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Contrasting Ledgers: considerations for U.S. dollar interbank payment systems[1]

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February 2026

Abstract: this paper describes the current U.S. dollar interbank payments landscape and identifies its key characteristics. It then discusses major considerations and potential tradeoffs that various conceptual alternatives might raise.

[**Note**: Diagram formatting keys provided in Figure 1 are used consistently throughout the paper's diagrams, except as additional symbols are otherwise noted.]

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Introduction

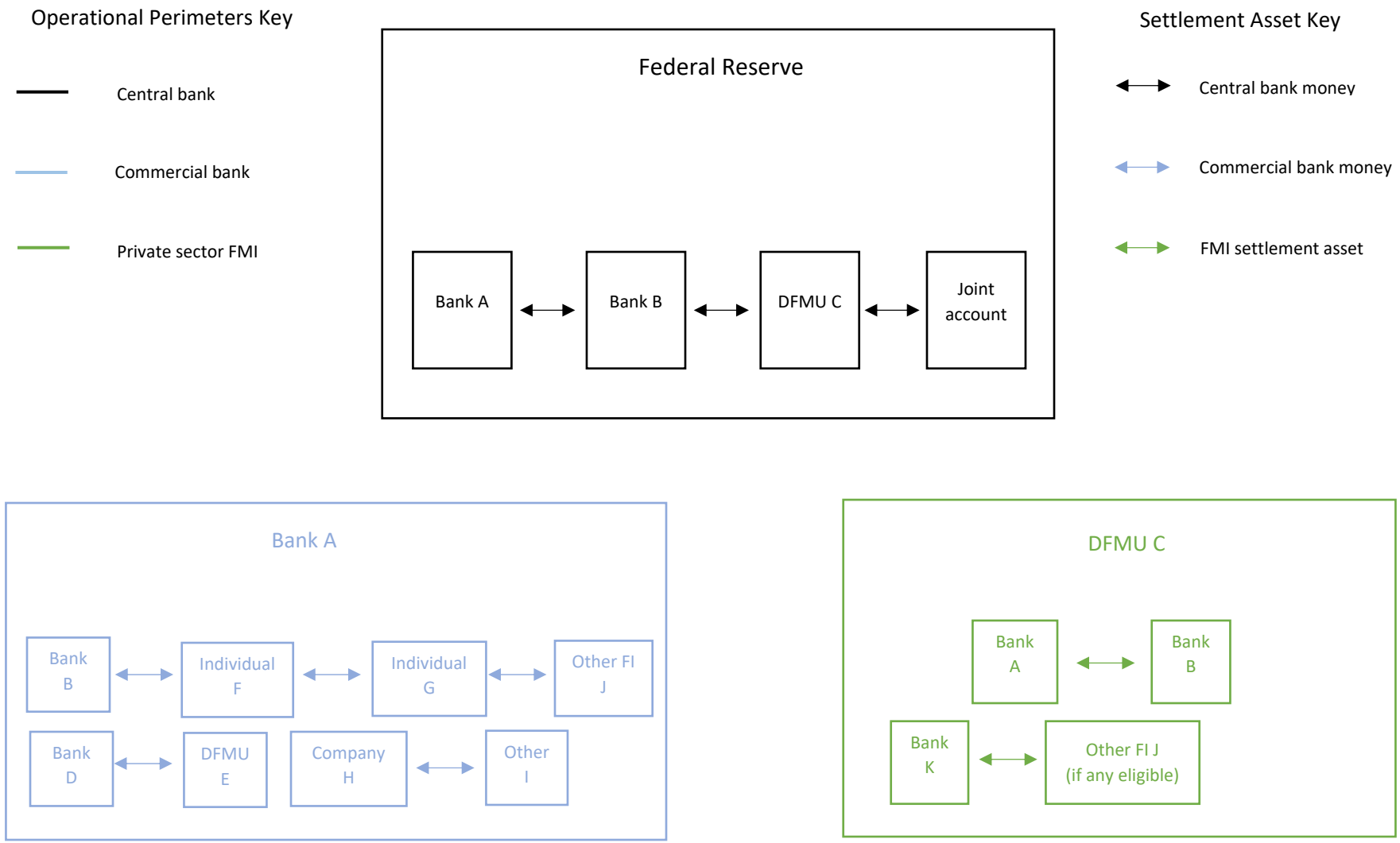
Current U.S. dollar (USD) payment systems provide interbank settlement using a variety of models. This variety, when supported by the legal framework and appropriate risk management, supplies multiple safe options that participants may choose between, based on their specific uses and needs. Notwithstanding this variety, USD interbank systems have three key characteristics in common: operational perimeters of individual entities are distinct; settlement assets remain constrained within operational perimeters of their issuers; and ledgers are connected through entities holding accounts with one another.

These key characteristics of USD interbank payment systems are not universal globally. Some interbank payment systems in other jurisdictions have differing key characteristics. In particular, there are jurisdictions in which the central bank allows money it issues to be used as a settlement asset outside of the central bank's operating perimeter. Canadian dollar interbank payments systems and Denmark's 2025 move to settlement of its central bank money on Eurosystem infrastructure are two examples.

Improving the safety and efficiency of payment systems is an ongoing effort of both the public and private sectors. Interest in increasing optionality, lowering costs, strengthening security, and otherwise improving USD and cross-border payments is very high. Potential paths to improvement under consideration by stakeholders are numerous and diverse. Included among these many possible paths to improvement of USD payments are potential initiatives that would change the key characteristics of USD interbank payment systems. Such potential changes may entail particularly complex tradeoffs.

This paper describes the current USD interbank payment system landscape. It identifies and explains the three key characteristics that shape the operation of these systems, demonstrating with stylized examples how a wide variety of settlement models are currently implemented within the parameters of the characteristics. Section 1 of the paper describes the overarching landscape and the three characteristics. Section 2 provides system-by-system examples and elaboration. Section 3 then briefly discusses examples in other jurisdictions where one or more characteristics is varied and theorizes on tradeoffs that were contemplated as these choices were made. The paper then examines in section 4 a subset of published ideas for potentially altering the key characteristics of USD or multicurrency settlement systems and analyzes potential complex tradeoffs such conceptual alternatives might entail, if implemented. Lastly, section 5 identifies, more generally, some of the complex questions and tradeoffs that stakeholders may consider if contemplating changes to the current key characteristics of USD interbank payment systems. This paper does not attempt to answer any of these questions, nor does it make any recommendations.

Figure 1: Simplified U.S. Interbank Settlement Landscape[2]



[2] Except for the Federal Reserve, no depicted entity refers to any specific bank, FMI, or other institution. The diagram is conceptual.

1. Overview of U.S. dollar interbank payment system landscape

Figure 1 above depicts a simplified representation of the USD interbank payment system landscape. At present, interbank settlement occurs in multiple payment systems, both public and private sector operated, using a variety of settlement models. The key characteristics common across the current U.S. interbank settlement landscape are:

- Operational perimeters of individual entities are distinct
- Settlement assets remain constrained within operational perimeters of their issuers
- Ledgers are connected through entities holding accounts with one another

While various banks, financial market infrastructures (FMIs), and other entities likely rely on common technology service providers for their operations, the implementation, control, and governance of their internal ledgers remains separate from that of other entities.[3] The Federal Reserve Banks, whose internal ledger is included in Figure 1, for example, set the terms and procedures by which depository institutions or other eligible entities may open accounts, access settlement services, and instruct specific transactions. Depository institutions cannot create new service options, alter records, or otherwise control functioning inside the Federal Reserve operating perimeter. Similarly, while the Federal Reserve and other banking regulators promulgate rules that define appropriate conduct for depository institutions, these rules are not enforced through direct control of bank internal ledgers by regulators. Example Bank A in Figure 1 above has an operating perimeter that is distinct from those of other entities and Bank A controls its internal records, including any settlement between its account-holders on its ledger.

Notwithstanding these distinct operational perimeters, the financial system safely and efficiently moves value across these ledgers. Key to connecting the ledgers is the practice of entities holding accounts with one another. As depicted in in Figure 1, eligible banks and private sector FMIs may hold accounts at the Federal Reserve and with one another.[4] Similarly, in some instances, the Federal Reserve holds accounts with banks and FMIs.[5] Eligible account holders at the Federal Reserve are limited by law. Account eligibility at private sector FMIs may be wider than at the Federal Reserve, but typically remains relatively narrow, driven by which financial institutions participate in the market served by the FMI and the FMI's risk management considerations. Banks generally have the widest set of eligible account holders, offering accounts to financial institutions, commercial companies, government entities, and

[3] Further discussion of risk dimensions of common reliances and broader questions of perimeter permeability in included in section 4 below.

[4] DFMUs (designated financial market utilities) are featured in Figure 1 because they are a set of private sector FMIs for which the Federal Reserve Board may authorize Federal Reserve Banks to establish and maintain accounts. See 12 U.S.C. § 5465(a). As shown in Figure 1, DFMUs (or other FMIs) also may choose to open commercial bank accounts to facilitate their operations.

[5] Though this note predominantly focuses on the domestic context, central banks often also hold accounts with one another.

individuals, depending on the business lines of the bank.[6] Entities maintaining accounts on one another's ledgers link the systems together and facilitate a diversity of available interbank settlement models (elaborated next in section 2).

Concurrently, across these systems settlement assets remain constrained to the operational perimeters of their respective issuers. As depicted within Figure 1, central bank money remains within the Federal Reserve ledger, commercial bank money remains within the Bank A ledger, and the settlement asset used on the DFMU ledger does not leave the DFMU perimeter.[7]

2. Diverse U.S. interbank settlement services: specific systems and models

The Federal Reserve operates multiple payment systems within its ledger structure depicted above in Figure 1. Each service transfers central bank money between Federal Reserve account holders. Briefly, the Fedwire Funds Service is a large-value real-time gross settlement (RTGS) system; the National Settlement Service (NSS) is a large-value multilateral settlement system that settles debits from and credits to multiple Federal Reserve account holders in a single transaction; FedACH is a low-value, high-volume, batch settlement service; and FedNow is a low-value RTGS system that—as discussed further below—also ensures by rule that end users outside of the Federal Reserve ledger (i.e., bank customers) also receive their funds instantly.[8]

Similarly, the private sector operates multiple interbank payment systems. CHIPS is a large-value hybrid payment system; EPN is a low-value, high-volume, batch settlement service; and RTP is a low-value RTGS system that ensures by rule that end users outside of the RTP ledger (i.e., bank customers) also receive their funds instantly.[9] These private sector payment systems each link to Federal Reserve payment systems to allow for liquidity to flow among systems and to enhance risk management. To illustrate, Figure 2A provides a simplified depiction of the CHIPS payment system and its link to the Federal Reserve systems.

