, can reduce the actual number of Bitcoin transactions – to zero if the CASP is a global company that can internalize all the Bitcoin transactions needed for the cross-border payments. This is likely to be efficient but makes the approach similar to the one of a global stablecoin denominated in Bitcoin.

5.3 Assessment: Can Bitcoin be the holy grail of cross-border payments?

The Bitcoin network (complemented by additional layers such as the Lightning Network to ensure speed and capacity, assuming that these are effective) may have some properties which would seem to make it potentially suitable to be the holy grail of cross-border payments:

- **One single system can be used "as is" for the entire world;** i.e. no further interlinking is necessary. Cross-border payments in Bitcoin appear as efficient as domestic payments in Bitcoin, without any further investment needed. This is also because the FX conversion takes place outside the Bitcoin solution, i.e. it is left to each user to convert from/into domestic currencies.

- **The absence of intermediaries suggests a high potential for efficiency** and no risks from operational or financial failures of intermediaries.

- **Wallet providers (CASPs) have in the meantime developed relatively efficient on and off-loading services from domestic currencies into Bitcoin**. However, at the same time no intermediaries are needed once a sufficient position of Bitcoin is available to a user for payment services and the user comfortable in accepting Bitcoin positions over time despite the large valuation changes (and implied accounting profits or losses).

Nevertheless, the list of Bitcoin's drawbacks as means of payment is lengthy (see also Bindseil, Papsdorf and Schaaf, 2022):

- **The underlying technology (and in particular its "proof-of-work" layer) is inherently expensive and wasteful.** If anything, it proves that a decentralized trust-creating mechanism relying on "proof-of-work" to render stable a permission-less blockchain is more expensive and less efficient than a centralized (e.g. based on central bank money) or semi-centralised

one (e.g. based on transfers between commercial bank accounts). As Nabilou (2020, p. 14) puts it: *"Rather than opt for fast and efficient payments, Bitcoin goes a long way to create extreme inefficiencies by introducing a distributed ledger that should be maintained, updated and validated by all fully validating nodes, only to make sure that no single or a small group of participants violate the rules of the Bitcoin protocol, modify the ledger arbitrarily or censor other stakeholders from participating in the Bitcoin network. Such a tradeoff has been made because the unique value proposition of Bitcoin and blockchain technology is not to replicate the functions of centralized technologies in a faster or cheaper fashion. Indeed, as blockchain technology is one of the least efficient technologies for payments and data storage, and as virtually everything that can be done on blockchain can also be performed on a network that uses a client-server or master-slave architecture, the very use of blockchain technology creates inefficiencies that do not apply to centralized systems. As the client-server architecture uses a centralized coordination mechanism, it is much faster, cheaper and efficient than the systems relying on blockchain technology….Since Bitcoin is designed to operate outside the legal framework…, it assumes an adversarial environment and prepares to defend itself against various attack vectors using a variety of ex-ante built-in mechanisms within the Bitcoin network rather than rely on the external legal system for ex-post remedies."* Even if additional payment layers like the Lightning Network attenuate speed and capacity issues in the sphere of micro-payments, this does not change the fact that these solutions also rely on the Bitcoin blockchain as an eventual settlement layer, which remains a wasteful system.

- Much of its perceived attractiveness for cross-border payments stems **from having escaped (so far) an equal regulatory treatment in terms of KYC, AML/CFT compliance**. This has led to a widespread use of Bitcoin for criminal purposes.[11] Regulators are expected to close this gap, which will increase the costs of (legal) Bitcoin transactions. The value proposition of Bitcoin must not be based on a misalignment of regulation across payment solutions. Some regulators have acted forcefully against Bitcoin (e.g. Chinese authorities banning it) and many are moving towards addressing the large AML/CFT compliance gap of Bitcoin that undermines the effectiveness of AML/CFT rules in general.

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[11] See Foley, Karlsen and Putniņš (2019) and Paquet-Clouston, Haslhofer and Dupont (2019).

- **Governance issues**: one of the supposed main strength of the system, that is to be secured against human intervention, seems to be at least as much of a weakness than a strength as it makes it difficult to agree and apply useful changes in view of a changing environment.
- **Its price volatility makes it unsuitable as unit of account** and also undermines its suitability of means of payment – both for domestic and cross-border.

In conclusion, Bitcoin is unlikely to be the holy grail of cross-border payments, primarily for three reasons. First, its underlying proof-of-work mechanism is inherently inefficient. Second, the supposed comparative advantages in cross-border payments are the result of regulatory gaps, which will however be closed as authorities realize that these gaps have significantly undermined the effectiveness of AML/CFT regulation and have supported Bitcoin as predominant global means of illicit payment. Third, Bitcoin is not even suitable as *domestic* payment system because it is inherently unstable in terms of its purchasing power.

It is still interesting to briefly compare the options (i)-(vi) in terms of their performance across several key criteria, as done in Table 6.

