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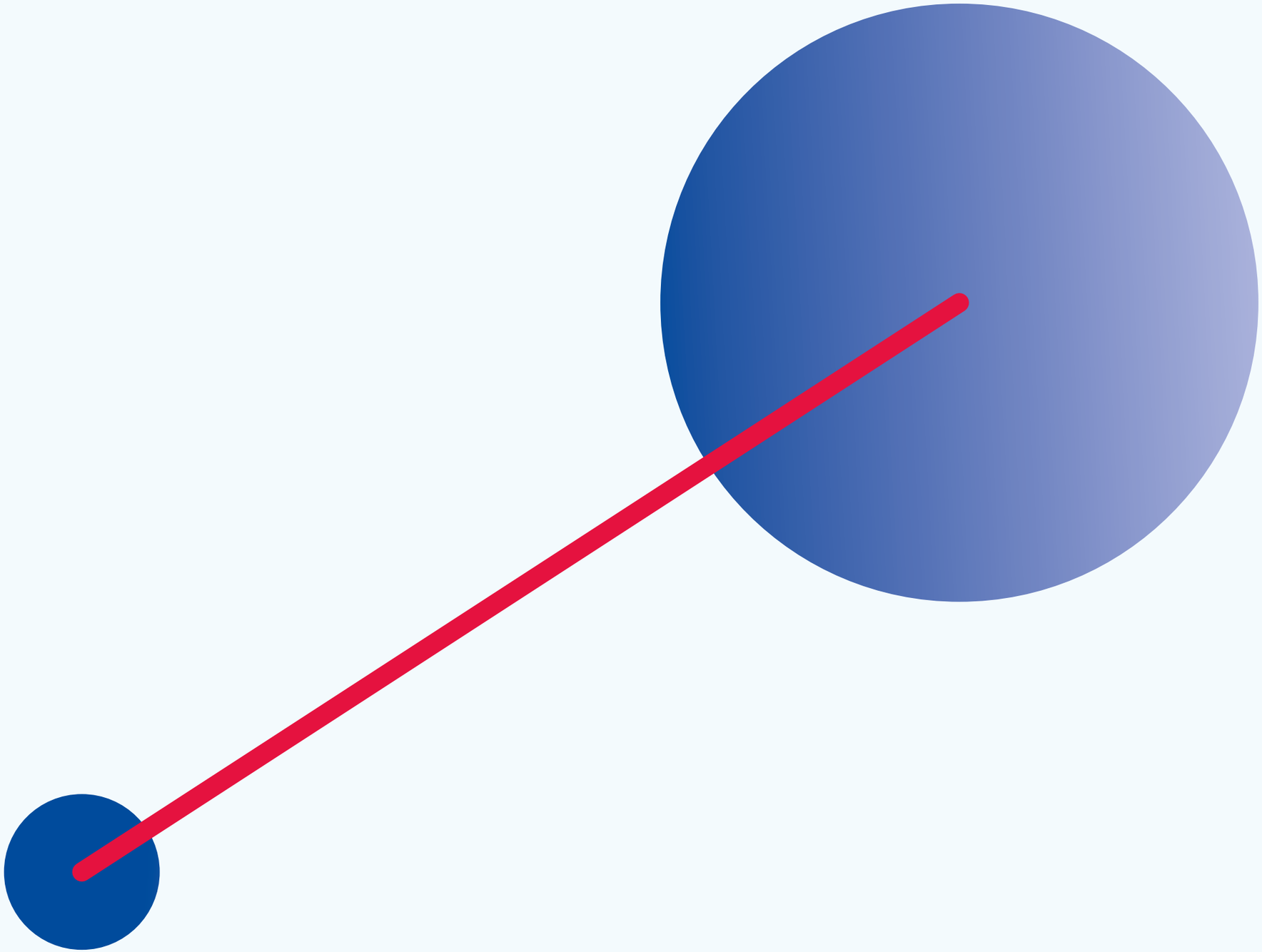

Pix: The new gold standard for Fast Payment Systems

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Pix is the world's most advanced Fast Payment System – FPS, transforming Brazil's finances with instant, 24/7, low cost (usually free) transactions. Its ubiquity across the financial system and generativity, allowing for innovation without infrastructure changes, distinguishes it from other FPSs, driving rapid adoption and economic impact. Pix's success, rooted in strategic decisions, provides a model for nations aiming to enhance financial inclusion and efficiency. This study details Pix's origins, functionality, global context, and future role in FPS evolution globally.

Zetta, in partnership with **Labrys**, prepared this study to detail Pix's origins, functionality, global context, and future role in FPS evolution globally

Labrys | Zetta

I. Pix Deep Dive

Context and background

Pix's development was spurred by the Brazilian Central Bank – BACEN's drive for increased competition, financial system digitalization, and greater financial inclusion. Despite existing systems like boletos, banking-hours wire transfers, and a high volume of payment cards, Brazil faced significant challenges: a large unbanked population (close to 25% of adults in 2011), a strong reliance on cash, and a concentrated banking market with expensive, manual services.

Regulatory reforms by BACEN began in 2013, with Law 12.865/2013 introducing payment institution licenses and empowering BACEN to establish a specific regulatory framework. The pro-competition approach reduced entry barriers, combated anti-competitive practices, and leveled the playing field, leading to decreased banking concentration, a dynamic fintech market with over 2,000 firms (three times more than any other LATAM country), and substantial foreign investment.

BACEN already had experience developing successful digital infrastructure, with the Reserves Transfer System – STR, a Real-Time Gross Settlement system launched in 2002. STR to these days serves as backbone to the securities market (SELIC and B3) and traditional electronic interbank transfer (TED), while also being the source of liquidity to Pix itself.

This pre-existing regulatory and tech landscape provided a favorable ground for Pix's successful inception.

Key Decisions

Key decisions that contributed to Pix's success included effective governance through Requests for Inputs – RFIs and defining clear principles from the start, focusing on openness, cost-effectiveness, ease of use, safety, and integration with existing payment methods.

Pix Key Decisions	Description
Governance	BACEN builds, decides rules, acts as guardian of public interest. Industry provides inputs.
Technology	Use of abstractions, 1-to-n information and settlement system, alias based on event logs, distributed systems engineering, versatile design, open standards.
Policy	Mandatory participation for large payment service providers, free of charge for basic use, low activation cost, usability standards, trust-enabling mandates, SLA requirements.

Development and Launch

BACEN gathered input on regulations through RFIs within Pix Forum, an advisory committee created by BACEN composed of supervised institutions and other relevant players. BACEN led discussions and used industry feedback to inform decisions. Its decisive authority avoids the problems of "design by committee" — lengthy processes, inconsistent choices, and complex code risking cost and security in critical infrastructure — and facilitate new system elements alignment with previous decisions.

After a sandboxing and homologation period, Pix launched in November 2020. The launch saw widespread adoption with millions of users, payment alias registered, and transactions processed in the first month.

Impact

Pix transformed Brazil's economy, demonstrating successful state intervention. Within a short period, it exceeded all other payment methods in transaction volume and most in financial volume. Half the banked population adopted it within six months, and its financial volume surpassed 50% of Brazil's GDP within eight months. By 20 months, 50% of businesses used Pix, and its financial volume exceeded the nation's GDP.

Today, over 95% of the adult population and 84% of businesses are Pix users. The system now moves more than twice the country's quarterly GDP every quarter. Pix is the most utilized payment method in Brazil, both in transaction numbers and value, even surpassing cash, which fell from 76.6% in 2019 to 22% in 2024, while Pix became the primary method for most Brazilians (46%).

Pix has become the dominant payment P2B transactions in Brazil, surpassing credit and debit cards. This leadership, particularly fueled by QR codes and payment alias, positions Pix P2B ahead of even debit and credit card payments in the UK and Germany.

Between 2013 and 2025, 72 million Brazilians became customers of financial or payment institutions, 50 million before Pix. Pix penetration reached over 96% of the adult population and 84% of businesses in four years, a significant rise from the just over 45% who used digital payments in 2017.

Pix also influenced account diversification, with the average number of accounts per person or business rising from 3.28 in January 2021 to 5.80 in January 2025, and total accounts opened exceeding 1.2 billion. This effect was more pronounced in less developed regions like the North, with higher per capita transaction numbers. Pix's digitization of payments has enabled more people to build a digital financial footprint, facilitating access to other financial services and credit.

For small businesses, 97% accept Pix, and 48% prefer it for receiving payments, accounting for over half of their pay-ins. Pix has facilitated credit access for small businesses, contributing to an increase in new company openings and a decrease in the informal economy rate.

Pix has fundamentally changed the Brazilian payment market, creating a ubiquitous network that connects all participants, eliminating the size advantage for newcomers. Any PSP can reach all 190 million Pix users. This fosters competition and innovation, allowing smaller players to compete for primary account status and offer other financial services. The reduced market concentration in total assets, total deposits, and credit operations reflects this shift. Each new customer integrated into the financial system is estimated to have a lifetime value of USD 3,000.00, indicating a market potential of hundreds of billions of dollars.

Pix also has fostered the digitalization of public services, such as tax payments (less than 4% in 2024, but growing rapidly) and social benefit disbursements as well as government payouts.

Functionality and Architecture

Pix is a highly regulated and robust infrastructure managed by BACEN. It allows various regulated entities to participate as either mandatory or voluntary members, offering different roles. Pix covers a wide array of payment scenarios, serving individuals, businesses, and government bodies use cases.

The system's core is the Instant Payments System (SPI), which handles both money and data flows, ensuring real-time, final, and irrevocable gross settlements. Transactions are secured with digital certificates and managed through a unique end-to-end ID for idempotency and reliability. The DICT database stores payment payment aliases (Tax ID, phone number, email and random virtual payment addresses) for routing information and also works as an anti-fraud information database.

Payment initiation methods include payer-initiated (manual insertion, payment alias, QR Codes: Static, Dynamic, Compound) and third-party-initiated (API/Open Finance, Pix Automatic Payments).

Usability is prioritized with requirements for Pix services on main digital channels, minimum UX standards, and standardized APIs for third-party providers. The system ensures integration, reliability, state transparency, and competition, making it a transformative payment solution in Brazil.

Security is a central aspect, featuring robust information security, dedicated links, transaction idempotency, and strong error handling. Pix also emphasizes user experience with standardized APIs and minimum technical requirements for participants.

Pix has established comprehensive fraud prevention measures, including mandatory transaction limits and a special refund mechanism (MED). While instances of fraud, notably social engineering attacks, exist, Pix's fraud rate remains extremely low. The fraud per transaction rate in 2023 was lower than 0.01%, while the card network's rate was at 1%.

II. Global Trend in Fast Payment Systems

FPSs are transforming the global payments market. Initially, interbank transactions used Deferred Net Settlement – DNS, creating credit risk. Central banks then shifted to Real-Time Gross Settlement – RTGS to mitigate this risk.

While RTGS focused on interbank settlements, the concept of fast end-user payments emerged in the early 2000s, with Korea pioneering EBS in 2001. Today, many jurisdictions use RTGS for FPS, offering real-time transfers for both end-users and institutions.

The BIS Core Principles emphasize secure and efficient payment systems, prompting a global move towards RTGS. Currently, 123 countries have live FPS benefiting from their positive economic impacts, particularly in emerging economies.