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[6] The bulk of this note focuses on interbank/other multilateral settlement. Briefly expanding on the broader context, however, one can generally consider end-user payment services as being provided by banks to their customers and/or by banks' customers to end-users (e.g., a payment company provides services and products to end-users and has accounts at one or more banks to facilitate its business).

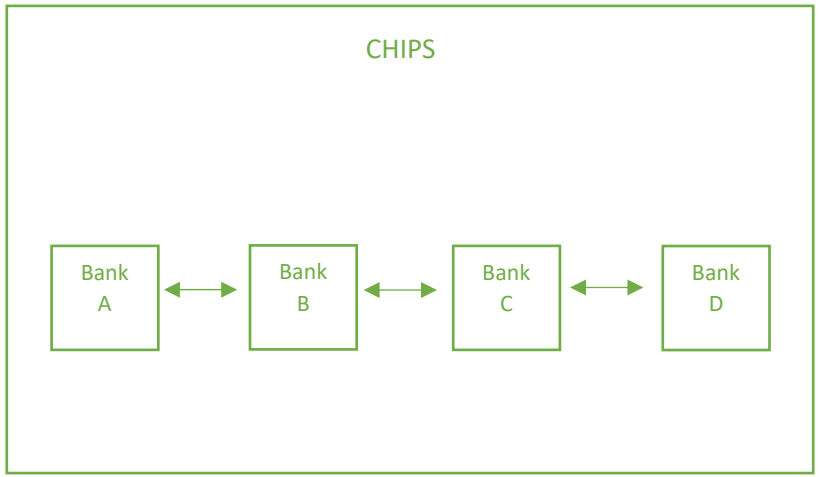
[7] A settlement asset is the liability that is transferred in a payment. Central bank money is a liability of the central bank and can be used as a settlement asset. Commercial bank money is a liability of commercial bank and can be used as a settlement asset. Private sector FMIs that settle on their own ledgers are utilizing an FMI settlement asset--that is, liabilities of the FMI to its users. In contrast to central bank and commercial bank monies, FMI settlement assets do not generally have other uses unrelated to settlement and its risk management.

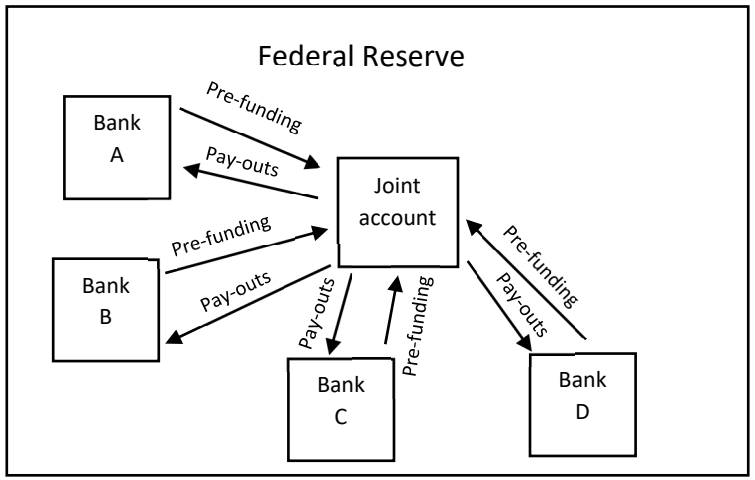
[8] Large-value and low-value characterize the systems' primary functional purpose, but there is no strict bifurcation. Service users may send any value through the services as long it is under the per-transaction maximum for each system. For more information on service terms, including per-transaction maximums, see https://www.frbservices.org/

[9] These payment systems are owned and operated by The Clearinghouse Payments Company, which is owned by 22 large banks. More information on these systems is available at https://www.theclearinghouse.org/payment-systems

Figure 2A: Simplified CHIPS Settlement and Federal Reserve Interaction

At the beginning of the processing day, participating banks transfer balances in their accounts at the Federal Reserve to the joint account maintained for CHIPS settlement.[10] During the day, banks may transfer additional balances into this account.[11] The total balance of money in the joint account is the available liquidity for settlement on the CHIPS ledger. This balance equals the sum of the balances recorded on the CHIPS ledger. In other words, CHIPS settlement is pre-funded in central bank money.





Throughout the day, CHIPS maintains records of each participating bank's balances on its ledger. Starting balances reflect the amounts transferred into the joint account. The banks then send payment instructions to CHIPS for transfer of funds between CHIPS participants. CHIPS settles those payments on its ledger and adjusts its balances accordingly. The settlement asset for these payments is an FMI settlement asset. While the Federal Reserve maintains the joint account for CHIPS settlement on its ledger (within its operational perimeter) and knows the balance in that account, it does not have visibility into or responsibility for the payments settled on the CHIPS ledger. At the end of the processing day, CHIPS, as settlement agent for the joint account, instructs payments out of the joint account to the participating banks, based on their balances on the CHIPS ledger.[12]

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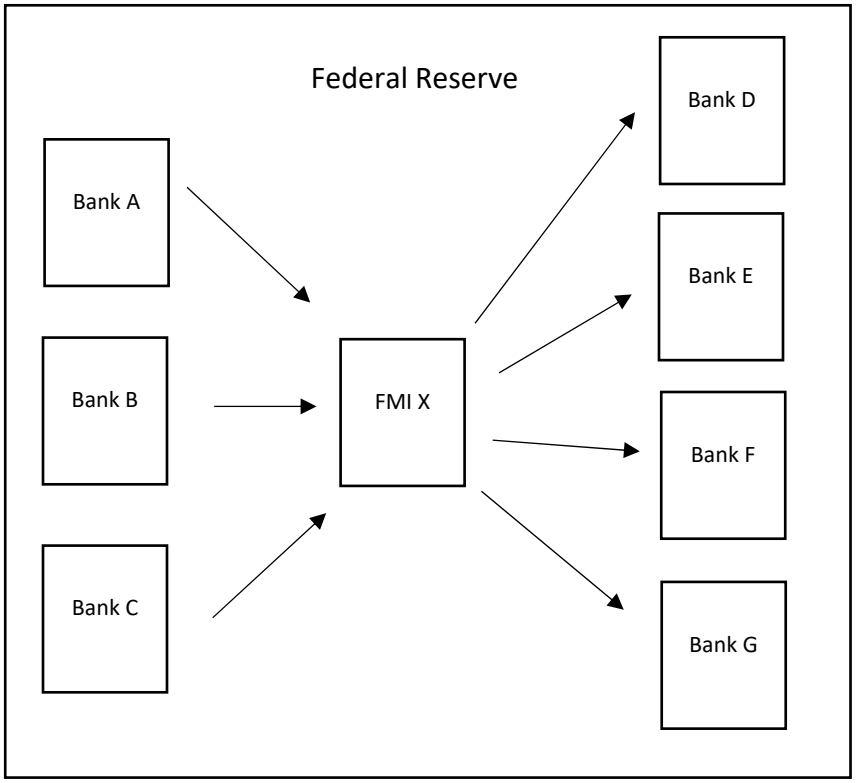
[10] A joint account is one where the rights and liabilities are shared among multiple account holders, each of which is individually eligible to open an account at a Reserve Bank. For more information, see https://www.federalreserve.gov/paymentsystems/joint_requests.htm.

[11] Among the simplifications made in this figure is a one-to-one bank representation where the set of banks settling payments on the CHIPS ledger is identical to the set of banks funding the joint account at the Federal Reserve. This is not a requirement. Banks may arrange to have another bank supply their prefunding. There could be, for example, a Bank E that participates in CHIPS but does not have a Federal Reserve account or a Bank F that participates in CHIPS, has a Federal Reserve account, but arranges to have a different bank fund the joint account on its behalf.

[12] Whereas the one-sided arrows in the Federal Reserve ledger loosely depict individual payments (in central bank money), the double-sided arrows in the CHIPS ledger represent multiple payments (in the FMI settlement asset); CHIPS typically settles hundreds of thousands of interbank payments each day. See CHIPS public disclosure

CHIPS settlement with funding and defunding at the Federal Reserve is one model of interbank settlement in use. Figures 2B-2D on the following pages illustrate more of the variety of settlement models in use in the current USD interbank payment landscape. These figures depict large-value settlements of other hypothetical FMIs as instructive examples. Private sector FMIs, such as central counterparties, conduct large-value multilateral money settlements as part of the clearing and settlement functions they provide to their respective financial markets. To do so, these FMIs use the large-value interbank payment systems identified above and/or settle on commercial bank ledgers.

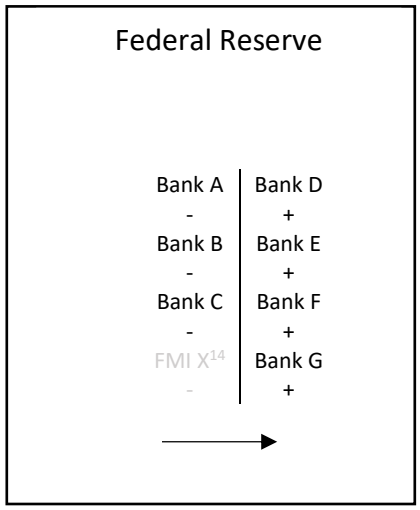
Figure 2B: FMI Money Settlements Using Fedwire



In this illustration, money settlements related to the operations of FMI X all occur inside the Federal Reserve operating perimeter using central bank money. All depicted commercial banks are participants of and/or settle on behalf of participants of FMI X. Banks that owe the FMI each send a payment over Fedwire from their respective accounts at the Federal Reserve to the FMI's account at the Federal Reserve. The FMI sends payments to each bank it owes using Fedwire.[13] While the potential timing of all these payments is likely constrained by the contractual requirements of the FMI rules, the specific timing of any individual payment is determined by the funds sender.

[13] Which and how many of the total banks owe or are owed by the FMI may be expected to change in any given settlement cycle. The specific values owed and in what direction are determined by activity at the FMI that is not known to the Federal Reserve. The Federal Reserve's perspective is simply that 7 funds transfers are instructed and settled.