Table 6: Performance of Bitcoin across key criteria, differentiating between how it is used as cross-border means of payment

	(i)	(ii)	(iii)	(v)	(vi)
(Potential) compliance with KYC, AML/CFT, etc.	-	+	+	+	+
Efficiency (environmental and economic)	-	-	0	-	0
Fulfill vision of Bitcoin as unregulated peer-to-peer network	+	0	-	-	-
Avoid exposure to service providers	+	0	-	+	-

It seems difficult to rank the options overall, although from a public policy perspective, (i) appears particularly bad and (iii) and (vi) marginally less bad. The classification into red / orange / green is of course simplistic. The positive assessment of (ii)-(vi) in terms of compliance assumes that the relevant regulations of service providers are in place and thoroughly applied.

6. Global stablecoins

6.1 Motivation and design

The term "stablecoin" was first used in the White Paper of the "Dai Stablecoin System" (MakerDAO, 2017), which outlined that:

> "Popular digital assets such as Bitcoin (BTC) and Ether (ETH) are too volatile to be used as everyday currency. The value of a bitcoin often experiences large fluctuations, rising or falling by as much as 25% in a single day and occasionally rising over 300% in a month. The Dai Stablecoin is a collateral-backed cryptocurrency whose value is stable relative to the US Dollar. We believe that stable digital assets like Dai Stablecoin are essential to realizing the full potential of blockchain technology."

The next project using the term stablecoin was Havven, which was a so-called "algorithmic" coin project (Brooks et al, 2018). The vision of Havven was to make supply endogenous so as to stabilize the purchasing power of money. Section 1.3 of its whitepaper explained that:

> "Stablecoins are cryptocurrencies designed for price stability. They should ideally be as effective at making payments as fiat currencies like the US Dollar, while retaining their other desirable properties. A decentralised payment network built on a stablecoin would be able to capture all the benefits of a permissionless system, while also eliminating volatility. One approach to achieving price stability is to produce a token whose price targets the value of a fiat currency."

Today's biggest stablecoin in terms of market capitalisation is Tether which claims to provide "individuals and organizations with a robust and decentralized method of exchanging value while using a familiar accounting unit" (Tether, 2016). Tether has become a common means of putting funds into and out of crypto trading platforms. The Whitepaper of Tether of 2016 ("Tether: Fiat currencies on the Bitcoin blockchain") explains that:

> "The innovation of blockchains is an auditable and cryptographically secured global ledger. Asset backed token issuers and other market participants can take advantage of blockchain technology, along with embedded consensus systems, to transact in familiar, less volatile currencies and assets. In order to maintain accountability and to ensure

stability in exchange price, we propose a method to maintain a one to one reserve ratio between a cryptocurrency token, … and its associated real world asset, fiat currency."

The most ambitious global stablecoin initiative so far, Libra/Diem, claimed in its 2019 white paper to aim at providing an ethical, inclusive, frictionless, low-cost global payment network for all, i.e. to deliver the holy grail of global payments. As a construct, Diem was envisaged to offer (in its White Paper 2.0 version) both single currency coins, and a composite coin based on the IMF-SDR currency basket (called "≋LBR"). Both would be fully backed by highly liquid assets. The Libra Reserve – i.e. the assets to match the issued stablecoin – was envisioned to be composed essentially of high-quality liquid assets (e.g. government bonds).

The flow of funds mechanics of the creation of a stablecoin such as Libra was described in Bindseil (2020, p. 29). In section 6.2 below, we instead consider the flow-of-funds in the case where either single currency stablecoins are used for cross-border payments, presumably including FX conversion, or a multi-currency one (like ≋LBR) is used for cross-border payments without FX conversion. A single currency stablecoin could also be used for cross-border payments without FX conversion, but the case is not shown below, being similar to the multi-currency case.

In their efforts to define stablecoins, regulators have generally followed the technological perspective of the early stablecoin projects emphasizing the core relevance of blockchain technology. For example, the FSB (2019) provides the following definitions:

> *"**Crypto-asset:** A type of private digital asset that depends primarily on cryptography and distributed ledger or similar technology.*
>
> ***Stablecoin:** A crypto-asset that aims to maintain a stable value relative to a specified asset, or a pool or basket of assets.*
>
> ***Global stablecoin (GSC)**: A stablecoin with a potential reach and adoption across multiple jurisdictions and the potential to achieve substantial volume."*

One may wonder if underlying technology ("distributed ledger or similar") really should make a difference from a regulatory perspective. From any public policy perspective, be it payment system policies, monetary policy, financial stability, or consumer protection, the underlying IT technology should not matter per se - as long as it is effective and secure. It can be assumed that such a global stablecoin can be based either on DLT and blockchain or on central ledger technology with different

storage and validation techniques, with both having their specific advantages. Therefore, regulators could reconsider the technology dimension in the stablecoin definition at some stage. Maybe regulators and legislators accepted too easily the narrative of stablecoin initiatives that the use of DLT/Blockchain would per se create a class of payment systems or payment instruments on its own, and one which would be revolutionarily better. Compared with a system like Bitcoin (built on a permissionless blockchain and without convertibility promise), viable stablecoins appear in any case as rather conventional. In the following financial accounts in which the use of stablecoins as cross-border means of payments is illustrated, technology per se is indeed irrelevant.