Selected Case Studies

The study details successful cases in different continents, including Mexico, Costa Rica, India, Thailand, South Korea, Sweden, Australia, Uganda, Tanzania, Project Nexus, and SEPA Instant Credit Transfer (SCT Inst). Each case is analyzed in terms of architecture, policy, user experience, use cases, and adoption.

Pix stands out as a groundbreaking Fast Payment System due to its high adoption rates, extensive use cases, low costs, and innovative platform approach, consistently outperforming or equaling other systems in metrics like transaction per capita and % of GDP. This can be seen in selected samples from the jurisdictions analyzed:

	Brasil	Mexico	India	Australia
	Pix	**CoDI**	**UPI**	**NPP**
Transactions (value, 2024)	**USD 4.49 trillion**	**USD 0.0002 billion**	**USD 2.96 trillion**	**USD 1.28 trillion**
Transactions (number, 2024)	**63.44 billion**	**0.0042 billion**	**172.21 billion**	**1.65 billion**
Users (% adult population)	**96%**	**up to 3.4%**	**32.03%**	**68.35%**
Transactions per capita	**373.17**	**0.04**	**157.58**	**75.28**
Transactions (% of GDP)	**225.65%**	**0.01%**	**76.11%**	**70.77%**

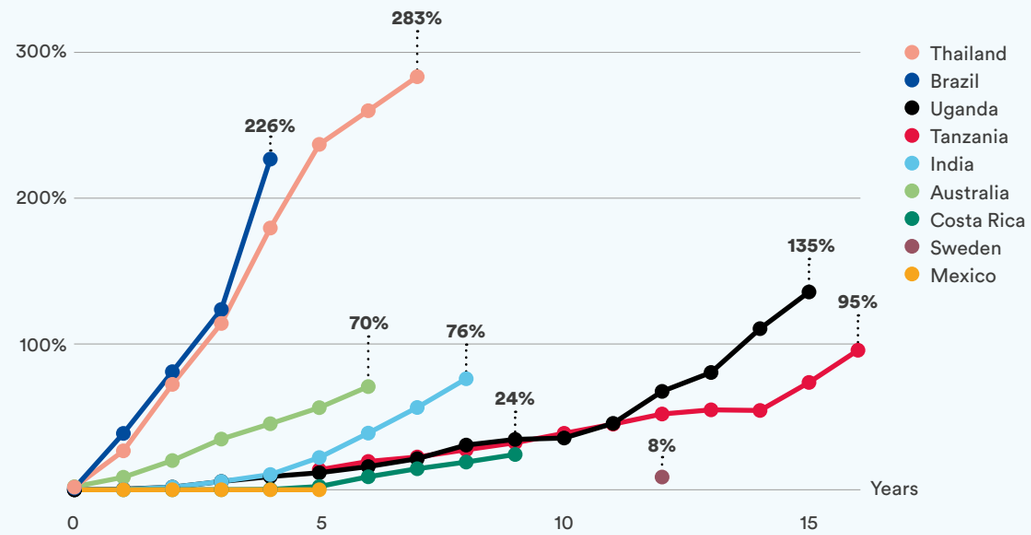
III. The Future of Fast Payment Systems and Pix as the New Gold Standard

A new gold standard

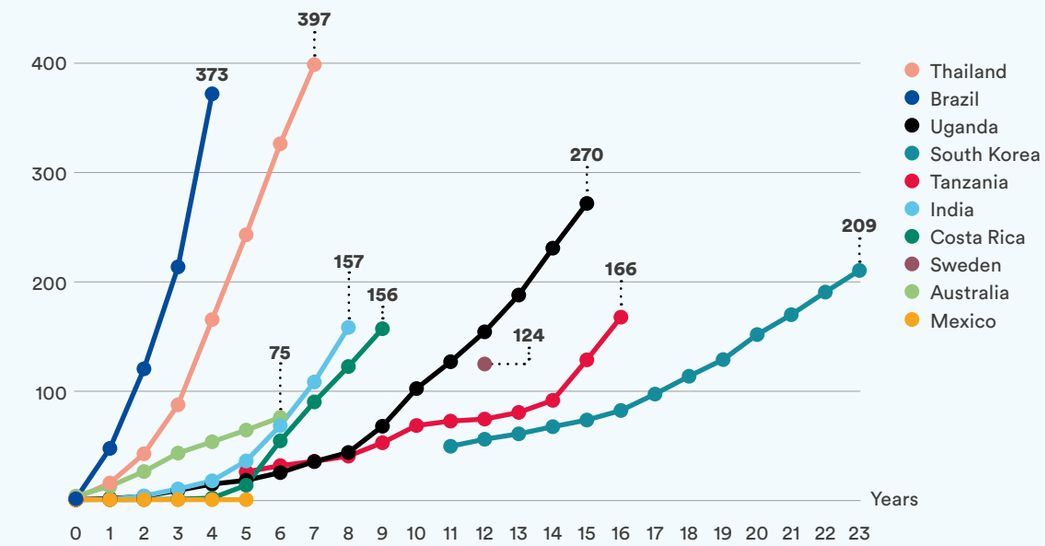
A comparative analysis of FPSs globally reveals that while many have achieved success and significant impact, Pix in Brazil stands out as extraordinary. Metrics like transaction per capita and transaction-value-to-GDP rate highlight Pix's exceptional performance, surpassing other systems even in their mature stages. Thailand's PromptPay shows strong early performance, and South Korea's EBS has the highest % of current GDP, but Pix consistently outperforms all analysed systems at a similar development stage.

The timing of Pix's launch during the Covid-19 pandemic is often cited as a success factor, but data suggests other FPSs experienced declines in growth during that period, questioning the sole reliance on this explanation. The success of Pix warrants close attention and analysis to understand the key learnings for the global payment ecosystem.

Fast Payment Systems: % of GDP, Years since launch



Fast Payment Systems: Transactions per capita, Years since launch



Pix's contribution to the FPS debate world-wide

Pix serves as a powerful blueprint, demonstrating the transformative impact of an alternative approach to FPS. Its journey offers key insights for those shaping the future of payment systems.

BACEN leadership in building and operating a centralized infrastructure has demonstrably fostered greater adoption and more optimized decision-making. The "One Platform Approach" championed by Pix, encompassing diverse payment use cases within a single, scalable infrastructure, significantly enhances efficiency and drives down costs for participants.

Furthermore, Pix's design as an innovative and extensible platform is crucial for sustained innovation and adaptability. Its core principle of enabling payments "anywhere, to anyone, for anything, at any time, and in an instant" showcases a user-centric vision.

A robust technological design, coupled with clear communication protocols regarding transaction status, ensures the reliability and positive UX vital for widespread adoption. Ultimately, the Pix experience provides a compelling case study for achieving diverse policy goals in the realm of FPS.

The hidden potential

Pix's platform approach is pivotal. Abstractions facilitated its design, development, integration, and evolution. Pix established versatile communication between payers/payees and PSPs, separate from the core, use-case-agnostic money flow.

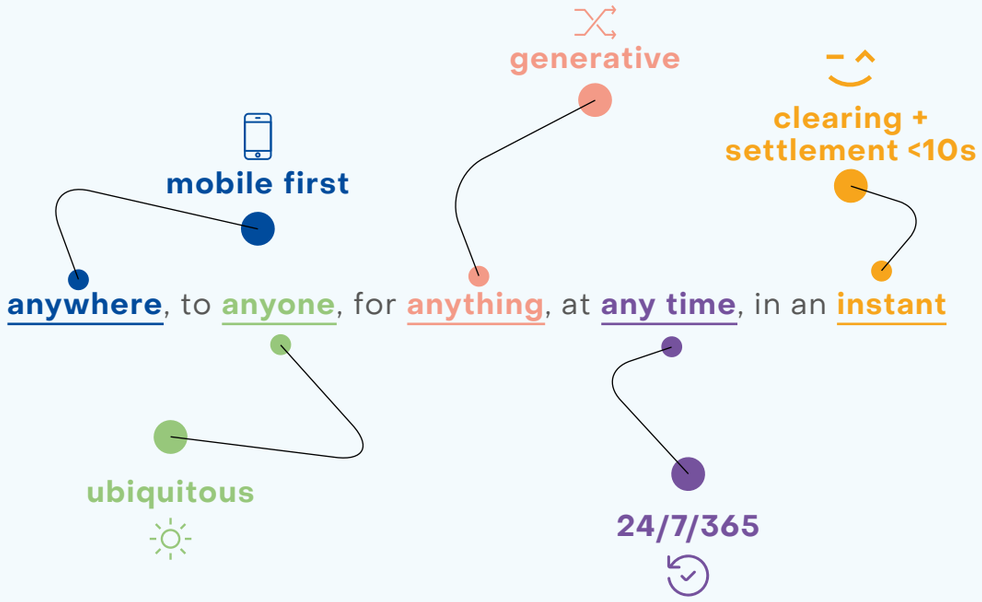
This approach suggests FPSs benefit from separating core payment capabilities from use-case-specific payment initiation. Extensible standards for payment-initiation ensure a unified messaging structure. For example, a QR code URL can adapt to NFC, recurring, or specialized payments. Standards like ISO 20022 can define messaging for core payment functions.

Such architecture benefits national and international systems. Nationally, it balances stability and adaptability. Extensible platforms, with predefined messaging, enable stable integrations and gradual evolution. This is important internationally, where PSPs from various countries may use the same infrastructure. Lack of flexibility can disrupt global PSP implementations.

Therefore, following Pix's model of an adaptable platform for payments anywhere, anytime, is the best path for FPS world-wide, for domestic, bilateral and multilateral systems in both developed and developing economies.

Introduction: anywhere, to anyone, for anything, at any time, in an instant

Pix is the most advanced Fast Payment System – FPS[1] in the world today. It's Brazil's platform that allows payments anywhere, to anyone, for anything, at any time, and in an instant. It's mobile-first, 24/7/365, and both clears and settles 99% of transactions in less than 10 seconds, like many other FPSs in the world. Pix, however, goes beyond and creates the new gold standard for payments by adding two additional flavors: ubiquity and generativity.



By ubiquity we mean it is not yet another network competing for space and size. Pix's network is the whole financial system. There's no escaping it. It can connect every payment account without the need of a specific sign up from the end-users. And because it's either free or much cheaper than alternatives, anyone in Brazil can leave their homes in the morning knowing that people they encounter throughout the day – from the morning food truck to their coworker who bought them a beer at the end of the day – can accept Pix payments. Brazil reached this status at an incredible speed.

By generativity we mean Pix was built not as a single product, but as a platform that can be extended to host virtually any number of different products. Pix's approach to generativity sets it apart from other payment systems. Pix has extension points that allow both the Brazilian Central Bank – BACEN, as Pix's operator and regulator, and any other participant in the rail to create new products and experiences without requiring changes to the Pix infrastructure or in all participants' integration at once. That means Pix is future proof and can efficiently function as an all-in-one rail, reducing transaction costs across the whole economy.

