The international payment system, euromarkets, and central bank swap lines

Dario Laudati* Otto Benedek*

August 8, 2025

*Columbia University. Corresponding author: Dario Laudati (dl3768@columbia.edu).

Table of Contents

1 The international payments system

Payment systems fulfill the need for society to structure its monetary transactions in an organized and reliable way. Money is intrinsically connected to any economic transaction — It allows the discharge of obligations when real or financial resources need to be acquired. Therefore, the design of an appropriate monetary system and of a reliable form of money have always been essential for thriving and functioning economies.

From a theoretical point of view, a good form of money is characterized by three functions: (*i*) Unit of account; (*ii*) Medium of exchange; and (*iii*) Store of value. The first function specifies the ability of money to measure the value of goods and services to be sold. By acting as a unit of account, money creates a measurement device, an intangible yardstick. Thanks to it, different commodities can be expressed as a function of a third element (say, US dollars) rather than one in the units of the other (say, apples as a function of the number of oranges).

Working as a medium of exchange, money also allows for the physical exchange of goods and services to happen efficiently. By having material coins and banknotes, not only can any two goods be expressed as a function of a third element (as previously noticed), but no *actual* barter exchange need to occur in practice either. To maximize efficiency, some materials such as metallic coins are better suited for this purpose than others (shells, wampum, etc.). In modern times, we would say that electronic transactions are the most efficient way for such operations to occur.

Finally, the store of value function is intuitively the ability for money to maintain its value over time if held outside of circulation (Wang, 2020; Treasury, 2022). The purchasing power of money may be reduced by inflation (rising market prices); however, the value *per se* of money instruments with this characteristic is preserved.

Payment systems have not been invariant through time. In fact, waves of financial revolutions have made it one of the most interesting and fast-evolving institutions in the world (Goetzmann (2017), Humphrey (2019), Sullivan (2022)). Payment systems have advanced from metal to paper-based format, and then to complex electronic systems. In this respect, one of the most visible shifts in global payment systems has been the ongoing transition from cash to digital transactions (FRB, 2022; Riksbank, 2022; Rose, 2023b). This is due to various forces, including technological innovations and changes in market participants' preferences and needs. Electronic payments both at retail level – through credit and debit cards, wires, mobile payments, and more – and at the wholesale level – see, the interbank market, among others – have made monetary transactions highly efficient, and they helped generate deep interconnections in the world economy. Section 1.1.1 provides a more detailed description of payment instruments.

In modern times, the need for efficiency and speed has pushed the banking system to develop different mechanisms to execute interbank transactions. From Real-Time Gross Settlement (*RTGS*) systems to Deferred Net System (*DNS*), the optimal mechanism to settle and clear accounts is still in the making. Large infrastructural investments are still under way both at public and private level. In order to grasp the complexity of the modern payment system, Section 1.1.2 makes these technical points clearer and

accessible.

An important characteristic associated to payment systems is that they rely on so-called "network effects" (Freixas and Rochet, 2008). The idea behind network effects is that the value of a payment system increases with the number of participants (the nodes in the network). The network effects generate amplifying feedback loops: The more people use a payment system the more valuable it becomes for people to use, thereby attracting ever more users and establishing itself as the preeminent standard. Section 1.1.3 expands on this point by providing a cross-country comparison of the main existing payment networks.

International or cross-border payment systems are fundamentally different from national systems (BIS, 2016; Grolleman and Jutrsa, 2017). They involve multiple currencies, bridge different regulatory jurisdictions, and often have a longer settlement period. Interoperability, transparency and cost-effectiveness are even bigger challenges in cross-border payments systems. As such, both national and international regulation and oversight may prove to be a daunting task. Section 1.2 provides an overview of the international payments supervision and oversight organization.

This reliance introduces additional layers of cost, complexity, and risk — including compliance with anti-money laundering and countering the financing of terrorism regulations, which have contributed to a decline in correspondent relationships in certain regions. Efforts to improve these systems have focused on coordination between countries, standardizing procedures, and taking advantage of technology to ease the payment delivery processes. The aim is to streamline payment delivery while maintaining robust safeguards for financial integrity and stability. However, the open challenges for the global payment system are multiple and multifaceted. Section 1.3 lists some of the main issues at stake at the time of writing. From geo-economic tensions to the issuance of cryptocurrencies and Central Bank Digital Currencies, the list of new ways in which world economic equilibria and technological innovations intersect the international payments system is very much open.

1.1 Components and infrastructure of the payment systems

1.1.1 Payment instruments

Payment instruments are indispensable means for the execution of most monetary transactions. The oldest such instrument still in use today is cash. Cash in its modern form consists of physical banknotes and coins, often printed by a government's Treasury department, and distributed by its monetary authority. With some exceptions, it is accepted universally within the jurisdiction of a state's economic authority as *legal tender*. Its primary use is for small, face to face transactions, offering immediacy, convenience, and anonymity for both payers and payees. Many bills are either watermarked or marked with unique security "threads" for sellers to verify legitimacy and mitigate counterfeit risks. Cash comes with handling risks, and storing large quantities requires multiple layers of security on the part of businesses and banks.[1] Given the limited scope of cash transfers for economic transactions of higher notional amounts,

[1] A surprising feature of several of today's industrialized economies is the so called "cash paradox." By cash paradox, we describe the phenomenon of increasing demand for cash – measured as a ratio of currency in circulation to gross domestic product – amidst a decline in the proportion of cash transactions as a fraction of the total.

the payment infrastructures of modern societies have gradually produced financial innovations that allowed payments to be leaner, faster, and more secure.

Historically, checks have been a key instrument to ensure such efficiency gains. They can be seen as paper orders to transfer resources from a payer's bank account to the payee's. A similar instrument is the *giro* transfer. However, in the giro system the payer initiates a request of payment to the payee, which is completed and credited once the payer's financial institution has verified the existence of such funds. On the other hand, the check is effectively a credit instrument that may not be substantiated by a sufficient outstanding amount of funds to support the desired transaction. In this respect, the giro can be considered a proper money instrument, while the check resembles a credit tool until it is cleared, settled, and thus monetized. The Association for Financial Professionals (2022) found that issuing a paper check typically costs between 2.01 USD and 4.00 USD, while receiving one costs around 1.01 USD to 2.00 USD. The high costs of checks compared to digital payment methods can be attributed to a variety of factors, including risk of fraud, mailing and printing costs, manual processing and settlement, and more. Even though many businesses are still reluctant to digitize their payments, check usage has continuously declined in recent years.

Payment cards have become widely used non-cash instruments in retail transactions across many countries. Card companies like Visa, MasterCard and Discover connect merchants, banks, and consumers in a four-party system enabling instant authorization of payments at the point of sale and subsequent clearing. These networks operate globally and at scale: by the 2010s, Visa evolved from BankAmericard into a worldwide electronic value exchange facilitating high-volume and secure transactions. Card transactions incur merchant fees and interchange fees that fund the network and the issuing banks. Nonetheless, their convenience and wide acceptance have made them the most frequently used cash substitute in advanced economies.[2] Card companies typically offer both credit and debit cards.

Credit cards allow users to transact regularly on their bank's books, usually with a monthly limit set by the card issuer. Every month, users must pay back the amount they spend to the issuer.[3] Conversely, debit cards are associated with a bank account, and they are directly linked to its balance. In this respect, the distinction between credit and debit cards resembles the electronic version of the checks vs. giro transfers mentioned above. When used for purchases, card payments are immediately noted and reviewed by each bank before adjusting the account balances. Both credit and debit cards have transaction costs associated with their use in many settings. Such costs are typically charged to merchants by issuers. In turn, merchants often pass these costs on to consumers by charging fees for card payments.

In terms of electronic payments, it is important to mention the familiar bank transfers and wire transfers, which are electronic account-to-account payments. A bank transfer is a local payment between two bank accounts directly using local routes, such as ACH. Conversely, wires use a third party intermediary – such as SWIFT – to go from the payer's to the payee's bank account.[4]

Cards and wires do not represent the only cornerstones in the process of digitization of the payment

[2] See Stearns (2011) for an in-depth review on this.

[3] In the U.S., credit cards are also necessary for building a credit score, which is needed for individuals needing loans for education, cars, homes, entrepreneurship, etc.

[4] Section 1.1.2 and 1.1.3 explain in greater detail ACH, SWIFT, and other systems.

system. The market for digital wallets has grown following increasing demand for convenience and protection from digital identity thefts risks. PayPal and similar platforms allow users to link existing card or bank information and provide a convenient interface for e-commerce and peer-to-peer payments.[5] They offer cost-splitting mechanisms and electronic verification so that users do not have to enter their card or bank information into sites that could be exposed to hackers. These non-bank players also offer multi-currency and cross-border retail payments. A feature that has become increasingly valuable in the financial globalized ecosystem. PayPal's network grew to serve over 200 million users by providing easy online payments, effectively becoming a *de facto* retail network alongside card schemes.

In recent years, digital innovations have expanded the array of payment instruments. Cryptocurrencies like Bitcoin introduced decentralized payment mechanisms using blockchain record-keeping technologies. Blockchain is a type of distributed ledger technology (*DLT*) that records transactions across a decentralized network of computers in an immutable and transparent way. Each block in the chain contains a set of timestamped records and is linked to the previous one via cryptographic hashes, ensuring integrity and resistance to tampering. Blockchain can be permissioned (restricted to verified participants, as in enterprise or central bank contexts) or permissionless (open to anyone, as in cryptocurrencies). In payment systems, blockchain enables real-time settlement, programmability, and traceability, and is being explored for use in securities settlement, cross-border payments, and supply chain finance (BIS, 2017).

Cryptocurrencies are decentralized digital assets that use cryptography and DLT to secure transactions and verify issuance. They are not backed by any central authority and typically rely on public blockchains to maintain consensus — notable examples include Bitcoin and Ethereum. Cryptocurrencies gained prominence as alternative payment systems, which could disintermediate the established banking industry, and potentially the central banks money issuance sovereignty. However, cryptocurrencies are characterized by volatility, limited scalability, and regulatory uncertainty, which have thus far limited their use as everyday payment instruments. Figure 1 provides an illustration of such wild fluctuations over time. It followed that cryptocurrencies have functioned mostly as speculative assets rather than mainstream means of payment. With that being said, it is undeniable that they have played a key role in stimulating innovation in digital finance and payment system design also thanks to their decentralized nature.[6]

Central banks have also entered the crypto space with central bank digital currencies (*CBDCs*). These are digital forms of central bank money that serve as a liability of the central bank, and are designed for public and/or institutional use. They aim to complement cash, and can be structured for either retail or wholesale use. CBDCs are intended to preserve monetary sovereignty in an increasingly digital economy, support payment system resilience, offer a public alternative to private digital money, serve parts of the population which are left unbanked or underbanked. For example, the Bahamas' Sand Dollar

[5] PayPal was launched in 1999, and created a web-based network that initially facilitated person-to-person payments via email. It leveraged existing infrastructure but provided a trusted third-party model for online transactions.

[6] For a deeper dive on cryptocurrencies and their regulatory, financial, and technological implications, see ECB (2019), Carstens (2020), FSB (2020), BIS (2021a), Bordo and Roberds (2023), Garratt and Shin (2023). For broader context, see Adrian and Mancini-Griffoli (2019).

Figure 1: Bitcoin (BTC) and Ethereum (ETH) price series, 2018q1-2025q2

Notes: The prices shown are closing prices expressed in US dollars. The series have been retrieved from Yahoo Finance.

aims to provide a low-cost payment instrument for a population spread across many islands with limited banking access. Such innovations are relevant in Global South contexts where traditional banking infrastructure is weak or transaction costs are high. More generally, an efficient and accessible payment system intersects with issues of financial inclusion and population bankability. Section 1.3 tackles some of these most pressing issues in the payments domain.

1.1.2 Clearing, settlement, and the authorization process

Every payment for a given transaction goes through three main steps. First, *authorization*, which ensures the payer is legitimate and has sufficient funds or credit. Second, *clearing* — where payment information is transmitted between the parties' institutions, often aggregating or netting obligations. Finally, *settlement*: the operation that allows the final transfer of funds to complete the transaction.

When a credit card is swiped, an authorization message goes from the merchant's acquirer to the card issuer — a real-time clearing request that puts a hold on funds. At the end of the day, all approved card transactions are cleared in batches: the network calculates what each issuer owes each acquirer and those net positions are settled via bank transfers. Automated Clearing House (*ACH*) systems clear batches of electronic debit or credit transfers like payroll direct deposits or bill payments by accumulating them and calculating multilateral net obligations among banks. ACH payments are typically processed with next-day settlement, despite same-day ACH also being possible now (Rose, 2023a). Similarly, check clearing involves physical or electronic presentment of the check from the depositor's bank to the check writer's bank, often through clearinghouses that exchange checks and net out positions.