6.2 Settlement mechanics

We consider the financial accounts representation of payments in the following two cases: (i) without FX conversion using a global stablecoin denominated in any reference asset (such as a currency basket, a single currency, or a commodity); and (ii) using two separate single currency stablecoins which however are part of one global network (like single currency stablecoins envisaged by Diem). While in the case of Bitcoin, we explicitly considered both the case of permanent positions in Bitcoin versus the case that Bitcoin is only held briefly for the purpose of cross-border payments, in what follows we will only illustrate the cases where the stablecoin is held permanently. Of course, it would also be possible to add the uploading and offloading transactions from domestic bank accounts into and out from the stablecoin, as done in section 5.2 for Bitcoin.

(i) Without FX conversion (i.e. a single stablecoin used globally for payments).

This case is rather similar to Bitcoin in which there were no service providers and permanent holdings (Bitcoin case (i)). Indeed, it does not really matter what assets are underpinning the stablecoin – it could be a basket of global securities, a single currency, Bitcoin, or gold. Country B is the exporter of a good that has a price in the domestic currency "a". The price expressed in the global stablecoin is αa (where α is the number of stablecoin units needed to buy one unit of B-currency). The price expressed in the currency of A-country is βa (β is the number of A-currency units needed to buy one B-currency unit; needless to say that arbitrage implies that one needs α/β units of the stablecoin to buy one unit of the A-currency).

Table 7a: Stablecoin used without FX conversion

Country A - in A-currency			
Firm (or household) A			
Real goods	X + β a	Equity	X
Bank deposits	X		
Stablecoin	X - β a		
Global stablecoin (e.g. in SDR basket)			
Reserve (e.g. Gvt bonds)	X	Stablecoin owned by firm A	X - α a
		Stablecoin owned by firm B	X + α a
		Stablecoins held by others	X
Country B – in B-currency			
Firm (or household) B			
Real goods	X - a	Equity	X
Bank deposits	X		
Stablecoin	X + a		

The settlement mechanics are as simple as in the case of a direct use of Bitcoin in the Bitcoin network. Nonetheless, this arrangement can be more efficient than Bitcoin. First, the convenience of access can be high without the need for an intermediary between the Bitcoin network and the user, saving one layer. Second, there is no need for an inefficient proof-of-work mechanism like the one enabling Bitcoin. It would be important that the global stablecoin is audited and supervised, to ensure that it is fully backed and that it has a sufficient amount of liquid reserves.

(ii) With FX conversion (i.e. two domestic stablecoins denominated in the respective fiat currency).

Table 7b: Two stablecoins denominated in domestic currencies with FX conversion

Country A - in A-currency			
Firm (or household) A			
Real goods	X + β a	Equity	X
Bank deposits	X		
A-Stablecoin	X - β a		
A-stablecoin (in A-currency)			
Reserve	X - β a	Stablecoin owned by firm A	X - β a
		Stablecoins held by others	X
B-stablecoin (in B-currency)			
Reserve	X + a	Stablecoin owned by firm B	X + a
		Stablecoins held by others	X
Country B – in B-currency			
Firm (or household) B			
Real goods	X - a	Equity	X
Bank deposits	X		
B-Stablecoin	X + a		

The cross-border transaction seems to take place without the creation of any cross-border claim. However, if one would consider the full financial accounts, and would look for what is implied by the change of the reserve of the stablecoin in both currencies, one realizes that there has to be a counterbalancing item that squares the accounts on both sides. For example, some investor in country A, B or a third country, has to switch from A-bonds into B-bonds, as shown below.

Table 7c: Case (ii)

Investor (in any place)				
Country B bonds	X	+ a	Equity	X
Country A bonds	X	- a		

When one includes this account, then the domestic accounts in each country balance.

6.3 Can stablecoins be the holy grail?

Compared to Bitcoin, which is a very special "coin" without an issuer based on a blockchain protocol, stablecoins are a less revolutionary, broad asset type with various possible specifications in terms of both (i) underlying currencies, basket of currencies, or assets; and (ii) technology, like e.g. single ledger, distributed ledger, blockchain, etc.

Because of their flexibility and their non-ideological search for an efficient global means of payment, stablecoins have the potential to provide an efficient means of cross-border payment for several reasons:

- **Potentially high technological efficiency**. Stablecoins can be rather efficient as they are per se technology agnostic, i.e. the most efficient and modern technology can be chosen.
- **Economies of scale**. Low costs can also be achieved thanks to scale, e.g. in case existing membership in social networks is used as a basis to onboard users. Indeed, BigTechs like Facebook with billions of customers can approach potential stablecoin customers efficiently, even if additional KYC is required for payment functions to prevent illicit payments and money laundering, particularly in an international context.
- **Value stability.** By binding their value to existing fiat currencies or to related meaningful baskets like the SDR, the value stability required for a means of payment can be achieved.

There are however some potential drawbacks of stablecoins, which include:

- **Market power and network effects**. A successful global stablecoin which would perform well in terms of universal reach would have significant market power across international borders, presumably giving it leeway to eventually exploit this market power in one way or another. BigTechs could also store, use and sell payments data, raising privacy concerns (see e.g. G7 working group on Stablecoins, 2019; Adachi et al, 2020; FSB, 2020c; Panetta, 2020; CPMI-IOSCO, 2021).