All these key features amounted to the fastest growing and the most impactful instant payments infrastructure in the world. While many countries and international organizations have been discussing building new payment systems, we argue it will be a null effort unless the right governance, policy, and technology decisions are put in place for maximum effectiveness. The scale of adoption and impact of Pix should be enough to call attention from any developing nation looking for similar results in financial inclusion and economic prosperity. We argue, moreover, that the key decisions that enabled Pix to transform the Brazilian market could also help developed countries overcome their own particular challenges and increase efficiency across the board.

To that end, we'll go into the specifics of how Pix came to be in Brazil (Part I), how it works and, more importantly, why it works, to then assess what were its impacts on the Brazilian economy. Then, we'll analyze how FPS spread through the world and how they compare to Pix in terms of architecture, policy, user experience, use cases, and adoption (Part 2). Finally, we'll get into the future of FPSs by going through the key contributions Pix has made to FPS debates and development and how other jurisdictions could achieve similar results.

Pix Key decisions

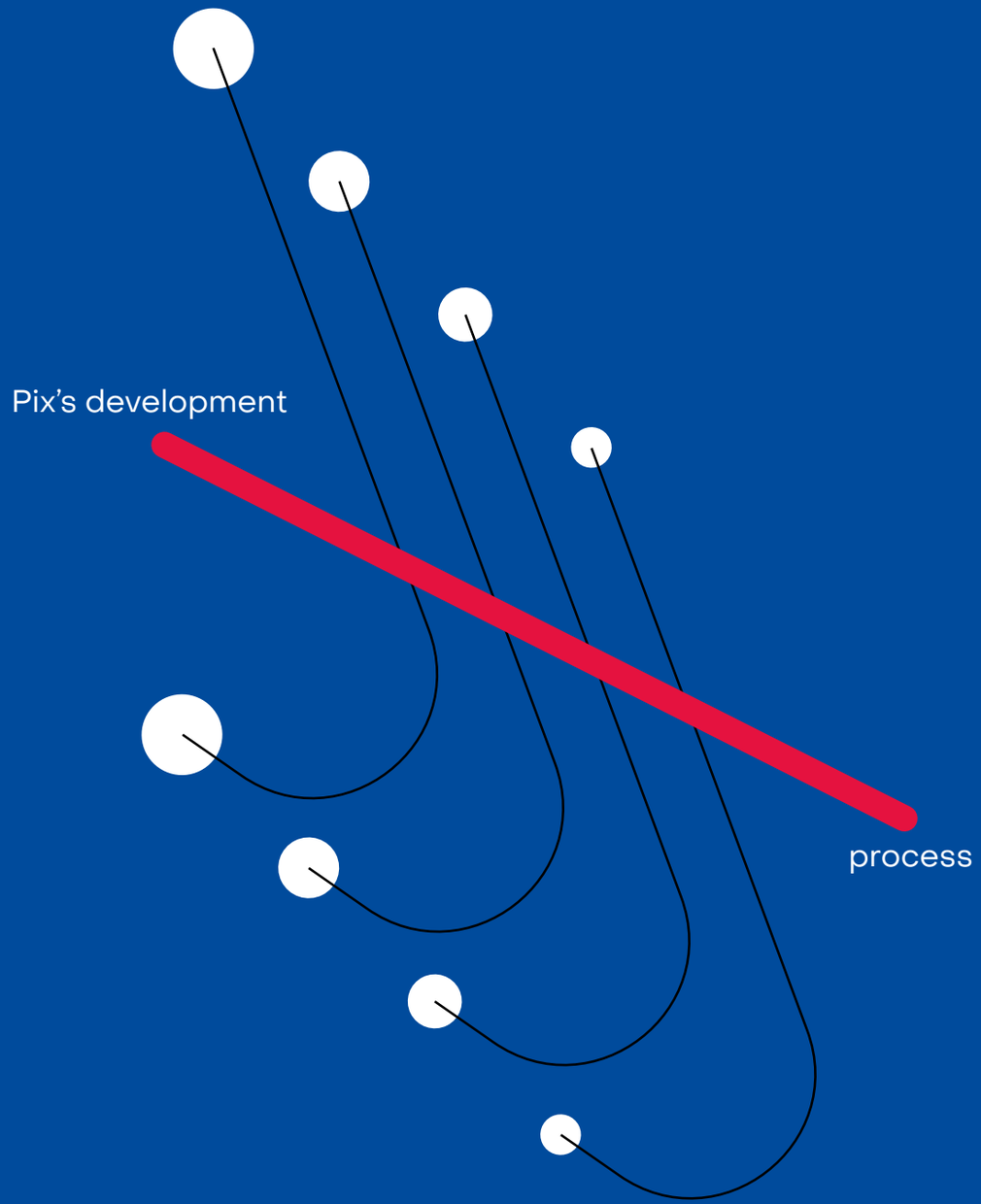
Governance	• BACEN builds, decides the rules, acts as guardian of public interest. Industry has local knowledge, sends inputs, concerns, suggestions and BACEN makes the decision that would best serve the public interest through the principles that were established in the beginning
Technology	• Use of powerful abstractions that reduce design, development, implementation, and operational costs. Ex: Payments = communication and transfer of funds. Payment information = value, time, destination, and payment-specific metadata. Payment initiation = payment information + authorization. • Pix created a 1-to-n information and settlement system • Implementation of the alias base on top of event logs • Adoption of good practices of distributed systems engineering • Implementation of versatile, evolvable design • Adoption of open standards • Creation of testing and homologation environments • Implementation of trust-enabling features, such as payer-initiated transfers, payment status transparency, etc.

Policy	• BACEN's role as the Pix payment scheme's settlor. • Mandatory participation for payment service providers – PSPs with over 500.000 active accounts. • Free of charge: (i) for all users for receiving transfers and making payments; (ii) for natural persons also for making transfers. Fees may apply for natural persons receiving payments and businesses making transfers and receiving payments[2]. • End-users don't need to sign up to start using, so the activation cost to join the rail is extremely low. • Reduced adoption cost by allowing use of Pix without a specific registration and creating a bridge between the previous rails usability and Pix. Apart from the improved usability mechanisms (QR Codes and payment aliases), BACEN also incorporated the exact same experience of traditional transfers rail, with the manual input journey, which also reduces the adoption cost for new users. • BACEN created guardrails to prevent less motivated PSPs from preventing rail penetration, for example: forbidding the charge of fees from natural persons, creating segmented SLA requirements based on PSP transactional volume, and mandating minimum usability standards. • Trust-enabling mandate, such as: Payer controls the interface, Payee gets confirmation from their own PSP • BACEN also created a fertile terrain for competition over Pix payment aliases and created a buzz over which PSP would register more payment aliases by opening a registration window a month before Pix's launch and by publicizing the number of payment aliases each PSP managed to register. • BACEN created a form of indirect participation in the Pix rail, which allowed non-regulated players to connect through a regulated partner (direct participant) and gave an option for smaller regulated players to connect to the rail through a partner as well. • Pix mandates all participants to implement its functionalities throughout every service channel they maintain with their users • Creation of a strong brand Brazilians can recognize and trust

I

Pix deep dive

I.1



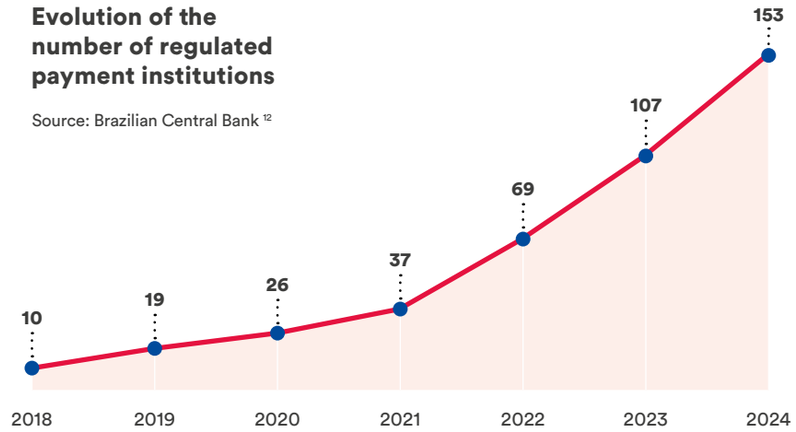
A. The perfect storm

Pix's development came amid a strong push from BACEN to improve competition, digitalize the financial system, and increase financial inclusion. Brazil had a barcode voucher payment system in place ("boletos") since 1993[3], a Real-Time Gross Settlement transfers system in operation since 2002[4], and over two payment cards per capita since the early 2010s[5]. However, the country suffered with almost 25% of its adult population unbanked in 2011[6], a persistent reliance on cash, and an increasing concentration of its banking market[7], which was marked by its expensive and manual services.

In the mid-2010s, however, that Brazil began brewing the perfect storm[8] for the financial and payment technology boom the world has witnessed in the last few years. The year 2013 marked the beginning of a wave of Central Bank-led regulatory transformations that both removed barriers and created material conditions for new entrants to start competing in the payments space[9]. It began with the Federal Statute nº 12.865/2013 introducing payment institution licenses[10], and assigning BACEN with creating a specific regulatory framework for these companies[11].

Evolution of the number of regulated payment institutions

Source: Brazilian Central Bank [12]



In the following years, BACEN paved the road for hundreds[13] of new entrants, including some of the largest payment companies in LATAM[14], who benefited from a pro-competition approach to regulation and supervision[15], removing entry barriers in the regulation, combating anti-competitive practices in the market, and counterbalancing inherent asymmetries that typically shielded incumbents from competitive pressure in the financial and payments industries. All of which culminated in the reduction of banking concentration and a vibrant, innovative market[16], attracting billions of dollars in foreign investments[17]. The feat is especially impressive considering the last two decades were marked by a banking concentration trend worldwide[18]. Still, BACEN managed to create an environment that fostered competition from different kinds of entities and completely transformed the country's payment landscape.

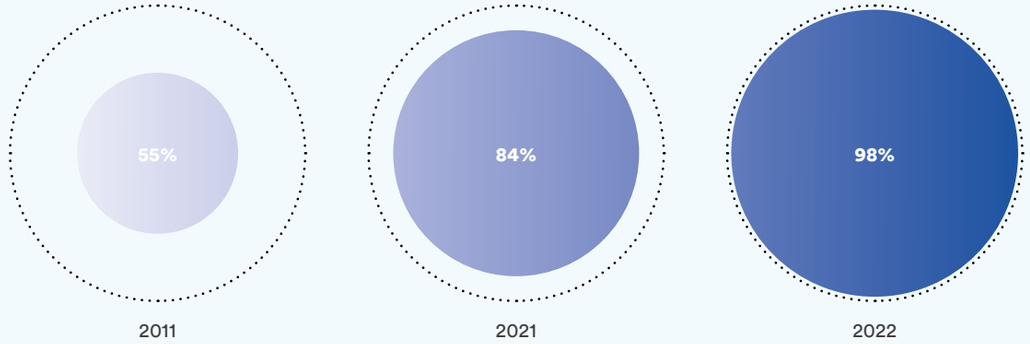
Today, between regulated, unregulated, and in the process of becoming regulated, Brazil is home to over 2.000 fintech firms, three times as many as any other country in LATAM[20]. Brazil's banked population went from 77.19% in 2011 to 89.89% in 2019 and 98% in 2022[21].