Settlement is when funds actually change hands, or when accounts are debited or credited "with

finality". Two main models exist. The first is called Real-Time Gross Settlement (*RTGS*). Under RTGS, each payment is settled individually, in real time, typically across banks' balances at a central bank for interbank payments. RTGS offers immediate finality: Once processed, the payment is irrevocable and complete. This reduces credit risk by eliminating any build-up of obligations, but requires high liquidity for every transaction. Fedwire and other high-value systems operate on RTGS. Because of RTGS' liquidity demands, many countries operated on Deferred Net Settlement until technology and policy shifted toward RTGS in the 1990s-2000s to control systemic risk (Conti-Brown and Wishnick, 2020).

Deferred Net Settlement (DNS) is when payments are held and settled on a net basis at specified intervals, like at the end of a day. During the clearing phase, obligations accrue, and at settlement time only the net differences are exchanged. DNS drastically reduces the amount of liquidity needed. For example, rather than every payer providing funds for each transaction, banks only need to fund their net debit positions. The trade-off is that between clearing and settlement, participants are exposed to credit risk if a counterparty fails before settling. Systems like ACH or check clearing or card networks traditionally use DNS. They rely on risk controls like caps, collateral, loss-sharing arrangements, or prefunding to mitigate the credit risk in the interim. For instance, the Clearing House Interbank Payments System (*CHIPS*) – a private clearing house for large-value wire transfers – requires participants to post intraday funds and prevents any one failure from causing unpaid obligations beyond what the system can absorb.[7]

Continuous Linked Settlement (*CLS*) is an international system designed specifically for foreign exchange transactions. When banks trade currency pairs, there is a risk that one party delivers the currency it sold but does not receive the currency it bought. CLS Bank was established in 2002 as a global multi-currency settlement system to eliminate this risk. It is a specialized bank owned by the major FX-dealing banks, and operates a payment-versus-payment (*PvP*) mechanism, where both sides of an FX trade are settled simultaneously. CLS only transfers currency X to Party B if it has received currency Y from Party A in the same settlement cycle. The sophisticated CLS system has proved to be very resilient during both the 2008 financial crisis and Covid-19. In both cases, foreign exchange markets maintained an orderly flow of transactions despite overarching market dislocations happening elsewhere.

The past decade has seen development of real-time retail payment systems. These are effectively RTGS for low-value payments, often operating 24/7, but with mechanisms to make them efficient for high volumes. They settle payments in seconds at any time, typically by leveraging centralized instant clearing services and prefunded accounts to eliminate credit risk. Several systems incorporate an alias directory (mapping phone numbers or email to accounts) and near-zero fees, which allows for broad usage.

The World Bank's Frictionless Affordable Safe Timely Transactions initiative (*FASTT*) has been actively promoting the adoption of fast payment systems globally, noting their benefits for financial inclusion and economic development. By 2020, at least 55 jurisdictions had live fast-payment systems and this number keeps growing. It may come as a surprise to some that emerging markets were early adopters of instant retail payments. However, countries in the Global South are often at the frontier of monetary

[7] See BIS (1997), Bech et al. (2017), Bech and Hobijn (2022) for further discussion.

innovation adoption due to their lower position in the international monetary hierarchy and the specific needs they need to satisfy without an earlier infrastructure. The US was relatively late – the Federal Reserve's *FedNow* service was launched only in 2023 to provide instant payments.

Among the many efficiency benefits, real-time systems can reduce the reliance on costly short-term credit by speeding up payroll or bill payments. Yet, moving to faster settlement also brings risks. Instant settlement means less time for risk checks and intervention – funds move irrevocably, which can be a challenge for fraud mitigation or error recovery. It also means banks must manage liquidity continuously across 24/7 cycles. Research by McLaughlin (2023) points out the trade-off between shorter settlement cycles and netting benefits: the shorter the cycle, the fewer opportunities to net transactions, so liquidity needs rise. Conversely, longer netting cycles maximize efficiency but accumulate risk exposure.

Risks in payment systems have long been a focus of central banks and international bodies like the Bank for International Settlements's Committee on Payment and Settlement Systems (*CPSS*). *Credit risk* is the danger that a participant cannot fulfill its payment obligation. In DNS systems, this is the risk a bank fails between clearing and settlement. Credit risk is mitigated by measures such as limits on net debit positions, collateral requirements, or loss-sharing agreements among members. *Liquidity risk* is the risk that a participant has insufficient funds when payments are due, even if solvent. This is acute in RTGS systems, where a bank might face daylight overdrafts (negative intraday balance) if outgoing payments exceed incoming. Central banks often provide intraday credit to ensure smooth RTGS flow, but this exposes them to credit risk. Policies like the Federal Reserve's Payment System Risk policy impose caps and fees on daylight overdrafts to incentivize banks to manage intraday liquidity. CHIPS and other liquidity-saving systems directly address liquidity risk by offsetting payments multilaterally, so that far less funding is needed at any moment. Crucially, a liquidity crunch at one bank can cause systemic risk if its inability to pay delays others from receiving funds to make their payments. *Cross-country settlement risk* is notable in FX transactions, where one party could lose the full principal value without PvP. CLS, as discussed, was the solution to virtually eliminate principal risk in FX transactions by using PvP. One example is so well known that the name of the bank involved became the name of the associated type of settlement risk: *Herstatt risk*. This is the danger that one party in a foreign exchange trade could lose the full value of the currency it pays out if the counterparty fails to deliver the other currency in return.[8]

Political and *operational risks* are also present in the payment system. Political risks are risks of financial disruptions due to political factors such as a lack of cross-border cooperation among governments, fragmentation of trust in national political institutions, and more. State authorities like central banks are responsible for maintaining efficiency, trust, and stability in payment systems, making such risks especially impactful. Operational risks encompass the potential for financial losses and other damages resulting from the processes, systems, and conduct involved in the payment-processing infrastructure. Examples include fraud, data breaches, compliance failures, technological glitches, and more. For a more

[8]This risk is named after the 1974 failure of Bankhaus Herstatt in Germany. In that incident, Herstatt received Deutsche mark payments from counterparties during the German banking day; however, before US banking hours began, the bank was abruptly closed by regulators. The result was that Herstatt's counterparties had already paid out German marks but never received the US dollars Herstatt owed them. In effect, those banks lost the full principal amount they paid, illustrating how severe cross-currency settlement risk can be.

detailed discussion of political risks affecting payment systems, including the impact of geopolitical tensions and regulatory fragmentation, see Cipriani, Goldberg, and La Spada (2023). On operational risk, see BIS (2011), CPMI-IOSCO (2016), and Bech, Faruqui, and Shirakami (2020). For additional risks such as: legal, general business, custody and more, see BIS (2012b).

A point of interest in the modernization of clearing and settlement infrastructure is the improvement of cross-border and multi currency payment systems, which have historically been fragmented, costly, and slow due to reliance on correspondent banking chains, non-aligned operating hours, and isolated settlement processes. Innovations are converging on a model of interlinked domestic RTGS systems and common technical standards to facilitate real-time, cross-border settlement. Several central banks are now pursuing bilateral and multilateral interlinking of fast payment systems to allow participants in one jurisdiction to initiate payments that are immediately settled in another, without routing through traditional correspondent networks. Examples include the linkage of Singapore's *PayNow* and Thailand's *PromptPay*, which enables 24/7 retail payments between the two countries using only mobile numbers or national IDs. Similarly, the *Nexus project* led by the Bank for International Settlements Innovation Hub proposes a single connection point for countries' domestic fast payment system infrastructures (Nexus, 2023). In wholesale contexts, these innovations are complemented by developments such as multi-currency RTGS systems that allow participants to settle in multiple currencies within the same technical platform. These systems are increasingly being designed to support settlement across currencies, reducing Herstatt risk and enhancing liquidity efficiency through PvP mechanisms. Furthermore, the push for common access, synchronized operating hours, and shared data formats is aimed at lowering barriers to entry and enhancing scalability. This is particularly important for lower-volume corridors and emerging market economies. These shifts represent a gradual but noteworthy re-engineering of the global payment infrastructure.

1.1.3 Payment networks and cross-border payment systems

A joint phenomenon to the increased digitization of payments has been the globalization of the payment structure, which effectively made financial globalization itself possible. Understanding the functioning of payment systems, both nationally and across borders, requires a discussion of the methods of communication used by correspondents.

There are several crucial interbank and cross-border payment structures. The Society for Worldwide Interbank Financial Telecommunication (*SWIFT*) was founded in 1973 to create a secure and standardized manner of financial messaging between banks around the world (Scott and Zachariadis, 2012, 2014). SWIFT provides a reliable and efficient manner of transmitting instructions for payment and for miscellaneous financial messages which support international trade and investment. It is neither a bank nor a clearing house. Instead, its primary objective is to facilitate the secure exchange of proprietary data between financial services professionals in a standardized manner. Previously, financial institutions used *Telex* to exchange information related to transactions. This platform was plagued with inconveniences, as it not only required numerous messages to be exchanged for any transaction, but it also transmit-

ted such messages in the form of free text, which had to be interpreted manually by an employee. The financial sector understood the need for cooperation and a common messaging language, and gradually agreed upon the adoption and development of SWIFT, a milestone in the globalization of financial services. Widely regarded as the most secure and trusted third-party network for financial messages, it enables global wire transfers by carrying the instructions that are then settled via correspondent banking accounts.

Banks rely on interbank transactions to manage short-term liquidity, borrowing from or lending to one another to maintain reserve balances and comply with regulatory requirements. These transactions are also essential to the functioning of foreign exchange markets, where banks actively trade currencies among themselves. In the United States, two primary networks – *Fedwire* and *CHIPS* – handle high-value interbank payments in US dollars. Fedwire processes time-sensitive payments (e.g., interbank loans, settlement of securities or other large transactions) individually with immediate finality by debiting or crediting banks' reserve accounts (Rose, 2023c). Fedwire is operated by the Federal Reserve Bank of the United States, which executes settlement in central bank money. It has evolved technologically from telegraph wires to a modern distributed computer network, thereby increasing capacity to handle over 200 million transactions annually as of 2022. The Clearing House Interbank Payments System (*CHIPS*), by contrast, is a private-sector network owned by major US banks (FNA, 2023). It settles the bulk of international dollar payments. Most payments clear within seconds, but final settlement occurs once daily on the Fed's books.

The Single Euro Payments Area (*SEPA*) is a regional network initiative combining retail payment systems across Europe. It includes 41 countries, some of which are part of neither the Euro-area nor the EU. It introduced common standards for Euro credit transfers, direct debits, and card payments, enabling cross-border transactions to be as easy as domestic ones. Through SEPA, a European business or consumer can pay any other beneficiary within the network by direct deposit or credit transfer. Electronic payment orders process within no more than one day, while paper-based payment orders take up to two business days. It is a key piece of European financial infrastructure, fostering integration of payments in the Eurozone and beyond. Members primarily use SEPA for low-cost Euro-denominated transactions.[9]

The European Central Bank and national central banks form the *Eurosystem*, which now supervises *T2* and *TIPS*, among others.[10] The Eurosystem's main function is to act as a "bank of banks" for domestic and cross-border purposes and comprises the European Union member states that have adopted the Euro as their currency. When banks execute large-value payments, they prefer to settle these transactions via central bank accounts to avoid interbank credit risk.

Central bank-operated RTGS systems, such as T2, provide immediate intraday finality in the ECB, ensuring that funds are instantly settled and available for reuse. T2 is the latest update of the original TARGET financial market infrastructure, originally launched in January 1999 alongside the Euro's introduction. TARGET became a cornerstone of the Euro area's large-scale monetary infrastructure, facil-

[9] In Europe, SEPA falls under the umbrella of *STEP2*, a pan-European automated clearing house.

[10] TIPS stands for TARGET Instant Payment Settlement; in turn, TARGET is an abbreviation for Trans-European Automated Real-Time Gross-Settlement Express Transfer.

itating the integration of the Euro money market. It quickly set the benchmark for speed, reliability, and operational standards in Euro-denominated payments. Payments related to Eurosystem monetary policy operations are settled through T2, affecting the accounts of participating counterparties. Although not all credit institutions take part in these operations, the liquidity effects are redistributed through the money market, where most resulting transactions are also settled via T2. T2 ensures that all eligible credit institutions have equal direct access to settlement in central bank money, removing reliance on commercial competitors. This setup allows banks across the euro area to transfer liquidity directly and with immediate finality. Some non-euro area EU countries also connect to T2 voluntarily through their national central banks. TIPS acts as an extension of T2 that complies with the SEPA scheme. It allows to settle instant payments within the Eurosystem in central bank money. As of 2024, 99 percent of all TIPS transactions were settled in less than five seconds.

