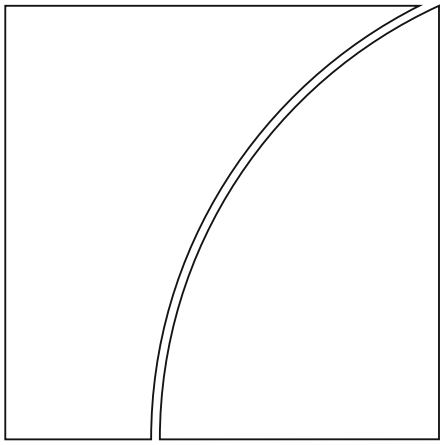


# BIS Papers

No 167

# Cross-border payment technologies: innovations and challenges

by Stijn Claessens and Tara Rice

Monetary and Economic Department

March 2026

JEL classification: E41, E42, E51, E52, E58, G21, G28

Keywords: payments systems, cross-border, technology, harmonization, standards, digital innovation, wholesale, retail, remittances

The views expressed in this publication are those of the authors and do not necessarily reflect the views of the BIS or its member central banks.

This publication is available on the BIS website (www.bis.org).



ISSN 1682-7651 (online)
ISBN 978-92-9259-939-3 (online)

# Cross-border payment technologies: innovations and challenges

Stijn Claessens and Tara Rice[1]

## Abstract

Cross-border payments (XBP), particularly remittances and retail transactions, remain more costly, slower, less accessible, and less transparent than domestic payments. The continued inefficient XBP arrangements, in contrast to progress made in domestic payments using new technologies and innovative models, reflect that private actors alone cannot overcome the many market failures that hinder XBP. The most binding constraint concerns the limited interoperability which relates to the multi-sided market frictions in XBP and the institutional differences between countries. These, ultimately, only proactive and collaborative public sector efforts can overcome. Key priorities are therefore greater harmonization of standards, especially for message transmission, more effective compliance regimes, and promotion of competition.

Keywords: payments systems, cross-border, technology, harmonization, standards, digital innovation, wholesale, retail, remittances

JEL classificazioni: E41, E42, E51, E52, E58, G21, G28

## 1. Introduction

"*The difficulty of international trade lies not in the exchange of goods but in the exchange of currencies.*" John Maynard Keynes (1944) - Bretton Woods Conference.

Cross-border payments (XBP) have been an important part of the development of financial systems and countries for centuries (e.g., Bindseil & Pantelopoulos, 2022). Historically, banks' key roles have often been facilitating cross-border transactions. Italian, Dutch and other banks as early as the 16th century financed trade, helped issue and place sovereign notes abroad, and transferred funds across borders. Major financial centers like London emerged in part because of their role in XBP (Kindleberger, 1974). This role continues, with daily trading in foreign exchange (FX) in April 2025 estimated at $9.6 trillion (BIS, 2026 [forthcoming]), making it the financial market with the world's largest turnover.

[1] Stijn Claessens is an Executive Fellow at the Yale School of Management and a fellow of CEPR; Tara Rice is Head of the Secretariat of the Bank for International Settlements' Committee on Payments and Market Infrastructures. Draft for Volume 18 of the *Annual Review of Financial Economics*. We would like to thank respectively Thomas Lammer and Jamie McAndrews for their extensive comments, the referee for their useful feedback, Federico Semorile for data analysis, Chakree Aksonthung for his editorial assistance, and Deborah Lucas for inviting us to author this paper. The opinions expressed do not necessarily represent those of the Bank for International Settlements or its Committee on Payments and Market Infrastructures.

Yet, in many ways, progress in XBP has lagged behind the needs of society, especially when one differentiates wholesale XBP (institution to institution) from retail XBP (households and small firms paying abroad or sending money across borders) and remittances. While still less efficient than domestic payments, wholesale XBP are relatively low cost and fast. Retail and remittances XBP are, however, much more costly and slower than domestic payments. Globally, it still costs today on average $12 to remit $200 across borders and it can take multiple days.

The goal of this paper is to review research and policy work to draw lessons for how best to enhance XBP. While research on domestic payments is increasing, studies on XBP are few, particularly on new and possible innovative models supporting XBP. Common to both domestic and XBP is nevertheless the significant scope for market failures associated with two-sided markets—how to effectively cater to both payors and payees—and the related network effects. Consequently, efficient payments arrangements can fail to emerge or, if they do, become uncompetitive. Public sector interventions have typically been needed domestically. But establishing XBP arrangements and ensuring their efficient operation, including by using the technologies that are rapidly changing domestic payments landscapes, is much harder given the large differences in countries' institutions, regulations and governance structures, and the limited presence of public sector mitigants commonly employed domestically.

Considerable progress has been made under the G20 XBP program, started in 2020, through establishing and enhancing the efficiency of XBP-arrangements (FSB, 2020; CPMI, 2020a, 2020b). But there is still much to be done. While innovative technologies offer scope for benefits and can accelerate progress in some cases, in general they alone are insufficient, and may introduce new risks. Most important, greater harmonization of standards and more efficient compliance checks are necessary. This will require public sector initiatives and collaborative approaches across jurisdictions to overcome the many coordination failures.

The paper is structured as follows. Section 2 reviews the evolution and current state of affairs on XBP, including its main achievements and deficiencies. Section 3 reviews the research and policy work on domestic payments systems to identify and classify the key frictions that underly the current deficiencies in XBP systems. Section 4 documents current progress in XBP, including using new models, and ongoing and future policy work, including international efforts for enhancing XBP. Section 5 concludes.

## 2. Evolution and current state of cross-border payments

This section reviews the process for payments, domestic and XB, and associated entities and aspects, referring to recent domestic developments, describes the current state of affairs of XBP, explains its challenges, and reviews the various new XBP developments. Throughout, it notes the differences across types of payments, here in broad terms classified as retail (households and firms) XBP and remittances, and wholesale XBP.

*Domestic payments*. Payments involve a chain of steps—a process—which can be divided into front-end and back-end. The front-end for payments refers to the

part of the process that interacts in a broad sense directly with the "customer". The customer here includes retail consumers (households), businesses (merchants), financial institutions, government agencies, and many others, whether they be payor and payee.

The front end defines the market for how one initiates payments and determines the customer experience. Focusing on the market for retail payments, it is typically the private sector that provides the front-end services. The front-end arrangements available today include ATMs, bank offices, other payment system providers (PSPs), online banking, mobile apps, and shopping points-of-sale (POS), including contactless forms.

The back end refers to the entities, infrastructure and systems that handle the messages after the payment is initiated, authorize the payment, move the funds between financial institutions or intermediaries, and finalize ("settle") the payment. The entities involved in this part of payments include banks and nonbank PSP, clearinghouses and the central bank, with a large oversight role of the public sector in both retail and wholesale payments. The infrastructures used include various systems for messages and clearing and settling the payments. The processes involved are many and ensure among others compliance with prevailing rules, like those for anti-money laundering (AML) and combating the financing of terrorism (CFT). Together, they ensure that payments are securely and efficiently executed without losses, and the system's integrity is preserved.

Recent domestic front-end technological innovations have been steadily progressing. Consumers can now use a broad set of tools to initiate payments, offered by a wide set of entities with easy access (CPMI, 2018; Bruno, Denecker & Leibbrandt, 2025; Cipollone, 2025a and 2025b; SWIFT, 2025b). Current developments offer further opportunities to enhance the efficiency and ease of domestic payments. While the back-end systems are also continuously being updated and enhanced, changes mostly do not alter their fundamental structures.

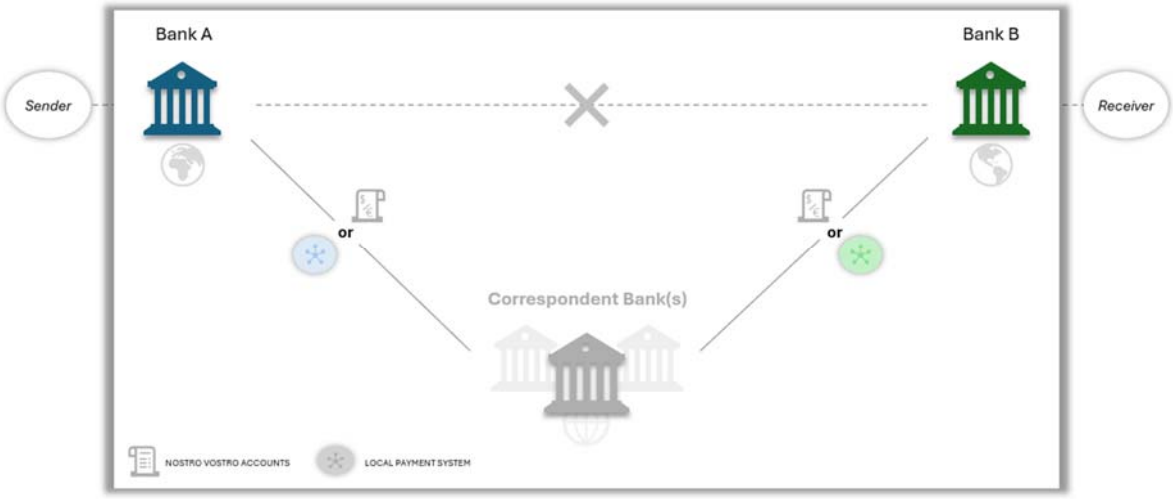
*Cross-border payments*. XBP have similar front-end and back-end operations as domestic payments do. But XBP are much more complex than domestic payments due to differences in currencies and regulations, which imply additional systems for currency conversion and cross-border compliance checks. And XBP typically involve a larger number of intermediaries.[2] This greater complexity is best illustrated by correspondent banking, the traditional model for XBP, which stretches back centuries.[3] *Correspondent banking* operates through a network of bilateral relationships, allowing banks to provide services in jurisdictions where they do not have a physical presence (Graph 1). Banks use so called "nostro accounts" (held by the respondent bank at the correspondent bank) and "vostro accounts" (held by the correspondent on behalf of the respondent). When a cross-border payment is initiated, the transaction is processed and settled, involving several rounds of communications between the two (or more) banks (and the final end-users). The

[2] It can involve, besides the two sets of domestic end-users and the platform, various payment service providers (PSPs) and/or commercial banks (most transfers involve two to four, and in particularly complex transactions, five or more), and often more than one central bank. Besides these multiple sets of agents, it can involve several different technologies for transmitting messages and processing payments, and multiple legal and enforcement systems.

[3] See further CPMI (2016b) and papers of the Global Correspondent Banking 1870-2000 project.

funds are then transferred through the correspondent bank(s) (there can be more than one leg in the payments chain whereby each acts as another intermediary). The (last) correspondent bank provides the final payment, clearing, and settlement services on behalf of the respondent bank.