From 0 to 100 in 10 years[23]: Brazil's regulation-driven payments takeoff

Number of regulated payment institutions in operation today[24]	**154**
Estimation of total fintech firms in Brazil[25]	**2,067**
Payment cards issued per capita[26]	**8**
Financial Inclusion from 2012 to 2022[27]	**~50 million people (~25% of Brazil's population)**

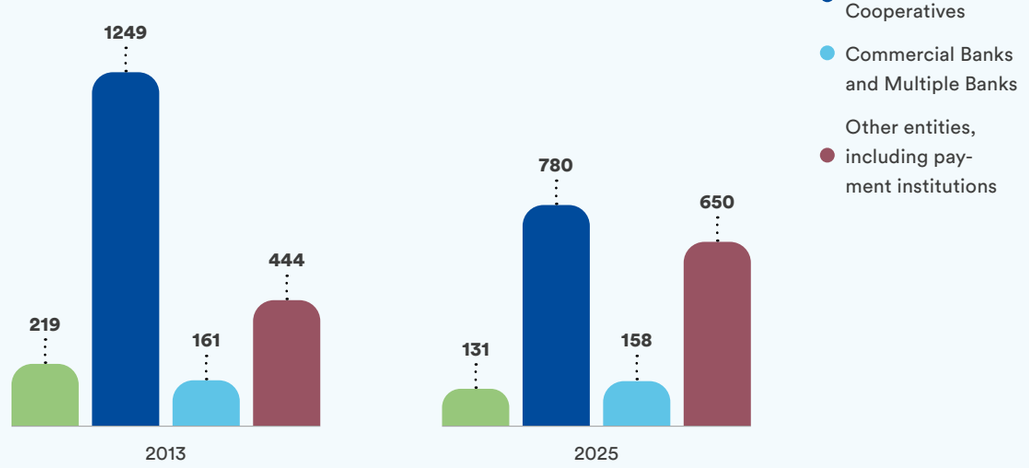
Banked Population

World Bank, Brazilian Central Bank[23]



BACEN - regulated institutions: 2013 / 2025

Source: Brazilian Central Bank [12]



Source: Brazilian Central Bank [19]

B. The inception

The project to create Pix came from this general context. It has its roots in the technical ranks of BACEN many years ago. The analyses that led to the conclusion a system like Pix should be a priority for BACEN date as far back as 2005[28], 2010[29] , 2013[30], and 2016[31]. High costs, inefficiencies, risks, high unbanked population, low level of competition in the market, and high reliance on cash were the main drivers for the project[32].

Back in 2018, an electronic transfer between banks worked only during an operation window that closed at 5 p.m. and could cost payer users about R$14[33] (around 2.5[34] dollars and 0.8% of the current Brazilian minimum wage[35]). Fast, free transfers were only offered for same-bank transactions, with limited usability and nearly no acceptance as a payment method. Utility payments were only possible on a handful of incumbent banks and were mostly done with cash[36]. On the other hand, barcode voucher payments could take up to 3 days to clear and settle[37], and card payments, with no viable alternative and limited competition, could be very expensive for the merchant, with online purchase merchant discount fees reaching the double digits[38]. As a result, back then, 76.6% of transactions in the country still involved cash[39].

The BACEN **saw in the instant payments international debate an opportunity to accelerate the market evolution and drive it towards**: (i) reducing the cost and risk associated with cash transactions, (ii) digitalizing the economy through payments, (iii) fostering competition and retail market efficiency, (iv) fostering innovation across the economy, (v) promoting financial and digital inclusion, (vi) reducing the cost of electronic transactions, and (vii) offering a simple, safe, and seamless digital payment experience to the citizens[40].

At this point, BACEN already had a successful track record of building robust technical infrastructure for the financial system. In 2002, BACEN launched the Reserves Transfer System – STR[41], which brought Brazil to the group of countries compliant with the Bank of International Settlements – BIS's Core Principles for Systemically Important Payment Systems[42]. STR enabled real-time, irrevocable and unconditional settlement of interbank transactions, reducing the systemic risk in the Brazilian market[43]. STR was also connected to Brazil's federal securities infrastructure, SELIC[44], which provided risk mitigation capability also to the securities market[45].

On top of the STR infrastructure, the Electronic Funds Transfer – TED[46] launched to enable interbank transfer between end-user accounts. Depending on the value of the transfer and the choice of the payer's bank, the settlement could go directly through STR or through the market-owned netting system, SITRAF[47]. TED already allowed end-users to complete transactions in up to one working day, depending on the time and amount of the transaction[48], placing Brazil in the forefront of account-to-account transfers since then.

In 2018, BACEN created a Working Group[49] to discuss with the industry if and how an instant payments infrastructure could improve the competition, efficiency, safety and inclusiveness of the Brazilian payments market. Later, in March 2019, the working group gave room to a permanent forum to subsidize BACEN in its role as the payment scheme regulator and operator: the Pix Forum[50].

The Forum is structured as four working groups, encumbered with promoting the discussions over every technical, business, and regulatory issue affecting the rail. Three of these groups are led by BACEN: (i) Business, (ii) Standards and Technical Requirements, and (iii) Messaging. The fourth and newest working group, focused on Security matters, is formed by the trade associations members of the Pix Forum, such as Zetta and FEBRABAN, the association of the largest banks in the country[51].

Pix Forum in a glance

Structure	**A Plenary Forum and four working groups: (1) Business, (2) Standards and Technical Requirements, (3) Messaging, (4) Security**
Number of members	**First meeting: 150 Last meeting before launch: 504**
Eligibility	**- Trade associations representing account, payment initiation, and technical service providers; - Associations of end-users (payers and payees); - Any other public or private entity BACEN may deem helpful for the discussions**
Number of plenary meetings	**Before launch (2019-2020): 11 After launch (2021-2024): 12**
Number of rounds of RFIs at the working groups level	**35**

The Business, Standards and Technical Requirements and Messaging working groups operate on the basis of Requests for Inputs (RFIs). BACEN sends proposals of what they are considering for the rail and the members of each working group can send their comments and suggestions back to BACEN. After considering the inputs from the members, BACEN calls in a plenary session of the Forum. There, they communicate the decisions that were made following the latest RFIs, explain the next steps, and answer questions from the members. The Security working group operates in work cycles, during which priority topics defined by BACEN are discussed, and the market presents its proposals and recommendations. At the end of each cycle, BACEN presents its conclusions and decisions during the plenary session.

At the time of the development of Pix, BACEN submitted a wide range of subjects for discussion to the groups regarding the rules and standards governing the interactions between Pix's core infrastructure and their PSPs, usability and other rules governing the interaction between the PSPs and their users. The forum, however, was not used by BACEN to discuss topics such as: (i) technical standards between PSPs and their end-users, which was left largely unregulated, so that each PSP could decide how to implement the usability requirements within their mobile and web apps, and (ii) technical aspects of the inner workings of Pix's core infrastructure[52].

As highlighted, the Pix Forum is a permanent forum, formally established within Pix regulation. This means that, beyond its key role during the development phase, its four working groups remain active. BACEN regularly consults them through request for inputs on technical and regulatory improvements, new feature development, and the expansion of Pix use cases. Moreover, the Security Working Group GE-SEG also operates in periodic cycles to discuss fraud and information security matters[53].

C. Early wins

This is where the first big learnings from Brazil's experience lie. The success of the development process of Pix can be traced back to two critical procedural decisions: (i) the choice of an effective governance scheme, and (ii) the definition of clear principles from the start.

The **key governance decision** was, in short, to combine BACEN's leadership and initiative on the discussions with an open dialog with the industry without forgoing its burden as ultimate decision maker and defender of the public interest. Three points help drive this conclusion.

The two early decisions that put Pix in the path of success	
1	**Effective development governance through RFIs**
2	**Clear principles that communicated BACEN's priorities and definition of success**

First, the fact that BACEN coordinated the debates of the three core working groups meant the regulator controlled the pace and the focus of the discussions. BACEN set clear deliverables for each working group[54] and systematically worked its way through that list in a proposal-RFI-decision continuous motion[55]. That way, however reluctant any given market player may have been in supporting the project evolution, the discussion would move forward in a productive way.

Second, BACEN benefited from a dedicated team of technical public servants but did not try to make all decisions by itself, within closed doors. Instead, they leveraged the local knowledge from the industry and a diversity of technical backgrounds brought by years of market opening, substantial foreign investments and the fast-paced development of the fintech and banking markets in Brazil. That gave BACEN access to some of the most specialized professionals in the region who were willing to contribute to the bold assignment of building the best payment rail they could imagine.

Third, after considering all input from the industry, BACEN would decide which suggestion could better serve the public interest. At that point, the Brazilian payments market had evolved to a point where there were different interest groups operating in the market. What would better serve the interest of incumbents not necessarily would be well received by new entrants and vice versa. Payee-focused companies had different priorities than payer-focused companies. Depending on the firm's business model and strategy, a more consumer-centered approach could be more favorable. In the middle of all those different perspectives, BACEN had the attribution, as guardian of the public interest, to make the final decision.

That's important not only because of the alignment with the public interest itself. Because the Central Bank, as monetary, prudential, and competition regulator, has the institutional capacity to balance the interest groups' arguments and make a decision that makes the market better off. Besides, having a clear decision-maker that receives different proposals and decides which one should prevail also avoids what has come to be known as *design by committee*[56]. When decisions about software are made by majority rule, the result is inevitably longer decision-making processes, inconsistent choices due to mutual compromises, and greater complexity in the code. And complexity in critical infrastructure breeds cost and security vulnerabilities[57]. So, by making sure BACEN had the authority to take in all available proposals and that it chose the one most likely to achieve their vision allowed them to guarantee every new element of the system was coherent with the decisions taken previously.

As to **the second critical decision**, BACEN set, from the start, **a list of principles the new rail should implement**[58]. This was not just about setting a clear goal or deliverables, although that was also crucial for the efficient conduction of the project. BACEN also created a set of values that should be pursued on every decision. From the start, BACEN made it clear the new payment infrastructure should be open to all and any regulated player, cost-effective, easy to use, safe, and should be able to incorporate any method of payment available in Brazil[59-60]. That helped create a common language in the debate with the forum members, who could then send more useful contributions defending that one approach or the other would better serve the Central Bank's goals. From these principles, BACEN started deriving a few fundamental decisions that started shaping the rail, such as that BACEN would be in charge of defining the rules of the scheme, much like a scheme settler, that there would be a centralized settlement infrastructure, and that BACEN would be the one to build and run it. Moreover, BACEN decided that this system would be brand new, to leverage the advancements in technology from the previous 18 years[61], but it would be connected to Brazil's first RTGS infrastructure, STR[62], and to the federal securities infrastructure, SELIC[63], for liquidity provision[64]. Finally, BACEN also decided it would build and run an alias database to facilitate mobile payments[65].