A key issue when it comes to cross-border payment systems is the one of *interoperability*. Each payment system may have an underlying hardware and software that enable the clearing and settlement of transactions managed according to defined technical and operational standards. Interoperability allows participants in different systems to clear and settle payments or financial transactions across systems without participating in multiple systems. It requires technical, semantic and business system compatibility so that end users can seamlessly transact with each other across systems. Interoperability is thus viewed by payment system participants as important for cross-border payments to be efficient and reliable. We refer to BIS (2021b) and World Bank (2021) for further technical details on the different modalities through which interoperability may be implemented in the years to come.

1.2 Payment systems regulation and oversight

The regulation of payment systems, particularly in the context of cross-border integration and real-time innovation, relies on multiple layers of oversight. This structure includes national regulatory bodies, supranational institutions like the European Central Bank (*ECB*), and international standard-setters such as the Bank for International Settlements (*BIS*) and the Financial Action Task Force (*FATF*). Payment and settlement systems are typically overseen by central banks and financial conduct authorities. While the goals of stability, efficiency, and security are shared, regulatory structures differ across jurisdictions.

In the US, payment system oversight is somewhat fragmented across multiple authorities, but the Federal Reserve plays a central role. The Fed operates key wholesale systems like *Fedwire Funds Service*, the RTGS system for large-value interbank payments, besides overseeing the payment networks. Under the legal framework established under the Dodd-Frank Act of 2010, the Financial Stability Oversight Council (*FSOC*) can designate certain payment systems as "systemically important" if their failure could threaten US financial stability.

In 2012, FSOC designated a few major payment systems as systemically important, notably the Clearing House Interbank Payments System – *CHIPS*, a private large-value payments network – and CLS Bank, a foreign exchange settlement system. Once designated, these systems are subject to the Federal Reserve oversight, and must meet risk-management standards set out in Fed regulations. In practice, the Fed-

eral Reserve conducts examinations and requires improvements to governance, liquidity controls, cyber resiliency, and more. For example, CHIPS is supervised by the Federal Reserve Board as its primary regulator, and is expected to observe the CPMI-IOSCO Principles for Financial Market Infrastructures (PFMI) in areas like settlement finality, and credit risk control.

Retail payment systems in the US such as the ACH networks for batch payments, card networks, and emerging digital wallets historically have not been subject to the same intensive oversight as wholesale systems. However, regulation is evolving. The Consumer Financial Protection Bureau (*CFPB*) has authority over consumer-facing payment services. In 2023, it proposed new rules to bring large non-bank payment firms (including Big Tech-operated digital wallets) under its supervisory examinations to ensure large technology firms and other non-bank payments companies are subjected to appropriate oversight and play by the same rules as banks. This is intended to level the playing field and eliminate regulatory gaps that firms might exploit. Although the US payment system oversight is spread across agencies, the Federal Reserve acts as a lead overseer for systemically important infrastructures, and it is increasingly focused on extending oversight to FinTech payment providers.

The European Union's regulatory framework for payment systems is structured around both supranational oversight by the European Central Bank and regulatory coordination through the European Banking Authority (*EBA*). The ECB, through its oversight framework and Eurosystem responsibilities, sets standards ensuring payment system stability, efficiency, and security, particularly for systemically important infrastructures like T2 and TIPS. The Revised Payment Services Directive (*PSD2*), administered by the European Commission, further harmonizes regulation of payment service providers, including licensing, conduct, and open banking rules; while the EBA develops technical standards to enforce EU-wide consistency in risk management, operational resilience, and consumer protection. The ECB also combats Herstatt risk through its support for PvP mechanisms and coordination with CLS Bank, thereby ensuring simultaneous settlement of cross-currency transactions in and out of the Eurozone.

The literature on supervision and oversight is very large, and a chapter section may not do justice to the complexity of the subject. For other important national case analyses of supervision and oversight, we refer to the literature. For information about the regulatory landscapes of the United Kingdom, see IMF (2016). For China, Perez-Saiz and Zhang (2023) provide insights into offshore Renminbi clearing structures, the evolution of CIPS, and regulatory developments under the People's Bank of China (PBoC).[11] The World Bank (2021) Global Payment Systems Survey adds a comparative perspective, with the latest editions including regulatory, technological, and operational data for both countries.

At the global level, the Committee on Payments and Market Infrastructures (*CPMI*) under the Bank for International Settlements plays a central role in setting technical, legal, and risk management standards. The BIS is an international organization providing banking services to central banks and promoting international financial cooperation. The CPMI plays a central role in addressing coordination failure — when parties have differences in operating hours, technical systems, regulatory standards, and set-

[11] BIS (2012a) offers dedicated chapters on both the U.K. and China by covering key systems such as the UK's version of RTGS (*CHAPS*) and China's *CNAPS* and *CIPS* platforms, along with descriptions of national governance under the Bank of England and the PBoC.

tlement currencies — by building international consensus, offering harmonized technical frameworks, and coordinating pilot projects like *Nexus*, which seeks to connect cross border real-time payment systems. Bech, Faruqui, and Shirakami (2020) highlight legal and regulatory incompatibility as one of the primary challenges in cross-border reform, reinforcing the need for global standard-setting bodies like CPMI to bridge these gaps.

Another important international forum is the Financial Action Task Force (*FATF*), which, while focused on anti-money laundering and counter-terrorist financing, issues influential recommendations that shape regulation of payment flows globally. The FATF Recommendations constitute an international standard to combat misuse of the financial system. FATF's standards require that jurisdictions impose certain controls on payment service providers. Banks and money transmitters must collect and transmit sender/recipient information with payments, and now these rules are being extended to cryptocurrency transfers as well. In 2019, FATF updated its guidance to explicitly cover virtual asset service providers (*VASPs*) like crypto exchanges and wallet providers. FATF has emphasized that stablecoins and other digital payment tokens should not create loopholes. See Section 1.3 for further discussion. According to BIS (2023), jurisdictions and firms must identify, assess and understand the risks of money laundering and terrorist financing in these new systems and take mitigating action. FATF noted that stablecoin arrangements can pose significant risks due to their potential for anonymity, global reach, and rapid transfer of funds, including facilitating sanctions evasion. By setting a common baseline like requiring that all crypto transactions above a threshold carry identifying information, FATF seeks to prevent regulatory arbitrage where actors could exploit lax regimes. Without that common baseline, criminals could route transactions through countries with weak standards on the prevention of money laundering. They could also engage in what is known as *layering* in the anti-money laundering community, which is when funds are moved across different wallets and exchanges rapidly to make their trail hard to follow.

The Financial Stability Board (*FSB*) plays a distinct role alongside regulatory bodies by focusing on the consistency and alignment of national regulatory frameworks for cross-border payment systems. The Financial Stability Board promotes six key policy recommendations aimed at harmonizing how both bank and non-bank payment service providers (*PSPs*) are regulated across jurisdictions (FSB, 2024). Unlike CPMI, which focuses on technical and operational standards, or FATF, which centers on anti-money laundering and counter-terrorist financing compliance, the FSB addresses broader systemic concerns like regulatory arbitrage, financial stability risks, and creating a level playing field for banks and non-bank payment service providers. It emphasizes the need for licensing requirements, clear supervisory expectations, and cross-jurisdictional data sharing to mitigate compliance frictions and financial crime risks in global payment systems.

In sum, international standard-setters provide the connective infrastructure for oversight. CPMI and IOSCO define technical and risk management standards for payment systems, the FSB coordinates cross-border initiatives and responses to emerging systemic risks, and the FATF sets the global rules of the road for anti-money laundering and counter-terrorist financing in payments. Together, they guide authorities and facilitate coordination across jurisdictions so that oversight is more consistent. This consistency is

crucial, as inconsistent regulations can be exploited.[12]

1.3 Selected open points and future challenges

As mentioned in the introduction of this section, the payment system infrastructure and its instruments have evolved massively over the course of time in order to meet new needs that economies around the world experienced. As such, the modern payment system is itself in the midst of challenges and opportunities that will redefine its configuration in the years to come.

Digital currencies, financial innovations, and financial inclusion. Central banks, regulators, and businesses worldwide are exploring digital currencies — both in public (CBDCs) and private forms — as tools to enhance payment efficiency and inclusion. CBDCs offer a digital form of cash that can be universally accessible, potentially improving financial inclusion in economies with large unbanked populations. While new digital currencies can bring benefits, they must be designed to complement the existing monetary system's stability and trust. For a reliable monetary and payment system to work, it is important to maintain the singleness of money when introducing new digital forms, i.e., the parity among all forms of money. Historical analysis by Bordo and Roberds (2023) suggests that any successful monetary innovation like CBDC must balance microeconomic efficiency gains with macroeconomic credibility (trust in the currency); achieving both may require policy compromises to avoid undermining financial stability in pursuit of innovation. In practice, early CBDC projects (e.g. Sand Dollar in the Bahamas[13]) are testing how digital legal tender might expand access to payments.

Furthermore, other risks from CBDCs exist. One pertinent risk is that of disintermediation, or unsustainable low deposits in the banking sector. If widely adopted, CBDCs could crowd out commercial bank deposits; banks would then struggle to lend, given that deposits are a cheap and stable source of funding for them. As a result, if the banking sector were unprepared to deal with a move away from deposits, contagion episodes may ensue.

It is also worth mentioning the rise of *stablecoins* – crypto-assets pegged to *fiat* currency –, which can be thought of as the money market funds in the digital space. They act as tokenized bank deposits (digital claims on banks) that settle in central bank money to better preserve monetary uniformity. However, they can break parity with the dollar if their value deviates from face value. Their emergence has garnered both interest and concern from traditional financial institutions, among them large banks like JP Morgan, Citigroup, and Bank of America. Brian Moynihan, CEO of Bank of America, has referred to current decentralization trends as "attack(s) on the payment system". Nonetheless, he and other Wall Street CEOs have recognized the need for the banking sector to explore deposit tokens and bank-issued stablecoins to remain competitive and preserve the stability of the payment system.

Meanwhile, cryptocurrencies and blockchain-based networks have demonstrated new capabilities

[12] Notice that SWIFT is not a payment system and thus neither regulated nor supervised as such.

[13] The Bahamian Sand Dollar is the CBDC issued by the Central Bank of The Bahamas. Launched in 2020, it was the first fully deployed retail CBDC globally, aimed at improving financial inclusion and payment system efficiency across the country's dispersed island geography.

(such as decentralized finance and programmable smart contracts), but their volatility and lack of legal tender status mean they currently complement rather than replace traditional money. Overall, CBDCs and regulated digital currencies are seen as a way to harness the benefits of blockchain technology while safeguarding the public interest of stable money and inclusion.

The past decade has seen a slew of FinTech firms providing payment services, often operating outside traditional banks. These non-bank payment providers have expanded financial access by offering cheaper, faster, and more user-friendly payment solutions, both in advanced and emerging economies. For example, mobile money services in Africa (like *M-Pesa*) allow underserved populations to store and transfer funds using just a cellphone. In the cross-border context, FinTech companies such as *Wise*, *Ripple*, *dLocal* and others have begun to erode banks' dominance in international transfers by providing lower fees and real-time tracking. Traditionally, international payments relied on slow correspondent banking networks, where transfers hop between intermediary banks (often taking days and incurring high fees). New entrants have built alternative digital rails or optimized use of existing networks to shorten this process. They leverage technologies like blockchain (e.g., *RippleNet* for settling remittances to migrants' home countries) or simply better front-end platforms and partnerships to increase speed and transparency (BIS, 2020; Hollanders, 2020; Tok and Heng, 2022; Asif et al., 2024).

New financial instruments and digital services are being deployed to include disadvantaged and unbanked populations in the formal financial system. One key approach is leveraging digital technology to overcome geographic and economic barriers. For instance, prepaid e-money accounts and mobile wallets allow people in remote or poor areas to store money, make payments, and even access credit using a mobile phone without a physical bank branch. Studies show that FinTech solutions have helped bridge certain inclusion gaps, although challenges like digital literacy remain. In addition, public-private initiatives are experimenting with novel instruments tailored to underserved groups. For example, savings and loan products can now be delivered via mobile apps, or agricultural microinsurance using blockchain to automatically pay farmers after adverse weather. (McGath, 2018; Iqbal et al., 2020; Narula et al., 2023; Sutton-Lalani et al., 2023). For additional references, see Eichengreen and Viswanath-Natraj (2022), Eichengreen (2022).

There is also growing interest in whether CBDCs can promote inclusion by offering a risk-free digital means of payment, a retail CBDC might serve people who currently rely only on cash. However, without careful design, digital currencies could just as easily widen the *digital divide* rather than alleviate it. To truly reach marginalized users, a CBDC would need features like offline functionality (for regions with low connectivity), an intuitive interface, support for local languages, and perhaps intermediaries to assist those with limited tech literacy.