- **Financial stability issues.** International regulators and standard setters have identified significant potential financial stability and market integrity issues relating to the large-scale balance sheet of a global stablecoin and its reserve of liquid assets. In case of a massive sell-off of stablecoins by holders, the need of the stablecoin vehicle to liquidate assets is likely to destabilise markets, implying fire sale losses. This could only be prevented if the stablecoin invests exclusively into the most liquid and risk-free assets, and/or has adequate equity buffers. Any surveillance on how the strablecoin issuer manages these reserves is not straightforward to design and implement, also from a legal perspective, depending also on the regulatory framework of the licensing country. Relatedly, it is unclear who would provide a lender-of-last resort function to a global stablecoin issuer.

- **Risks of currency substitution**. The cross-border usage of global stablecoins (including cross-border holdings) implies significant risks of currency substitution and of related macro-economic destabilisation. This can be limited by allowing only cross-border use involving FX conversion between stablecoins denominated in the two relevant domestic currencies.

- **Threat to monetary sovereignty**. Successful global stablecoins will likely be perceived by sovereign states as a threat to their monetary sovereignty. In addition to the issue of currency substitution, the availability of global cross-border payment information to the stablecoin issuer and its use for commercial purposes, or access to it by a foreign power, and the possible vulnerability of the stablecoin issuer to political pressures (e.g. sanctions suddenly prohibiting to serve certain jurisdictions), create vulnerabilities for nation states and their citizens.

- **Fragmentation.** Already CPMI (2018) noted that non-interoperable closed-loop payment solutions like stablecoins create fragmentation. Interoperability may be a solution, but potentially successful stablecoin providers may specifically want to avoid it in view of achieving higher market power.

- **Illicit finance concerns.** As highlighted by US Treasury (2021), stablecoins present risks to the integrity of the financial system, as there are concerns that if adopted on a wide-scale and not regulated and supervised in a consistent manner, issues with respect to AML/CFT will proliferate.

One may conclude that relative to Bitcoin, stablecoins seem to have more potential to deliver the holy grail of cross-border payments by combining conventional and progressive technology in a pragmatic manner and by leveraging the technological abilities and large global client base of BigTech firms. At the same time the financial stability, monetary policy, strategic sovereignty, market power and fragmentation concerns raised by stablecoins are significant. Most nations will feel for good reasons uncomfortable about the prospects of few BigTechs controlling global payments as payments are a matter of strategic sovereignty, network effects, and market power. Therefore also global stablecoins do not seem to be the holy grail of cross-border payments.

7. Interlinked instant payment systems with FX conversion layer

7.1 Motivation and design

CPMI (2018) explains that whilst interconnecting domestic payment infrastructures for the settlement of cross-border payments is complex, it may have significant advantages, relative to innovative closed-loop solutions. The basis for interlinking instant payment systems in a cross-border context is the rise of domestic instant payment platforms in many jurisdictions around the globe, as already noted by CPMI (2016b). Instant (or "fast") payments are payments in which the transmission of the payment message and the availability of final funds to the payee occur in real time or near-real time and as close to a 24/7 basis as possible. The report noted that the first fast payment systems appeared in Korea (2001), South Africa (2006), and the United Kingdom (2008). According to Bech, Hancock and Zhang (2020), the number of jurisdictions with fast retail payments stood at 55 in March 2020 and is expected to increase to 65 in the near future.

The interlinking of national payment systems as one option for enhancing cross-border payments constitutes building block 13 of the FSB/CPMI work on cross-border payments (CPMI, 2020). CPMI (2020) described that as cross-border payments through correspondent banking arrangements frequently involve lengthy transaction chains and truncated data standards – as noted in section 3 –

the interlinking of retail payment systems for the purposes of executing cross-border payments allows financial intermediaries to interact directly via linked infrastructures and thereby reduce reliance on correspondent banks.

The creation of bilateral or multilateral arrangements – through interlinking payment systems – and integrating an instant FX conversion layer - would in principle allow for cross-currency/ cross-border payments to be completed in central bank money. A number of preconditions however need to be fulfilled for this:

- **Addressability of accounts cross-border:** ideally, there is a global standardization of unique bank account identifiers (such as the IBAN) to ensure an efficient and secure routing of the payment to the payee. The "Single European Payment Area" (SEPA) has achieved this for the adhering European countries. From the user perspective, addressing accounts via a proxy (e.g. a unique e-mail address or a unique phone number) would be very advantageous, but would require a global proxy-look up solution.

- **Interlinked domestic systems:** The two or more instant payment systems need to be interlinked through a connecting layer that transmits payment orders from one domestic system to the other and more generally routes payment process information in both directions. This layer needs to address possible differences in message data formats by providing translation capabilities, while ideally being cost efficient.