Those principles also informed every decision from then on. Developing Pix as a payment scheme of its own enabled BACEN to lay out all policy decisions that were crucial for Pix's success. define participation rules, and usability requirements with an end-user-first mindset, and even create a strong brand Brazilians can recognize and trust. From the tech side, a few examples of the ramifications of these first fundamental decisions are: (i) reducing implementation cost so that the infrastructure could be truly open; (ii) adopting open protocols that were widely known in the industry and that would be cheaper to operate than proprietary ones; (iii) reducing the size of the messages that would travel the infrastructure to reduce operational cost; (iv) implementing a minimum usability requirements for all PSPs to ensure a great usability to all users; (v) defining that all information should come from a trustworthy source, to increase security; (vi) defining that all critical messages should be signed and encrypted to improve security and trust; (vii) adopting an extensible data schema so that Pix could be truly used to pay anything from a loaf of bread to a car dealer, from a friend to the electricity bill or taxes and beyond.

D. The launch

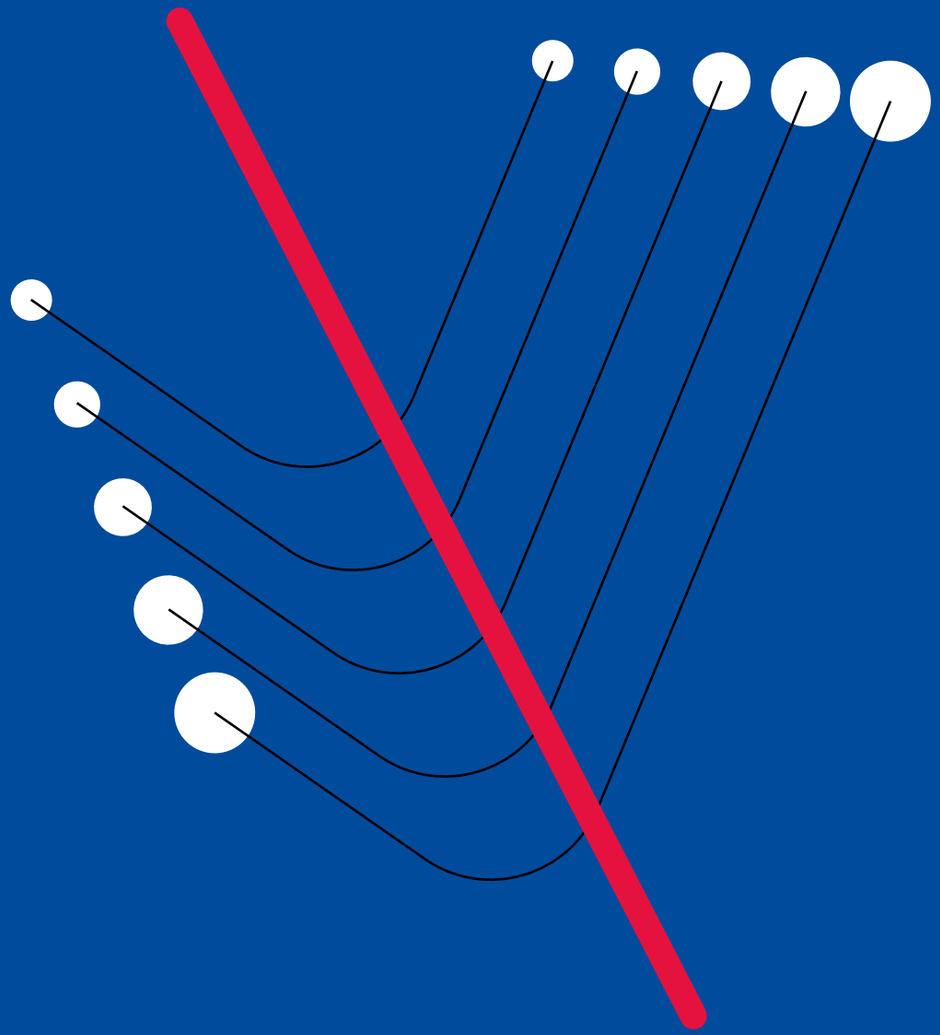
That collaborative process resulted in the Pix regulation and its twelve technical manuals[66]. The manuals are organized as follows: (i) Brand, (ii) Payment initiation Standards, (iii) Pix Payment Flows, (iv) Minimal UX Requirements; (v) Network Connectivity, (vi) Network Security, (vii) Network Services, (viii) Communication Interface, (ix) Time SLAs, (x) Alias Base Operation, (xi) Dispute Resolution, (xii) Penalties.

In 2020, as the basic rules were being published, there was a four-month period of voluntary sandboxing (April-June) followed by four months of mandatory homologation process (June-October)[67]. On October 5th, BACEN started accepting registration of Pix payment aliases to the alias base in preparation for launch[68]. The strategy to open registration beforehand was very successful. As banks and fintech firms started competing to become the default account to receive Pix payments, about 50 million payment aliases were registered in the weeks preceding the launch[69]. Pix soft-opened on November 3rd[70] and went live with full operation on November 16th, 2020, exactly 20 months after the kickstart of Pix Forum[71].

Pix Launch Numbers	
Time from inception to launch (design + development + PSPs integration)	**20 months**
Total development cost[72]	**USD 4 million**
Number of PSPs at launch[73]	**762**
Percentage of accounts connected to Pix at launch[74]	**>90%**
Number of active users on the first month[75]	**46 million (~30% of the banked population)**
Number of Pix alias registered on the first full month of operation[76]	**~134 million**
Number of transactions on the first full month of operation[77]	**~125 million**
Financial volume of transactions on the first full month of operation[78]	**~R$ 107 billion (~USD 18.67 billion)**

I.2

The day after:

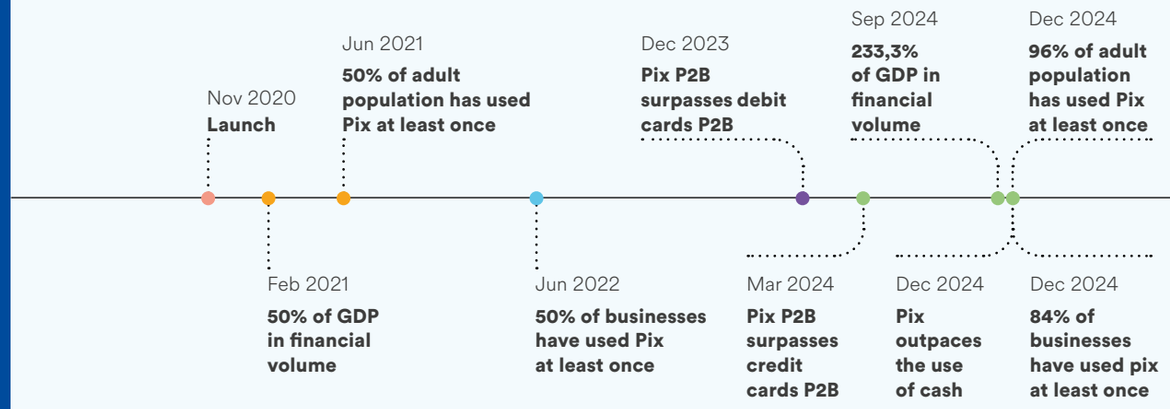


Impacts on the economy

The result was massive – positioning Pix as an illustrative case of state intervention in the economy that enhanced social welfare. In just a few years, the new type of transaction surpassed all the consolidated payment and transaction options in number of transactions and most of them also in financial volume (behind only the traditional TED rail[79]). In six months, more than half the banked population had already used the rail at least once[80]. In 8 months, Pix's financial volume was over 50% of Brazil's GDP[81]. In 20 months, 50% of businesses in the country had used Pix at least once[82] and its financial volume surpassed Brazil's GDP[83].

Today, 96% of the adult population and 84% of businesses are Pix users and every quarter the rail moves more than twice the country's quarterly GDP[84]. Pix is the most used payment method in Brazil, both in transactional number and value, surpassing even the use of cash[85] and getting right on the path towards a less cash-reliant society[86]. In 2019, cash was the main payment method for 76.6% of Brazilians[87]. Only five years later, the number reduced to 22% while Pix took the post of primary payment method for most Brazilians (46%)[88].

Pix Milestones

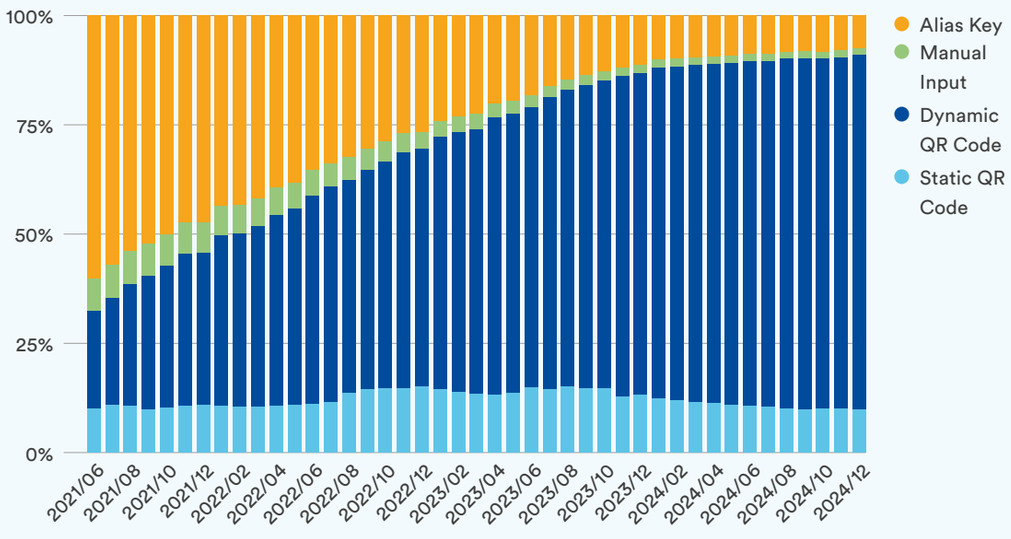


A. Competition with other payment rails

Pix's total number of transactions surpassed those of credit and debit cards long ago, but a closer look reveals that a better comparison would be that between Pix P2B payments and personal cards domestic transactions[89]. Even in this more conservative cut, however, there is little debate Pix has become the most important rail for P2B payments in Brazil.

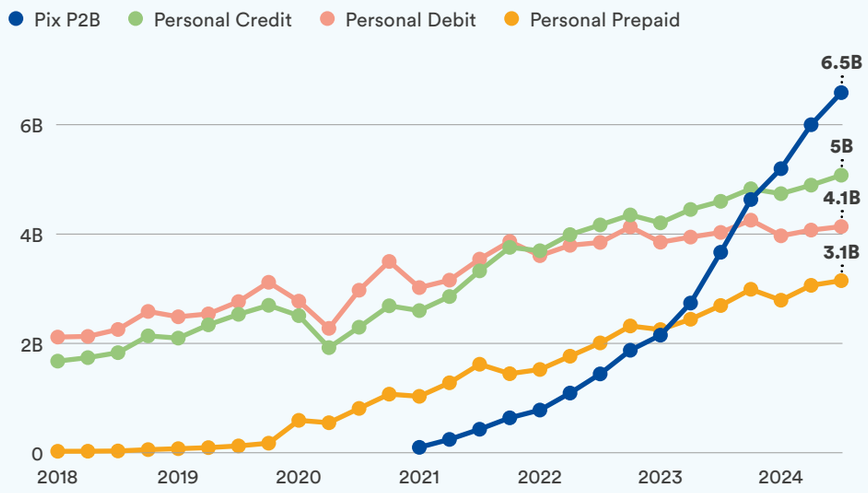
That's a remarkable feat, for at least two reasons. First, the absolute numbers themselves are impressive. To provide a better sense of the scale of this rail, the number of Pix P2B payments is greater than traditional digital payments (debit card or credit cards) in developed countries, such as the UK[92] and Germany[93], for instance. Second, Pix P2B reached these impressive marks mostly on the basis of QR Codes and payment aliases alone.