Regulators have generally welcomed non-bank payment innovations for their inclusion benefits, but also stress the need to bring FinTech companies under appropriate oversight. In this respect, the FSB and other global bodies in 2020 called for expanded access of qualified non-bank payment providers to core payment infrastructures, especially to enhance cross-border payments (BIS, 2020). Overall, FinTech payment providers are narrowing payment gaps across borders by lowering costs and enabling new services, complementing the banking sector and extending financial services to those previously excluded.

In parallel with public sector innovations like CBDCs, traditional banking institutions are actively acquiring or partnering with FinTech firms. A notable example is Goldman Sachs, which in March 2022 acquired GreenSky, a prominent home-improvement lending FinTech platform, in a 2.24 billion USD all-stock transaction. More recently, Goldman has spun out its blockchain based platform GS DAP, aiming to build a permissioned DLT network for institutional clients and further embedding distributed technology into its operational model. This trend is echoed across major banking firms. JPMorgan, HSBC, and others have accelerated internal innovation programs or purchased startups to remain competitive in real-time payments, digital wallets, and tokenized asset services. Technology acquisition can offer faster integration of innovation than in-house development, enabling banks to maintain relevance in an increasingly digital financial ecosystem.

In today's payment landscape, new synergies are emerging between FinTech firms, large technology companies (such as Apple and Google), and traditional financial institutions. These technology firms' access to extensive personal and transactional data introduces both opportunities and risks when combined with traditional financial services. By partnering with financial institutions, big tech firms can leverage this data to offer hyper-personalized financial products such as tailored credit offers, dynamic insurance pricing, or predictive savings tools. Financial institutions, in turn, gain access to more granular consumer insights than traditional banking channels would provide, improving credit risk assessment, marketing efficiency, and product development. However, this trend also raises regulatory and ethical concerns. The integration of financial services with platforms that already control significant amounts of personal information can lead to market dominance and reduced competition, as well as increased privacy risks (Doerr, Frost, Gambacorta, and Shreeti, 2023).

Beyond retail payments, financial innovation is also reshaping wholesale payments and securities settlement. One promising area is the use of distributed ledger technology to modernize the post-trade infrastructure for securities. Currently, transactions pass through centralized clearinghouses and custodians, [14] with settlement taking *T+2* days or longer in many markets. Tokenization of securities — representing shares or bonds as digital tokens on a ledger — could speed up settlement and reduce costs by automating processes. According to Bech, Hancock, Rice, and Wadsworth (2020), transforming traditional securities into digital tokens could streamline trade processing, given that an estimated 17–24 billion USD is spent annually on post-trade processing in some systems.

In a tokenized model, a network of participants on a blockchain could settle trades peer-to-peer, eliminating certain intermediaries. These promised efficiency gains and potentially greater transparency, since each transaction is recorded on the shared ledger. However, researchers caution that fundamental trade-offs of settlement — credit and liquidity risk — do not disappear in a DLT system. Instant settlement requires participants to have liquidity on hand, and a failure of any party to deliver could still pose risk. Thus, new risk management mechanisms would still be needed. Moreover, for the foreseeable future, tokenized ledgers must interoperate with existing account-based systems (central securities

[14] According to Investopedia, a custodian is "a bank or other financial institution that holds and safeguards customers' securities to prevent theft, loss, or damage. Custodian banks may store assets such as stocks, bonds, or other securities, either physically or electronically."

depositories, payment networks).[15] Early experiments in markets like Switzerland and Singapore show DLT platforms can technically handle securities settlement, but aligning them with legal frameworks and ensuring broad adoption may take time. Distributed ledgers could herald a more efficient future for securities settlement if they can be integrated safely, reducing frictions while still protecting against settlement failures.

OTC vs. CCP clearing implications for transparency and stability. During the 2008 Great Financial Crisis, derivatives operations in over-the-counter (*OTC*) markets have proved to be particularly dangerous for financial stability due to their opaqueness. In response to such challenge, policymakers pushed to reform derivatives markets by shifting trade clearing from OTC to centralized counterparties (*CCPs*).

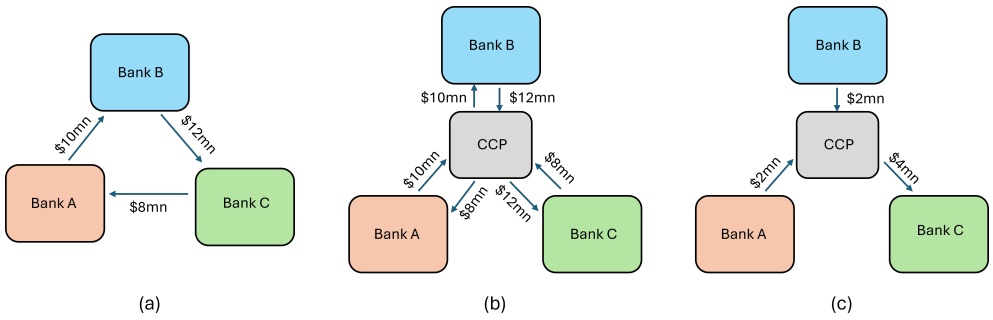
An OTC market refers to trades being made without a centralized exchange, such as the stock exchange. In financial markets, OTC-traded securities are facilitated by broker-dealer agencies which either represent clients or trade on their own books. OTC markets are thus divided into two types. The former is a customer market where investors who want to trade securities use broker-dealers to take positions. The latter, an interdealer market, is a medium for said broker-dealers to trade with each other, minimizing risk and improving liquidity. The collapse of major OTC derivatives players in 2008 exposed how a complex web of bilateral contracts can transmit and amplify shocks. By 2009, G20 leaders agreed that standardized derivative contracts (like interest rate swaps and credit default swaps) should be cleared through CCPs to mitigate systemic default risks.

A central counterparty is a clearing house that acts as the buyer to every seller and the seller to every buyer in the securities exchange. By doing so, CCPs are financial market infrastructures that can reduce and mutualize counterparty credit risk. Central counterparty clearing addresses several weaknesses of the old OTC market structure. First, a CCP multilaterally nets exposures among all participants, meaning that each member has just a single net position with the CCP. This netting can drastically reduce the tangle of counterparty exposures and credit risk in the payment system, as shown in Figure 2. Second, CCPs provide daily variation margins — members post collateral that is marked-to-market (priced at market value) daily or intraday, ensuring that losses are covered as they accrue rather than letting them accumulate uncollateralized. Third, CCPs bring greater transparency than OTCs, given that trade details and prices are reported, and the concentration of risk is more visible to regulators. Finally, in case a clearing member defaults, the CCP orchestrates an orderly unwinding (or *default waterfall*) of that member's positions, and it uses a prefunded default fund contributed by members to cover losses, thereby mutualizing the risk. These mechanisms mean that no bilateral counterparty is solely responsible for covering the default, reducing the domino effect of a default.

Standardized derivatives contracts, such as exchange-traded futures and options, have fixed terms regarding contract size, expiration dates, and settlement procedures. These contracts can be traded on organized exchanges and cleared through central counterparties (CCPs), which reduce counterparty risk

[15] Centralized securities depositories (CSDs) are vehicles for holding and transferring securities. The European Commission's webpage on CSDs highlights the key roles of CSDs: they allow the registration and safekeeping of securities, promote the settlement of securities in exchange for cash, track how many securities have been issued and by whom as well as each change in the ownership of these securities.

Figure 2: How central counterparty (CCP) netting works in practice



and enhance market transparency. In contrast, non-standardized derivatives are privately negotiated agreements between two parties, allowing for customized terms tailored to specific risk management or investment needs. Non-standardized — in particular OTC — derivatives, while more flexible, generally carry higher counterparty and liquidity risks and are subject to less immediate transparency. As discussed in Bliss and Steigerwald (2006) and CPMI-IOSCO (2012), the global regulatory push post-2008 has aimed at reducing systemic risk by moving many formerly OTC contracts into standardized clearing environments while preserving the potential for customized contracts in special cases. See Duffie (2015), Duffie, Scheicher, and Vuillemey (2015), and Duffie (2017).

However, moving to central clearing also concentrates risk in the CCP itself. The CCP may become a single point of failure if not managed safely or if the shock to absorb is too large. This feature can exacerbate the financial stability issue rather than reducing it. If one party fails to fulfill an obligation, they must be bailed out by other participants. It is unclear what happens if the actual losses in the CCP are so large that other members cannot bail out a party, which is typically the case during contagion episodes. Authorities have responded by raising regulatory standards for CCP resilience. International principles set rigorous requirements for CCP governance, financial resources, stress testing, and recovery planning.

There is an active debate in the financial industry, regulatory bodies, and academia about unintended consequences of the clearing mandate. For example, in his 2017 speech at the Federal Reserve Bank of Chicago Symposium on Central Clearing, Fed Chairman Jerome Powell pointed out that introducing a CCP for a class of derivatives can increase total collateral demands (margin requirements) and potentially reduce netting efficiency if firms still have many positions outside the CCP. Banks have also raised concerns that certain capital rules (like the leverage ratio, the proportion of a bank's Tier 1 capital to total leverage exposure) might discourage central clearing by making cleared exposures costly relative to risk. Regulators are reviewing such issues to not "unnecessarily discourage" central clearing participation and reduce the cost banks must pay to offer clearing to creditors. Today's clearinghouses, with their margin and default fund systems, are in part meant to ensure that the Herstatt risk discussed in Subsec-

tion 1.1.2 is contained system-wide.[16] Time will tell the effective resilience of CCPs under aggregate and systemic shocks.

The weaponized payment system under geo-political tensions. Geopolitical conflicts often enter the discussion of international finance, leading to what is often described as the "weaponization of the global payment system". In practice, this refers to countries leveraging their geopolitical and geoeconomic influence by using their key position within the international financial network as a form of power (Clayton, Coppola, Maggiori, and Schreger, 2025). Banks and payment institutions can be threatened with exclusion from these networks if they fail to comply with sanctions. For example, the United States has pushed the SWIFT organization to disconnect targeted banks as part of sanctions on rogue states, effectively cutting them off from most cross-border transactions. Such measures were notably used with large effects against Iran in 2012 (Laudati and Pesaran, 2023), and against some Russian banks in 2022 for the war in Ukraine (Itskhoki and Mukhin, 2025).

Financial sanctions include measures such as preventing access to bank accounts, blocking use of SWIFT messaging, freezing central bank reserves, receiving payments, and more. As highlighted in Cipriani, Goldberg, and La Spada (2023), governments increasingly use financial sanctions alongside traditional economic sanctions. Any bank that transgresses these rules risks losing access to dollar clearance or facing multibillion-dollar penalties. Such weaponization of the payment system has prompted backlash and counter-moves, especially by countries that fear they could be future targets of sanctions.

In response to the freezing of some of its banks out of SWIFT, Russia developed its own messaging system (*SPFS*), and has tried to shift some trade to alternative channels. More broadly, both Russia and China have sought to reduce reliance on the American financial architecture. China's Cross-Border Interbank Payment System (*CIPS*), launched in 2015, is a renminbi-based funds transfer system which can operate independently of SWIFT for messaging. While CIPS is still much smaller than SWIFT in usage, China has been fostering cross-border renminbi adoption and linking CIPS with other countries' banks to provide a parallel network. Although these alternatives remain limited at the time of writing, western sanctions could further incentivize targeted states to create parallel infrastructures that circumvent the dollar and SWIFT.[17]

Some of these current issues even intersect with each other. For example, blockchain technology was believed to improve the efficiency of the cross-border payment system even by key institutions such as the BIS, which financed the platform *mBridge*. With mBridge, SWIFT is effectively not needed anymore in favor of an instantaneous cross-border payments infrastructure using wholesale CBDCs and DLT. Besides the major Western economies, a host of countries around the world participated in the project including China, the United Arab Emirates, and Saudi Arabia. As geopolitical and geoeconomic tensions arose, the BIS itself shifted its interest towards other objectives, and ultimately withdrew from the project in October 2024. The BIS, instead, decided to bet on a new competing platform called *Project Agorà*, which

[16] For readers interested in the evolution of these regulatory frameworks, key references include Goodhart (2011) and CPMI-IOSCO (2012), which provide background, current standards, and ongoing challenges related to systemic risk management in clearing and settlement systems.

[17] For further readings, see De Goede (2012), Eichengreen (2018), Eichengreen, Mehl, and Chiţu (2019), Eichengreen (2024).

includes the major Western central banks of the world and puts the US dollar at the center of it. This sudden shift may be justified by the attempt to prevent China and other non-aligned countries to evade sanctions by using the decentralized mBridge platform itself.