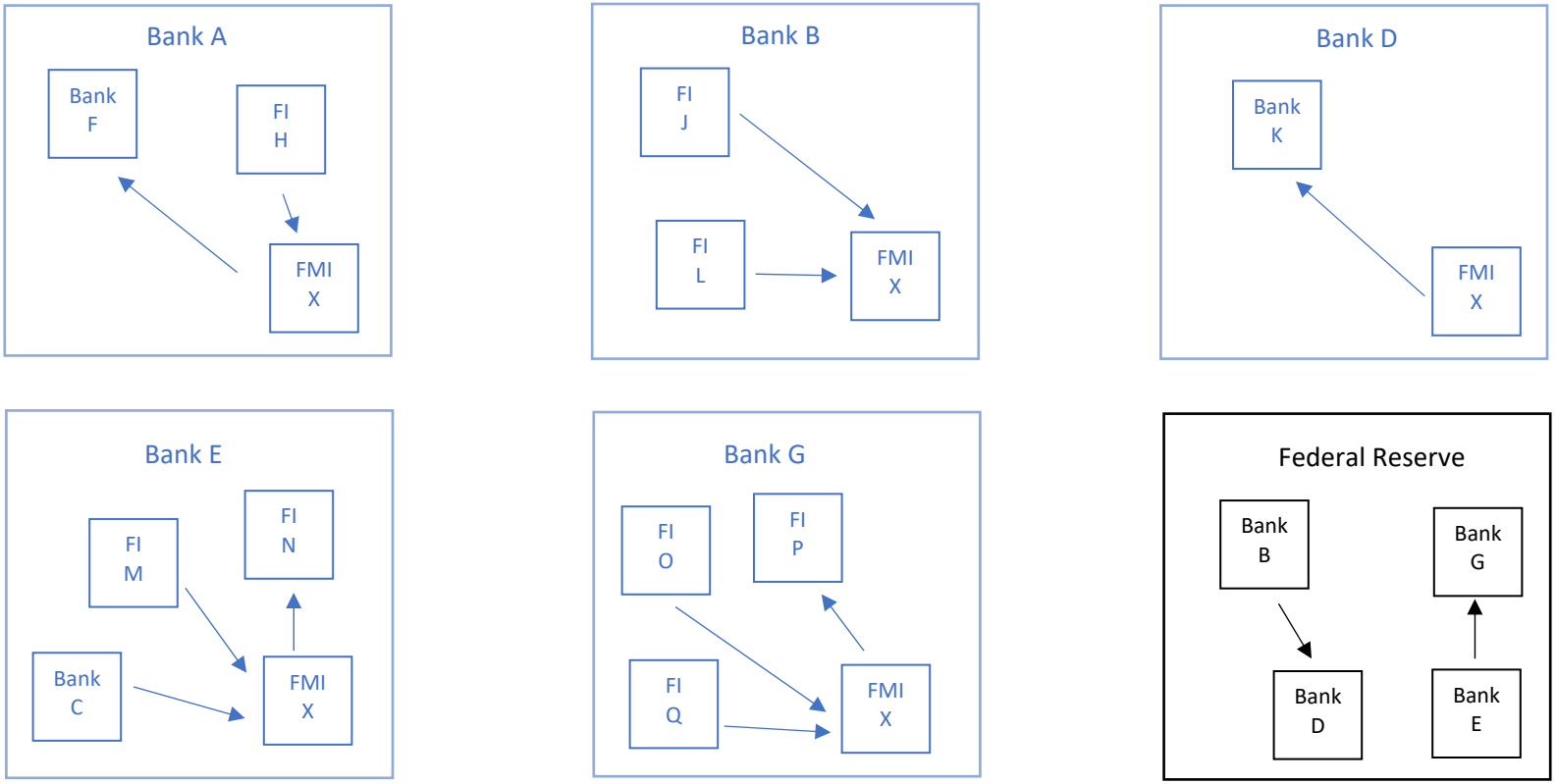
Figure 2C: FMI Money Settlements Using NSS



In this illustration, the relevant entities and settlement obligation values remain the same as in Figure 2B. Settlement again occurs within the Federal Reserve operational perimeter and in central bank money. The NSS transfer mechanism differs from Fedwire, however. Settlement of all relevant payments occurs in a single process. The settlement agent, typically the FMI, submits a settlement instruction file that contains all relevant information. Banks that owe are all debited and banks that are owed are all credited. It is an all-or-nothing process and the settlement agent controls the timing.

[14] The FMI may or may not be one of the receiving or sending accounts, depending on the specifics of the arrangement.

Figure 2D: FMI Money Settlements in Commercial Bank Money



In this illustration, all money settlements between the FMI and its participants are in commercial bank money. These settlements occur in multiple operating perimeters. The FMI has an account at each of its settlement banks and the FMI's participants have accounts at at least one of the FMI's settlement banks. Each payment between the FMI and a participant is executed individually. The FMI may transfer money between its commercial bank accounts as part of or between settlement cycles. Those interbank payments will settle in central bank money for the banks themselves, but the FMI is receiving commercial bank money in the form of a credit to its commercial bank account at some point after the interbank transfer is complete.[15]

[15] If the FMI has a Federal Reserve account, it may choose to send and receive the rebalancing interbank transfer through its FR account. FMIs may have business reasons for using commercial bank money for their money settlements, even with access to central bank accounts and services. Appropriate risk management of such arrangements is covered within the *Principles for Financial Market Infrastructures* (PFMI).

The FMI's relationship with its settlement banks is key to its operations in all three settlement models illustrated by Figures 2B-2D, but the nature of that relationship varies between the central bank and commercial bank money models. In the Fedwire central bank money settlement model, the FMI is operationally dependent on its settlement banks and it faces credit and liquidity risks from them to the extent that they might not pay in what they are obligated to when they are obligated to do so. In the NSS central bank money settlement model, a portion of the FMI's liquidity risk is mitigated because the FMI controls the timing of the money settlement process, but otherwise its risks are very similar to the Fedwire model. As both settle in central bank money, the credit and liquidity risks posed by the settlement asset are the lowest possible. Once settlement is complete, any balances the FMI has are in central bank money and it has no ongoing exposure to its settlement banks. In the commercial bank settlement model, the settlement asset is commercial bank money. The FMI sends and receives balances at (therefore claims on) one or more depository institutions during settlement and any remaining balances after settlement is complete are also in commercial bank money. The FMI faces the credit and liquidity risks of those depository institutions during settlement and on an ongoing basis thereafter.

Legally enforceable rules, procedures, and contracts

All of the above settlement models require clear and legally enforceable rules, procedures, and/or contracts to bind the multiple parties together consistently and to facilitate safe, reliable operations and appropriate risk management. These rules, procedures, and contracts make clear who has what rights and obligations. They define eligibility, decision-making, acceptable behaviors, and routine and contingent processes. Their enforceability provides recourse should any party not act in accordance with these provisions.[16] In this way, the operations of individual ledgers and connections between ledgers are reliably constrained and transparent to all, even as operational control resides with individual parties.

As an example, key terms of the CHIPS settlement and use of a joint account at the Federal Reserve depicted above in Figure 2A, include the following:[17]

- As described above, all settlements on the CHIPS ledger are pre-funded. Neither CHIPS nor its participants are extending one another credit as part of settlement on the CHIPS ledger.[18]
- All rights and liabilities of the joint account are shared by the banks that jointly hold it, which is the same set of banks that are CHIPS funding participants. This includes the relevant Reserve Bank's obligation with respect to any balance in the joint account, which is solely owed to those banks and not to CHIPS.[19] CHIPS does not own and nor can it possess the prefunding for itself.

[16] Regulation, supervision, and internal compliance programs also shape the content of these rules and agreements and reinforce conformance to them.
[17] In addition to being provided to participating institutions, these material terms are published, consistent with PFMI 23, Disclosure of rules, key procedures, and market data.
[18] To the extent that a funding participant extends credit to a non-funding participant as part of the pre-funding process, that is a separate bilateral arrangement. It does not affect the subsequent settlements on the CHIPS ledger, nor otherwise create any obligations between the other participants or attach to the balances in the joint-account.
[19] See https://www.federalreserve.gov/paymentsystems/joint_requests.htm for further description of joint-accounts and also CHIPS rules for discussion of the specific joint-account for CHIPS funding.

- CHIPS as settlement agent, however, controls the instruction of pay-outs to the joint-account holding banks. These banks do not face risks from their fellow joint-account holders of inappropriate withdrawals or other use of the pre-funding.
- The balances in the joint-account may be used solely for paying out the balances reflected on the CHIPS ledger and the balances on the CHIPS ledger may be paid out solely from the funds in the joint-account. Just as the balances in the joint-account are owed solely to the CHIPS funding banks, the balances on the CHIPS ledger represent joint obligations solely of the CHIPS funding banks.

In aggregate, these rules and contractual agreements link the private sector FMI and central bank ledgers and direct and constrain the behavior of all connecting parties, in order to define obligations and limit related risks.

The more-recently launched U.S. interbank instant payment systems similarly preserve separate operating environments, with settlement assets constrained to those respective environments, while utilizing rules and contracts to direct and constrain behavior across ledgers. These systems reach further down the payments chain via their rules, directing commercial banks' actions within their own ledgers, as well as their actions with respect to how they use their accounts on the central bank and private sector FMI ledgers. A key facet of the functioning of both FedNow and RTP is that their rule sets require receiving banks that accept a payment to immediately credit the account of and make funds available to the end-user being paid.[20] See figure 2E for a simplified illustration.