Pix P2B Payment Initiation - Number of Transactions



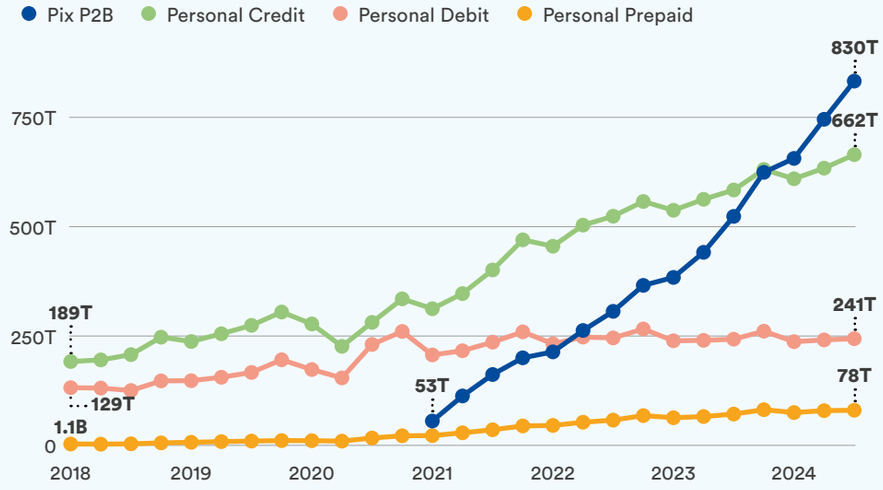
Source: Brazilian Central Bank [94]

Pix P2B vs Cards - Number of Transactions



Source: Brazilian Central Bank [90]

Pix P2B vs Cards - Value of Transactions



Source: Brazilian Central Bank [91]

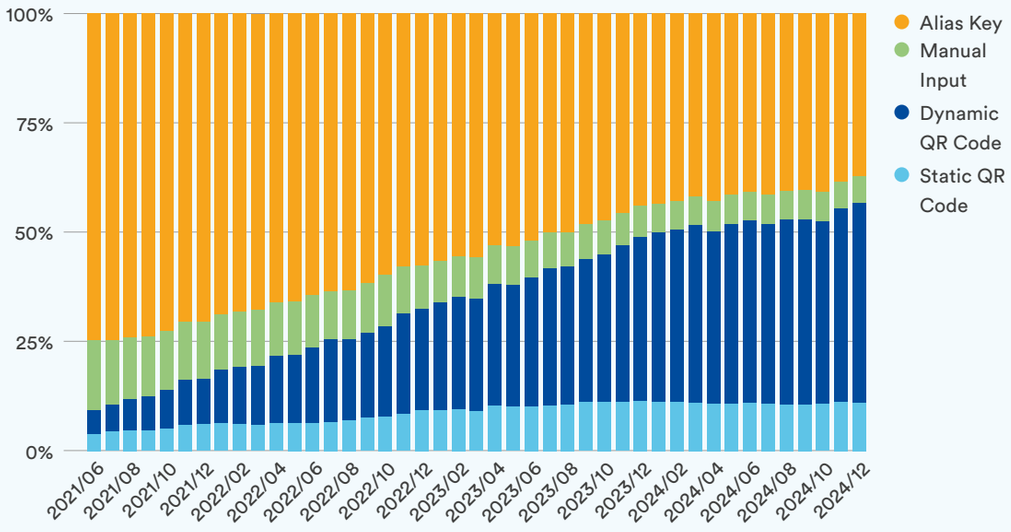
BACEN's approach to integrating QR Codes into mobile e-commerce was an effective solution, even if the experience continues to evolve[95].While Pix does not yet have payment links or a pervasive contactless feature[96], and its solution for recurring payments has just launched in June[97], it has still outpaced many payment rails that already offer these features—often seen as the last frontier of payment innovation[98]. This growth challenges the notion that instant payment systems must replicate the card payment experience to succeed.

That's not to say that the credit card market is facing a hard time in Brazil. On the contrary, the number of both issued and active credit cards in Brazil has been accelerating rapidly since Pix's launch. That's consistent with the view that, as Pix's impact on financial inclusion brings more people into the financial system

and the rail's impact on digitalization of payments helps more Brazilians build up a digital financial footprint, the market for credit services grows[100]. So, the introduction of Pix, far from posing an existential threat to credit card companies, catalyzed a systemic shift that benefited both market players and customers[101].

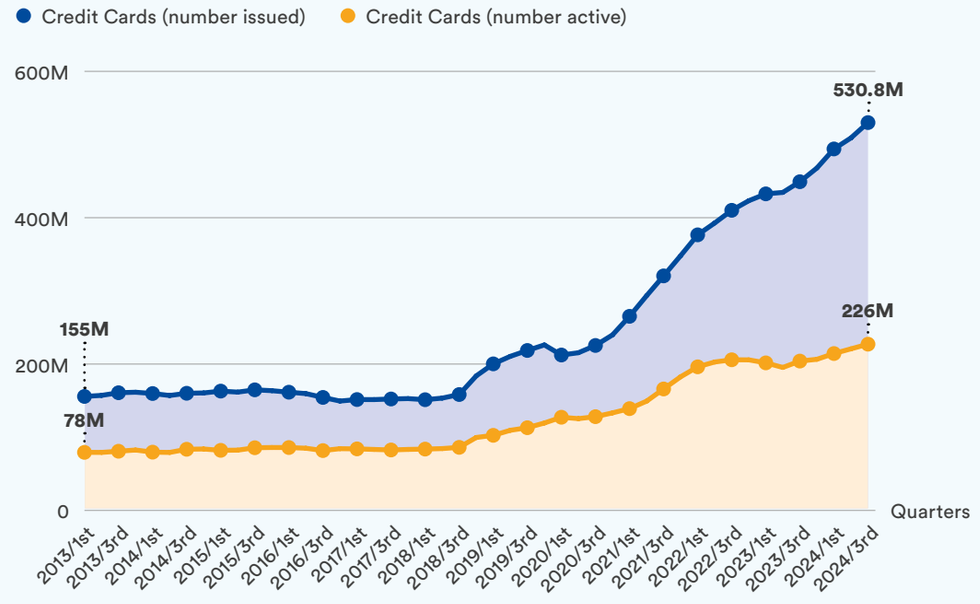
As Pix's customer-initiated payments changed the payment interface from the merchant's Point of Sale – PoS to the payers' payment app, payer PSPs also gained a more important role in the value chain. Customer-initiated payments like QR Codes and payment aliases amplify the frequency of interaction of payer users with their PSP's app and create opportunities to increase that customer's share of mind as well as for cross-sell and up-sell services, such as financing Pix payments themselves directly in the payment journey[103] .

Pix P2B Payment Initiation - Value of Transactions



Source: Brazilian Central Bank [99]

Pix P2B Payment Initiation - Value of Transactions



Source: Brazilian Central Bank [102]

B. Financial inclusion

As mentioned above, Pix was built in the context of profound transformations in the Brazilian financial and payment markets. From 2013, when the largest transformations began, until 2025, the number of individuals registered as customers of financial or payment institutions grew by 72 million (over 1/3 of the entire population), 50 million of which before Pix's launch[104].

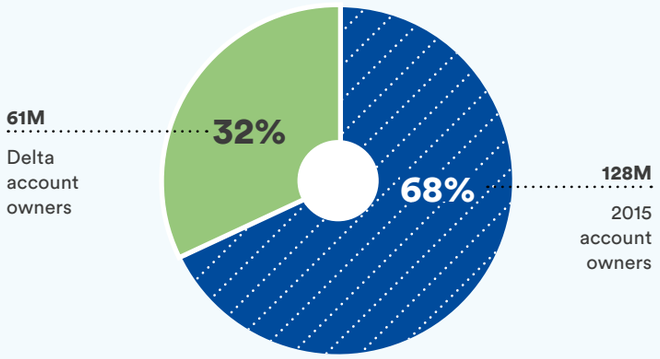
Pix also was launched amid the peak of the COVID-19 pandemic. Both these concurrent factors contributed to an increase in bancarization. Especially when considering that the Brazilian Government opened millions of accounts in the state-owned bank Caixa Econômica Federal on behalf of people with economic vulnerability to disperse economic relief in early 2020[106] and to incentivize savings in late 2020[107], raising the number of Caixa customers by 50% to over 140 million in 2020[108].

Financial inclusion, however, isn't achieved solely by opening accounts on behalf of individuals[109]. Actively using these accounts to build a financial history is the first step in the path to access to basic financial services and to unleash the benefits of financial inclusion[110]. That's where the real social and economic transformations lie. And that's where Pix promoted a radical change in Brazil. Data from BACEN show the number of active users of financial and payment products grew by 52% among natural persons and by 125% among business customers from 2020 to 2024, while such growth between 2018 and 2020 was of 32% and 62%[111]. Even more staggering, the data show that, for natural persons, the first year of the COVID-19 Pandemic had no impact on the growth of active users of financial services. Meanwhile, that growth accelerated to almost 150% in the year following Pix's launch.

Pix penetration has shown a remarkable evolution, hitting 96% of Brazil's adult population and 84% of registered businesses in four years. That's a long way from 2017, when the World Bank's Findex found that a little over 45% of Brazilians had ever done digital payments[112].

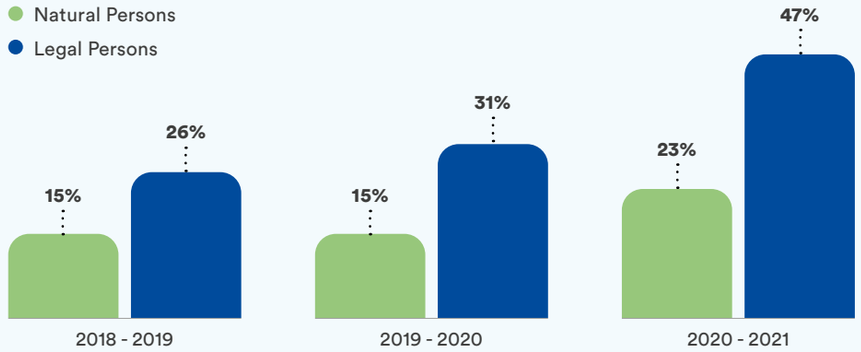
Pix also influenced the phenomenon of diversification of accounts in Brazil, where there was a surge in the number of accounts per account holder. From January 2021 to January 2025, the average number of accounts each person or business held in Brazil went from 3.28 to 5.80 and the total number of accounts opened has gone well over the mark of 1.2 billion[114].