Case study. The payment system and its weaponization: A case study looking at Russia in 2025

On June 25 2025, the Financial Times has reported experiments occurring with digital currencies to circumvent sanctions, where state-aligned "shadow stablecoins" were emerging as a new tool. A notable example is Russia's A7A5 token, launched under Western sanctions in early 2025 by Promsvyazbank via a shell company in Kyrgyzstan, a jurisdiction chosen for its lax oversight. Operating through the Kyrgyz-based Grinex exchange, A7A5 facilitates cross-border payments for Russian firms cut off from SWIFT. Within four months, over 9.3 billion USD in transfers were tracked, often during Moscow business hours, suggesting systematic use by elite or state-linked actors. A7A5 is pegged to the rouble and backed by deposits at Promsvyazbank, effectively functioning as a "crypto-rouble". Its creators market it as a "bridge to USDT," enabling indirect access to dollar liquidity through crypto rails. The token's rise followed the US shutdown of Garantex, Russia's largest sanctioned crypto exchange. Reports suggest that users and infrastructure migrated to A7A5 and Grinex, raising suspicions that Grinex serves as Garantex's proxy. This reflects a broader trend: rather than openly challenging dollar dominance, geopolitical rivals are building crypto-based alternatives to move capital beyond Western reach. If stablecoins like A7A5 succeed in creating viable cross-border access to commerce for sanctioned states, they may weaken the effectiveness of traditional financial sanctions. Even prior to recent events, the dollar's dominance in global reserves and payments has slowly eroded as some countries diversify holdings. High-profile users of the "financial weapon" in geopolitics (from Iran to Russia) have likely accelerated discussions among the BRICS and others about trading in local currencies or setting up new interbank networks. For example, India has experimented with rupee-based trade settlement with certain partners to reduce foreign exchange dependencies, and a number of countries have joined China's CIPS to facilitate RMB transactions. Furthermore, there is interest in whether multilateral digital currency platforms (like mBridge, a project for cross-border CBDC payments in Asia) could provide a sanction-proof pipeline in the future.

2 Eurodollars and Xenocurrencies

The previous section highlighted the importance of having an efficient and reliable payment system in order for money to circulate smoothly. As the world has become more globalized, countries issuing different currencies have begun interacting. The foreign exchange markets are the markets in which different monies are traded. Ideally, such markets would represent no more than a "veil", a simple re-indexing of the units of account from one money system to the other. In practice, this could not be farther away from truth. In cross-border financial operations, details of the financial assets, contracts,

and securities exchanged become important. One of the most important aspects is precisely the currency in which a given financial asset is denominated.

When the currency of the country issuing such assets is different from the currency in which the asset itself is denominated, then we speak of *eurodollar markets*. Notice that the term "euro-" does not refer to the actual Euro currency nor to the fact that the originating financial institutions are European. Rather, any deposit denominated in a currency different from the currency of the resident financial institution goes under the name of "euromarkets" (Hogan, 2016; Melvin and Norrbin, 2023). To fix ideas, we would say that a French bank based in Paris issuing US dollar-denominated bonds is issuing Eurodollar bonds. However, the same would be true of a Japanese bank based in Tokyo issuing a similar security. As noted by Machlup (1972), it would be more appropriate to define them *xenomarkets*, where the term originates from the Greek word "xenos" meaning "foreign". Some scholars have attempted to change the first part of the term according to the place of issuance, so that – in the previous example – a Japanese-issued dollar-denominated asset would be called *Asiadollar*; however, such use remains limited. The reason for the ongoing semantics is merely due to history. Originally, dollar-denominated assets by non-US financial institutions occurred in London and Paris to facilitate Russian citizens' attempts to circumvent the Soviet capital controls regime, and US banks to circumvent Regulation Q.[18] More generally, today we would refer to these type of operations as cross-border bank assets and liabilities.

2.1 Rationales behind euromarkets use

One may wonder why financial and non-financial institutions may be interested in issuing a liability in a currency different from the home country. Historically, London-based banks issued dollar-denominated liabilities in the late 1960s and early 1970s to get around the set of capital controls that was established post-WWII by the Bretton Woods agreements.[19] However, even after the collapse of Bretton Woods in 1973, the banking industry realized that these type of arrangements came with benefits. We try to identify here some of the most important ones.

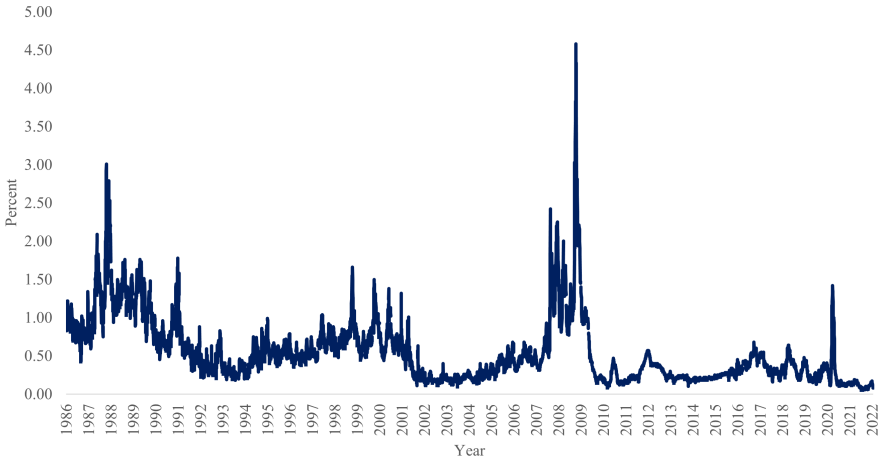
First, euromarkets allow markets to be more liquid and price-informative, while also reducing potential maturity mismatches. The eurodollar markets have become so liquid to effectively trade in a seemingly identical fashion to actual dollars. This statement is supported by the so-called OIS-LIBOR spread, a measure of the degree to which one is tradable relative to the other in the interbank market.[20] For a long time, market operators believed that the two were effectively indistinguishable, with the eurodollar market potentially being even better because of its larger depth. The 2008 Great Financial Crisis, however, has shown that segmentation and differences do emerge in times of stress. When markets jittered in 2008, it became apparent that under systemic risk, only the institutions that were formally backed by the

[18] See He and McCauley (2012), and Murau, Rini, and Haas (2020), amongst others, for further elaboration on this point.

[19] See Aliber (1980), McCauley and Seth (1992), Schenk (1998), Altamura (2016), McCauley, McGuire, and Wooldridge (2021) for in-depth historical analysis of the rise of the eurodollar markets.

[20] OIS stands for Overnight Indexed Swap. It is an interest rate swap contract. It represents the overnight lending rate between banks. LIBOR stands for London Inter-Bank Offered Rate. It was the interest rate average calculated from estimates submitted by the leading banks in London. LIBOR was phased out at the end of 2021 to transition towards SOFR – the Secured Overnight Financing Rate – also because of interest rate rigging scandals.

Figure 3: OIS-LIBOR spread series, 1986q1-2022q1



Notes: The data series was retrieved from the Federal Reserve Bank of St. Louis (FRED) data set, series name: TEDRATE.

US Federal Reserve, i.e., US-resident banks, could be rescued. As such, the OIS-LIBOR spread surged dramatically, as evident from Figure 3.

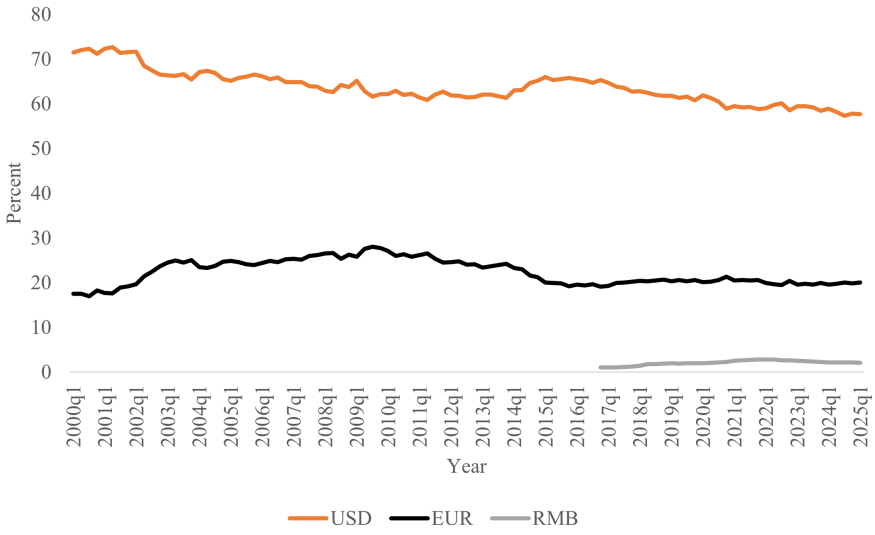
Second, there are large economies of scope from using a single international currency of invoice for firms and corporations involved in international trade and in the global value chains (Gopinath, Itskhoki, and Rigobon, 2010; Aldasoro and Ehlers, 2018). The choice of currency invoicing is an important choice for non-bank business when importing and exporting. Transacting in a single "international" currency allows to reduce transaction and information costs, besides foreign exchange uncertainty risks. See Ivashina, Scharfstein, and Stein (2015) on the role of multinational corporations in raising capital in euromarkets.[21] Being the largest economy in the world, the US has naturally come to provide its currency as the world's currency, just as the British pound set the standard of international currency before WWI.

Third, banks issuing eurodollars do not have to abide to the same regulatory and oversight scrutiny from financial supervisory bodies, therefore a profit-driven regulatory arbitrage may be an important driver. However, as aforementioned, intermediaries participating in these transactions are also aware that this does not come as a complete free lunch in case the country where these securities are issued does not have a central bank swap line with the US Federal Reserve. See Section 3 on this point.

Fourth, for developing economies it is an important source of credit both at the firm, bank, and sovereign level. By using eurodollars, many emerging markets participants can avoid the issue of no creditors willing to invest in their country. This is due to both higher perceived default and perceived foreign exchange risk. By issuing dollar-denominated assets, they attempt to at least remove the latter component. That said, the last few decades showed this practice also comes with risks when the domestic

[21] It is worth noting that usually offshore markets serve wholesale payments for business, while retail usually relies almost completely on onshore banking.

Figure 4: Major currencies foreign exchange reserves, 2000q1-2025q1



Notes: The series are foreign exchange reserves expressed as fraction of the total. USD is US dollar, EUR is European euro, RMB Chinese yuan renminbi. The series have been retrieved from the IMF Currency Composition of Official Foreign Exchange Reserves (COFER).

currency does depreciate thereby reducing the value of the assets (indexed in domestic currency) against a fixed value of dollar-denominated liabilities. For further discussion on this point, see the literature on the so-called *original sin* (Eichengreen, Hausmann, and Panizza, 2005) and *liability dollarization*.

Fifth, funding costs in USD (or other "core" currencies such as Euros) may be simply lower even after accounting for exchange rate fluctuations (Davies and Kent, 2020). This is a related, yet separate, issue from the previous point. For many world's economies, even if issuing debt in their currency is possible, firms prefer to do so in one of the "core" countries both because the premium on domestically-denominated debt would be too expensive, and because they could send a signal to international investors of how solid their operations are.[22]

Finally, it is also important to notice that the certainty of the legal framework matters. The New York and British law are the most trusted financial legal systems, which guarantee the certainty of the law when enforcing the delivery of a contract promise (Smedresman and Lowenfeld, 1989; Rice, von Peter, and Boar, 2020; Wang, 2020; Aldasoro, Ehlers, and Eren, 2022). Something rather valuable when counterparties need to be trusted across the board without the possibility of a higher international judicial court to be clearly present to settle these disputes.

This helps explaining why even after decades of massive globalization and rise of new economic powerhouses such as India and China, the world still very much demands US dollars. Figure 4 shows that before China entered the WTO in the early 2000, the percentage of USD held in foreign exchange

[22]See Bordo and Bastidon (2023) on the core-periphery structure of world currencies hierarchy.

reserves abroad was approximately 70 percent of the total. After 25 years, the USD assets held abroad have only been slightly reduced to about 60 percent of the total even after massive expansion of other countries and reduced importance of US GDP as fraction the world's total value added.

It is important to notice that this feature of the global financial infrastructure has implications especially for the United States. By tapping US Treasuries, international investors artificially compress the US interest rates thereby generating a "convenience yield" (Krishnamurthy and Vissing-Jorgensen, 2012). This phenomenon has sometimes been dubbed "exorbitant privilege" to point to the unfair advantage the US has in the global monetary system. That said, the next section clarifies why this is only part of the story.