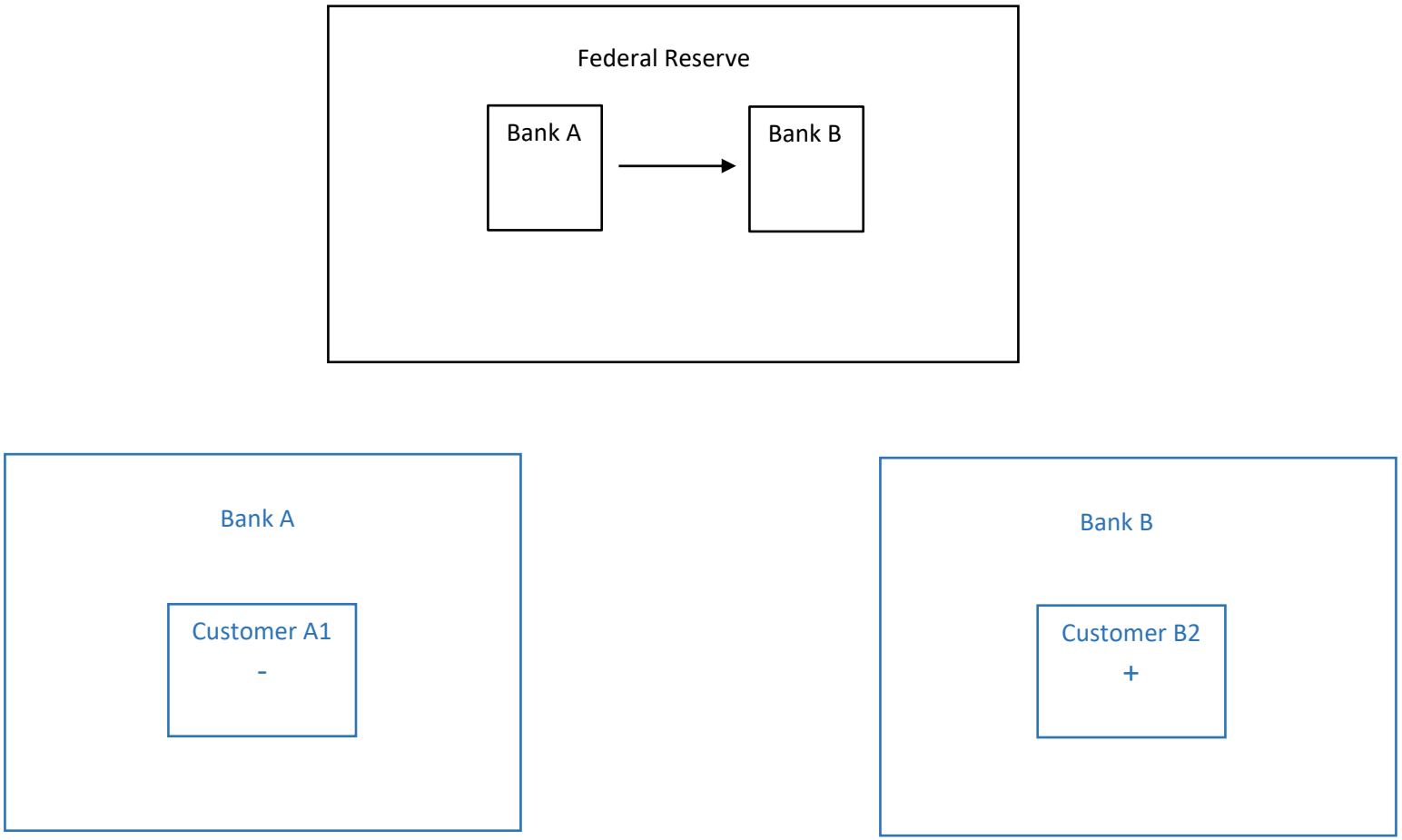
This contrasts with Fedwire and CHIPS, for which related rules and procedures do not encompass requirements regarding funds availability for the beneficiary of the payment.[21] Law, regulation, and contracts external to the two payment systems may set further expectations regarding when funds are made available to the receiving bank's customer, among other requirements, but these considerations are outside of the scope of Fedwire and CHIPS.[22]

[20] See, Federal Reserve Operating Circular 8 and RTP Rules.

[21] Payment instruction messages may include additional information that Fedwire and CHIPS transmit to receiving banks for those banks' use, including beneficiary details, but that information is not needed for the operation of the interbank settlement system.

[22] Fedwire and CHIPS' agreements with their participating banks do establish an expectation that the banks will act in compliance with legal and regulatory requirements as a condition of maintaining access to the payment systems.

Figure 2E: Simplified FedNow Settlement of a Single Payment and Related Bank Ledger Updates



The operational perimeters of the Federal Reserve and the two commercial banks remain distinct. The interbank payment settles in central bank money, while bank customers at all times have commercial bank money. Bank B credits customer B2's account and makes those funds available for use immediately after Bank B is advised by the FedNow Service that the interbank funds transfer has been credited to its Reserve Bank account (which is also the legal moment of final settlement). The Federal Reserve and commercial bank ledgers are connected by the banks having accounts at the Federal Reserve and the FedNow rule set directing and constraining all parties' behavior.

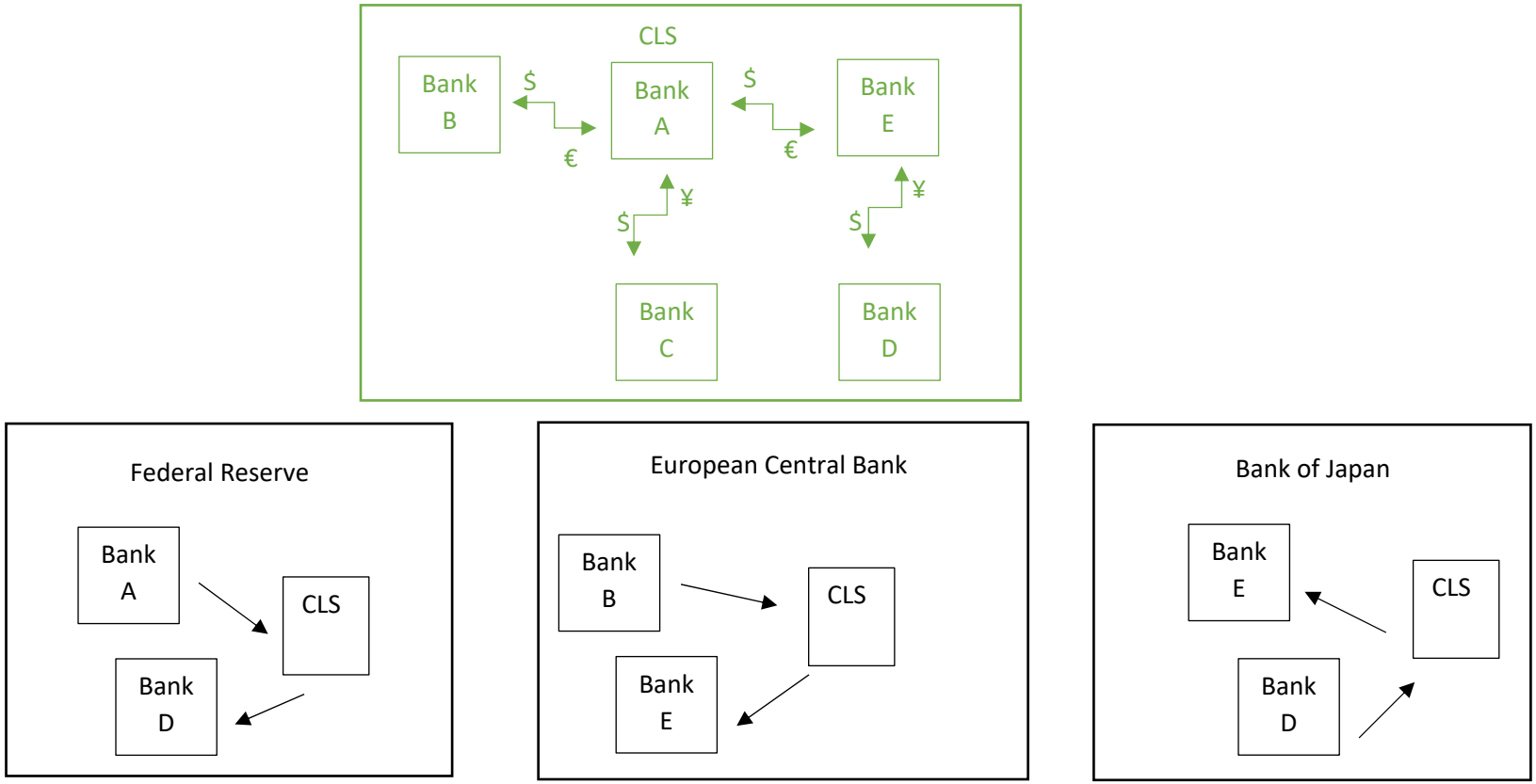
Multicurrency settlement with same key characteristics

Stepping beyond the domestic payments system, the largest cross-border payment system settling USD payments is designed with the same key characteristics: operational perimeters of individual entities are distinct; settlement assets remain constrained within the operational perimeters of their issuers; and ledgers are connected through entities holding accounts with one another. CLS is a payment-vs-payment (PvP) settlement system that settles instructions in 18 currencies.[23] CLS participants submit PvP settlement instructions to CLS and those instructions settle on the CLS ledger. CLS maintains accounts at each of the central banks of the 18 eligible currencies and its participants fund their settlements in CLS by sending central bank money into these accounts. After settlement, CLS then pays outs central bank money from these accounts to participants.[24]

Neither CLS nor the central banks operate or impact one another's ledgers beyond the central banks providing accounts to CLS and CLS setting rules for when its participants send in funding to those accounts.[25] While the Federal Reserve maintains an account for CLS on its ledger (within its operational perimeter) and knows the balance in that account, it does not have visibility into or responsibility for the payments settled on the CLS ledger. Balances on the CLS ledger represent claims on CLS, not claims on the Federal Reserve or any other central bank. Figure 2F provides a simplified illustration of CLS settlement on its ledger and related funding processes at relevant central banks.

[23] Payment-vs-payment is a settlement mechanism that ensures that the final transfer of a payment in one currency occurs if and only if the final transfer of a payment in another currency or currencies take place. (PFMI definition)
[24] This describes CLS's main settlement service. Information on additional services can be found in CLS's PFMI disclosure. https://www.cls-group.com/about/pfmi/
[25] CLS is subject to central bank supervision and oversight, but this does not entail any operation or control of the CLS systems.

Figure 2F: Simplified CLS Settlement and Related Funding Using Central Bank Ledgers



CLS settles PvP instructions between its settlement members' multicurrency accounts on the CLS ledger. Settlement of one side of the transaction cannot occur without settlement of the other. Separately, settlement members fund their CLS settlements by paying into CLS's account at the relevant central bank(s) and receive pay-outs from CLS's central bank accounts. CLS has an account at each of the eligible currencies' central bank, but settlement members do not have to have accounts at every (or any) central bank. They may contract with other settlement members to make pay ins or receive pay outs on their behalf. In this figure, Bank B is funding its euro pay-ins directly using its ECB central bank account[26] but it does not have a Federal Reserve account. It would rely on another bank for receiving its dollar payouts (not pictured). CLS settles payment instructions gross on its ledger, but settlement members fund this settlement on a net basis through its central bank accounts. This provides approximately 96% liquidity savings.[27]

[26] Structure between ECB and eurozone national central banks is compressed into single entity for simplicity.

[27] Further liquidity savings tools reduce total pay-ins to approximately 1% of total instructed settlements. See CLS PFMI disclosure. https://www.cls-group.com/about/pfmi/

In sum, the current USD interbank settlement landscape features multiple payment systems providing settlement using a variety of models. This variety, when supported by the legal framework and appropriate risk management, supplies a set of safe options that participants may choose between based on their specific uses and needs. Notwithstanding this variety, these systems have 3 key characteristics in common: operational perimeters of individual entities are distinct; settlement assets remain constrained within operational perimeters of their issuers; and ledgers are connected through entities holding accounts with one another.