One in every three account owners opened their first account in the last 10 years in Brazil



Source: Brazilian Central Bank [105]

Active Users Of Financial Services - YoY Growth

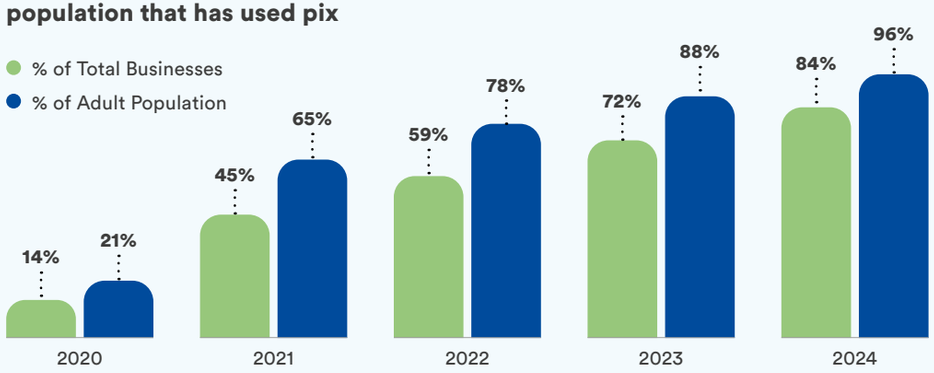


Such effects on financial inclusion and digitalization of payments were even more pronounced in less developed regions like the North of the country, where access to physical financial infrastructure may be challenging. In these regions, the number of transactions per capita reached are considerably higher than more developed regions like the South and Southeast[116].

The ability of making digital payments ubiquitous has a second-order effect of enabling a larger portion of the population to build what is called a financial digital footprint. For underserved communities with limited access to credit cards and bank accounts, Pix unlocked for the first time the path to digital payments. Digital payments leave behind a trace of income and spendings that financial service companies can use to offer other financial services. Consistently with this notion, access to credit has indeed grown since 2020, although many other factors may have concurred to that end.

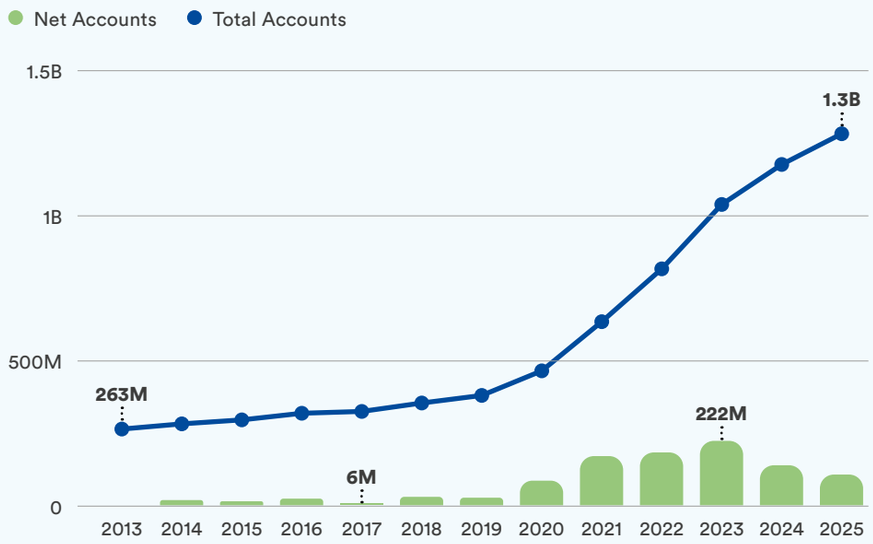
Payer's Region	Pix per Capita
North	30.3
Center-west	28.2
Southeast	27.6
Northeast	26.5
South	22.5

Pix Penetration: Percentage of the population that has used pix



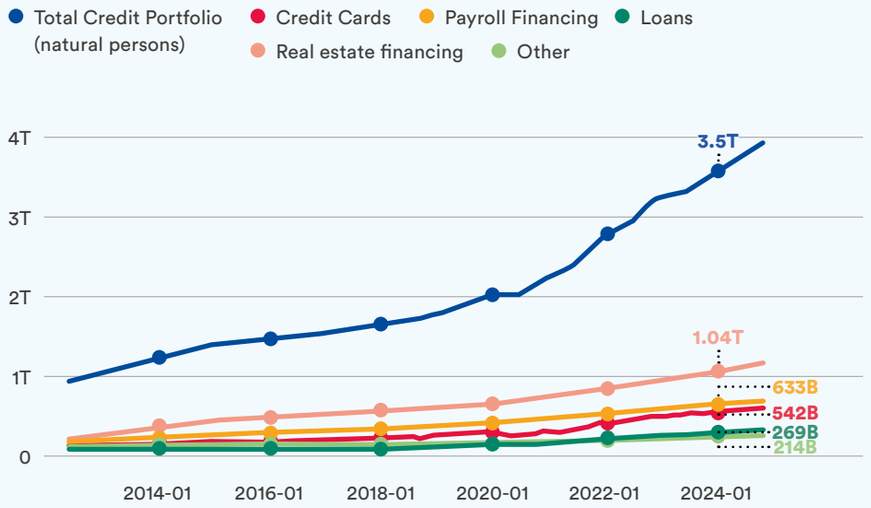
Source: Brazilian Central Bank, Brazilian Federal Government[113]

Impact of Pix on account creation



Source: Brazilian Central Bank [115]

Brazil Credit Portfolio (natural persons)



Source: Brazilian Central Bank [117]

C. Benefits to small businesses

Another area where Pix had a greater impact was on small businesses[118]. 97% of the individual business entrepreneurs accept Pix payments, while 48% of them place Pix as their favorite method to receive payments, which is already responsible for more than half of pay-ins for this kind of business[119]. According to the Brazilian Macro and Small Business Support Service, SEBRAE[120], Pix has been an ally in the financial inclusion of small businesses in Brazil, facilitating access to credit[121]. From a systemic perspective, the support to small businesses is incredibly important – especially in Brazil, where it's the leading employment-generating segment[122].

In fact, other metrics also support this conclusion. There's been an acceleration in the pace of opening new companies in 2021[123] and the informal economy rate has fallen in recent years[124].

D. Competition in the market

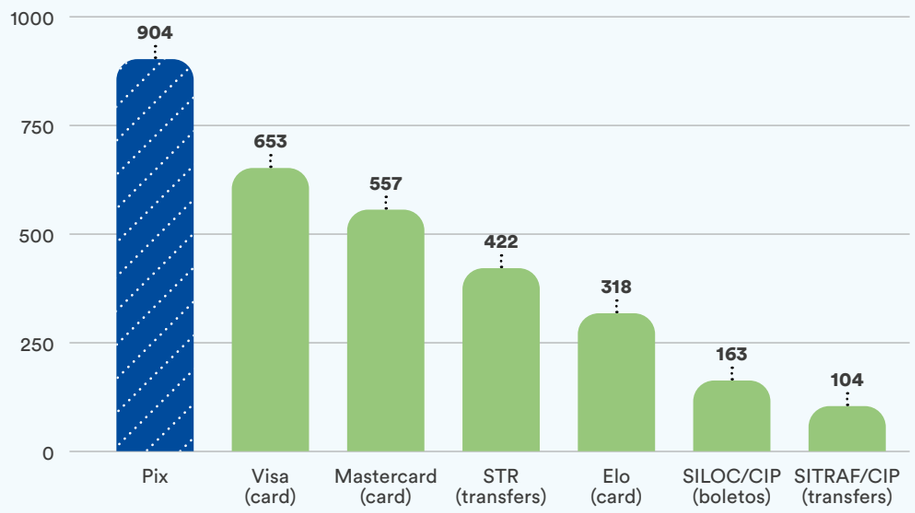
Pix has profoundly changed the dynamics of the Brazilian payment market. Payment markets are inherently a relational market, meaning that there's always at least two sides to any operation: a payer and a payee. As with any two-sided market, payment rails are ruled by network effects. Their value to any user is strictly dependent on how big the network is. To pay or receive payments in a rail, a user needs their counterpart to also be in the rail network. The more people and businesses on the rail, the more options they have for sending and receiving funds[125].

Because of that dynamic, there's a natural and powerful asymmetry between incumbents and smaller challengers in the market due to their size. The largest payment networks have on their sheer size a strong moat keeping new entrants from effectively competing with them. To offer a competing product, new entrants need a large-enough network, which can't be done if they don't have a competing product. Not by chance, a lot of the innovation efforts in the payments space have been revolving around the consolidated networks, not in opposition to them. Think competition between card issuers market and recent efforts on open finance payment initiation, where the locus of differentiation and competition is at the outer layer of payment services without disrupting their core networks.

The only exception to the incumbents advantage over challengers on payment services is the recent phenomenon of big tech entering financial services. That's because these players built the largest networks in the world based on something else rather than finance and can now use that network to outrank even the largest traditional payment rails. The threat exacerbated the concern with the asymmetric nature of the payment market and its resilience against a potential big tech oligarchy[126] .

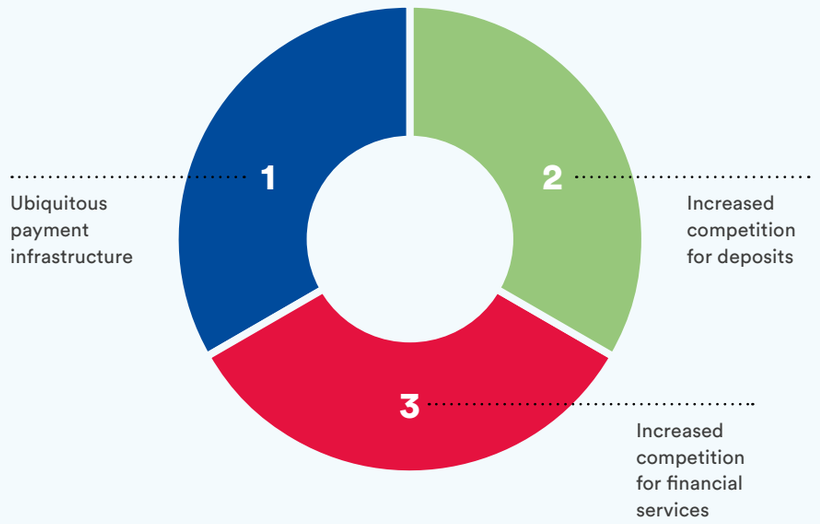
The introduction of Pix, however, flipped this dynamic on its head. Pix is the platform that connects any two accounts in Brazil. By being mandatory to the largest players, Pix created incentives to attract other 865 voluntary participants[127], becoming synonymous with an ubiquitous network.

Rails, by Number of Members (2025)



Source: Brazilian Central Bank, Visa Brasil, Mastercard Brasil, Elo, Nuclea[128]

Pix competition spiral



Its generative design means that any two PSPs in the country are not only connected by a payment settlement capability, but also by a secure data channel that can be leveraged to build any kind of payment capability. What it means effectively to the market is that no one needs to build a large network to offer payment products to their customers because the whole financial system has become one huge payment network.