2.2 The Federal Reserve as the world central bank

The United States, and any other country issuing a relatively safe currency, may enjoy a convenience yield. The cost of issuing debt can be seen as artificially low with respect to simple market dynamics. However, as usual, economic contingencies matter. Gourinchas and Rey (2022) have highlighted that this is true mostly in terms of expansionary economic times. In times of crises, things reverse. During downturns, the US is effectively called in to provide liquidity for the world — the exorbitant privilege becomes "exorbitant duty". The easiest way to think about this problem is from the perspective of insurance markets. Providing one's currency to the world is similar to an insurance mechanism: The US collects premia during good times, and pays off "reimbursements" in crises times. The literature on the matter is now vast. McCauley (2024) provides an interesting introduction to the footprint of US policy in offshore dollar markets.[23]

2.3 Implications for global financial instability

In addition to the points mentioned above, in a world without a formal international currency, there exist challenging issues in terms of financial stability when untapping a single currency funding market. As aforementioned, a host of institutions around the world finance themselves in dollars in order to maximize their profit and investment opportunities. The world funding markets are USD funding markets to a large extent. When stress occurs, the dollar "basis" rises – i.e., the premium that these institutions are willing to pay to obtain dollars. Such higher financing costs can act as the amplifying channel of financial instability. A higher basis generates higher financing costs, which may dent firms' profitability around the world and hit the capital stock. In the worst case scenarios, bankruptcies and worldwide panic may ensue — what goes under the name of "contagion".[24]

A world currency market that is centered around one currency – say, the USD now or the British pound before WWI – is certainly more efficient in good times; however, it is also a more fragile system when stress hits its core. Section 3 expands on the new role of the Fed to tackle this problem in 2008 and

[23] See Kreicher and McCauley (2016), McCauley et al. (2015), Miranda-Agrippino and Ricco (2021) for further international implications and spillover effects of the Fed's monetary policy choices.
[24] See Coffey et al. (2009); IMF (2019); EMEAP (2020); FRB (2021); FSB (2022).

during the 2020 Covid-19 pandemic. If the world depends on USD-denominated assets for its operations, then the Fed is faced with quite some heavy lifting to provide and create USD assets during crises times to relieve pressure in the global interbank market and act as shock absorber. Central bank swap lines provide an efficient way to keep the system afloat, as further discussed in detail in the next section.

3 Central banks swap lines

Central bank swap lines are bilateral agreements that allow one central bank to exchange its domestic currency for a specified amount of foreign currency with another central bank at a pre-agreed exchange rate and maturity. To understand the importance of central bank swap lines, it is first essential to focus on the global hierarchy of currencies and the structure of the dollar-based financial system. At the apex of this hierarchy sits the US dollar, which serves as the dominant medium for global reserves and cross-border trade and finance. This dominance makes the access to dollar liquidity vital (particularly during periods of market stress) for countries that fund themselves in dollars while issuing other sovereign currencies. See Section 2 for further discussion on this point.

There are three interrelated instruments that underpin this system: Collateralized debt; Repurchase agreements (*repo*) contracts; and Foreign exchange (FX) swaps. Collateralized debt enables financial institutions to obtain short-term funding by pledging securities. Repo markets are central to money markets and allow for the efficient allocation of liquidity. FX swaps, meanwhile, involve the exchange of currencies at an agreed rate and time, mitigating exchange rate risk while facilitating foreign currency funding. During crises, central banks use these tools to ensure access to dollars in their jurisdictions, often channeling them via commercial banks.

The following sections put central bank swap lines in historical context, describe their main technical aspects and operations, and remind the reader of the open points ahead in the fast-evolving international monetary landscape.

3.1 Background and historical evolution

Liquidity lines have long served as a tool of central bank cooperation during episodes of financial stress, particularly to support the international role of key currencies and stabilize foreign exchange markets. However, the architecture and usage of central bank swap lines have evolved significantly over time. Initially used during the Bretton Woods era to maintain fixed exchange rates, swap lines reemerged prominently during the 2008 Global Financial Crisis as tools for short-term dollar liquidity provision.

Under the Bretton Woods system of fixed exchange rates, swap lines were primarily used to provide short-term balance-of-payments support and to defend currency pegs. They enabled central banks to intervene in FX markets to maintain parity against the dollar, which functioned as the global anchor. The dollar's enduring status as the world's key currency created a structural need for dollar liquidity in global trade and finance. As such, the Federal Reserve has historically maintained FX swap lines with several central banks primarily for the purpose of foreign exchange market intervention.

The modern system of dollar liquidity swap lines traces its roots to earlier forms of central bank cooperation but underwent its most transformative expansion during the 2007-2009 Global Financial Crisis (Fleming and Klagge, 2010). In today's post-Bretton Woods floating exchange rate regime, swap lines are less about defending specific exchange rate levels, and more about alleviating funding pressures in the offshore dollar system (Ito and McCauley, 2019). In response to rising global dollar funding pressures, the Federal Reserve reinstated swap lines in December 2007 with the European Central Bank (ECB) and the Swiss National Bank (SNB). These facilities functioned primarily as an offshore extension of the Fed's Term Auction Facility (TAF), with the ECB conducting fixed-rate tenders at the TAF stop-out rate.

The Federal Reserve's network of bilateral agreements with other major central banks was designed to relieve stress in offshore dollar markets by allowing foreign central banks to pledge forward – "on-lend"– dollars to domestic institutions. These arrangements demonstrated a high degree of international monetary cooperation, often with the US Federal Reserve acting as the primary supplier of liquidity (Schenk, 2020). Over time, swap lines have become institutionalized, with standing arrangements among key central banks. This shift reflects a reorientation of swap lines from tools of FX rate stabilization to instruments of global financial stability, where their primary function is to backstop the international monetary system centered around the dollar. Yet, the structural logic remains consistent. Central banks like the Fed must still accommodate the systemic demand for their currency, especially when private markets retrench (Ito and McCauley, 2019). See also Aldasoro et al. (2020), Ito and McCauley (2020) on this point.[25]

Case study. The Federal Reserve swap lines in 2008 and 2020

During the Great Financial Crisis of 2008, as market stress deepened, unmet demand for dollar funding became evident for foreign institutions, constrained by the caps on the swap lines. Bid-to-cover ratios soared, indicating the scarcity of dollar liquidity among European banks.
Following the failure of Lehman Brothers in September 2008, the Fed rapidly expanded the scope and scale of its swap arrangements. New swap lines were established with additional central banks, including the Bank of England and Bank of Japan, among others, and the total program capacity surged from 67 billion USD to 620 billion USD in less than a month. Central banks broadened their lending terms to include overnight and one-week operations in addition to one- and three-month maturities, often through variable-rate auctions to adapt to market volatility. By the end of this phase, over 330 billion USD in dollar loans were outstanding. On October 13-14, 2008, the Fed removed the caps on its swap lines with major central banks, signaling a commitment to stabilize global dollar markets. In turn, these central banks began offering fixed-rate tenders for uncapped amounts at maturities of one week, one month, and three months. This innovation allowed eligible institutions to borrow as much as needed against appropriate collateral, help-

[25] See Bordo (2021); Perks et al. (2021); Eichengreen and Kakridis (Eds.) (2023) for further historical notes on the evolution of the international monetary cooperation and swap lines.

ing restore liquidity and confidence in interbank markets. Swap line usage peaked in December 2008, reaching 580 billion USD, representing more than 25 percent of the Fed's balance sheet at the time. By 2009, market conditions began to normalize, and the use of the swap lines declined due to penalty-rate pricing and improved private funding alternatives.

During the Covid-19 the Fed response has been extraordinary in terms of speed and magnitude. On March 15, 2020, the Fed activated existing swap lines with five major central banks: the European Central Bank, the Bank of Japan, the Bank of England, the Bank of Canada, and the Swiss National Bank. The terms of these swap lines were also enhanced, lowering the interest rate and extending the maturity of the swaps. On March 19, 2020, the Fed established temporary swap lines with nine additional central banks: Australia, Brazil, Denmark, Mexico, New Zealand, Norway, Singapore, South Korea, and Sweden. These lines had specific limits, ranging from USD 30 billion to USD 60 billion depending on the central bank. The temporary swap lines were initially approved for six months and were subsequently extended multiple times, with the final extension lasting until December 31, 2021.

Aizenman, Ito, and Pasricha (2022) estimate that central bank swap lines were granted to the recipient economies that had close financial and trade ties with the US. By accessing global liquidity, the global trade exposure to the Covid-19 shock decreased, the currencies of recipients countries appreciated, which temporarily reduced deviations from the covered interest parity, and persistently reduced sovereign bond yields. The authors also claim that by buffering such shocks, the effects spilled over the global economy at large, benefiting even the most vulnerable economies thanks to overall reduction in global stability threats.

3.2 Technical and operational aspects

The activation of a central bank liquidity line follows a structured protocol. A recipient central bank begins by submitting a request to the source central bank for a specific amount of foreign currency, with a defined settlement date and maturity. Upon approval, the agreed funds are transferred, typically requiring at least one business day's notice for operational processing, though overnight swaps may proceed with same-day notice if requested early enough (Bahaj and Reis, 2023).

A typical swap line arrangement consists of two transactions. First, the foreign central bank exchanges its domestic currency with the source central bank for an equivalent amount of foreign currency at the prevailing spot rate. Simultaneously, a second leg is agreed upon to reverse the transaction at the same exchange rate on a specified future date. This structure limits foreign exchange risk for both parties over the life of the swap. Importantly, the collateral exchanged between the central banks is the currency itself, deposited at a fixed exchange rate. This differs from repo operations where securities are used as collateral, making swap lines distinct in structure and operational focus. Since repo agreements require marketable securities often denominated in the source currency, they raise the bar for access due to their collateral demands. The reason for that is the monetary cooperation element among central banks justifying the use of such lines in times of crisis.

Maturities of swap line transactions are typically short, from overnight to at most three months, tailored to the intended use of the funds. However, such agreements may be "rolled over", i.e., renewed at maturity for a period to be established between the parties. The liquidity is credited to the recipient central bank's correspondent account in the source jurisdiction, while the source central bank's received collateral is simultaneously held in a designated account. Once the foreign central bank receives the foreign currency, it allocates the liquidity to domestic institutions through its own lending operations, typically via fixed-rate auctions. The foreign central bank determines borrower eligibility, collateral requirements, and lending terms, while retaining full responsibility for repayment and credit risk. The borrowing central bank is obligated to return the funds to the source central bank, ensuring the lending remains domestically anchored and insulated from the source's balance sheet. Interest is paid back to the source central bank based on the actual proceeds earned by the foreign central bank on its domestic lending of the source currency. Meanwhile, the source central bank does not earn interest on the foreign currency it holds but agrees to leave it idle, minimizing reserve management complications abroad.

This operational framework enhances liquidity predictability for foreign financial institutions and reduces the likelihood of disorderly asset sales in dollar funding markets. The objective is not to rescue distressed institutions or recapitalize banks, but to preserve orderly funding flows and market functioning by alleviating short-term dollar liquidity shortages. Swap lines offer targeted relief to foreign jurisdictions while indirectly promoting stability in domestic financial markets. As highlighted in Section 2, institutions untapping eurodollar markets may face heightened stress when the dollar basis surge. The swap lines effectively act to reduce such stress by easing monetary conditions and lubricating the plumbing system with newly created reserves to be pledged offshore.

Another distinction lies in the bilateral versus multilateral arrangement of these instruments. The Federal Reserve's swap lines are bilateral, established individually with central banks.[26] More recent initiatives like the Chiang-Mai Initiative Multilateralisation (CMIM) in Asia or the ECB's extended repo operations with multiple national central banks reflect a more multilateral design. While the CMIM began as a network of bilateral liquidity lines in Asia, in 2010 it became a multilateral swap line. Central banks participating in such arrangement could swap their own currency for US dollars drawn from a pool generated from the combined reserves of the participants (Bahaj and Reis, 2023). While bilateral arrangements along a few permanently established swap lines for the biggest central banks allow for tailored terms and rapid deployment, multilateral systems can support a broader regional stability framework (Fleming and Klagge, 2010).

Such arrangements are mutually advantageous. The recipient central bank gains foreign currency liquidity to stabilize domestic financial institutions, while the source central bank stabilizes global markets and prevents negative feedback loops from foreign turmoil. The roles of the source and recipient central banks are also technically distinct. The source central bank provides its own currency (e.g., the Fed provides USD) and typically sets limits, terms, and maturities. Most arrangements are technically

[26] The Fed's current swap lines are limited to five central banks: the European Central Bank (ECB), the Bank of England (BoE), the Bank of Japan (BoJ), the Swiss National Bank (SNB), and the Bank of China (BoC), although during the Covid-19 pandemic, temporary lines were activated for the first time to a number of additional countries.

reciprocal, but usage tends to be asymmetric. For example, the Fed has not drawn on its swap lines, reflecting the US dollar's role as the dominant funding currency. Still, reciprocal terms serve to reinforce trust and minimize political asymmetries. The recipient central bank is responsible for allocating the liquidity domestically and bears the counterparty credit risk. This division of responsibility ensures alignment of incentives: the recipient has both the knowledge and the incentive to manage risk locally.