Stylized cross-border payments chain Graph 1




*Correspondent banking has been the model traditionally used for international finance and trade*. And in value terms, it still dominates XBP today. Along with domestic payments systems, the technology supporting correspondent banking has evolved. It started with transferring gold, silver or other precious species across borders, but then quickly evolved to charging through instructions the specie ownership while it remained in a central location. This change made payments more about messaging than about transferring species. Indeed, when "wire transfers" were introduced in the U.S. in 1871 using the telegraph network, senders would bring money to the telegraph office, which then would send a message to another location and in that way "wire" the funds. Such systems were quickly adopted for XBP (Schenk, 2021). For example, in 1881, not long after the establishment of the transatlantic cable (in 1866), wire transfers between the U.S. and Europe were enabled. Links with and between other countries followed, with the establishment of direct connections varying depending, among other factors, on overall values.

To this day the correspondent banking model has not drastically changed, with the "wire-transfer" remaining at its core. And the system has retained its distinct hub and spoke pattern with regional and global (London and New York) hubs at the center. But there have been technological and institutional advances. For example, for some time now, it is supported by two key institutions, SWIFT and CLS bank (Schenk, 2024).

SWIFT (Society for Worldwide Interbank Financial Telecommunication), established in 1973, is a secure messaging network through which financial institutions—over 11 thousand are members—can send payment instructions (SWIFT, 2025b). A recent advance, SWIFT gpi (Global Payments Innovation), offers real-time,

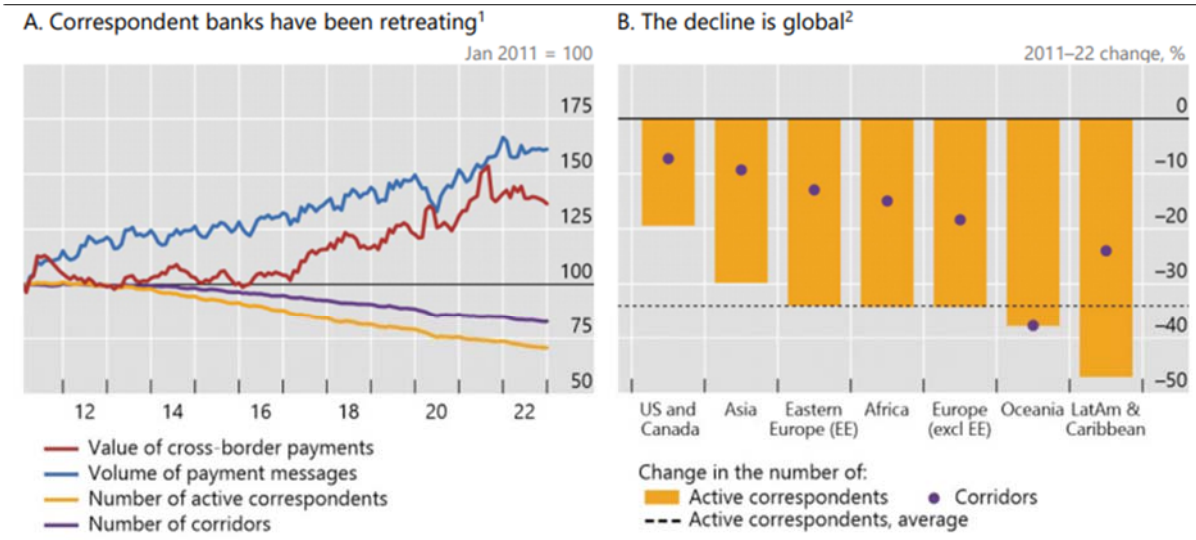
end-to-end message tracking, improving transparency and efficiency, and enabling action on delays. Now some 60% of Swift gpi payments are credited to end beneficiaries within 30 minutes and almost 100% within 24 hours (SWIFT, 2025b). Aligned with the G20 2027 XBP roadmap targets, SWIFT and over 30 early-adopter banks across 17 countries are defining a retail XBP scheme that commits to upfront fee and FX transparency, guaranteed full-value delivery, end-to-end tracking, and instant settlement where available. The scheme will be rolled out in phases and targets last-mile domestic frictions, which could account for about 80% of total processing time due to local regulations, market infrastructures, and practices. (SWIFT, 2025c).

CLS (Continuous Linked Settlement) Bank, established in 2002, plays a complimentary role in wholesale payments, particularly in FX transactions. Established to eliminate what is often referred to as Herstatt risk, also called FX settlement risk (the risk that one party delivers the currency it owes but does not receive the corresponding currency from the counterparty (CPSS, 1998), CLS provides a payment-versus-payment (PvP) settlement mechanism for 18 major currencies (CPMI, 2022b). FX trades outside the 18 currencies are still subject to significant FX settlement risk. The global foreign exchange market has grown considerably over time, with turnover of FX at $9.5 billion as of April 2025; the US dollar on the side of 89.2% of all trades (CLS, 2026). To mitigate this settlement risk, CLS introduced CLSnet in 2018, which uses DLT to provide a bilateral payment netting calculation service for FX trades in more than 120 currencies, particularly emerging markets (EME) currencies (CLS, 2018; BCBS-CPMI, 2020).

*Achievements, deficiencies and new XBP-arrangements. The* correspondent banking model has largely achieved the key essentials for any payment system: safety and integrity, preserving the singleness of money, and maintaining the trust of final users.[4] But it remains focused on wholesale payments and serves consumers, whether for retail XBP or remittances, by being one essential step in the chain of transfers. Related, and mainly so for its role in non-wholesale payments, it is often criticized for its inefficiencies. These include its high transaction costs, slow processing times, high frequency of mistakes, and limited transparency (FSB, 2020; CPMI, 2020a). Much of these arise from a high reliance on multiple intermediaries, which introduces many (bilateral) relationships that come with limited interoperability and added complexity (CPMI, 2020b). Additionally, the model has suffered in recent years as correspondent banking relationships have declined, particularly in emerging markets and developing economies (EMDEs), in part due to rising AML/CFT compliance costs (Rice, von Peter & Boar, 2020; see also Stebunovs, 2025, which shows that the costs are largely incurred in advanced economies, AEs).

[4] It has experienced shocks, like the failure of the Herstatt bank in 1974, but through continued enhancements, international cooperation and new institutions, it has proven resilient (see e.g., Leibbrandt & De Tran, 2004; CPMI, 2022, Schenk, 2024).

Correspondent banks have been retreating globally Graph 2




[1] Three-month moving averages. [2] Averages across countries in each region. Correspondent banks that are active in several corridors are counted several times. Grouping of countries by regions is according to the United Nations Statistics Division; for further details, see unstats.un.org/unsd/methodology/m49/.

Sources: Rice et al. (2020), Garratt et al. (2024).

While over the past decades, technological innovation has drastically changed domestic payments, it is making much more measured inroads into the XBP ecosystem. Still, the correspondent banking model is being complemented, and replaced to some degree by retail payments, offering alternative and innovative arrangements. By changing the front and back ends, these aim to create a more seamless, accessible, efficient and global interoperable payment ecosystem. But progress in overcoming the deficiencies is slow.

As to the front end, the private sector has launched several retail XBP arrangements, both global and regional (e.g., Wise, Revolut, M-Pesa Global, Western Union Online). Their attraction is lower costs, increased transparency, 24/7 availability, and ease of use, especially in demand by the digitally native (Petralia et al., 2019). To date, while they are gaining market share in certain corridors, their values and volumes have been limited. And they largely still rely on existing XBP-systems.

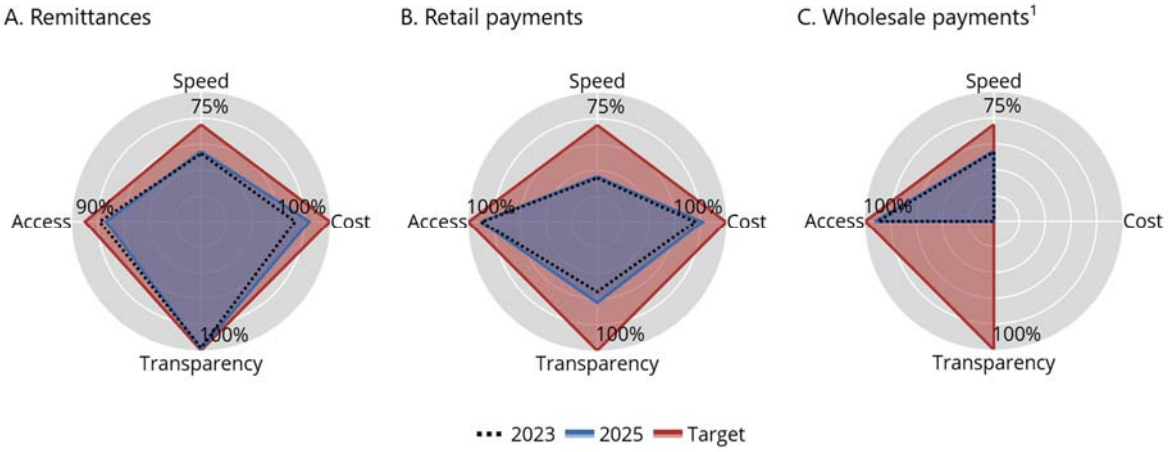
As to the back-end, XBP is slowly evolving from relying fully on the correspondent banking model to using a broader range of models, which still largely rely on traditional infrastructures. Bech, Faruqui & Shirakami (2020) reviewed the landscape in 2020 and found then about 20 successful public sector-initiatives that offered cross-border, cross-currency, multicurrency or payments vs payments system (PvP) services that differ from the correspondent banking model. Today that number has nearly doubled (see Fitzgerald, Illes & Lammer, 2024).[5] Current initiatives, in various state of development or prototype, include Nexus, TIPS, Promptpay-Promptnow (2025), and Passps (2025).

[5] In principle, bilateral links can be numerous (e.g., with 80 jurisdictions with a FPS, some 3160 combinations ((802 - 80)/2), but only few have enough volume to justify a dedicated link.

In spite of some new arrangements, XBP remain more costly, less accessible, slower, and less transparent than domestic payments, as shown in key statistics (Table 1). Costs often exceed domestic payments by multiple percentage points. Retail XBP can take up to several days and transparency can be extremely limited. There has only been limited progress over the last 20 years . For example, the global average cost to transfer $200 in remittances in 2024 was $12 (or 6%), only down from $18 (or 9%) some 20 years ago (see also World Bank, 2018). In contrast, domestic payments, large or small, are (nearly) costless to end users today in many economies. And the costs of using a credit or debit card across borders (adding the cost to the merchant and consumer) has barely declined and remains much above those domestically (BIS, 2020).