Contemporary discussion regarding potential ways to improve domestic or global payment systems may generally be bucketed either as, 1) designing new systems or altering existing systems with new functionality and/or technology while maintaining these characteristics, or 2) altering one or more of these characteristics in concert with new functionality. Proposals in the second bucket often assert that desired functionality cannot be achieved without altering the key characteristics. Interrogating this assertion is high on the minds of central banks, FMIs, and other payment system stakeholders.

Section 4 of this note introduces a few examples of current initiatives or payment system concepts that would alter one or more of the key characteristics and considers related trade-offs. First, however, section 3 briefly discusses non-USD systems operating today that do not fully share the same key characteristics.

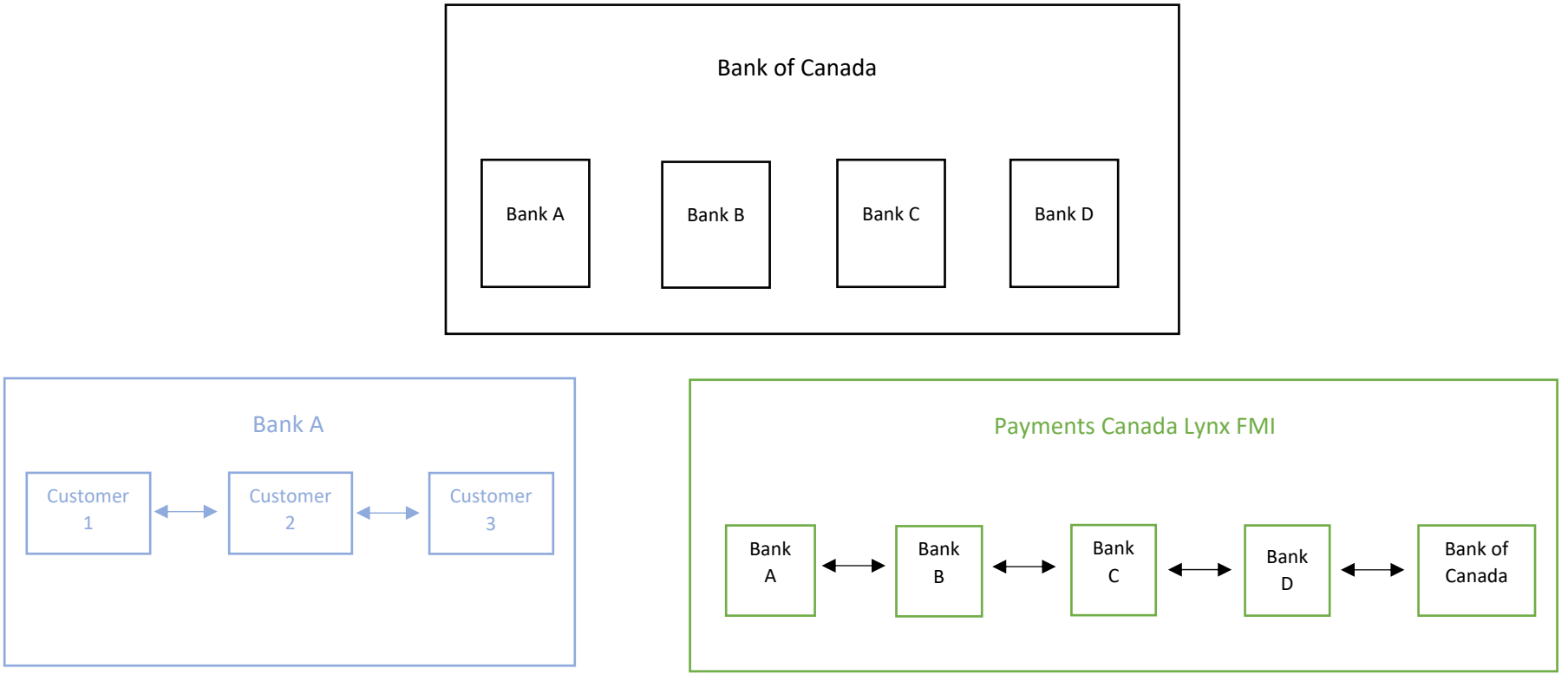
3. Non-USD payments systems with differing characteristics

Contrasting with USD payments infrastructure, in which central bank owned and operated systems are distinct from private sector owned and operated systems, Canadian dollar (CAD) payments infrastructure is provided by the Canadian Payments Association (branded as Payments Canada), a corporation established by statute that has voting membership made up of Canadian commercial banks, the central bank (Bank of Canada), and certain other entities, such as authorized foreign banks.[28] Payments Canada owns and operates CAD payment systems, which are funded by participating institutions using settlement accounts at the Bank of Canada. Settlement in these payment systems is legally deemed to occur in central bank money.[29] That is, Payments Canada and Bank of Canada retain distinct operating perimeters for their respective ledgers, but the settlement asset of the Payments Canada ledger is a liability of the Bank of Canada. Figure 3A depicts a simplified illustration of the Canadian interbank settlement landscape.

[28] See Canadian Payments Act.

[29] https://www.bankofcanada.ca/wp-content/uploads/2022/05/Overview-Lynx-Canadas-High-Value-Payment-System.pdf

Figure 3A: Simplified Canadian Interbank Settlement Landscape



The account holders in the Payments Canada Lynx FMI[30] are the same set of institutions that have settlement accounts at the central bank, plus the Bank of Canada itself. Interbank payments are settled in central bank money on the FMI ledger. Interbank payments are not settled on the central bank operated ledger. Banks fund their Lynx accounts each day through intraday loans from the Bank of Canada, which are recorded on the Lynx ledger and made available as liquidity for settlement.

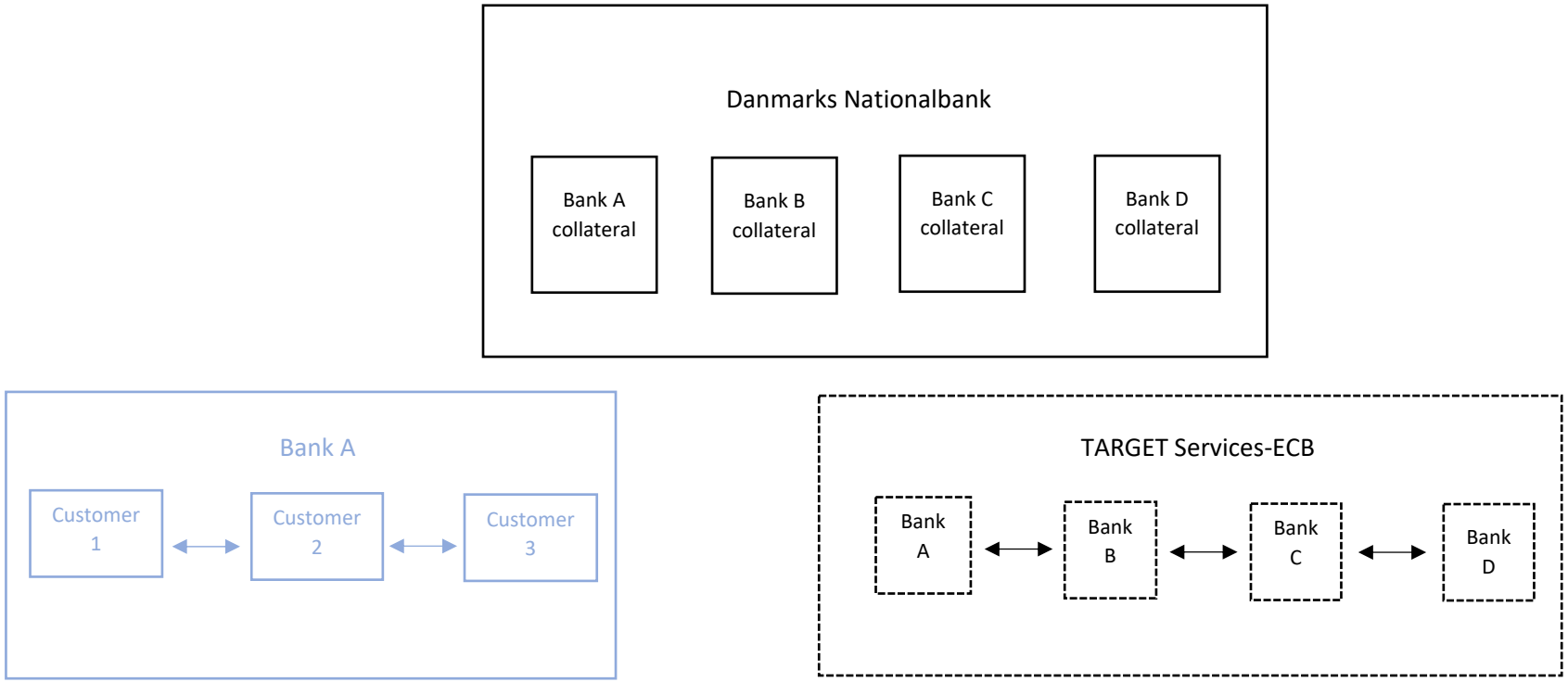
[30] The Lynx system encompasses multiple settlement mechanisms that have separate, but linked, accounts for each direct participant. This illustration compresses those into one account for simplicity. According to Lynx documentation, Lynx accounts are operated and controlled by Payments Canada on behalf of Bank of Canada, which is "providing the accounts" to participant banks. See Lynx Primer and By-laws.

Offering another contrast to USD infrastructure are European countries' continued movement toward sharing pan-European infrastructure. The Eurosystem, composed of the European Central Bank (ECB) and the national central banks (NCBs) of the countries that make up the eurozone, owns and operates payment and securities settlement infrastructure, known as the TARGET Services, that connects the national central banks and their respective account holders.[31] The ECB additionally offers this infrastructure for interbank (or similar) settlement for use by European countries that have not adopted the euro. To-date, Sweden has adopted TARGET for Swedish krona instant payments and is considering further uses. Denmark has use TARGET for Danish kroner (DKK) securities settlements since 2018. Denmark migrated fully to the TARGET payments and settlement infrastructure in April 2025, ceasing operation of its own interbank payment system.[32] These settlements in non-euro currencies over TARGET are legally defined as settling in central bank money.

According to Danmarks Nationalbank's materials, eligible banks continue to have accounts and contractual relationships with the Danmarks Nationalbank only, not with the ECB or TARGET Services.[33] Only Danmarks Nationalbank has a legal relationship with TARGET Services.[34] The record of the banks' DKK central bank balances is housed in TARGET, not within the Danmarks Nationalbank operating environment. At the same time, Danmarks Nationalbank continues to operate its existing collateral management system and banks have separate access processes for sending instructions to the two operating perimeters. Collateral pledged to Dansmarks Nationalbank in its system updates the balance record in TARGET, constituting an available credit line. When this credit line is utilized, balances are credited in one or more TARGET service cash accounts for use in settlement (e.g., banks can assign some liquidity for RTGS settlement, some for securities settlement, etc.). Figure 3B depicts a simplified illustration of the DKK settlement landscape.