Finally, it is worth mentioning how contractual details such as the interest rate are decided. The charged interest rate is determined by the source central bank, typically as a spread over its policy or market benchmark rate. The recipient does not receive interest on the collateral it posts. By this measure, these arrangements can act as implicit interest rate ceilings. By offering foreign currency liquidity at a fixed spread over benchmark rates, swap lines place an upper bound on short-term interest rates in stressed markets. If market rates rise above the swap rate, usage of the facility can help contain volatility and panic-driven price spirals. The Fed's crisis-era swap lines, for instance, served precisely this function by stabilizing dollar funding markets abroad. For further discussions on the technical aspects, see Borio, McCauley, and McGuire (2017), Bahaj and Reis (2020), Bahaj, Fuchs, and Reis (2024).

3.3 Main goals of central bank swap lines

Global financial stability and contagion avoidance. Many non-US entities issue liabilities denominated in USD, i.e., eurodollars. This liability dollarization arises from the dollar's global role as a unit of account and store of value. However, because these entities typically earn revenue in local currencies, they become exposed to currency mismatch risks during periods of market stress, when the availability of dollar funding can suddenly dry up. These dollar liabilities are often intermediated through offshore USD funding markets beyond the Federal Reserve's jurisdiction. In crisis times, demand for dollars surges globally while supply contracts, leading to acute dollar shortages outside the US. This market dislocation underscores the need for reliable access to US dollar liquidity. In response, the Fed has established swap lines with key foreign central banks, allowing them to obtain dollars and on-lend them domestically. This institutionalizes the Fed's role as a *global lender of last resort*, providing a floor not only to the US banking system but to the overall global dollar-based financial architecture.

The ability to access Fed swap lines strengthens the safe-haven status of the US dollar. During crises, investors and institutions gravitate toward dollar-denominated assets, expecting that dollar liquidity will remain ample and backstopped by the Fed. Swap lines institutionalize this expectation, reinforcing the dollar's role as a global anchor currency. However, access to these swap lines is selective, primarily reserved for the most systemically important economies, potentially reinforcing a tiered monetary hierarchy where only certain currencies benefit from "swap line insurance" (Bahaj and Reis, 2022a).

Traditionally, countries accumulated large reserves of USD to self-insure against funding shocks, as previously seen in Figure 4. This approach is costly, requiring sterilized interventions and often distorting local financial conditions. In contrast, swap lines offer a more efficient and targeted insurance mechanism. Instead of holding inert reserves, central banks can draw liquidity as needed. Bahaj and Reis (2022b) highlights this shift, suggesting that liquidity lines may substitute for reserve accumula-

tion under certain conditions.[27] However, access to swap lines is neither guaranteed nor universal. For countries without such arrangements, reserves remain a crucial – albeit expensive – tool for financial resilience. Furthermore, swap lines rely on mutual trust and political alignment, which can be uncertain in periods of geopolitical tension and financial fragmentation.

International trade finance and global influence. In contrast to the Federal Reserve's swap lines, which primarily serve to provide liquidity during market stress, the People's Bank of China (PBoC) has used its swap line network to advance the internationalization of the Renminbi (RMB). Since 2009, China has signed over 30 bilateral swap agreements with a diverse set of central banks. These agreements are less about backstopping global financial markets and more about facilitating RMB usage in trade and investment, especially with countries participating in the Belt and Road Initiative (Cheung, McCauley, and Shu, 2019; Arslanalp, Eichengreen, and Simpson-Bell, 2022; Eichengreen, 2019).[28]

Swap lines with central banks in emerging and developing economies often aim to enable RMB settlement in cross-border transactions, thereby reducing reliance on the dollar. While China's swap lines symbolically challenge the dollar's hegemony, their impact remains constrained (Eichengreen et al., 2024). Most transactions under these agreements are limited in scale, and RMB usage in global finance and trade remains modest, also because of China's capital controls.

Financial hegemony requires more than diplomacy. It demands the world's deepest and most liquid capital markets, rule of law, and invoicing dominance in international trade. These are features that still overwhelmingly favor the United States. The international use of the RMB remains constrained by China's capital controls, limited investor confidence in the Chinese legal system, and the relative opacity of its financial system. While institutions like the CIPS and swap lines help build RMB infrastructure, they have yet to create meaningful substitution for the USD in the global financial system. In this light, China's ambitions for financial leadership must still contend with significant structural disadvantages. With that being said, it is undeniable that the use of central bank lines can induce an instrument of power to gradually fill a gap left by the countries at the core of the currency system.

3.4 Open points in central bank swap lines

Settlement mechanics remain a nontrivial challenge for liquidity lines. Swap line arrangements require mirrored deposits at each central bank, with accounts typically restricted from active use during the life of the swap. While this reduces operational risk and prevents currency misuse, it can complicate reserve management for recipient central banks, particularly those with less developed financial infrastructure. In repo lines, collateral transfer is more straightforward but demands high-quality liquid assets denominated in the source currency, which can limit access for emerging markets.

There is a risk that swap lines could reduce recipient central banks' incentives to maintain sound macroeconomic policies or develop robust domestic funding markets. While the Federal Reserve never

[27] See Dominguez and Gomis-Porqueras (2023) for a study on the macroeconomic implications of swap lines.
[28] China's global infrastructure project adopted in 2013 to invest in more than 150 countries and international organizations

formally penalized missed swap repayments, the expectation of rollover and implicit trust-based mechanisms suggest that reputational risk is often the only element to discipline recipients. The moral hazard consequences of large swap lines have not been tested yet (Bahaj and Reis, 2022a).

It is also important to notice that swap lines have increasingly coexisted with other liquidity backstops like the IMF's Flexible Credit Line and regional mechanisms such as the Chiang Mai Initiative or the Asian Infrastructure Investment Bank. Unlike the IMF, swap lines are fast-acting and bilateral, often privileging geopolitically close or systemically important countries. However, their discretionary nature and lack of transparent access criteria can undercut multilateral mechanisms by creating a two-tiered system of global liquidity support, which may exacerbate the distance between the conditions in the Global North and Global South. Historically, swap lines were extended primarily among advanced economies. Recent crises, however, prompted their activation for select emerging markets, including Brazil, Mexico, and South Korea. These countries benefited from rapid and reliable dollar access at the height of market stress. Yet, the criteria for inclusion remain opaque, and many large emerging markets remain outside the formal swap line network. This asymmetry raises concerns about fairness, effectiveness, and the broader architecture of global financial safety nets.

As geopolitical tensions rise and global economic power diversifies, the architecture of liquidity provision is likely to evolve. Financial hegemony requires not only currency use but also deep capital markets and invoicing dominance features still unique to the United States. China's push to internationalize the renminbi through swap lines and the development of alternative payment systems illustrate a move toward a multi-currency world. However, absent capital account openness and broader trust in Chinese institutions, the renminbi's challenge to the dollar remains constrained.

Finally, the emergence of CBDCs introduces new possibilities for real-time cross-border liquidity provision. While still nascent, platforms such as mBridge and Project Agorà, mentioned in the previous section, could one day serve as programmable, multilateral alternatives to existing swap lines. Whether CBDCs will displace or complement traditional liquidity arrangements depends on adoption, interoperability, and trust. These factors remain in flux for the time being.

Bibliography

Adrian, T. and T. Mancini-Griffoli (2019). The Rise of Digital Money. *Annual Review of Financial Economics 13*(1).

Aizenman, J., H. Ito, and G. K. Pasricha (2022). Central bank swap arrangements in the COVID-19 crisis. *Journal of International Money and Finance 122*, 102555.

Aldasoro, I. and T. Ehlers (2018). The geography of dollar funding of non-US banks. *BIS Quarterly Review, December*.

Aldasoro, I., T. Ehlers, and E. Eren (2022). Global banks, dollar funding, and regulation. *Journal of International Economics 137*, 103609.

Aldasoro, I., T. Ehlers, P. McGuire, and G. von Peter (2020). Global banks' dollar funding needs and central bank swap lines. *BIS Bulletin No.27*.

Aliber, R. Z. (1980). The integration of the offshore and domestic banking system. *Journal of Monetary Economics 6*(4), 509–526.

Altamura, C. E. (2016). *European Banks and the Rise of International Finance: The post-Bretton Woods era*. Routledge: London.

Arslanalp, S., B. Eichengreen, and C. Simpson-Bell (2022). The stealth erosion of dollar dominance and the rise of nontraditional reserve currencies. *Journal of International Economics 138*, 103656.

Asif, M., R. N. Lodhi, F. Sarwar, and M. Ashfaq (2024). Dark side whitewashes the benefits of fintech innovations: a bibliometric overview. *International Journal of Bank Marketing 42*(1), 113–132.

Association for Financial Professionals (2022). 2022 Payments Cost Benchmarking Survey.

Bahaj, S., M. Fuchs, and R. Reis (2024). The Global Network of Liquidity Lines. *CEPR discussion paper 19070*.

Bahaj, S. and R. Reis (2020). Central bank swap lines during the Covid-19 pandemic. *Covid Economics 2*(1), 1–12.

Bahaj, S. and R. Reis (2022a). Central Bank Swap Lines: Evidence on the Effects of the Lender of Last Resort. *Review of Economic Studies 89*(4), 1654–1693.

Bahaj, S. and R. Reis (2022b). The Economics of Liquidity Lines Between Central Banks. *Annual Review of Financial Economics 14*(1), 57–74.

Bahaj, S. and R. Reis (2023). The workings of liquidity lines between central banks. In *Gurkanyak, R.S. and J.H. Wright (eds.), "Research Handbook of Financial Markets", 102–124*. Edward Elgar Publishing: Cheltenham, UK.

Bech, M. L., U. Faruqui, and T. Shirakami (2020). Payments without borders. *BIS Quarterly Review, March*.

Bech, M. L., J. Hancock, T. Rice, and A. Wadsworth (2020). On the future of securities settlement. *BIS Quarterly Review, March*.

Bech, M. L. and B. Hobijn (2022). Technology diffusion within central banking: The case of real-time gross settlement. *International Journal of Central Banking*.

Bech, M. L., Y. Shimizu, and P. Wong (2017). The quest for speed in payments. *BIS Quarterly Review, March*.

BIS (1997). Real-time gross settlement systems. *BIS Committee on Payments and Market Infrastructure papers No. 22*.

BIS (2011). Principles for the Sound Management of Operational Risk. *Basel Committee on Banking Supervision technical report*.

BIS (2012a). Payment, Clearing and Settlement Systems in the CPMI Countries. *Bank for International Settlements Committee on Payment and Settlement Systems techinical report*.

BIS (2012b). Principles for financial market infrastructures. *BIS Committee on Payments and Market Infrastructures papers No. 101*.

BIS (2016). Correspondent banking - final report. *BIS Committee on Payments and Market Infrastructures papers No. 147*.

BIS (2017). Distributed ledger technology in payment, clearing and settlement - an analytical framework. *BIS Committee on Payments and Market Infrastructures No. 157*.

BIS (2020). Payment aspects of financial inclusion in the fintech era. *BIS Committee on Payments and Market Infrastructures papers No. 191*.

BIS (2021a). Annual Economic Report. *Bank for International Settlements technical report*.

BIS (2021b). Interoperability between payment systems across borders. *BIS Bulletin No 49*.

BIS (2023). Considerations for the use of stablecoin arrangements in cross-border payments. *CPMI 2023 Report*.

Bliss, R. and R. Steigerwald (2006). The Future of OTC Derivatives Markets. *Federal Reserve Bank of Chicago Economic Perspectives 30*(4).

Bordo, M. D. (2021). Monetary Policy Cooperation/Coordination and Global Financial Crises in Historical Perspective. *Open Economies Review 32*(3), 587–611.

Bordo, M. D. and C. Bastidon (2023). The International Monetary System and International Financial System as an Analogy to the Copernican Heliocentric system: A simple multi-layers network model with simultaneous regime changes. *NBER Working Paper 31716*.

Bordo, M. D. and W. Roberds (2023). Central Bank Digital Currencies, an Old Tale With a New Chapter. *NBER Working Paper No. 30709*.

Borio, C. E., R. N. McCauley, and P. McGuire (2017). FX swaps and forwards: missing global debt? *BIS Quarterly Review, September*.