G20 cross-border payments progress - stylized overview of progress as of 2023 and 2025

Graph 3




A subset of the targets and KPIs has been selected. The red area represents the desired end state; the blue area reflects the status quo for 2025. Dotted lines present the status as of 2023. Based on existing KPI data for 2025, synthetic indicators have been calculated to visualise the status quo. Therefore, the KPIs shown in this graph are not always directly comparable with those in FSB (2025).

[1] The G20 targets do not include *wholesale payment costs*. No KPI for *wholesale payment transparency* has been published to date, hence no data for *wholesale payment transparency* are shown in Graph 2.C.

Source: Lammer et al. (2026), based on FSB (2025); World Bank remittance prices worldwide (2025); authors' calculations.

*Current initiatives*. Besides front end, new back-end systems are being pursued. The two that appear most meaningful at this point are bilateral links and hub-and spoke, which can be defined as follows (see further CPMI, 2022, also for other, less promising models).

**Bilateral linked systems** establish direct connections between two domestic systems, enabling the exchange of payment messages and settlement instructions. Participants in one system can directly access all participants in the other (foreign) system instead of through an entity (as in correspondent banking). Linked systems involve much integration but face challenges in scalability and governance as the number of connections grows and interoperability becomes more challenging. Examples of these systems include FAST (SG), UPI (IN), BUNA (Arab region), IPN (EG), RPP (MY), Raast (PK), and Promptpay (TH).

**Hub and spoke systems** introduce a centralized access point that connects multiple domestic systems, allowing participants to access XBP services through a common intermediary (the hub). This model simplifies operations and enhances efficiency by reducing the need for multiple connections. However, it requires robust governance and well-specified operational frameworks to ensure effectiveness and reliability. Examples include TCIB (SADC), TIPS Clone (Balkans), and GIMACPAY (CEMAC). A close variant is a common platform, as used by TIPS (EU), BUNA (Arab region) and PAPSS (Africa).

These two models aim to address and overcome one or more of the back-end limitations of the traditional correspondent banking model. The bilateral model focuses on creating technical and operational linkages between existing payment systems which reduces reliance on intermediaries and improves the speed and transparency of transactions. The more complex hub and spoke model offers centralized and standardized solutions that significantly streamline XBP. Besides these two, at smaller scale, some single access point systems still exist, but they are mostly phased out. And while new common platform are explored (e.g., Agorá of BISIH, 2024a), their practical use is some time off.

In addition to these models and their variations, **nontraditional technologies**, notably **distributed ledger technology (DLT)** and **decentralized finance (DeFi)**, in combination with **stablecoins**, are increasingly being explored by both the private and public sectors to improve XBP.[6] Tokenisation alters trust links and could allow for a more efficient market structure to exchange money, including a global marketplace to trade tokenised money directly across borders (Adrian et al., 2023). These technologies can in principle enhance XBP, but there are some serious caveats and preconditions. DLT, preferably of the permissioned type, can support real-time settlement and provide an immutable record of transactions, enhancing transparency and reducing reconciliation efforts. This could reduce the complexity, costs and delays typically associated with traditional systems. DeFi, which operates on DLT platforms, can provide diverse services, including (cross-border) payments and FX exchange, without relying on traditional intermediaries. For XBP, DeFi protocols can in principle facilitate instant FX exchange and settlement, and, using smart contracts that automate processes, reduce the need for manual intervention, increasing efficiency. DLT-based XBP solutions are being trialed by the private sector in various contexts, including by using stablecoins and tokenized assets.

*Use cases and preconditions.* The traditional correspondent banking model, the new arrangements and the nontraditional technologies outlined above each have distinct strengths and challenges, and their specific suitability likely depends on the use case targeted, the circumstances of the jurisdictions involved and the final objectives, which will vary most by the type of XBP. In very broad terms, the following apply.

**Wholesale XBP** are typically large in value, but more limited in volumes and most often between the same (or at least similar) set of financial institutions. The correspondent banking model has suited this XBP segment for decades relatively well (despite still higher cost and slower speed compared to domestic payments). It uses

[6] For more description, see BIS (2025) and Cecchetti & Schoenholtz (2025). We discuss in section 4 the requirements for these technologies, except for cryptocurrencies, to genuinely add to XBP.

arrangements and systems integral to domestic payments, such as Real-Time Gross Settlement (RTGS) systems, to secure reliably settlement, and leverages private sector solutions such as SWIFT and CLS Bank, themselves continuously upgrading. While challenges remain, most improvements are expected to be evolutionary, even as in scope involving innovative technologies and alternative arrangements. As such and provided the public sector plays its catalyzing and oversight roles, including competition policy, private sector efforts largely suffice to make the wholesale XBP system more efficient, while maintaining its integrity and stability.

For consumer and non-financial firm XBP, progress is more likely to come through new arrangements. **Retail XBP's** relatively high cost and slow speed are largely because of their much smaller value, yet greater volume, and more occasional nature, i.e., not repeated (e.g., when travelling abroad or buying an item from abroad). **Remittances** are also mostly small in value and large in volume but tend to be regular and between the same set of individuals, yet may at times involve informal methods (e.g., cash-in and cash-out, the processes of moving currency into and out of the formal payment system, where the first and last leg needs to go through, e.g., a money transfer operator (MTO)). For these and other reasons, as for domestic payments, provided they are reliable and trustworthy, technological advances and new models in the front and back ends may accelerate progress relatively more in consumer XBP.

The specific XBP model chosen will also depend on the **domestic payment market structures**, which vary greatly across jurisdictions. Domestically, the biggest development in recent years has been the emergence of publicly and privately operated fast retail payment systems (FPS). They generally enable instant or near instant beneficiary crediting for retail (or low-value) transactions. Currently about 100 FPS are in operation and another 30 are under development, with adoption in EMDEs similar to in AEs (World Bank, 2023b; Fitzgerald, Illes & Lammer, 2024).

Importantly, the choice of a specific XBP system and its efficient functioning reflects in part the **degree of trade, financial and other integration** between respective jurisdictions. For one, the degree of real integration drives the value and volume of XBP. This explains why corridors, e.g., routes or pathways, that process a high value or volume (or both) at relatively low costs are typically between countries or regions that are tightly integrated through trade, migration and temporary workers. Such corridors cover the complete flow of money, from initiation to settlement, are often in multiple currencies, and are vital for the countries' trade and financial interactions. But corridors can require some degree of cohesion (e.g., lack of sanctions) and are not always competitive.

Lastly, jurisdictions with fewer institutional differences can overcome any remaining ones easier, explaining the greater presence of more centralized payments systems regionally.

This section made clear that significant deficiencies in XBP exist and that new technologies have not yet made much impact. While some will likely improve XBP, new technologies alone will not solve the problems in their entirety, as the evolution of domestic payment systems discussed next suggests. Furthermore, regulatory and governance issues are more significant than domestically, and supervisory mandates in individual jurisdictions to enhance systems do not translate easily across borders.

# 3. Lessons from domestic payments systems for XBP

This section reviews the more developed research on domestic payment systems evolution and related policy applications to help prioritize the issues to be addressed and practical solutions to pursue. Research highlights the network nature of payments and the market failures arising from their two-sided market nature. Payments systems therefore typically require a mix of private and public actions to get closer to socially desired outcomes, as concrete examples of steps and models that have improved domestic systems illustrate. It ends with detailing how failures multiply for XBP, largely as more sets of rules and actors are involved—at least two-times more for any model. This then transitions to section 4 that discusses the potential for specific new arrangements.

## 3.1. Two-sided markets, their emergence and competitiveness

For most products and services, market structures, dynamics and impacts are typically analyzed from either the supply or demand side, with the standard corner cases of perfect competition and monopoly (or monopsony). For payments systems, however, like for other services provided through (digital) platforms, the forms of both demand (users) and supply (providers) matter. Such a network market is characterized by the interaction of two distinct groups of users, both of whom benefit from the platform's services, but whose participation depends on the platform's ability to address their respective needs and incentivize their engagement. Specifically, in payments potentially enormous number of users (buyers or payors, e.g., cardholders, smart phone/app users) must be matched with multiple providers (sellers or payees, e.g., merchants or other individuals) through a platform with common, or least interoperable, standards and technology, (near) ubiquitous availability, and enough scale to be financially sustainable.[7]

The seminal contribution to analyzing such *two-sided markets* is Rochet & Tirole (2003). They, and many others since, have analyzed how multiple market failures can arise because the end-users on both the demand and supply sides do not internalize the welfare impact of their use of the platform on other end-users (McAndrews, Nosal & Rocheteau, 2011) review the literature on payments system, including its links with monetary economics). One key failure is that no (efficient) arrangement emerges as it can be difficult to coordinate a critical mass of payees and payors on one, in part as it requires a large upfront investment with uncertain payoffs. Another outcome may be a single arrangement with poor service and excessive cost, yet prohibitive barriers to entry. Yet, another possibility is that multiple arrangements emerge, but each lack the scale to operate effectively (i.e., do not have enough of both payors and payees onboard), differ in technologies and standards, and are not able or only inefficiently to interact with each other (i.e., they are only limitedly interoperable).

[7] Importantly, interoperability can be at different points in the payments chain. It is obviously necessary at the stages of final payment and settlement (often involving the central bank) but can also be present earlier (e.g., by allowing cross-bank payments and settlement within a bank or through private systems) and can extend to the final end-user interfaces (e.g., having a common POS reader).

Empirical work has examined these network effects in various segments. For wholesale payments, network effects mostly relate to the need for intraday liquidity, though at the expense of lower settlement risk (Martin, 2005; Galbiati & Giansante, 2010). For retail, network effects have been found in credit cards (Bolt & Humphrey, 2007; Schmalensee & Evans, 2007), clearing (Gowrisankaran & Stavins, 1999) and mobile money (Van Hove, 1999).[8] Conversely, research has shown that overcoming barriers to interoperability and unifying separate networks can increase usage (Copestake et al., 2025 suggest by more than 50% in the case of India under its Unified Payments Interface (UPI) program). Notably, fast payment systems improve interoperability and thereby can increase financial inclusion and social welfare.

Monopolistic and oligopolist behavior can also arise, reflected in socially adverse pricing and lack of access on either (or both) sides of the market.[9] This shows up along the payments chain by merchants not experiencing much decline or even increases in their fixed (upfront investments) and variable costs (fees) of offering digital payments over the past decades in spite of large technological advances (Li, McAndrew & Wang, 2020; Van Hove, 2004). While consumers have experienced some reductions in explicit costs, considerable "hidden" costs can still fall on them. They can pay through higher retail prices and interest charges on credit cards, and cross-border additionally via larger FX conversion fees and beneficiary charges (Leibbrandt & de Teran, 2021).[10] Research also shows that the lowest-income cohort, which uses more cash, often pays more of the hidden costs, whereas higher incomes "earn" points by paying with credit cards (Felt et al., 2023). Only limited empirical work exists, however, on what drives platforms' competitiveness and fairness in pricing and access policies (see Kwoka et al., 2023).