[31] Descriptions of these systems are available here: https://www.ecb.europa.eu/paym/target/html/index.en.html
[32] https://www.nationalbanken.dk/en/what-we-do/safe-and-efficient-payments/interbank-payments
[33] See target-dkk-memo-version-30-english-2023.pdf (nationalbanken.dk); see also https://www.nationalbanken.dk/en/what-we-do/safe-and-efficient-payments/terms-and-conditions-for-account-holders
[34] Banks also establish a contractual relationship with one of the two authorized service providers that control use of the TARGET access port, the Eurosystem Single Market Infrastructure Gateway (ESMIG). Use of ESMIG is the only method of communicating with TARGET and the authorized providers are the only entry points to ESMIG.

Figure 3B: Simplified Interbank Settlement Landscape for DKK



The operational perimeters of the ledgers controlled by the Danmarks Nationalbank and the ECB remain separate.[35] Interbank settlement in DKK takes place in the ECB perimeter using a settlement asset that is legally defined as Danmarks Nationalbank's central bank money.[36] Interbank settlements do not take place in the Danmarks Nationalbank's operated ledger. Banks can increase their available balances in TARGET by pledging collateral to Danmarks Nationalbank.

[35] Two depicted ledger perimeters are black because they are both central bank perimeters. To distinguish between the two central banks, one is dashed.
[36] Represented by solid black line arrow in diagram. Settlement asset arrow would be dashed if ECB money.

Considerations

In each of these non-USD examples, the key characteristic that differs from the USD interbank payment system is that settlement assets are no longer constrained to the operating environment operated by the issuer. The respective central banks in Canada and Denmark are allowing their liabilities to be recorded, transferred, and updated by other entities. In the Canadian example, this entity is a special-purpose private sector corporation, in which the BoC has a decision-making role, but not a controlling or heavily-weighted vote.[37] In the Danish example, this entity is operated and governed by other countries' central banks. Underlying both arrangements are a set of public policy choices that, 1) have concluded that the benefits of offering consolidated payments infrastructure (e.g., cost savings) outweigh the costs, including any risks, and 2) within the category of risks, have concluded that any misalignment of interests between the public and private sectors (Canada) or between separate countries (Denmark and the eurozone states) is sufficiently managed by the legal arrangements in place. That is, these jurisdictions have concluded that the Canadian and Danish central banks can trust these other entities with control of and updates to the records of their liabilities, and that ceding this control either does not cede other forms of control—for example, of setting monetary policy for CAD and DKK—or does so in an acceptable manner.

4. Published concepts for future USD or multicurrency payment systems that alter one or more key characteristics

For a variety of reasons, there is currently very strong interest in easing existing frictions in payments.[38] Consequently, there are many proposals, concepts, and nascent ideas about how best to make improvements, which are subject to ongoing research and debate. This section describes a selection of published concepts for improving USD or multicurrency settlements, compares them against the key characteristics of the current USD interbank settlement landscape, and identifies the tradeoffs and choices these concepts appear to entail. Use of the term "FMI" in this section is largely based on the language used by the initiative proponents and does not imply that any particular concept would or would not meet CPMI or jurisdictional definitions of FMIs.

RLN

In November 2022, a group of financial institutions published a paper outlining a concept they titled, the Regulated Liability Network (RLN).[39,40] The premise of an RLN was that utilization of new technologies should not require shifting the legal underpinnings and treatment of money. If distributed or shared

[37] All members, including the BoC have one equal vote on matters decided by membership. BoC officers and employees are ineligible to serve as directors in the Association's board. Canadian Payments Act (justice.gc.ca)
[38] See, for example, FSB roadmap to enhance cross border payments and related reports from FSB, CPMI, and other organizations.
[39] See https://regulatedliabilitynetwork.org/wp-content/uploads/2022/11/The-Regulated-Liability-Network-Whitepaper.pdf
[40] The paper credited a 2021 Citibank article as originating the concept: https://www.citibank.com/tts/sa/insights/articles/article191.html

ledger technologies are judged to have advantages over other technologies for financial transactions, the paper asserts, it should not follow that use of those technologies requires adoption of cryptocurrencies or other non-regulated monies. Conceptually, an RLN would allow central bank, commercial bank, and regulated nonbank monies in a given currency, as authorized by a nation state, to share a ledger. This ledger would serve both as the record of each included institution's liabilities—which would be meant to have the same legal characteristics that they do today—and also as the FMI that settles payments between institutions. Liabilities of differing issuers would be recorded in separate "partitions" on the ledger. The RLN concept could be extended to multiple currencies, recording and transferring liabilities cross-border.

The RLN contributing institutions then conducted a 12-week proof-of-concept (PoC) using hypothetical central bank and commercial bank USD liabilities, publishing reports from the PoC in July 2023.[41] The hypothetical central bank money served as the settlement asset for all interbank settlement. In the PoC, the FMI function entailed receiving proposed payment information from a bank, distributing the proposed payment information to all other relevant entities, receiving approvals from all entities (completion of this step is defined as the moment of settlement finality), updating the FMI record of all transactions, and announcing final settlement to the relevant entities. Subsequently, the relevant participants update their respective partitions.

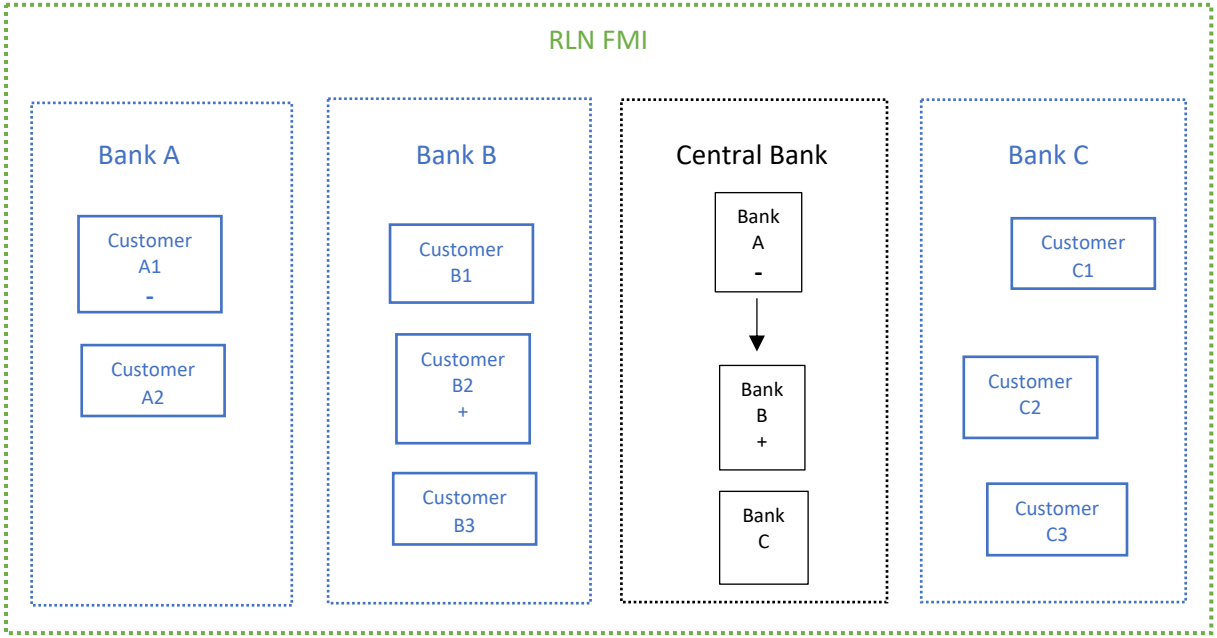
The key distinction articulated by RLN is that all participants utilize an external (shared) ledger instead of each operating an internal ledger. The FMI "orchestration" of the above steps means all partitions are updated near simultaneously and, more specifically, interbank settlement is tightly coupled with execution of customer payments and updating of all relevant records. This coordination reduces reconciliation processes and operational risk therein. The PoC materials specify that two distinct configurations were tested, achieving the above steps and outcomes in differing ways. The PoC posits that many technology solutions might achieve the same ends and, potentially, an RLN could be constructed in which participants made heterogeneous technology selections.

Comparison against key characteristics

Comparing against the key characteristics of the current USD interbank settlement system, the RLN concept appears to include the following: 1) it establishes an FMI that conducts operations similar to existing private sector payment system FMIs, but that does not utilize its own settlement asset; 2) interbank settlement occurs in central bank money, but the central bank does not operate the FMI; 3) settlement assets never leave the partition of their issuer; 4) while participants each update the records in their respective partitions, the broader outlines of the operating perimeter(s) and how it (they) are controlled largely is unknown; and 5) bank partitions include customer account information, allowing steps along the full length of the payment chain to be executed as a single operational process. Figure 4A provides a potential simplified illustration of this arrangement.

[41] See www.rlnuspoc.org

Figure 4A: Simplified Potential RLN Arrangement, with Single Transaction



After receiving a proposed payment from a bank, the FMI executes process steps that communicate among and between participants and instruct action by participants.[42] The combination of participant action/FMI receipt of that action executes settlement. After settlement, crediting and debiting of relevant accounts happens in respective partitions, triggered by the instruction of the FMI and executed by the partition owners (degree to which automation cedes operational control from banks to FMI is undetermined). The interbank settlement asset is central bank money. The depicted transaction is financially identical to the payment depicted in Figure 2E. Operationally, all updates happen through one connected process in RLN, with the FMI keeping a record of all parts of the transaction. (In contrast, in 2E, separate operational processes occur, linked by contract, and no entity has the record of all parts.)

[42] Dotted operational perimeters signify the FMI having established rules and control that pertain to all entities, but some degree of independent control is also envisioned for bank and central bank partitions. Exact interaction, governance, and sharing of control between these nested perimeters is unclear. In contrast, customer-bank relationships and bank-central bank relationships are clearly demarcated with solid lines. Account holders do not operate their accounts.

Consideration of potential benefits, costs, and tradeoffs

The RLN white paper and PoC are, inherently, limited in scope and detail. Broadly though, the RLN focus is eliminating complicated reconciliation and otherwise tightening the execution of a payment across its complete chain from one end-user, through all relevant intermediaries, to the final end-user. By and large, while commercial bank liabilities are a key component of the RLN concept, the authors appear to expect that partition-owners will have separate internal systems as well and/or will otherwise not move their entire set of banking records and functions onto the RLN.[43] Descriptive focus remains on pairing an interbank settlement in central bank money with related commercial bank account updates. Intrabank payments between a single bank's customers and other internal customer-facing functions are not discussed.