Carstens, A. (2020). Shaping the future of payments. *BIS Quarterly Review, March*.

Cheung, Y.-W., R. N. McCauley, and C. Shu (2019). Geographic Spread of Currency Trading: The Renminbi and Other Emerging Market Currencies. *China & World Economy 27*(5), 25–36.

Cipriani, M., L. S. Goldberg, and G. La Spada (2023). Financial Sanctions, SWIFT, and the Architecture of the International Payment System. *Journal of Economic Perspectives 37*(1), 31–52.

Clayton, C., A. Coppola, M. Maggiori, and J. Schreger (2025). Geoeconomic Pressure. *NBER Working Paper No. 34020*.

Coffey, N., W. B. Hrung, H.-L. Q. Nguyen, and A. Sarkar (2009). The Global Financial Crisis and Offshore Dollar Markets. *Current Issues in Economics and Finance 15*(6).

Conti-Brown, P. and D. A. Wishnick (2020). Private Markets, Public Options, and the Payment System. *Yale Journal on Regulation*.

CPMI-IOSCO (2012). Principles for financial market infrastructures. *Bank for International Settlements and International Organization of Securities Commissions technical report*.

CPMI-IOSCO (2016). Guidance on cyberresilience for financial market infrastructures. *Bank for International Settlements and International Organization of Securities Commission technical report*.

Davies, S. and C. Kent (2020). US dollar funding: an international perspective. *BIS Committee on the Global Financial System papers No. 65*.

De Goede, M. (2012). The SWIFT affair and the global politics of European security. *Journal of Common Market Studies 50*(2), 214–230.

Doerr, S., J. Frost, L. Gambacorta, and V. Shreeti (2023). Big techs in finance. *BIS Working Paper No. 1129*.

Dominguez, B. and P. Gomis-Porqueras (2023). Accessing U.S. Dollar Swap Lines: Macroeconomic Implications for a Small Open Economy. *MPRA Working Paper No. 118293*.

Duffie, D. (2015). Resolution of failing central counterparties. In T. Jackson, K. Scott, and J. E. Taylor (Eds.), *Making Failure Feasible: How Bankruptcy Reform Can End 'Too Big To Fail'*, pp. 87–109. Hoover Institution Press: Stanford.

Duffie, D. (2017). CCPs should prep to quash Sifi swap termination stays. *Risk.net*.

Duffie, D., M. Scheicher, and G. Vuillemey (2015). Central clearing and collateral demand. *Journal of Financial Economics 116*(2), 237–256.

ECB (2019). Crypto-Assets: Implications for financial stability, monetary policy and payments and market infrastructures. *European Central Bank Occasional Paper Series No. 223*.

Eichengreen, B. (2018). Banks, financial markets and the development of international currencies. *Financial Innovation and Resilience: A Comparative Perspective on the Public Banks of Naples (1462-1808)*, 313–325.

Eichengreen, B. (2019). *Globalizing Capital: A History of the International Monetary System (Third Edition)*. Princeton University Press: Princeton.

Eichengreen, B. (2022). Digital Currencies—More than a Passing Fad? *Current History 121*(831), 24–29.

Eichengreen, B. (2024). Geopolitics and the global economy. *Journal of International Money and Finance 146*, 103124.

Eichengreen, B., R. Hausmann, and U. Panizza (2005). The Pain of Original Sin. *in Eichengreen, B. and R. Hausmann (eds.) "Other people's money: Debt Denomination and Financial Instability in Emerging Market Economies"*, 13–47. Chicago: University of Chicago Press.

Eichengreen, B. and A. Kakridis (Eds.) (2023). *The Emergence of the Modern Central Bank and Global Cooperation*. Cambridge University Press: Cambridge, UK.

Eichengreen, B., C. Macaire, A. Mehl, E. Monnet, and A. Naef (2024). Currency internationalization with Chinese characteristics: Is capital-account convertibility required for the renminbi to acquire reserve-currency status? *International Finance 27*(2), 102–128.

Eichengreen, B., A. Mehl, and L. Chiţu (2019). Mars or Mercury? The geopolitics of international currency choice. *Economic Policy 34*(98), 315–363.

Eichengreen, B. and G. Viswanath-Natraj (2022). Stablecoins and central bank digital currencies: policy and regulatory challenges. *Asian Economic Papers 21*(1), 29–46.

EMEAP (2020). Study on US dollar Liquidity andFunding Dynamics in the EMEAP Region. *Executives' Meeting of East Asia-Pacific Central Banks WorkingGroup on Financial Markets report*.

Fleming, M. J. and N. Klagge (2010). The Federal Reserve's foreign exchange swap lines. *Current Issues in Economics and Finance 16*(4).

FNA (2023). CHIPS Review: Assessing the Efficiency of CHIPS.

FRB (2021). Financial stability report 2021.

FRB (2022). Money and Payments: The U.S. Dollar in the Age of DigitalTransformation. *Federal Reserve Board Research and Analysis mimeo*.

Freixas, X. and J.-C. Rochet (2008). *Microeconomics of Banking (Second Edition)*. MIT Press: Cambridge, USA.

FSB (2020). Regulation, Supervision and Oversight of "Global Stablecoin" Arrangements.

FSB (2022). US Dollar Funding and Emerging Market Economy Vulnerabilities. *Financial Stability Board report*.

FSB (2024). Recommendations for Regulating and Supervising Bank and Non-bank Payment Service Providers Offering Cross-border Payment Services. *Financial Stability Board 2024 Final report*.

Garratt, R. and H. S. Shin (2023). Stablecoins versus tokenised deposits: implications for the singleness of money. *BIS Bulletin No. 73*.

Goetzmann, W. (2017). *Money changes everything: How finance made civilization possible*. Princeton University Press: Princeton.
Goodhart, C. A. E. (2011). *The Basel Committee on Banking Supervision: A History of the Early Years, 1974–1997*. Cambridge University Press: Cambridge.
Gopinath, G., O. Itskhoki, and R. Rigobon (2010). Currency choice and exchange rate pass-through. *American Economic Review 100*(1), 304–336.
Gourinchas, P.-O. and H. Rey (2022). Exorbitant Privilege and Exorbitant Duty.
Grolleman, D. J. and D. Jutrsa (2017). Understanding Correspondent Banking Trends: A Monitoring Framework. *IMF Working Paper No. 17/216*.
He, D. and R. McCauley (2012). Eurodollar banking and currency internationalisation. *BIS Quarterly Review June*, 33–46.
Hogan, W. P. (2016). *Eurodollar Market*, pp. 1–4. Palgrave Macmillan: London.
Hollanders, M. (2020). FinTech and financial inclusion: Opportunities and challenges. *Journal of payments strategy & systems 14*(4), 315–325.
Humphrey, D. (2019). Payments. In A. N. Berger, P. Molyneux, and J. O. Wilson (Eds.), *The Oxford Handbook of Banking*, pp. 285–320. Oxford University Press: Oxford.
IMF (2016). United Kingdom Financial System Stability Assessment. *IMF Country Report No. 167*.
IMF (2019). Banks' dollar funding: A source of financial vulnerability. *Global Financial Stability Report: Lower for longer*.
Iqbal, K., P. K. Roy, and S. Alam (2020). The impact of banking services on poverty: Evidence from sub-district level for Bangladesh. *Journal of Asian Economics 66*, 101154.
Ito, H. and R. N. McCauley (2019). A key currency view of global imbalances. *Journal of International Money and Finance 94*, 97–115.
Ito, H. and R. N. McCauley (2020). Currency composition of foreign exchange reserves. *Journal of International Money and Finance 102*, 102104.
Itskhoki, O. and D. Mukhin (2025). Sanctions and the Exchange Rate. *NBER Working Paper No. 30009*.
Ivashina, V., D. S. Scharfstein, and J. C. Stein (2015). Dollar Funding and the Lending Behavior of Global Banks. *Quarterly Journal of Economics 130*(3), 1241–1281.
Kreicher, L. and R. N. McCauley (2016). Asset Managers, Eurodollars and Unconventional Monetary Policy. *BIS Working Paper 578*.
Krishnamurthy, A. and A. Vissing-Jorgensen (2012). The aggregate demand for treasury debt. *Journal of Political Economy 120*(2), 233–267.
Laudati, D. and M. H. Pesaran (2023). Identifying the effects of sanctions on the iranian economy using newspaper coverage. *Journal of Applied Econometrics 38*(3), 271–294.
Machlup, F. (1972). Euro-dollars, once again. *Banca Nazionale del Lavoro Quarterly Review 25*, 119–137.
McCauley, R., P. McGuire, and P. Wooldridge (2021). Seven decades of international banking. *BIS Quarterly Review September 2021*.
McCauley, R. N. (2024). The Offshore Dollar and US Policy. *Federal Reserve Bank of Atlanta's Policy Hub report No.2-2024*.
McCauley, R. N., P. McGuire, and V. Sushko (2015). Global dollar credit: links to US monetary policy and leverage. *Economic Policy 30*(82), 187–229.
McCauley, R. N. and R. Seth (1992). Foreign bank credit to US corporations: The implications of offshore loans. *Federal Reserve Bank of New York Quarterly Review 17*(1), 52–65.
McGath, T. (2018). M-PESA: how Kenya revolutionized mobile payments. *N26 Magazine 9*.
McLaughlin, D. A. (2023). The trade-off between shorter settlement times and multilateral netting benefits in deferred net settlement. *Journal of Financial Market Infrastructures*.
Melvin, M. and S. Norrbin (2023). Eurocurrency Markets and the LIBOR. In *International Money and Finance* (*Tenth Edition*), pp. 89–101. Academic Press: London.
Miranda-Agrippino, S. and G. Ricco (2021). The Transmission of Monetary Policy Shocks. *American Economic Journal: Macroeconomics 13*(3), 74–107.
Murau, S., J. Rini, and A. Haas (2020). The evolution of the Offshore US-Dollar System: past, present and four-possible futures. *Journal of Institutional Economics 16*(6), 767–783.

Narula, N., L. Swartz, and J. Frizzo-Barker (2023). CBDC: Expanding Financial Inclusion or Deepening the Divide? Exploring Design Choices that Could Make a Difference. *MIT digital currency initiatie technical report*.

Nexus (2023). Enabling instant cross-border payments. *BIS Project Nexus – Conclusions from a technical proof of concept between the Eurosystem, Malaysia and Singapore*.

Perez-Saiz, H. and L. Zhang (2023). Renminbi Usage in Cross-Border Payments: Regional Patterns and the Role of Swap Lines and Offshore Clearing Banks. *IMF Working Paper No.77*.

Perks, M., Y. Rao, M. J. Shin, and K. Tokuoka (2021). Evolution of Bilateral Swap Lines. *IMF Working Paper 21/210*.

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

Riksbank (2022). Payments report.

Rose, J. (2023a). Automated Clearing House Payments. *Federal Reserve History report*.

Rose, J. (2023b). Cash services. *Federal Reserve History report*.

Rose, J. (2023c). Fedwire. *Federal Reserve History report*.

Schenk, C. R. (1998). The Origins of the Eurodollar Market in London: 1955–1963. *Explorations in Economic History 35*(2), 221–238.

Schenk, C. R. (2020). Central bank cooperation and US dollar liquidity: What can we learn from the past? *BIS Per Jacobsson Lecture*.

Scott, S. V. and M. Zachariadis (2012). Origins and development of SWIFT, 1973–2009. *Business History 54*(3), 462–482.

Scott, S. V. and M. Zachariadis (2014). *The Society for Worldwide Interbank Financial Telecommunication (SWIFT): Cooperative governance for network innovation, standards, and community*. Routledge: London.

Smedresman, P. S. and A. F. Lowenfeld (1989). Eurodollars, Multinational Banks, and National Laws. *New York University Law Review 64*(4), 733.

Stearns, D. L. (2011). *Electronic value exchange: Origins of the VISA electronic payment system*. Springer: Berlin.

Sullivan, T. (2022). What is an ACH Transfer? All about ACH bank transfers. *Plaid*.

Sutton-Lalani, A., S. Hernandez, J. Miedema, J. Dai, and B. Omrane (2023). Redefining Financial Inclusion for a Digital Age: Implications for a Central Bank Digital Currency. *Bank of Canada Staff Discussion Paper No. 2023-22*.

Tok, Y. W. and D. Heng (2022). Fintech: Financial Inclusion Or Exclusion? *IMF Working Paper No. 22/80*.

Treasury (2022). The Future of Money and Payments. *U.S. Department of the Treasury Report Pursuant to Section 4(b) of Executive Order 14067*.

Wang, J. (2020). *Central banking 101*. Self-publication: New York.

World Bank (2021). Interoperability in Fast Payment Systems. *World Bank Focus Note Sep. 2021*.