- **An instantaneous and cost-efficient currency conversion layer:** This layer would effectively decompose the (pseudo-) cross-border payment into two domestic instant payments. Market makers would consist of banking groups having accounts in instant payment systems on both sides i.e. in the two relevant domestic instant payment systems. The cross-border payment would therefore be "simulated" by the banking group providing the fx conversion service, as one member of this group would simultaneously receive a payment in currency A by the payer (located in country A) within the country A domestic instant payment system, and the other member of the banking group, namely the one in B country would make in currency B a domestic instant payment to the payee within the domestic instant payment system of country B. To ensure that the currency conversion layer maintains an instant processing of the cross-border payment, market makers would have to accept an obligation to provide immediately executable, binding quotes for cross currency payments up to the agreed maximum value. The automated process would always immediately choose the most attractive conversion rate amongst the provided binding bid-ask

quotes. The set up should incentivize a sufficient number of banks to commit to be FX market makers in the conversion layer, such as to ensure competitive price setting, depth and liquidity. This will of course be simpler for large FX/cross-border payment corridors.

- **Straight-through processable instantaneous AML/CFT checks:** Finally, AML/CFT compliance checks should be made automated and instantaneous by relying on positive ex ante criteria. Of course, "suspicious" payments would have to be rejected or be re-routed to a non-instant processing to allow for additional non-automated analysis.

- **Political support for the alignment of legal, regulatory and oversight frameworks** is also required, and maybe more challenging than for some other solutions because of the nature of interlinking existing payment solutions which have had their own established environments for extended periods of time.

A number of initiatives are briefly described below which aim at interlinking instant payment systems in different currencies:

a. Nexus

Nexus is a blueprint for interlinking instant payment systems cross-border. The July 2021 report by the BISIH (2021a) describes the potential benefits of linking instant payment systems with the purpose of completing cross-border payments. The report notes that the interlinking of existing domestic payment platforms face a number of challenges, such as adding a conversion layer, and AML/CFT compliance checks. In addition, it highlights the difficulties of making different domestic instant payment processes compatible with one another (e.g. data formats, scheme rules, etc). Such complexities would obviously increase exponentially the more one links a greater number of domestic instant payment systems through bilateral solutions. For example, it is noted that "a network of 20 countries would require 190[12] country-to-country links", as each payment system operator would be required to maintain 19 separate links with each payment system operator. Nexus would remedy such issues by setting one single standard and processing model for cross-border and cross-currency payments. The Nexus platform would also cover currency conversion, through the system coordinating with FX providers to ensure that the currency of the payer is swapped for the currency of the payee via FX providers competing against one another to provide the best swap rates. Although FX providers can set a quote which is below the market rate, they are not permitted to "exit" the market (BISIH,

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[12] This number should probably be 380 (20*19)

2021b). Moreover, it is anticipated that through "pre-screening" the system will be designed to mitigate common sources of delay through automatic processes (i.e. AML/CFT). Finally, with regards to message formats, Nexus will employ ISO 20022, but will provide a message translation service for those payment systems which do not use ISO 20022 (BISIH, 2021a).

b. Thailand – Singapore retail instant payments link

In a press release dated 29 April 2021, Singapore and Thailand announced the "launch of the world's first linkage of real-time payment systems" (MAS, 2021). Under the scheme, customers of participating banks in Singapore and Thailand will be permitted to transfer funds (up to S$1,000 or THB25,000) using mobile phone numbers. Through the PayNow-PromptPay linkage, transfers will be executed within minutes, as opposed to the average 1-2 working days under current arrangements. Under the framework, participating banks would commit to benchmark their fees against prevailing market rates that will be displayed to users in a transparent manner prior to any fund transfer being executed.

c. TIPS RIX-EUR approach

The ECB and Riksbank announced in a press release of 6 October 2020 work on interlinking the Swedish and Euro area TIPS platforms (ECB, 2020; Riksbank, 2021). The announcement explained that both the ECB and Sveriges Riksbank will explore ways of enabling the TIPS platform to execute payments denominated in Euro and Swedish Kronor, thereby permitting Swedish citizens to shift funds in Kronor to a payee located in the Euro area in seconds (and vice versa). As the interlinking of the instant payment systems of both the Riksbank and the ECB will rely on TIPS, all payments will be settled in central bank money (analogous with the other proposals) (e.g. Renzetti, Dinacci and Börestam, 2021).

d. EBA-Clearing – TCH collaboration

In a press release of 11 October 2021, EBA Clearing, SWIFT and The Clearing House announced to join forces in an effort to speed up and enhance cross-border payments through interlinking of USD and EUR payment systems (The Clearing House, 2021). In conjunction with 11 participating banks – which include Bank of America, J.P. Morgan, HSBC and Deutsche Bank – the initiative of Immediate Cross-Border Payments (IXB) has arisen due to the introduction of instant domestic payments, which has led to a renewed emphasis by market participants to lobby for an improvement to the way in which cross-border payments are executed. As with other proposals, IXB employs ISO 20022.