With this scope, the clearest metric for evaluating the potential benefits of an RLN relative to the current USD system appears to be the marginal improvement that an RLN could provide relative to use of RTP or FedNow, which similarly scope in rapid settlement and funds availability for end users. As noted above, RTP and FedNow systems settle the interbank portion of a payment, prescribe rules regarding commercial banks' updates to their customers' balances and making those funds available for additional use, and transmit messages and otherwise make information available to allow action in conformance to those rules. These systems reach through the payment chain with a combination of rules and messages. RLN also relies on rules and messages, but with two differences from RTP and FedNow. Firstly, messaging among parties to a payment is internal to the RLN starting with the payment instruction and continued through the end-user balance update. At the same time, reliance on external messaging and reconciliation processes is also necessary to allow RLN commercial bank customer records and external commercial bank customer records to stay in sync. This reliance is thus outside of, but still surrounding, the payments process.[44] Secondly, RLN FMI has visibility into whether rules were followed and messages lead to all related actions being taken.

If the potential efficiencies of RLN seem most connected to communication and reconciliation changes, the potential tradeoffs for various participants seem most connected to decision-making and control. Similar to the CAD arrangement described above, participating in RLN, as described, would take the central bank's liability out of the system it owns and operates and allow it to serve as the settlement asset in a ledger that (likely) has some form of shared public-private governance. Differing from the CAD example, in which the LYNX FMI has a distinct operational perimeter and a single operator, RLN entails shared and overlapping operational perimeters for the central bank, commercial banks, and the FMI.[45] From both the central bank and commercial banks' perspectives, RLN entails ceding some degree of decision-making and operational control of the banks' own liabilities to others, possibly along a

[43] The next related PoC and set of published reports, the Regulated Securities Network, which are largely out of scope of this note, similarly approached the shared ledger as limited to certain purposes and not the all-purpose systems and records of its participants. One of the key areas of research was considering tradeoffs between moving more functions to the ledger vs. connecting the ledger to larger numbers of external systems. Further information can be found at https://www.sifma.org/resources/general/regulated-settlement-network-proof-of-concept/

[44] In contrast, RTP and FedNow do not record customer balance information and the commercial banks are instead reconciling their internal customer records with their bank balances at the FMI and the messages from the FMI regarding settled payments and which customer should be credited immediately.

[45] As described above, other existing consortium-owned FMIs (e.g., CHIPS) similarly have a singular operator.

spectrum from everyone having equal shares of authority and equal dependence on one another to one entity having full authority over all others.

Since in all potential RLN arrangements along this spectrum the central bank is the only issuer of interbank settlement assets, an arrangement in which the central bank had full control of the RLN ledger governance and operations would be closest to today's Federal Reserve owned and operated interbank payment systems. Like in current Federal Reserve systems, commercial banks would rely on the central bank for accounts and services and would be subject to the central bank's related rules and procedures for using accounts and services. At present, the Federal Reserve sets rules, manages access, determines available services, and leads risk management.[46] This "most similar" version of the RLN concept nonetheless appears to alter the nature of the risks and responsibilities faced by the central bank. Specifically, the provision of the commercial bank partitions potentially would entail the central bank accepting operational and legal obligations related to the accuracy and security of commercial bank account balances, as well as acquiring bank customer information and related obligations for privacy protections, fraud protections, and anti-money laundering and sanctions compliance requirements.

Elsewhere on the spectrum of possible arrangements, wherein there is shared governance and/or operations, the central bank may concurrently be taking on these types of new obligations while also ceding full control over governance and operation of its own partition. The central bank's own records of its issued liabilities are no longer independent from the decisions and actions of others. In these same instances, commercial banks may not necessarily be any more or less dependent on other entities than they are today. Rather, who they depend on may change. In current USD infrastructure, commercial banks have core dependencies on the central bank and private sector FMI operators, and potentially on selected correspondent banks through which they access payment system infrastructure. In an RLN, commercial banks theoretically may have wider-spread mutual dependence on one another rather than dependence on a few particular entities. Alternatively, other theoretical RLN arrangements could entail broad commercial bank dependence on a dominant commercial bank or service provider, possibly an entity which is not currently in any such central position.

Unified Ledgers

In February 2023, BIS General Manager, Agustín Carstens, gave a speech promoting the benefits of "unified ledgers" for payment systems improvements.[47] The BIS expanded on this discussion in its 2023 Annual Report. Where RLN focused on a shared ledger that could capture the full length of payments chains, the BIS's unified ledgers were more expansive, aiming to bring a wider set of records, institutions, and activities onto a singular platform. Carstens described a unified ledger as financial infrastructure provided in a public-private partnership between central banks, other public agencies, and industry participants. The unified ledger would record balances in both central bank and commercial bank monies, as well as other financial assets. Like the RLN, conceptually each asset type and/or issuer would have a specific partition in the ledger. Once respective monies and other assets were recorded on the ledger, which would be designed with extensive, flexible programming to allow instruction and execution of diverse types of transactions and the capacity to develop more over time, reference to any

[46] Within statutory limits (e.g., access eligibility).
[47] See full text at https://www.bis.org/speeches/sp230222.htm

other ledger or information would be unnecessary.[48] Thus, the unified ledger is not a shared ledger for a payments function, but is the shared ledger used by one or more currencies' central bank, commercial banks, and other financial firms as their core books and records.

Comparison against key characteristics

It is difficult to concretely identify the key characteristics of the unified ledger concept, but some clear differences from the USD interbank settlement system are apparent. Mostly notably, the articulated concept does not specify who controls the operating perimeter. A wide set of arrangements are theoretically possible, from a single institution controlling everyone's environment (e.g., a specific central bank provides and maintains the ledger, offering it for others to use and setting the conditions of that use); to a widely shared control structure that requires group agreement for every major decision (e.g., participating entities function as a consortium with little delegation). The BIS explanation of the unified ledger describes separate partitions for individual central banks, commercial banks, or other entities. The degree to which any of these entities has either decisional or operational control over the design, functioning, and specifications of their respective partitions appears uncertain. More clearly, and consistent with the current USD interbank system, the concept discussion unambiguously describes that money issued by individual entities remains constrained to its issuer's partition and that layered account structures in which central banks offer accounts to certain private sector institutions (particularly banks) and those institutions offer accounts to everyone else should be maintained.

Consideration of potential benefits, costs, and tradeoffs

Broadly, the unified ledger concept aims to, 1) capture operational efficiencies and 2) enforce consistent behavioral compliance across the scope of markets, institutions, and currencies included in the unified ledger. Potential operational efficiencies may result from consolidating what are currently distinct operational perimeters and varying communication methods into one operational perimeter that links its sub-components together in a standardized way. These efficiencies could include economies of scale that would lower operational costs, clear arrangements for sharing those costs, and fewer potential vectors by which costly miscommunication may occur.

Consistent behavior enforcement would be pursued by using programming to operationally limit executable transactions to those that meet specific regulatory compliance, contract, or other coded requirements (e.g., transaction history to track assets and prevent illicit activity, pooling and sharing of data cross-border to enrich credit decisions, mechanisms to prevent rapid sales in stress conditions). The same control structure that facilitates concurrent updates to the various relevant partitions in a transaction could also serve to constrain behavior consistently across all parties on the ledger. In contrast, current practices entail roles and responsibilities divided across many entities, such as intermediaries constraining their specific customers as required by law (e.g., through know-your-customer and anti-money laundering programs) or written in contract, and regulators constraining

[48] Except as desirable, such as transactions whose execution is contingent on external events. In that instance the contingency information would be recorded in the ledger and collection of the relevant external data would be automated.

financial intermediaries subject to their authorities (e.g., by setting requirements and supervising against them).

This use of operational controls to enforce acceptable behaviors should not be mistaken for a lesser role for the legal frameworks that underpin today's financial transactions to play in future hypothetical unified ledgers. Instead, it highlights the criticality of decisions regarding whose legal framework is enforced. Which jurisdiction sets the standards and whose policy choices dominate? Or, alternatively how much agreement, coordination, negotiation, and consistent resolution of conflict must be in place to set up and maintain the system? The unified ledger's hypothesis is that the potential operational efficiency benefits of a centralized, automated platform outweigh the costs of either A) ceding independence and control to a dominant peer and its legal and policy choices, or B) cross-jurisdictional compromise and coordination to develop a single set of shared rules that is consistent with all relevant legal frameworks and/or those frameworks are harmonized with one another.

XC Platforms

In 2023, IMF staff published a note titled, "The Rise of Payment and Contracting Platforms."[49] It built on a related staff working paper from November 2022.[50] The note articulates a potential solution for improving cross-border payments: a multilateral, multicurrency platform that combines trading and settlement of FX transactions (an "XC platform"). The combined materials posit that price, timing, and other measures of efficiency in cross-border payments of any type could be improved with a platform that 1) allowed real-time multicurrency settlement in central bank money, 2) was accessible by a wide variety of relevant intermediaries, and 3) using advanced programmability, created a centralized marketplace for entering into FX spot, futures, forwards, and other contracts. Settlement mechanics were more specifically described as being based on "tokenized" central bank reserves. Participating central banks would establish accounts in which reserves could be "escrowed" for the XC platform. Banks or other participants could transfer reserves to that account for escrow and then the XC platform would create a corresponding digital escrow token on the platform for use in settlement. Tokens could be sent to other XC participants to settle trades, make one-way payments, or other uses. Among other possibilities, the trading component of the platform could convene the relevant entities from the global FX market, establish a central information source for publishing bids and offers, assist with counterparty selection, and run auctions. Programming would enforce that trade execution would be contingent on having the assets to deliver and settlement generally would be immediate. If forward settlement was desired, programming could allow rehypothecation and other reuse of assets in the interim.

In light of the combination of jurisdictions, entities, and functions in an XC platform, the staff note acknowledges that such a system would raise complex governance questions. These would include who operates the platform, how its rules are determined, and how its provision of common infrastructure could be designed fairly, efficiently, and resiliently.