Recent research has additionally focused on two related features: subsidization and cross-side network effects. PSPs are often willing to cross-subsidize payments to bring in other business (e.g., banks provide some payment services for free). Furthermore, large conglomerates, notably Big Techs, may cross-subsidize payments because this provides, besides more business, valuable data. This can lead to "walled gardens," where providers entice customers to stay within their ecosystem, which combines payments with other services (BIS, 2020). This risk of anti-competitive behavior has increased with the emergence of large, globally operating platforms which activities straddles many markets, including payments, and which big data and extensive networks, scale and scope create many advantages, including ability to cross-sell and cross-subsidize (Croxson et al., 2022). All this can come with cross-border dimensions, notably if such platforms create private digital currency areas

[8] Besides payments, many other markets display two-sided features. Such markets have increased in importance with digital platforms and as services have digitalized (e.g., share rides, (short-term) rentals, part- and full time jobs, financial, music, video and other digital services). Research has correspondingly expanded to become a field, "the economics of platforms" (see Croxson et al., 2022).

[9] Indeed, Rochet & Tirole in their 2004 review of the already then much larger literature, defined two-sided markets as "markets in which one or several platforms enable interactions between end-users and try to get the two (or multiple) sides "on board" by appropriately charging each side." This definition highlights the "competition for the market," i.e., how does a platform get established and possibly become dominant, and the issue of "appropriate" pricing (see Rysman & Wright, 2014, and Xue, Tian, & Zhao, 2020, for more recent reviews).

[10] The mechanisms to secure these rents vary by market but include merchant and interchange fees set high by the platforms.

(Brunnermeier, James & Landau, 2021). More generally, cross-selling and -subsidizing effects may soften merchant-side competition and raise (implicit) fees (Frost et al., 2025).

## 3.2 Innovation in domestic payments systems

Enhancing cross-border payments has to consider the evolution of domestic payments, for its lessons, and since the first and last miles of XBP are typically processed by a domestic system (Fitzgerald, Illes & Lammer, 2024). Digital payments systems have varied across countries in terms of time of deployment, number, type as well as degree of interoperability. Historically, differences in part dependent on financial development and the quality of alternative (paper) payment forms, as seen in the variations between AEs and EMDEs.[11] Economic, regulatory, and technological factors matter too, as seen in wholesale versus retail payments. Systems also importantly vary by ownership and operation. Either the public sector or the private sector can establish them, or in some cases both do, as separate systems or a joint venture. When run for profit, they can be owned mutually and by outside third-party shareholders, including large financial groups and conglomerates (including big techs). Incentives to innovate can vary accordingly.

Systems have varied over time. Early on, large value payments and settlements were often conducted through banks or mutual-owned clearinghouses (first formalized in the 18th century in London, see Boel, 2019). Over time, these became more tightly integrated and interoperable. A significant development in wholesale payments over the last decades has been the rapid growth of RTGS systems to achieve near universal coverage in the early 2000s. Thanks to ongoing efforts to harmonize standards—such as payment messaging (ISO 20022) and open banking (application programming interfaces, APIs)—they are now interoperable with other systems in the country (see Bech & Hobijn, 2007; Allsopp, Summers & Veale, 2009; CPMI 2024; CPMI 2025) and largely among countries. This happened importantly because today the central bank is the owner, operator and/or settlement agent for more than 90% of RTGS systems (Fitzgerald et al., 2024).[12] Yet, even with interoperability, local and global network effects remain, notably in intraday liquidity, as seen in the concentration of FX trading in London and New York.

Retail payment systems evolved in more varied ways, in part due to the greater difficulty of coordinating many users and merchants on one (or multiple interoperable) platforms with like standards and technology. Early on, for example, individual banks often had proprietary automated teller machines (ATMs) that were

[11] We do not review the history of money, paper and digital, which has its own externalities and public good features (e.g., see BIS, 2020; BIS, 2025), but want to note that Marco Polo reportedly said in the 13th century: "The Great Khan issues paper money, and it is accepted by all under pain of death. Yet, in distant lands, merchants must still carry gold and silver to trade" (from *Travels of Marco Polo*). This ability to pay only in specie but not in paper money in some countries remained until in the late 19th century (e.g., see Maechler & Moser, 2019, for an anecdote on Africa).

[12] Similarly, banks (e.g., large or small community banks) often joined together and developed cooperative interbank payments system(s). Where multiple systems arose, they were connected for business necessity through various means (e.g., membership of one or more banks in both systems) but often with limited end-user interoperability.

generally not compatible.[13] Similarly, the merchant POS debit (and credit) card-based systems that emerged in the 1970s were initially just for the banks' clients. These closed loop systems lacked interoperability for end-users, were expensive, and generally only used by larger retailers (Bech & Hancock, 2020; BIS, 2020; Bindseil & Pantelopoulos, 2022). These systems were clearly socially inferior as users were inconvenienced (i.e., by having fewer choices in accessing ATM or POS terminals), costs for merchants were high (e.g., with the front end not interoperable, multiple card readers were needed), and banks duplicated investments and costs (as systems were not integrated or shared).

More recently, users in AEs and EMDEs have benefited from new front-end technologies and platforms (e.g., Alipay, Apple Pay, Google Pay, PayPal, Samsung Wallet, Venmo, Zelle), often with P2P, P2B and B2B capacities and other services. These apps use existing digital infrastructures and, like other recent platform-based services, can reach critical mass more quickly than past ones (Petralia, et al., 2019), with adoption typically "S"-shaped (e.g., Bech, Shimizu & Wong, 2017). At the same time, these technologies still rely on the main banking back-end systems to transfer funds and as such largely offer greater end user convenience. Furthermore, once established, interoperability can be lacking (like ATMs in their early days). For example, even though end-users can easily access (or be users of) multiple platforms, they can often not transfer funds between them. Related, the risks of "walled gardens" can be large, especially in case of private ownership.

Some EMDEs have taken quite different paths over the past two decades. Their financial and payment systems were – compared to AEs – less developed, with a heavy reliance on cash, low inclusion and poor access, and inefficient retail and large-value payments arrangements. However, technological advances have allowed EMDEs to leapfrog in some dimensions over some AEs. M-Pesa, introduced in 2007 in Kenya, provides for payment messages to be delivered over phones using telecom networks and online (Jack & Suri, 2014). Since then, many other EMDEs have rapidly digitalized payments. Progress has been driven by cost-effective, user-friendly applications, aided by the growing availability and affordability of mobile phones, and benefitted from network effects. More recently, advanced payment models have been introduced, such as PIX in Brazil and UPI in India (Croxson et al., 2022 review these and the overall growth in platform-based finance).

## 3.3 The role of the public sector in overcoming market failures

Over time, due to a mix of market forces and regulatory steps, most domestic ATM and POS systems did become interoperable, typically first for end-users and later in other parts of the chain (CPSS, 1999, 2012). Market forces reflect natural incentives (e.g., the lower cost of a shared system for ATMs and POS). For example, in the Netherlands, the major banks have recently teamed up to operate shared ATMs, replacing individual bank branded machines. Still, market forces did not always lead to interoperability let alone to a pooling or jointly running (e.g., few countries run today joint venture, no-label ATMs). To achieve socially desired results required at times public sector actions, some based on anti-trust policies. This raises the roles of

[13] Barclays Bank introduced the first ATM machine in London in 1967.

the central bank and other public agencies, and their mandates, which can be an operator, overseer, and catalyst of payments systems (CPSS, 2003). Foremost, the public sector needs to ensure a stable, predictable and conducive environment. Public-private dialogue is next important to catalyze, particularly to foster interoperability, regulatory harmonization, and adoption of new technologies. Together, this makes the private sector compete, innovate, and adopt, deliver and scale novel and efficient solutions, all to lower costs and offer more choice and greater convenience to both consumers and merchants.

Legal and regulatory actions have often been needed to address limited interoperability and other market failures (Lammer, Lauer & Tomilova, 2016; CPMI, 2016c). To benefit from the latest generation of innovations and to fully integrate and digitalize the payment process, a mix of carrots and sticks was typically used. For example, the Reserve Bank of India (RBI) mandated interoperability for mobile wallets in 2018, requiring them to link to the UPI to enable seamless transactions across platforms. In the European Union, the Second Payment Services Directive (PSD2) required banks to open their payment systems to third-party providers through APIs, fostering interoperability. When to best foster interoperability can vary by market (it was for example pushed relatively late in Keyna but required earlier in Tanzania, see Claessens & Rojas-Suarez, 2020). The introduction of an FPS typically needs much public coordination given its multi-sided nature with numerous merchants and users, and many banks and other PSPs. In some cases, mandates required banks to join the FPS (i.e., PIX in Brazil, UPI in India). When a more hands-off approach was taken with only limited pricing or other incentives (e.g., Mexico), adoption has been more limited, exactly because of the many externalities and vested interests with existing systems.

To ensure fair competition while promoting innovation in network industries, regulators need to use anti-trust tools. Barriers to entry should be low, access to payments systems by merchants and other end users should remain on fair terms, standards should be open and promote interoperability, and fees and terms should be transparent. As the nature of competition evolves over time and differs by market segment, so too must the remedies. Potential anti-competitive behavior by dominant actors (i.e., big tech firms) requires especially responses today. To create and maintain fair and open payments markets, horizontal, cross-sectoral type of regulation is called for. It can mean requiring dominant platforms to register or be licensed with financial or competition authorities and be subject to ongoing regulatory scrutiny; to prohibit self-preferencing, exclusive contracts, and tying practices; to require platforms to interoperate with rivals and allow third-party services (e.g., wallets or apps) to connect without discrimination; and to ensure consumers have control over their financial data, including through data portability requirements. The Digital Markets Act (DMA) in the European Union is an example aiming to do this. Of course, ensuring this globally is extremely hard, as the insufficient competition and excessive cost in the market for credit cards shows.[14]

Examples show that specific public policy interventions can lead to meaningful efficiency enhancements and reduction in costs. For example, the US Check 21 Act – a federal law effective in 2004, designed by the Federal Reserve – made cheque

[14] Agarwal et al. (2022) document for the United States the excessive costs of credit cards and the redistribution towards sophisticated individuals through rewards and Drechsler et al. (2025) document the large (excess) returns on credit cards for issuers.

images legal tender (rather than abolishing check use), thus abolishing the physical transportation of cheques and enabling banks to process cheques in a manner similar to debit cards. It made processing faster, cheaper and more efficient. Another example is the Single Euro Payments Area (SEPA) for euro credit transfers and direct debits which was put in place using EU directives and regulations to make the cost of a transfer between bank accounts in two different SEPA countries equal to that of a regular, local transfer, leading the average transfer cost in the area to decline substantially. Another example is the use of caps on interchange fees. In the United States, fees on covered (regulated) debit card transactions fell dramatically after regulations took effect in 2011, while those on exempt cards remained stubbornly high, even after 10 years. More generally, where authorities have capped card fees, costs are lower than elsewhere for any given degree of competition (see further BIS, 2020).