e. BUNA-TIPS experiment

In a press release dated 28 September 2021 (Banca d'Italia and Buna, 2021), Banca d'Italia and the Arab Regional Payments Clearing and Settlement Organization (ARPCSO) announced the completion of a joint experiment aimed at linking for the first time the instant payment settlement platforms with multi-currency features (TIPS and BUNA) operated by the two organizations. According to the release, "The excellent results … demonstrate that different clearing and settlement mechanisms can interact with each other, without necessarily requiring new technical infrastructures and the significant investment this would entail … enhancing interoperability, breaking down geographical borders, increasing transparency and execution times and, above all, reducing costs with respect to more traditional cross-border transactions, in line with the expectations set out in the G20 global roadmap".

f. P27

According to its White Paper (P27, 2020), the vision of P27 is "to establish, within the Nordics, the first integrated region for domestic and cross-border payments in multiple currencies. … An open-access, common infrastructure will deliver a state-of-the-art payment experience to customers across the Nordics and provide the foundation for future developments. P27 is preparing to enable real-time, batch, domestic and cross-border payments to be carried out quickly and at low cost on a secure and versatile platform. The platform is preparing for allowing payments to flow instantly between people and businesses within the countries of Denmark, Finland, Sweden and eventually Norway…".

7.2 Settlement mechanics

The following steps take place in this case:

- Firm A purchases a good from Firm B for a value of "**a**" in B-currency.
- It pays via an instant payment in A-currency with its bank, Bank A. The banking app of Bank A is able to convert for Firm A the amount of **a** B-currency into the SEK amount **βa** that it needs to transfer from its A-currency account with Bank A to be equivalent to **a** units in B-currency. This relies on the cross-border FX conversion layer selecting amongst market makers the best quote for the currency A to currency B conversion. This happens to be FXBank which is a banking group that has subsidiaries in both currency regions. The FX conversion quote is **β** (for simplicity we assume that the real good's value is also calculated in the same manner in the accounts of Firm A).
- Settlement of the FX transaction effectively consists of two domestic instant payment credit transfers between bank accounts with the central bank on each side, whereby the market maker

(FXBank) acts as counterparty on both sides and creates as a balancing item an intra-FXBank group claim and liability. This illustrates that in some sense "cross-border payments with FX conversion" do not really exist in reality.

- To achieve PvP, settlement needs to be simultaneous, and must be linked through the relevant program code.

Table 8: Instant cross-border payment with central FX conversion layer

Country A (in A-currency)			
Firm A			
Real goods	X **+ β a**	Equity	X
Account Bank B	X **- β a**		
Bank A			
Deposits with central bank	X **- β a**	Deposits	X **- β a**
Other assets		Credit from central bank	X
Central Bank A			
Credit to banks	X	Deposits Bank A	X **- β a**
		Deposits FXBank A	X **+ β a**
		Banknotes issued	X
FXBank – A-country subsidiary			
Deposits with central bank	X **+ β a**	Credit from central bank A	X
Other assets	X	Intra-Group liability	X **+ β a**
FX-Bank – B-country subsidiary			
Deposits with central bank	X **- a**	Credit from central bank B	X
Other assets	X		
Intra-Group claims	X **+ a**		
Country B (in B-currency)			
Firm B			
Real goods	X **- a**	Equity	X
Account Bank B	X **+ a**		
Bank B			
Deposits with central bank	X **+ a**	Deposits	X **+ a**
Other assets	X	Credit from central bank	X
Central Bank B			
Credit to banks	X	Deposits Bank B	X **+ a**
		Deposits FXBank B	X **- a**
		Banknotes issued	X

7.3 Can interlinked instant payment systems with FX conversion layer be the holy grail?

There are a number of advantages of interlinking domestic instant payment systems including a competitive FX conversion layer, as also developed in the Nexus report (BISIH, 2021a):

- **It is efficient** as it re-utilizes the domestic instant payment infrastructure and the associated services of banks and their relationship with bank account holders (including KYC);

- **It preserves competitiveness** to the extent that the connecting and conversion layer is not run by a single profit-maximizing firm with market power, but governed like a utility which aims at organizing strong competition between FX market makers. Further, it also avoids the potential market power of closed-loop stablecoin arrangements and/or the implied market fragmentation.

- Compared to correspondent banking, i**t allows for a simpler, more efficient and more competitive architecture** of cross-border payments.

- At the same time it preserves the **universal reach** achieved by correspondent banking (every bank account holder can be addressed if a link has been established).

- **Monetary sovereignty is preserved** as interlinking prevents currency substitution and the global power of a few dominant payment firms (such as under a global stable coin arrangement).