[49] Adrian, Tobias and Tommaso Mancini-Griffoli 2023. "The Rise of Payment and Contracting Platforms" IMF Fintech Note 2023/005, International Monetary Fund, Washington, DC.
[50] https://www.elibrary.imf.org/view/journals/001/2022/217/001.2022.issue-217-en.xml

Comparison against key characteristics

Though articulated as a novel settlement solution with an expanded—but controlled--use of central bank settlement assets, a comparison with current USD and multicurrency settlement systems demonstrates that it is neither. Focusing on the relevant settlement assets, the arrangements the note envisions generate FMI settlement assets, fully analogous to existing FMI settlement assets described above. More specifically, they would be FMI settlement assets that 1) remain constrained to operating perimeter of the FMI and, 2) are pre-funded in central bank money. The balances on the platform may be transferred within the platform, but not outside of it. These balances would not represent claims directly on the central banks of the respective currencies.[51] The exact legal parameters of the FMI settlement asset claims could vary, just like balances on the CHIPS ledger (which prefunds through a joint account) are not fully identical to balances on the CLS ledger (which prefunds through CLS's central bank account). Those parameters would be a function of the rules, procedures, and contracts governing the platform, including its use of central bank accounts.

Additionally, though CLS participants predominantly choose to use its settlement service that provides liquidity savings through gross settlement with net funding (and thus not immediate settlement upon instruction), there is great overlap in existing settlement functionality of CLS and that described for an XC platform.[52] Similarly, nothing pertaining to the described XC platform settlement functionality appears to require a design that would remove the implementation and control of the FMI internal ledger from the FMI itself, though diverging in this manner is not ruled out by the paper's parameters.

Consideration of potential benefits, costs, and tradeoffs

The novel aspects of the XC platform concept are not tied to settlement functionality or settlement assets. Rather, it is the proposed centralization of the FX trading market that represents material change from current arrangements. This redesign of the global market appears to generate the concept's potential improvements, costs, risks, and tradeoffs. Briefly, IMF staff describe the decentralized nature of FX trading, the high relative portion of cross-border payment fees that are driven by the transaction costs of converting between currencies, and the variation in those fees between relatively heavily traded currencies and thinly traded currencies. They then posit that a centralized global trading market should decrease costs of trading, which would both lower the costs of supplying trade intermediation services and increase demand for trading. The link to settlement is that, assuming the costs, risks, and tradeoffs of organizing such a centralized market were worth the benefits, the benefits would be most material for relatively illiquid currencies. This, in turn, would also decrease costs of and increase willingness to pay for centralized settlement infrastructure for these currencies.

Interrogating the potential benefits, costs, risks, and tradeoffs of creating a centralized global FX trading market is beyond the scope of this paper. It seems straightforwardly clear, however, that such an endeavor would require intensive coordination across a large number of countries (theoretically all), public and private sectors, demanding aligned legal, policy, and financial commitments. Assuming

[51] This is clearest where the note specifies that banks without access to a central bank would have claims on the platform, not on the central bank whose currency is being used or any of the escrowed funds.
[52] For example, CLSNow is gross settlement, gross funding PvP service that settles transactions as soon as they are funded.

feasibility of that outcome, large questions regarding resulting concentration risk and the resilience of coordination mechanisms over time and as geopolitical concerns evolve would remain.

Assorted other approaches

The previous 3 approaches, as articulated in their concept papers are far from the only ideas for potential changes to USD or multicurrency interbank settlement. For example, a large and varied set of initiatives explicitly aim to maintain the existing key characteristics of the USD system, while improving the efficiency of the connections and communication between separate ledgers and/or the efficiency of each individual ledger. A complex but not particularly new dimension of these efforts is an ever-dynamic set of questions around these connection points and whether and how operating perimeters are made permeable. When does coordination, orchestration, automation, or any other path toward more seamless operations entail ceding autonomy, security, or resilience? Are the tradeoffs worth the benefits and do entities understand their risks and controls? This is, of course, the heart of operational risk management and the subject of great industry investment and supervisory attention.

There is also much interest among industry participants in the potential uses of permissionless ledgers. Permissionless ledgers gained attention first and foremost as potential pathways to categorically throw out all key characteristics of the USD or other payment systems, as well as reliance on central banks, commercial banks, and intermediaries of all types. Quickly though, broad reliance on intermediaries emerged within much activity on permissionless ledgers, questions of who might dominate ledger operations became relevant, and interest in connections to USD systems and institutions grew substantially. Among other outcomes, these dynamics have incentivized exploration of how firms might build on and over permissionless systems to reinstate some or all of the key characteristics. Innovations in this vein are rapidly evolving.

5. Considerations for the next phases of USD and multicurrency interbank payment systems

Heretofore, launches of new USD multilateral systems and expansion of the functionality of established systems have not altered the key characteristics of USD interbank settlement systems. While private sector FMIs often have group ownership and governance, that shared decision-making has not extended to shared operational control, nor blended internal ledgers. Many, possibly most, current initiatives aimed at further improvements similarly retain the existing key characteristics. Efforts to expand hours, automate processes, improve communication, expand optionality, create links, etc. abound. Contemporary discussions and investigations of potential improvement include, however, a wide variety of lines of inquiry and these include potential alteration of the key characteristics. While all major initiatives entail potential benefits, risks, costs, and tradeoffs, initiatives that alter one or more of the key characteristics may raise particularly complex questions. As USD payment system stakeholders contemplate these questions and evaluate tradeoffs, some relevant considerations may include:

Would a change increase or decrease choice?

In the U.S. context, this question seems particularly relevant to the key characteristic of settlement assets remaining constrained to the operating environments of their issuers. In the Canadian and Danish examples of central banks allowing their liabilities to be recorded, transferred, and updated by another entity, and to serve as the settlement asset on a system the central bank does not own, operate, or control, the interbank payment system(s) in question is the currency's only such system (or group of systems). The large size of the U.S. economy, financial markets, and interest in the dollar globally yields a payment system landscape that is more extensive than in many jurisdictions. As described above, there are central bank and private sector interbank payment systems operating concurrently for large value, ACH, and instant payments. This multiplicity of systems creates wider settlement model options, differing features, and choice.[53] Specific services come and go as they do or do not get market take-up, but sufficient demand is present to maintain the existence of multiple systems. This is a different landscape from jurisdictions that may be challenged to bear the costs of maintaining one system or that, for any reason, have already consolidated to a single provider of interbank settlement. To the extent that the U.S. central bank either participated in a shared ledger or offered its liabilities as the settlement asset on a private sector system, would central bank money become the only available interbank settlement asset, either by design or by default? If so, would wider consolidation of multilateral settlement systems follow? Would this loss of competition shrink available services, make them more expensive, or more narrowly accessible?

How are trust relationships reorganized?

Payments and other settlements entail multiple layers of trust. At the base, there must be trust in USD as a currency such that economic actors are willing to receive USD payments and store USD value. Economic actors must trust in the central bank to maintain the currency, both the specific liabilities it issues and the price stability of the currency as a whole. Individuals and firms must trust financial institutions to safeguard their money and other assets. Financial institutions must trust one another for many services. The legal framework must reliably and consistently support these layers of trust and the conduct of these activities. Current USD and multicurrency interbank payment systems both leverage and reinforce these trust layers. Potential future systems similarly will require trust among operators, participants, one or more legal frameworks, one or more central banks, and other stakeholders. While trust relationships are often complex and require careful attention, alteration of key characteristics potentially adds new dimensions to this complexity. Shared, merged, or permeable operating environments may raise novel questions regarding the clarity and verifiability of dependencies, roles, responsibilities, and mechanisms of accountability. From the issuer's perspective, movement of settlement assets outside of the issuer's operated and/or controlled environment represents a new type

[53] Requirements of the Monetary Control Act promote fair competition by preventing the central bank from benefiting from cost advantages over the private sector. As described further here, the Federal Reserve Banks must set fees to recover all direct and indirect costs of providing payment services over the long run and also imputed costs that would have been incurred and imputed profits that would have been earned if a private firm had provided these services.

of dependency, potentially relying on new trust relationships. To the extent that these changes alter the issuer's abilities or practices regarding honoring its liabilities, the trust relationship between the issuer and its customers (e.g., FMI participants, bank account holders) changes too.

To the extent that changes to interbank or multicurrency payment systems reorganize existing trust relationships, stakeholders will need to ask themselves and one another, who do you trust and how much do you trust them? How can you put safeguards around that trust? What is your recourse if it breaks down? How closely must you be aligned to be able to establish a safe and efficient system? How similar are you already? How much coordination is required and what is cost of coordination?

How are opposing interests managed?

This question is related to the trust dimension, but not identical. A well-functioning FMI, including a payment system, is designed to serve equitably market participants whose financial interests are in opposition to one another.[54] While this paper has not explored in detail the functionality envisioned in the various extensibly-programmed ledgers described in RLN, the Unified Ledger, or the X-C platform papers, the vision for effectively managing these opposing interests often appears thin. At times, an undercurrent seems to run within these proposals, that operational efficiency and hard-coded behavior constraints could also eliminate the financial risks that pass between payment or trading counterparties. Financial transactions entail exchanging resources and risk. Understanding risk, appropriately pricing in risk and adopting effective risk management practices are key for financial institutions' activities. But that understanding, pricing, and management of risk is not same as eliminating risk altogether. Counterparties have opposing financial interests. Governance arrangements—defining relationships between all relevant parties—determine how interests are balanced, what and who is prioritized, and how any aberrations are managed. Among other outcomes, effective governance prevents parties with opposing interests from having the means to harm one another.[55] Many concepts that alter one or more of the key characteristics are concurrently combining and comingling a wider set of functions and interests into a single multilateral system. Identifying which such interests align or conflict and whether that varies over time and circumstances will be complex. Managing such conflicts and equitably serving participants will be even more so.

Conclusion

Current U.S. dollar interbank payment systems settle using a variety of models. Notwithstanding this variety, these systems have 3 key characteristics in common: operational perimeters of individual entities are distinct; settlement assets remain constrained within operational perimeters of their issuers; and ledgers are connected through entities holding accounts with one another. As public and private sector stakeholders consider how to improve one or more aspects of the broad USD payment system, inclusive of all mechanisms and parties in payments, to make operations safer, less expensive, faster,

[54] For example, financial firms compete one another to provide services to customers; market price moves result in one trading counterparty profiting and the other taking a loss.

[55] In an FMI, possible harms could relate to, among others, records alterations, canceled transactions, determining timing of actions, decisions regarding qualifications for/access to services, decisions about use of shared resources.

more widely available, or otherwise in support of U.S. economic welfare, there will be tradeoffs within and between potential paths forward. Those tradeoffs may be particularly complex when contemplating initiatives that change one of more of the key characteristics of the current U.S. dollar interbank settlement landscape. These tradeoffs are not necessarily new and other jurisdictions have previously deemed certain opportunities worth the costs and risks for their particular circumstances. Understanding the specifics of what might be gained and lost in the context of the U.S. payment system may benefit from interrogation of questions related to whether a change increases or decreases choice, how trust relationships are reorganized, and how are opposing interests managed.