## 3.4 Additional barriers for creating and maintaining efficient XBP-systems

To establish efficient arrangements, XBP face several more steps than payments domestically. These fall into three groups by degree of necessity: technological interoperability, domestic payment policies, and cross-border payments governance.

*Technical interoperability* refers to the ability of different systems, platforms, and technologies to communicate, exchange data, and process transactions, in this case across borders (Boar et al., 2023). Technical interoperability is more important, yet harder to achieve, for XBP as the typical transaction chain is longer and more complex than for a domestic payment. To achieve XBP-interoperability requires widespread adoption and consistent implementation of payment standards (CPMI, 2025). This will: (1) enhance operational efficiency and automation gains by reducing the reliance on intermediaries and manual processes, making for faster transaction processing and allowing for lower costs for end users; (2) support (near) real-time settlement, increasingly demanded, and improve the effectiveness and efficiency of compliance and risk management; and (3) expand access by allowing smaller institutions, fintechs, and non-bank PSP to participate without needing extensive relationships or proprietary systems, helping address gaps in underserved markets and for individuals and businesses with limited access to traditional banks, and improving overall competition.

*Domestic payment policies* include regulatory, operational, and technical frameworks to ensure the safety and integrity (and trust) of systems, as reflected in the Principles for Financial Market Infrastructures (PFMI).[15] Expansion of policies such as allowing access of non-bank PSPs to the payments system and open banking can encourage the growth of providers with new technologies and business models, and thereby foster innovation and competition, including for XBP. Policies can also ease how systems interact across borders (e.g., jurisdictions that fully implemented ISO 20022 data requirements saw enhanced interoperability in XBP (Payments Interoperability and Extension Taskforce, PIE, 2025)). Conversely, incomplete or

[15] The PFMI provides an overview of key risks faced by FMIs, which includes systemically important payment systems, and established principles for FMIs, addressing critical features such as settlement finality, and credit, liquidity, business and operational risk management.

inconsistent implementation fragments and limits interoperability (CPMI, 2023b; PIE, 2025). Alignment of and to the extent possible harmonized regulatory and risk management policies (e.g., those covering AML/CFT and data protection), reduce compliance burdens and facilitate smoother XBP. Since authorities responsible for AML/CFT regulations and compliance can vary from those responsible for payments systems or consumer protection, it can be necessary to coordinate domestically multiple agencies, often with conflicting objectives.

*Governance and oversight* concerns the rules, responsibilities, and decision-making structures.[16] For payments systems, including XBP arrangements, these need to ensure accountability and alignment with shared goals, to manage decision-making and dispute resolution, and to allocate costs and benefits, including among jurisdictions. As noted, systems' ownership and control structures vary widely (CPMI, 2024b), making incentives to innovate, pricing and access policies, and other aspects vary greatly too. These differences multiply for XBP. Oversight, typically by the central bank, helps to mitigate domestically that payment systems operate in secure, transparent, and reliable manners and risks (i.e., operational (e.g., cyber threats, disruptions), financial and legal). It also ensures that systems comply with regulatory requirements and international standards (including the PFMI). But again, because more agencies are involved, such challenges multiply across borders.

## 4. Lessons from experiences with XBP problems and solutions

How domestic payment systems have emerged and became generally efficient clarifies some of the challenges to implement new, superior XBP-arrangements. But, as noted, the parallel is imperfect as XBP-systems need to address some unique challenges. Using this framing, we next discuss, based on recent experiences and ongoing experimentation with modern technologies, how to further XBP—referring to possible specific solutions, offer general policy advice and sketch a path forward.

*Experiences and ongoing experimentation with new models*. Possible approaches are best organized by type of payment and illustrated by our stylized models. But a wide variation in possible models remains and applications will likely vary by type of XBP, corridor, level of integration, and other dimensions.

**Wholesale XBP is continuously changing.** Having been in operation for decades, many domestic wholesale systems (RTGS) need to modernize. This provides opportunities to better align systems with international standards and practices and thereby foster XBP. The *bilateral model*, which has only two agents to coordinate, already has many RTGS links. One example is the long-standing Directo a México, set up in 2005 between the US Federal Reserve's automated clearing house (FedACH) and the Mexican RTGS (SPEI) (CPMI, 2022c). RTGSs can further enhance

[16] Governance embeds the rules and processes for a payment system so that can meet relevant oversight expectations from authorities. Oversight is defined by CPSS (2005) as "a central bank function whereby the objectives of safety and efficiency are promoted by monitoring existing and planned payment, clearing, settlement and related arrangements, assessing them against these objectives, and where necessary, inducing change" (see also CPMI, 2024).

interoperability by extending and aligning operating hours with other jurisdictions and supporting FPS settlement. RTGSs can also improve compliance with AML/CFT and sanctions screening requirements, including by exploring new technologies, such as DLT, as some countries are doing (e.g., the UK).

As with other legacy systems, however, updating and enhancing can be harder than starting fresh. Indeed, BIS IH experiments suggest that leveraging recent technologies—such as DLT and tokenized assets—provides some scope to leapfrog, notably in wholesale XBP. For example, Project Helvetia explored settlement in central bank money with tokenized financial assets based on DLT. Project Meridian explored how DLT can streamline the settlement of wholesale payments and securities across borders (BISH, 2023), including by incorporating foreign exchange (FX) conversions and transactions (BISIH, 2025). Project Agorá (BISIH, 2024a) aims to test the desirability, feasibility and viability of a multi-currency unified ledger for wholesale XBP based in part on using tokenized commercial banks deposits and tokenized central bank reserves. For now, these are largely proofs of concept or moving from the design phase to the prototype building phase and not yet fully operational models.

**For retail XBP**, the single access model was often pursued first. It just involves linking one (or more) provider to the other system, which helps explain its early spread, notably for corridors. Examples are Hong Kong's RMB CHATS links with Mainland China's payment systems, and euroSIC, introduced in 1999 which processes euro payments to, from and within Switzerland (which is now being discontinued). Despite its simplicity and low setup costs, the model has limitations (Boar et al., 2021), similar to the related correspondent banking model. Access is largely indirect, e.g., using a front-end application to instruct a bank to make a XBP, which then starts the long chain, making often for delays and errors, and related need for rechecking. As such, while relatively common, it is difficult to scale up, not cost-effective, notably for small transactions, has limited access, and is slow.

More recently, the *single access model* is being replaced by the bilateral linked model. It only has two agents to coordinate. Technology requirements are less of a constraint, as incompatibilities can be easily addressed. For example, the interlinking arrangement between the FPS of India, UPI, and Singapore, PayNow, makes extensive use of APIs, enabling participants and customers of both to make instant, low-cost fund transfers without a need to participate in the other FPS (CPMI, 2022c).[17] While increasing, volumes and values processed today by interlinking arrangements are often still low.

Going forward, the *interlinking of FPS* is seen as one of the most promising solutions to enhance XBP (Panetta, 2024). Many such initiatives are underway. Starting early, Thailand has expanded its linkages—many of which based on QR codes—to a total of eight countries (Bank of Thailand, 2025). Many have a regional focus, such as the interlinking of Singapore's PayNow and Thailand's PromptPay systems, with planned expansion to other ASEAN countries. Many others are exploring interlinking new or existing FPS. Most FPS already use global standards and can leverage APIs, easing interoperability (CPMI, 2025). But there is the need to ensure interoperability

[17] With India, the world's largest receiver of inward remittance flows (World Bank, 2025a), enhancing remittance flows is one of its drivers for pursuing interlinking arrangements.

with other payment systems. And many still have to revert to traditional banks for currency conversions. And they need to carefully manage risks related to their real-time nature, 24/7 (or near to) availability, and increased XBP-use. Safe operations and avoiding financial stability threats call for robust security measures, and appropriate liquidity and credit risk management frameworks (see CPMI, 2024b).

The *hub and spoke* model has more agents to coordinate and technological choices become crucial. But it is scalable and efficient, since with one connection all other systems can be reached. One example is the relatively widely used Regional Payment and Settlement System (REPSS) of the Common Market for Eastern and Southern Africa. Although differences in governance structures can make reaching agreements protracted, establishing and joining *hub and spoke* systems otherwise typically centers on harmonizing standards, notably of messages and (payment) account identifiers (to ensure an efficient and secure routing of payments). Project Nexus (BISIH, 2024b), now in its live implementation stages, aims to interlink five ASEAN countries' FPS.[18]

Being the most demanding, few fully-working *common platform* systems with large-scale use exist. In Africa, the Southern African Development Community (SADC)-RTGS is one such, but it only settles in ZA rands. TIPS (TARGET Instant Payment Settlement), launched in 2018, which settles payments within the euro area in real time using a centralized system managed by the European Central Bank (ECB), is now also processing the Swedish and Danish kroners and is considering other currencies. And the Bank of Italy[19] will supply an FPS (based on a clone of TIPS) for payments in the currencies of participating Western Balkan countries,[20] with a link to TIPS (Bank of Italy, 2025).

**Remittances**, by nature, can be hard to improve since some of them originate from (or go to) users that conduct their businesses informally and are very vulnerable, often without a valid form of identification and no or limited access to formal financial services. Similar to retail payments, a front-end challenge for any remittance arrangement is the many users on both sides. And with some users dealing largely in cash with no access to formal financial services, the first and last legs can be expensive. Nevertheless, experience suggests that significant improvements are possible (CPMI-WBG, 2020a; CPMI-WBG, 2020b).

## 5. Research lessons, developments and general conclusions

*Research lessons*. Analysis on how (specific) XBP technologies emerge, and the related effects of market structure on competition and efficiency, is scarce. But what exists confirms the greater challenges compared to domestically. A key constraint is achieving political agreement. Ferrari Minesso et al. (2025) analyze the interlinking of FPS between 2016 and 2023 across 117 countries. They find politics to dominate economic and technical factors, with the probability of links being established

[18] India, Malaysia, the Philippines, Singapore and Thailand.

[19] The Bank of Italy is responsible for the operation of TIPS for the euro system.