Potential challenges relate to the technicalities and costs of interlinking and setting up the competitive and instantaneous currency conversion layer, which requires willingness and ability to collaborate not only by network service providers and message standard setters (e.g. SWIFT, ISO 20022) but also by legislators and central banks, i.e. there needs to be a political will to remove possible barriers and to make the arrangement legally sound, also in contingency scenarios, such as the default of a party to a payment. In other words, the legal and political set up costs have to be added to the other fixed costs of such arrangements. Interlinking will probably not be a solution for very narrow cross-border payment corridors in which the costs of the interlinking will be relatively high, and where it will be difficult to organize sufficient competition within the FX conversion layer, also in view of liquidity costs for the FX conversion services providing banks. A key element of the efficiency of interlinking will be the width of the bid-ask spread on which users can rely. This width will depend on factors such as (i) volatility of exchange rate; (ii) cost and reliability of liquidity available to FX conversion service providing banks in both currencies; (iii) duration for which a quote needs to remain binding (in view of processing times in the payment initiation phase). Notwithstanding these various challenges, it seems that for more important corridors the interlinking of domestic instant payment systems can constitute the holy grail of cross-border payments: it appears efficient, relies on existing tested and successful infrastructures, and avoids closed loop systems and the associated fragmentation and potential abuse of market power, whilst preserving monetary sovereignty. Global initiatives like Nexus could reduce the set-up costs for individual payment corridors by realizing economies of scale on the technical side and by providing a benchmark for domestic system providers and legislators.

8. Interoperable CBDC with FX conversion layer

8.1 Motivation and design

In the same way as domestic payment systems can be interlinked, one could also interlink future CBDCs (assuming that those would indeed be issued by a number of central banks interested in interlinking).[13] The two key differences between the interlinking of domestic instantaneous payment systems and CBDCs is that (i) the first exist and only need to be interlinked, while the second do not yet exist in major currencies; (ii) the first is from the perspective of the payer and payee in commercial bank money and the second in central bank money. The potential future role of CBDC for international payments has been acknowledged in the G20 work on cross-border payments by devoting building block 19 to it. A group under the CPMI (2021) prepared and published a report on "Central bank digital currencies for cross-border payments", which argues that (p. 2):

> *"The coordination of national CBDC designs could lead to more efficient cross-currency and cross-border payments. Cross-border CBDCs could offer the opportunity to start with a 'clean slate' and address the frictions inherent in current cross-border payment systems and arrangements from the outset. The enhancements could be made by offering secure settlement …, reducing costly and lengthy intermediation chains throughout the payment process, and eliminating operating hour mismatches by being accessible 24/7."*

Many of the advantages and challenges of cross-border CBDC payments with currency conversion seem to be similar as the case of interlinking instant payment systems. Also, the flow of funds mechanics have some similarity, as will be shown below.[14]

8.2 Settlement mechanics

The settlement mechanics are similar to the case of interlinked instant payment platforms.

- Firm A purchases a good from Firm B for a value **a** in B-currency. It pays via its CBDC account.

- The CBDC app tells Firm A that it needs to transfer a currency A-CBDC amount equivalent to **a** B-currency to a B-currency-CBDC account. This relies on the competitive CBDC conversion layer

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[13] For a general appraisal of CBDC, see Bindseil (2020) and references therein.

[14] Mandeng (2020) also sees merits of interlinked CBDCs in order to address cross border payments, whereby he emphasizes the merits of DLT-based CBDC.

selects amongst the market makers the one having committed in that moment the best quote for the A -> B currency conversion. Once again, this happens to be FXBank. This FX conversion quote is **β**. Note that conversion services can now also be offered by non-banks as holding CBDC is not a privilege of banks (a difference relative to the interlinking of domestic payment systems possibly contributing to more competition).

- The settlement of the FX transaction effectively consists of two domestic CBDC transfers between bank accounts with the central bank on each side, whereby the market maker (FXBank) acts as counterparty on both sides and creates as a balancing item an intra-FXBank group claim and liability.[15]

Table 9: Global interlinked instant cross-border payment with central FX conversion layer

A-country (in A-currency)				
Firm A				
Real goods	X $+ \beta\, a$	Equity	X	
CBDC A	X $- \beta\, a$			
Central Bank A				
Credit to banks	X	CBDC account firm A	X	$- \beta\, a$
		CBDC account bank FXBank A	X	$+ \beta\, a$
		Other liabilities	X	
FXBank – subsidiary in A country				
CBDC A	X $+ \beta\, a$	Credit from central bank A	X	
Other assets	X	Intra-Group liability	X	$+ \beta\, a$
FXBank – subsidiary in B country				
CBDC B	X $- a$	Credit from central bank B	X	
Other assets	X			
Intra-Group claims	X $+ a$			
B-country (accounts in B-currency)				
Firm B				
Real goods	X $- a$	Equity	X	
CBDC B	X $+ a$			
Central Bank B				
Credit to banks	X	CBDC account Firm B	X	$+ a$
		CBDC account FXBank B	X	$- a$
		Other liabilities	X	

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[15] Note that if CBDC would be a pure bearer instrument (which seems unlikely), then the CBDC accounts on the liability side of the central banks get merged into one for each central bank ("CBDC issued").

8.3 Assessment: can interoperable CBDC with central FX conversion layer be the holy grail of cross-border payments?

This solution shares many advantages of the interlinking of payment systems:

- **Monetary sovereignty is preserved** as currency substitution is prevented and the global power of dominant issuers is mitigated (in contrast to global stablecoin arrangements).

- **It is even somewhat simpler than the interlinking on instant payment systems**. Indeed, the financial account representation only shows a role of commercial banks as FX conversion provider, and not as bank account provider. However, this even higher simplicity should not be overstated in this context: it is a consequence of the general elimination of one layer when moving from commercial bank money to central bank money payments. This simplification through central bank money has however never led to the conclusion that all payments should be moved into central bank money payments.