[20] The countries are Albania, Bosnia-Herzegovina, Kosovo, North Macedonia and Montenegro.

between geopolitically aligned countries twice as high compared to that between geographically close ones, suggesting that being geopolitically aligned is key in establishing such arrangements.

Their finding relates to the other main cross-border constraint, different from domestic payments: the lack of a natural party or common authority to overcome the coordination issues (in standards, technologies, legal and enforcement) and encourage efficient XBP systems. While private interlinked systems do emerge organically, notably in corridors with sufficient scale to justify the initial investment, they can become closed systems or an oligopoly (where one or a few PSPs dominate). Only central banks and other public authorities of both countries acting jointly can promote competition by encouraging links open to multiple PSPs (e.g., by linking FPS) and by ensuring systems work efficiently, remain competitive and serve societies (Fitzgerald, Illes, & Lammer, 2024).

Public sectors' influence is often necessary, with their exact form and degree to vary. The harmonization of standards typically requires public involvement. SEPA achieved the migration from basic bank account numbers (BBANs) to International Bank Account Numbers (IBAN) for euro payments of the adhering countries through a formal public sector requirement to simplify bank transfers. Similarly, as CPMI (2025) shows, efficient interlinking mostly comes about with some public sector involvement. In terms of (ongoing) developments, the interlinking initiatives of the BISIH project Nexus required significant public-sector involvement (BISIH, 2024b), as did the EU's TIPS itself, a common platform. And the rapid spread of FPS is likely to mean more publicly linked systems.

DLT, De-Fi and Stablecoins. DeFi allows for borderless accessibility via permissionless, open-access peer to peer blockchains (DLT), but mainstream adoption for XBP faces significant challenges in AML/CFT compliance, supervision, privacy and scalability (Garratt & Lee, 2025). Recently, there is more interest in using stablecoins for XBP. Using the platforms and protocols of DeFi or other DLT-based modalities, which do not require participation in national banking systems, some argue stablecoins can unlock access to safe and low-cost XBP and enable automatic payments and real-time treasury and liquidity management for global enterprises. Some financial institutions and companies worldwide are already exploring related possibilities (e.g., PayPal has introduced a stablecoin for remittances). But many questions remain whether DLT, DeFi and stablecoins can provide safe and efficient payments services (CPMI, 2017, Zetzsche, Buckley & Arner, 2017, G7 2019, CPMI, 2022, FSB 2022, BIS, 2025, Adrian et al. 2025). Many observers today think that given the risks, other ways to improve XBP are preferred (e.g., Cecchetti & Schoenholtz, 2025). Overall, DeFi's and stablecoins' potential roles in safe and legitimate XBP will likely remain doubtful unless three issues are addressed.

First, to make stablecoins usable as XBP instruments requires a globally consistent legal framework (CPMI, 2022). Major countries have recently adopted regulatory frameworks, e.g., the EU, Singapore, and the U.S.[21] These steps, along with detailed guidance from their supervisory agencies, can substantially reduce

[21] For example, the EU with its Markets in Crypto-Assets (MiCA) Regulation, the U.S. with its GENIUS Act, Singapore with its Stablecoin Regulatory Framework, Japan with its Payment Services Act (amendment), and Canada, Switzerland and the UK with their (upcoming) regulatory regimes.

regulatory uncertainty. But globally the landscape still varies, including some countries banning private stablecoins (FSB, 2025b).[22] Also, importantly, even under some of the new regulations, stablecoins can fall short of being "money" when set against the tests of singleness and elasticity (Kosse, et al., 2023, BIS, 2025). Furthermore, while having grown much, but not being especially well and consistently regulated, stablecoins can raise systemic financial stability issues (e.g., ESRB, 2025, Ahmed et al. 2025). And there are monetary sovereignty issues, particularly for small open and emerging economies (G7, 2019, FSB, 2024).

Second, the regulatory framework must ensure financial integrity and protect users. Although DLT enables direct peer-to-peer transfers, it often relies on permissionless channels outside the traditional regulatory perimeter. Combined with its pseudonymous and borderless nature, this makes DeFi attractive to use for illicit purposes.[23] The Financial Action Task Force (FATF), the international body in charge of AML/CFT is addressing this (FATF, 2025), but as regulatory and legal frameworks are evolving, achieving compliance remains complex.[24] Today, AML/CFT enforcement is practically only feasible when converting stablecoins to and from local currencies (so called on- and off-ramps).[25] Regulating stablecoins will help reduce illicit use. Ensuring regulated stablecoin issuers are integrated with clearing infrastructure can further help enforce compliance throughout the transaction lifecycle, not merely at conversion points. Frameworks need also to ensure consumer protection and data privacy (e.g., DLT-based systems come with new legal risks arising from the joint performance of services and functions in DLT (Zetzsche et al 2021)).

Third is the lack of interoperability and limited scalability. DLT-based solutions require specialized on- and off-ramps or other such means to connect with the traditional financial system, hindering seamless integration. And they obviously cannot handle cash. Unproven is also their ability to scale up (BIS, 2022).

*More data and research are needed*. Finally, it is clear that data are limited and research on cross-border payments and their technologies is nascent. More granular and better quality data on costs, speed, access, and efficiency are needed to accurately assess the state and progress of XBP and to help to identify the key frictions. This will make decisions better-informed, including how public resources are best used and which actions to prioritize. More and better quality data would also allow for more empirical research. Detailed analysis would be especially helpful on: (1) which XBP-arrangements are most effective, efficient, accessible and transparent; (2) what XBP-arrangements best align with different countries' needs; and (3) what public and private sector efforts and actions, including various formal levers (sticks

[22] FSB (2025b) reports "significant gaps and inconsistencies" in implementation of crypto and stablecoin recommendations that "could pose risks to financial stability", noting that implementation for stablecoin frameworks is slower and uneven which "creates opportunities for regulatory arbitrage."

[23] Today, DeFi is reportedly much used for illicit XBP transactions (e.g., Cerutti, Chen & Hengge (2024) estimate about $8 trillion annually, much of it involving countries with outright bans on cryptocurrencies or subject to sanctions).

[24] The 2021 FATF Guidance for a Risk-Based Approach to Virtual Assets and Virtual Asset Service Providers, which cover this, are not fully implemented.

[25] Some (e.g., Aldasoro et al. 2025) propose to use DLT to score transactions for AML/CFT risk, using such scores for compliance in contacts with the banking system, but robustness remains unclear.

and carrots), best encourage the adoption of new efficient and successful XBP-systems and enhance existing arrangements at scale.

*International work, recent and future*. The G20 initiated a XBP-program in 2020 (FSB, 2020). Substantial work has since identified the shortcomings and main barriers (CPMI, 2020a; FSB, 2023). Specific proposals have been developed to materially improve existing arrangements and develop and operationalize new ones, working with all relevant stakeholders. Tasks now identified are for both the private and public sector (FSB, 2025a).

Going forward, the private sector—front-end providers (including bank and non-bank PSPs, tech providers) and back-end providers (mainly payments system operators and financial infrastructures)—will continue to drive innovation. But in doing so, they should better align their technologies with international standards and policies across payment systems to enable interoperability. To make greater progress, new joint private-public sector partnerships have been established, including the FSB Taskforce on Legal, Regulatory and Supervisory matters (LRS Taskforce) and the BIS-CPMI PIE Taskforce, as well as other collaborations including industry associations.

The public sector has a complementary set of priority actions. The BIS-CPMI will support the adoption of message standards, the harmonization of ISO 20022 data requirements and the governance of these requirements at least until end-2027 to ensure they remain relevant. It will also support the adoption of harmonized APIs, including recommendations on "confirmation of payee" solutions, a key step to reduce fraud and errors and increase trust in digital payments. FATF, which has already updated its standards on payment transparency ("the travel rule") to address how AML/CFT regimes and compliance standards should address innovations in digital payments, will produce associated guidance and engage with the private sector to help the industry prepare for changes. The FSB will support the legal, regulatory and supervisory aspects of the G20 program through its work on data models, Key Performance Indicators, and harmonized supervision of bank and nonbank PSPs. All this work will require continued political support at the highest levels and intensive engagement with the private sector.

## References


Adrian, T., R. Garratt, D. He, T. Mancini-Griffoli (2023), "Trust bridges and money flows", *BIS Working Papers Series*, no. 1112, July.

Adrian, T., P. Bains, M. Bechara, E. Cerutti, S. Forte, F. Grinberg, A. Gullo, M. Hengge, A. Jekabsone, K. Kao, T. Mancini Griffoli, S. Martinez Peria, M. Miccoli, M Reuter, and N. Sugimoto (2025), "Understanding Stablecoins, Monetary and Capital Markets Department", *Departmental Paper, IMF*, December.

Agarwal, S., A. Presbitero, A.F. Silva, C. Wix (2022), "Who pays for your rewards? Redistribution in the credit card market." *Finance and Economics Discussion Series*, 2023-007, Board of Governors of the Federal Reserve System, Washington, December.

Ahmed, R, J. Clouse, A. Rebucci, F. Natalucci and G. Sun (2025), "Stablecoins: A Revolutionary Payment Technology With Financial Risks", *CEPR,* DP20833.

Aldasoro, I., J. Frost, S.H. Lim, F. Perez-Cruz, H.S. Shin (2025), "An approach to anti-money laundering compliance for cryptoassets." *BIS Bulletin,* no. 111, August.

Allsopp, P., B. Summers, J. Veale (2009), "The evolution of real-time gross settlement: access, liquidity and credit, and pricing". *The World Bank Financial Infrastructure Series – Payment Systems Policy and Research*, February.

Boar, C., S. Claessens, A. Kosse, R. Leckow, T. Rice (2021), "Interoperability between payment systems across borders". *BIS Bulletin,* no 49, December.

Bank for International Settlements (BIS) (2020), "Central banks and payments in the digital era", *Annual Economic Report*, June.

——— (2022), "The future monetary system", Chapter 3, *BIS Annual Economic Report,* June.

——— (2025), "The next-generation monetary and financial system". *BIS Annual Economic Report*, June.

——— (2026), [On FX settlement risk] forthcoming.

Bank for International Settlements Innovation Hub (BISIH) (2024a), Project Agorá: central banks and banking sector embark on major project to explore tokenisation of cross-border payments, April (Updated October 2025). Available at: Project Agora: exploring tokenisation of cross-border payments.

——— (2024b), Project Nexus: enabling instant cross-border payments. Updated July.

——— (2025), Project Rialto: improving instant cross-border payments using central bank money settlement. Interim report, February. Available at: Project Rialto: improving instant cross-border payments using central bank money settlement (interim report).

Bank for International Settlements Innovation Hub (BISIH) and Bank of England (2023), Project Meridian: Simplifying transactions through innovation. Available at: Project Meridian: Simplifying transactions through innovation.

Bank of Italy (2025), "Agreement for the creation of an instant payment system in the Western Balkans". *Press release*, January. Available at: Agreement for the creation of an instant payment systems in the Western Balkans.

Bank of Thailand (2025), "Cross-border payment linkages". *Webpage,* July. Available at: Cross-Border Payment.

Basel Committee on Banking Supervision (BCBS), Committee on Payments and Market Infrastructures (CPMI) (2020), "Supervisory guidance on managing FX settlement risk and the Global FX Code". *Letter,* December 17. Bank for International Settlements, Basel. Available at: https://www.bis.org/press/201217_letter.pdf.

Bauer, P., G. Gerdes (2009), "The check is dead! Long live the check! A Check 21 update". *Federal Reserve Bank of Cleveland, Economic Commentary*, September.

Bech, M.L., B. Hobijn (2007), "Technology diffusion within central banking: the case of real-time gross settlement". *International Journal of Central Banking*, 3(3), September, pp. 147–181.

Bech, M.L., R.J. Garratt (2012),"Illiquidity in the interbank payment system following wide-scale disruptions". *Journal of Money, Credit and Banking*, 44(5), 903–929, August.

Bech, M.L., U. Faruqui, T. Shirakami (2020), "Payments without borders". *BIS Quarterly Review*, March, pp. 53–65.

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

Bindseil, U., G. Pantelopoulos (2022), "Towards the holy grail of cross-border payments". *ECB Working Paper,* no. 2693, European Central Bank (ECB), Frankfurt am Main.

Boar, C., S. Claessens, A. Kosse, R. Leckow, T. Rice (2021), "Interoperability between payment systems across borders". *BIS Bulletin,* no. 49, December.

Boel, P. (2019), "Payment systems: history and challenges". *Sveriges Riksbank Economic Review*, 2019:1, pp. 51–66.

Bolt, W., D.B. Humphrey (2007), "Payment network scale economies, SEPA, and cash replacement". *Review of Network Economics*, 6(4), pp. 453–473.

Brunnermeier, M., H. James, J.-P. Landau (2021), "The digitalization of money". *BIS Working Papers series,* no. 941, May.

Bruno, P., Denecker, O., Leibbrandt, G. (2025), "A retrospective: Looking back at 'A Vision for the Future of Cross-border Payments'". *Journal of Payments Strategy & Systems*, 19(2), Summer, pp. 103–113. DOI: https://doi.org/10.69554/GXBF2279.

Cerutti, E.M., J. Chen, M. Hengge (2024), "A primer on Bitcoin cross-border flows: measurement and drivers". *IMF Working Papers*, no. 24/85, April.

Cerutti, E.M., M. Firat, M. Hengge (2025), "Global cross-border payments: a $1 quadrillion evolving market?", *IMF Working Papers*, Strategy, Policy, and Review Department, June.

Cecchetti, S.G., K.L. Schoenholtz (2025), "Crypto, tokenisation, and the future of payments". *CEPR Policy Insight*, no. 146.

Cipollone, P. (2025a), "Enhancing cross-border payments in Europe and beyond". Speech at the Regional Governors' Meeting, Osijek, April 1. Available at: Enhancing cross-border payments in Europe and beyond.

——— (2025b), "The quest for cheaper and faster cross-border payments: regional and global solutions". Speech at the BIS Annual General Meeting, Basel, June 27. Available at: The quest for cheaper and faster cross-border payments: regional and global solutions.

Claessens, S., and L. Rojas-Suarez (2020), "A decision tree for digital financial inclusion policymaking". *Center for Global Development*, Washington, DC.

Committee on Payments and Market Infrastructures (CPMI) (2016a),"Payment aspects of financial inclusion". *CPMI Papers,* no. 144, Bank for International Settlements, April.

——— (2016b),"Correspondent banking – final report". *CPMI Papers*, no. 147, Bank for International Settlements, July.

——— (2017), "Distributed ledger technology in payment, clearing and settlement – an analytical framework". *CPMI Papers,* no. 157, Bank for International Settlements.

——— (2018),"Cross-border retail payments", *CPMI Papers*, no. 173, Bank for International Settlements, February 16.

——— (2020a), "Enhancing cross-border payments: building blocks of a global roadmap". Stage 2 report to the G20, July.

——— (2020b), "Enhancing cross-border payments: building blocks of a global roadmap". Stage 2 report to the G20 – technical background report, July.

——— (2022a), "Can multilateral platforms improve cross-border payments?" July.

——— (2022b), "Extending and aligning payment system operating hours for cross-border payments". Final report, May.

——— (2022c), "Interlinking payment systems and the role of application programming interfaces: a framework for cross-border payments". Report to the G20, July.

——— (2023a),"Facilitating increased adoption of payment versus payment (PvP)". Final report, March.

——— (2023b), "Harmonized ISO 20022 data requirements for enhancing cross-border payments". Report to the G20, October.

——— (2024a), "Service level agreements for cross-border payment arrangements: recommendations and key features". April.

——— (2024b), "Linking fast payment systems across borders: governance and oversight". Final report to the G20, October.

——— (2024c), "Tokenization in the context of money and other assets: concepts and implications for central banks". Report to the G20, October.

——— (2025) CPMI Briefs 10, "Moving on up: results of the 2024 cross-border payments monitoring survey", by Emilie Fitzgerald, Anamaria Illes, Thomas Lammer, Fanni Leppanen and Federico Semorile, December.

Committee on Payments and Market Infrastructures (CPMI), BIS Innovation Hub (BISIH), International Monetary Fund (IMF), World Bank (2021),"Central bank digital currencies for cross-border payments". Joint report to the G20, July.

——— (2023), "Exploring multilateral platforms for cross-border payments". January.

Committee on Payments and Market Infrastructures (CPMI), Board of the International Organization of Securities Commissions (IOSCO) (2021), "Application of the Principles for Financial Market Infrastructures to stablecoin arrangements". *CPMI Papers*, no. 198, October.

Committee on Payments and Market Infrastructures (CPMI), World Bank Group (2020a), "Payment aspects of financial inclusion: application tools". *CPMI Papers*, no. 195, September.

——— (2020b), "Payment aspects of financial inclusion in the fintech era", *CPMI Papers,* no. 191, April.

Committee on Payment and Settlement Systems (CPSS) of the central banks of the Group of Ten countries (1988), "Reducing foreign exchange settlement risk: a progress report". *Bank for International Settlements (BIS) papers*, July.

Committee on Payment and Settlement Systems (CPSS) (1999), "Retail payments in selected countries: a comparative study". Bank for International Settlements, September.

——— (2003a), "Payment and settlement systems in selected countries". Prepared by the Committee on Payment and Settlement Systems of the Group of Ten Countries, April.

——— (2003b), "The role of central bank money in payment systems". August.

——— 2005),"Central bank oversight of payment and settlement systems". Bank for International Settlements, May.

——— (2012), "Innovations in retail payments". Report of the Working Group on Innovations in Retail Payments, May.

Continuous Linked Settlement (CLS) Group (2018), "CLS's DLT payment netting service goes live with Goldman Sachs and Morgan Stanley", November. Available at: CLS's DLT payment netting service goes live with Goldman Sachs and Morgan Stanley | CLS Group.

Copestake, A., D. Kirti, M.S. Martinez Peria, Y. Zeng (2025), "Integrating fragmented networks: the value of interoperability in money and payments". *IMF Working Papers*, Research Department, June.

Croxson, K., J. Frost, L. Gambacorta, T. Valletti (2022), "Platform-based business models and financial inclusion: policy trade-offs and approaches". *Journal of Competition Law & Economics*, 19(1), March, pp. 75–102.

Di Iorio, A., E. Fitzgerald, T. Lammer, A. Perrella, T. Rice, F. Semorile, S. Siviero (2025), "Acta non verba: interlinking fast payment systems to enhance cross-border payments". *CPMI Brief,* no. 7, February.

Di Iorio, A., A. Kosse, I. Mustafi (2025), "And so we pay: more digital and faster, with cash still in play". *CPMI Brief*, no. 8, March.

Drechsler, I., H. Jung, W. Peng, D. Supera, G. Zhou (2025), "Credit card banking". *Federal Reserve Bank of New York Staff Reports*, no. 1143, March.

European Parliament and European Council (2012), Regulation (EU) No 260/2012 of 14 March 2012 establishing technical and business requirements for credit transfers

and direct debits in euro and amending Regulation (EC) No 924/2009 (Text with EEA relevance). Available at: Regulation - 260/2012 - EN - EUR-Lex.

European Systemic Risk Board (ESRB) Crypto-asset Task Force, 2025. Crypto-assets and decentralised finance, Report on stablecoins, crypto-investment products and multifunction groups, October.

Evans, D.S., R. Schmalensee (2005a),"The economics of interchange fees and their regulation: an overview". *MIT Sloan Working Paper,* 4548-05, Massachusetts Institute of Technology, May.

——— (2005b) "The industrial organization of markets with two-sided platforms". *NBER Working Paper*, no. 11603, September (revised September 16, 2022).

——— (2013),"The antitrust analysis of multi-sided platform businesses". *NBER Working Paper*, no. 18783, National Bureau of Economic Research, February.

Felt, M.-H., F. Hayashi, J. Stavins, A. Welte (2023),"Regressive effects of payment card pricing and merchant cost pass-through in the United States and Canada". *Journal of Banking & Finance*, 154, September, Article 106968.

Ferrari Minesso, M., A. Mehl, O. Triay Bagur, I. Vansteenkiste (2025), "Geopolitics and global interlinking of fast payment systems". *CEPR Discussion Paper,* DP20105, April .

Financial Action Task Force (FATF) (2025), "Targeted update on implementation of the FATF standards on virtual assets and virtual asset service providers (VASPs)". *FATF*, Paris, June.

Financial Stability Board (FSB) (2020), FSB reports on its work to develop a roadmap to enhance global cross-border payments. April.

——— (2021), G20 roadmap for enhancing cross-border payments: first consolidated progress report. October.

——— (2022), Review of the FSB high-level recommendations on the regulation, supervision, and oversight of "global stablecoin" arrangements: consultative report. October.

——— (2023), G20 roadmap for enhancing cross-border payments: priority actions for achieving the G20 targets. February.

——— (2024a), Cross-border payments: enhancing global financial innovation and structural change.

——— (2024b), Cross-border regulatory and supervisory issues of global stablecoin arrangements in EMDEs. July.

——— (2024c), G20 roadmap for enhancing cross-border payments: consolidated progress report for 2024. October.

——— (2024d), Annual progress report on meeting the targets for cross-border payments: 2024 report on key performance indicators.