However, it also has to be recognized that CBDCs do not really exist yet in advanced economies, and that first they need to be deployed successfully as a domestic means of payment, while keeping their future role as a vehicle for cross-border transactions in mind in preparation for the interoperability of major currency pairs in the future. Even if there are no reasons to doubt the commitment of central banks to prepare for CBDC issuance, there is still considerable work ahead. For example CBDC will have to rely in many respects on a distribution role of payment services providers such as banks, to ensure that they are efficient and do not require to replicate the functions of banks (KYC, customer relationship management, etc.).

Nevertheless, conditional on the assumption that CBDCs have been successfully deployed in several jurisdictions, their interlinking seems to be as promising to achieve the holy grail of cross-border payments as the interlinking of domestic fast payment systems. This is of course again subject to making AML compliance instantaneous as well and solving the other challenges of both solutions.

9. Conclusions

The holy grail, whereby cross-border payments can be (1) immediate, (2) cheap, (3) universal in terms of reach, and (4) be settled in a secure settlement medium such as central bank money is in reach for the first time. This is thanks to the rapid decline in the costs of global electronic data transmission and computer processing, new payment system technology (allowing for instant payments), innovative concepts (such as the interlinking of payment systems including a currency conversion layer; or CBDC), and unprecedented political will and global collaboration like the G20 work on enhancing cross-border payments.

The review of various visions as to how to achieve the holy grail suggests that Bitcoin is least credible; stablecoins, traditional correspondent banking, and cross-border Fintechs take an intermediary place, but may all contribute to improvement over the next years. From a public policy perspective, stablecoins appear somewhat more problematic than the other two options as they aim at deep closed loop solutions, market power and fragmentation. Two solutions – the interlinking of domestic instant payment systems and future CBDCs, both with a competitive FX conversion layer – may have the highest potential to deliver the holy grail for larger cross border payment corridors as they combine (i) technical feasibility; (ii) relative simplicity in their architecture; and (iii) maintaining a competitive and open architecture by avoiding the dominance of a small number of market participants who would eventually exploit their market power. Moreover, (iv) monetary sovereignty is preserved, and (v) the crowding out of local currencies is avoided due to a FX conversion layer at the border (which does not hold for Bitcoin and global stablecoins). Interlinking of domestic payment systems would also perform well in terms of preserving the universal reach of correspondent banking (although of course only for the payment areas that are actually interlinked). However, a number of challenges need to be addressed to set up these solutions, such as:

- the organization of an efficient competitive FX conversion layer conducive to narrow bid-ask spreads applying to the FX conversion;
- the global addressability of accounts;
- achieving the same degree of legal certainty for interlinked cross-currency payments as for domestic payments, including in the case of default of a party;

Finally, all solutions require that strong progress is made on the AML/CFT compliance side to ensure straight-through-processing (STP) for the large majority of cross-border payments. The recognition and the importance of this issue is illustrated by the significant number of building blocks devoted by the G20 to regulatory and compliance issues of cross-border payments, and also the Nexus initiative of the BIS recognizes the importance of such progress particularly for interlinked solutions.

None of these challenges are unresolvable and for large cross-border payment corridors with significant volumes and sufficient political will, both interlinking solutions should be feasible and efficient. For smaller corridors, fixed set up costs may be too high, or the political or legal preconditions may not be fulfilled. For those, a *modernized* correspondent banking or solutions relying on Fintechs with presence in both jurisdictions will likely remain good and flexible solutions that can contribute significant improvements. Also, for large corridors, these two solutions may play an important role for the coming years, and the interlinking solutions still need to prove that they can deploy their advantages relative to them.

Ranking *two* solutions at the top raises the question whether central banks and the industry should really work on both (i.e. the interlinking of domestic payment systems and future CBDCs), or whether only one should be selected and the other be dismissed to save on investment costs and focus all efforts to implement the holy grail as soon as possible. A number of arguments speak in favor of developing *both* solutions. First, there are synergies between the two in the sense that organizing competitive FX conversion layers is instrumental for both, as well as solving issues of international addressability of accounts (be it in commercial bank money or CBDC), persons and firms. Second, some FX and cross-border payment corridors are so large that they can easily support two solutions, and the eventual efficiency of cross-border payments will benefit further from the competition between two approaches. Third, for some cross-border payment corridors only one solution may eventually prevail, but this could be one or the other, and in view of the many cross-border corridors, it is favorable to have two fully efficient solutions available who can compete to become the solution for specific smaller corridors. Therefore, forceful work on both should continue, whereby for CBDC much of the energy of central banks will obviously be absorbed first for deploying them for domestic retail payments. Central banks should nevertheless keep in mind that CBDC will eventually be expected to make its contribution to efficient cross-border payments with FX conversion, and discuss at a relatively early stage the related interoperability issues. In the meantime, they should support and co-ordinate the efforts to interlink domestic payment systems for cross-border payments with competitive FX conversion.

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