——— (2025a), G20 roadmap for cross-border payments: consolidated progress report for 2025. October 9.

——— (2025b), Thematic review on FSB global regulatory framework for crypto-asset activities: peer review report. October 16.

Financial Times (2025), "The race for the future of cross-border payments: projects that aim to innovate correspondent banking should be seen as a geopolitical, not just technical, imperative". Chris Giles, *Central Banks Newsletter*, July. Available at: The race for the future of cross-border payments.

Fitzgerald, E., A. Illes, T. Lammer (2024), "Steady as we go: results of the 2023 CPMI cross-border payments monitoring survey". *CPMI Brief*, no. 5, June.

Frost, J., J.-C. Rochet, H.S. Shin, M. Verdier (2025), "Competing digital monies". *BIS Working Papers* series, no. 1301, Monetary and Economic Department, November.

G7 Working Group on Stablecoins (2019), "Investigating the impact of global stablecoins". *CPMI Papers,* no. 187. Bank for International Settlements, Basel, October. Available at: https://www.bis.org/cpmi/publ/d187.htm.

Galbiati, M., S. Giansante (2010), "Emergence of networks in large-value payment systems (LVPSs)". *DEPFID Working Papers,*1/2010, Department of Economic Policy, Finance and Development, University of Siena.

Garratt, R., M.J. Lee (2025), "The future of payment infrastructure could be permissionless". *Liberty Street Economics,* Federal Reserve Bank of New York, November 25. DOI: https://doi.org/10.59576/lse.20251125.

Garratt, R., P. Koo Wilkens, H.S. Shin (2024), "Next generation correspondent banking". *BIS Bulletin,* no. 87, May.

Gerdes, G., C. Green, X. Liu (2021), "Developments in noncash payments for 2019 and 2020: findings from the Federal Reserve Payments Study". Federal Reserve Board.

Global Correspondent Banking 1870-2000 project. Working Paper Series, Available at: https://glocobank.web.ox.ac.uk/working-papers.

Gowrisankaran, G., J. Stavins (1999), "Network externalities and technology adoption: lessons from electronic payments". Department of Economics, University of Minnesota, and Federal Reserve Bank of Boston, September.

Green, E. (2004), "Challenges for research in payments. The Economics of Payment"s, Federal Reserve Bank of Atlanta, March.

Illes, A., A. Kosse, P. Wierts (2025), "Advancing in tandem: results of the 2024 BIS survey on central bank digital currencies and crypto". *BIS Papers*, no. 159, August 22.

Jack, W., T. Suri (2014), "Risk sharing and transactions costs: evidence from Kenya's mobile money revolution". *American Economic Review*, 104(1), January, pp. 183–223. DOI: https://doi.org/10.1257/aer.104.1.183.

Kahn, C., W. Roberds (2009), "Why pay? An introduction to payments economics". *Journal of Financial Intermediation*, 18(1), January, pp. 1–23.

Kauffman, R.J., J. McAndrews, Y.-M. Wang (2000), "Opening the "black box" of network externalities in network adoption". *Information Systems Research*, 11(1), March.

Kindleberger, C. (1974), "The formation of financial centers: a study of comparative economic history". *Princeton Studies in International Finance,* no. 36, Princeton University.

Kohn, M. (1999), "Early deposit banking". Dartmouth College Department of Economics Working Paper, no. 99-03, February.

Kosse, A., M. Glowka, I. Mattei, T. Rice (2023), "Will the real stablecoin please stand up?", *BIS Papers*, no. 141, Monetary and Economic Department, November.

Kwoka, J.E., T. Valletti, L.J. White (2023), "Antitrust economics at a time of upheaval: recent competition policy cases on two continents." *Competition Policy International*, June.

Lammer, T., T. Rice (2022), "The G20 cross-border payments program: a global effort". *Journal of Payments Strategy & Systems*, 16(3), October, pp. 207–218.

Lammer, T., K. Lauer, O. Tomilova (2016),"Championing interoperability for financial inclusion: carrot or stick?", World Bank Blog. Available at: Championing interoperability for financial inclusion: carrot or stick?

Lammer, T., D Rees, T. Rice, T. Shirakami (2026), "Enhancing cross-border payments: state of play and way forward". *BIS Bulletin* No. 119, December.

Leibbrandt, J.G. (2004), "Payment systems and network effects: adoption, harmonization, and succession of network technologies in a multi-country world". Ph.D. thesis, Maastricht University, June.

Leibbrandt, J.G., N. de Terán (2021), "The Pay Off. Elliott & Thompson", London.

Li, B.G., J. McAndrews, Z. Wang (2020), "Two-sided market, R&D, and payments system evolution". *Journal of Monetary Economics*, 115, November, pp. 180–199.

Maechler, A.M., T. Moser (2019), "The evolution of payment systems in the digital age: a central bank perspective". Speech at the Money Market Event, Swiss National Bank, Zurich, March 28. Available at: The evolution of payment systems in the digital age: A central bank perspective.

Martin, A. (2005), "Recent evolution of large-value payment systems: balancing liquidity and risk". *Federal Reserve Bank of Kansas City Economic Review*, 90(Q1), pp. 33–57.

McAndrews, J., S. Rajan (2000), "The timing and funding of Fedwire funds transfers". *Economic Policy Review*, 6(2), July.

McAndrews, J., E. Nosal, G. Rocheteau (2011), "Payment systems". *Annual Review of Financial Economics,* 3, December, pp. 259–287.

Panetta, F. (2024), "The future of cross-border payments: faster, safer, together – safe and inclusive fast payments across borders". Speech at the 2024 Spring Meetings, World Bank, International Monetary Fund (IMF). Available at: The Future of Cross-Border Payments: Faster Safer Together – Safe and Inclusive Fast Payments Across Borders.

Payments Interoperability and Extension Taskforce (PIE) (2025), "Fostering ISO 20022 harmonisation: Cross-border payments interoperability and extension". January. Consolidated report. Available at: Fostering ISO 20022 harmonisation.

Pan-African Payment and Settlement System Connecting Payments (PAPSS) 2025. Accelerating Africa's Trade. Website https://papss.com/.

PayNow-PromptPay (2025), "Playbook for ASEAN and the World A real-time cross-border funds transfer service linking retail customers in Singapore and Thailand", White Paper, Monetary Authority of Singapore, the Bank of Thailand and Baker

McKenzie Baker McKenzie,abs.org.sg/docs/library/PayNow-PromptPay_Linkage_White_Paper.pdf.

Spaanderman, J. (2020), "The role and future of cash. DNB Occasional Studies", De Nederlandsche Bank, Amsterdam. Available at: OS Toekomst van contant geld.

Petralia, K., T. Philippon, T. Rice, N. Véron (2019), "Banking disrupted? Financial intermediation in an era of transformational technology". *Geneva Reports on the World Economy*, November.

Rice, T., G. von Peter, C. Boar (2020), "On the global retreat of correspondent banks". *BIS Quarterly Review*, March, pp. 1–16.

Rochet, J.-C., J. Tirole (2003), "Platform competition in two-sided markets". *Journal of the European Economic Association*, 1(4), June, pp. 990–1029.

——— (2004), "Two-sided markets: an overview", March.

Schenk, C.R. (2021), "The development of international correspondent banking in the USA, 1970–1989. Global Correspondent Banking 1870–2000", *Working Paper Series*, 1(1), University of Oxford, December.

——— (2024), "Moving money: redesigning the global payments system 1969–99. Global Correspondent Banking 1870–2000", *Working Paper Series*, 1(3), University of Oxford, February.

Schmalensee, R., D.S. Evans (2007), "Industrial organization of markets with two-sided platforms". *Competition Policy International*, 3(1), May, pp. 1–30.

Schnabel, I., H.S. Shin (2018), "Money and trust: lessons from the 1620s for money in the digital age". *BIS Working Papers*, no. 698, Monetary and Economic Department, February.

Stebunovs, V. (2025), "Clean money, high costs?", International Finance Discussion Paper No. 1422, Board of Governors of the Federal Reserve System.

SWIFT (2025a), "Ant International, Standard Chartered and SWIFT collaborate to pioneer bank-to-wallet payment solution backed by ISO 20022". Press release, August 27. Available at: Ant International, Standard Chartered and Swift collaborate to pioneer bank-to-wallet payment solution backed by ISO 20022 | Swift.

——— (2025b), "Transforming the experience for retail cross-border payments", September. Available at: Transforming the experience for retail cross-border payments | Swift.

——— (2025c), "Transforming the experience for retail cross-border payments". Press release, September 25. Available at: Transforming the experience for retail cross-border payments | Swift.

SWIFT and McKinsey (2025), "The path to enhanced cross-border payment experiences". June. Available at: The path to enhanced cross-border payment experiences | Swift.

The Economist (2023), "The fight over the future of global payments: digital payments have transformed domestic finance. Now competition is going global", May 18. Available at: The fight over the future of global payments.

Van Hove, L. (1999), "Electronic money and the network externalities theory: lessons for real life". Netnomics: Economic Research and Electronic Networking, 1(2), February, pp. 137–171.

——— (2004),"Cost-based pricing of payment instruments: The state of the debate". *De Economist*, 152, 79–100.

Vansteenkiste, I., A. Mehl (2025), "Financial fragmentation in global payments". Geneva Report, Chapter III, October.

World Bank Group (2018), "Migration and remittances: recent developments and outlook". Migration and Development Brief, no. 29, April.

World Bank (2023a), Global Economic Prospects, June.

World Bank Group (2023b), "A snapshot of payment systems worldwide: summary outcomes of the Sixth Global Payment Systems Survey. 2023". Available at: A Snapshot Payment Systems Worldwide - Summary Outcomes of the Sixth Global Payment Systems Survey : Data Tables

——— (2025a), Remittance Prices Worldwide Quarterly, Issue 50 – June 2024. *Database*. Website, last updated August. Available at: https://remittanceprices.worldbank.org.

——— (2025b), The Global Findex Database 2025: connectivity and financial inclusion in the digital economy. Available at: The Global Findex Database 2025.

Xue, C., W. Tian, X. Zhao (2020), The literature review of platform economy. Scientific Programming, Special Issue: Scientific Programming Towards a Smart World 2020.

Zetzsche, D.A., R.P. Buckley, D.W. Arner (2017), The distributed liability of distributed ledgers: legal risks of blockchain, August (revised October). Available at: (PDF) The Distributed Liability of Distributed Ledgers: Legal Risks of Blockchain.

Zetzsche, D.A., F. Annunziata, D.W. Arner, R.P. Buckley (2021). "The markets in crypto-assets regulation (MiCA) and the EU digital finance strategy," *Capital Markets Law Journal*, Oxford University Press, vol. 16(2), pages 203-225.