For the basic payment capabilities of sending and receiving funds, size is no longer a competitive advantage. A new entrant can allow its 50 thousand customers to make and receive payments from the 190 million Pix users. If they offer the best experience, they can now grow to compete with the largest players in the space. Consequently, there is no inherent value on closed loop rails, irrespectively of their size, as evidenced by the difficulty big tech-powered payment solutions are having in Brazil[129].

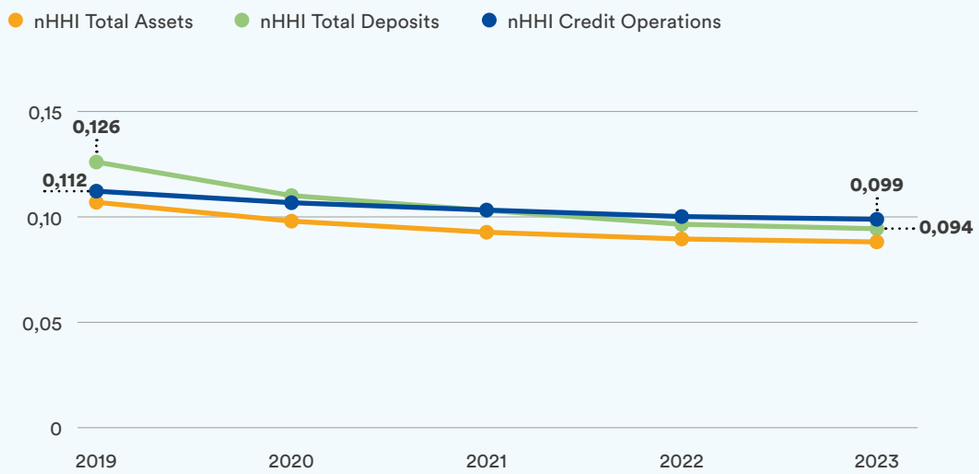
The result of this shift is a market more open for competition and innovation. Because Pix opens the infrastructure for payment as a whole and not just at the user interface level, smaller players can effectively compete for becoming the primary account for deposits, which, in turn, better position them to offer other financial services like credit, insurance, and investments. A recent research conducted by TransUnion confirmed that the number one reason for new-to-credit Brazilians to choose an institution for hiring a first credit product is “already banked there”[130]. Payments is the gateway for building share of mind in financial services and, from there, a deeper financial relationship can be built.

That competition-enabling mechanism coupled with Pix's other second-order effect of increasing financial inclusion result in a larger, less asymmetric market where innovation, better services, and lower costs can ignite the development of the whole sector. Some estimates reveal that every new customer that gets integrated to the financial system could bring a lifetime value of about USD 3.000,00, which means the untapped potential for market creation is at the scale of the hundreds of billions of dollars[131].

Indeed, Brazil has been experiencing a strong reduction in market concentration in all three areas of Total Assets, Total Deposits, and Credit Operations. As expected, the concentration in the segment of Total Deposits has been exhibiting a faster decline. Although this decline is also attributed to the broader context of BACEN-led competition-enhancing initiatives, it's remarkable how, for the first time in history, the index reached lower than 0.1 in all three categories. Moreover, after 2020, competition effectively forced prices down in the credit market, according to BACEN's analysis based on the Lerner Index[132].

As long as Pix remains true to its original evolutive and flexible design principles, the payment market can develop and evolve on top of the rail and maintain the competition-enabling trend Brazil has been experiencing.

Brazil Banking Market Concentration:
Normalized Herfindahl Hirschman Index



Source: Brazilian Central Bank[133]

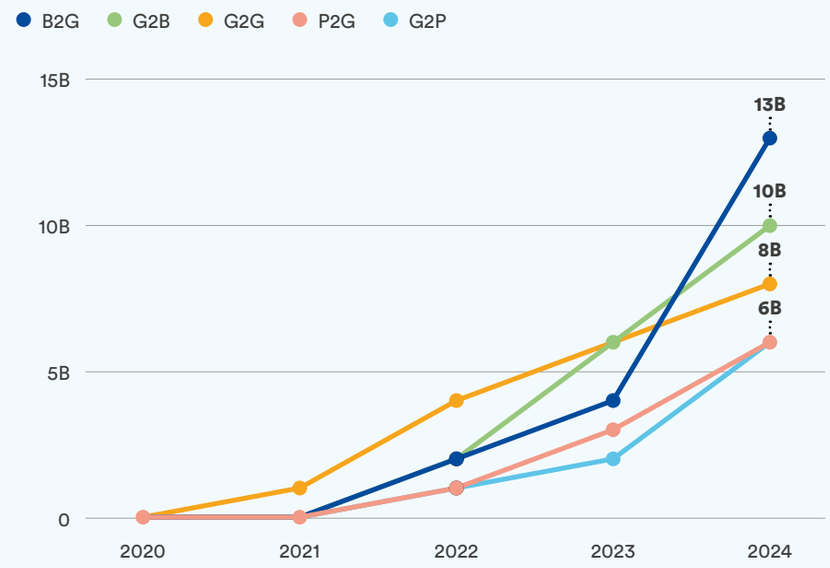
E. Support to efficient public services

Pix's development also has a great potential to improve and digitalize public services in Brazil. Pix was built to incorporate any kind of payment in Brazil, including those involving the government. Use cases such as collection of taxes, fees, fines, and payment of social benefits and contracts in general were considered since the beginning of Pix's design and can be greatly improved by using Pix instead of traditional rails[134].

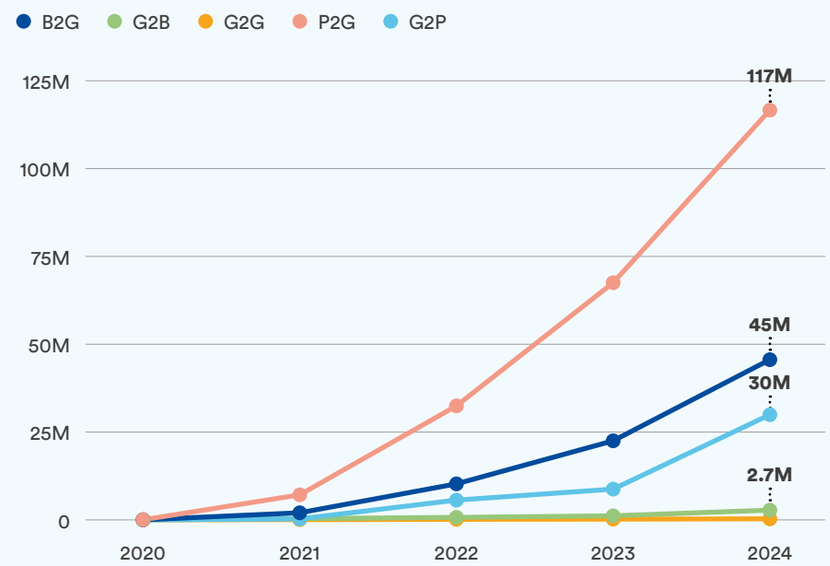
To further support the public sector in adopting Pix, BACEN signed three technical cooperation agreements with the National Treasury, the National Electric Power Agency, and a payment service provider from the telecommunication services industry[135]. The federal government[136] and some states[137] have already implemented Pix as a means to pay for taxes and government fees. The Federal Government has also started using Pix to streamline payout flows, such as tax refunds[138] and election workers compensation[139].

Pix statistics in the public sector are still low, with less than 4% of all 2024 taxes being paid through Pix[140]. The numbers, however, are in a strong upwards trend and have been accelerating with every year.

Pix and Government Payments value (USD, bi)

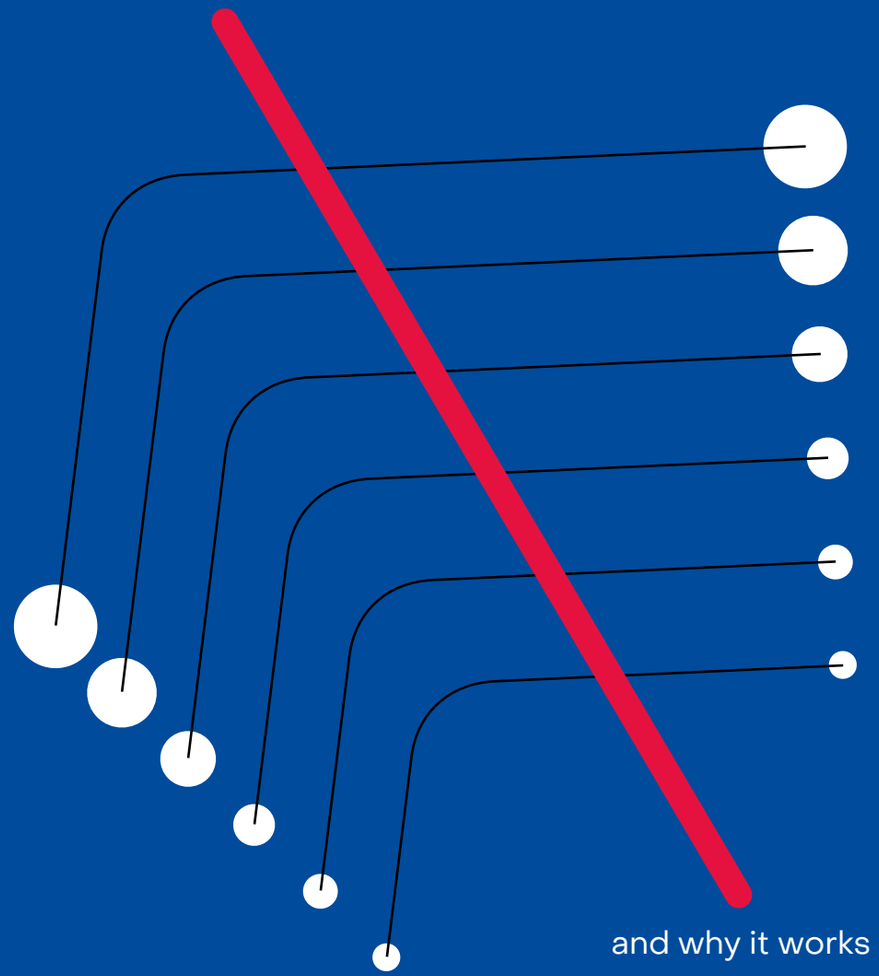


Pix and Government Payments volume (number of transactions)



I.3

How it works



and why it works

What makes Pix work and the key enabling decisions

How it works	Key decision
The infrastructure cost of each transaction is USD 0.00018 (BRL 0.001)	Open protocols (e.g.: HTTP APIs instead of proprietary messaging services), single settlement system operated by the regulator
New payment products can be introduced without any software development effort from BACEN	Flexible schemas
Both payer and payee can be aware of the state of the transaction at all times: no transaction is left in the limbo or in the dark	Eventual consistency through idempotency, transaction timeout, state transparency, and single source of truth
No synchronization or maintenance downtime for critical infrastructure such as the payment alias base	The alias base was built on top of an events log so it doesn't require synchronization downtime
No risk of not knowing exactly where your money is going	Payer PSPs are mandated to retrieve information about who is the owner of the payee bank account directly from BACEN's Alias Base and present it to the payer at the payment confirmation screen
No risk of waiting a long time to receive the funds from each sale	Payee PSPs are mandated to send confirmation of the funds on their account and p99 of transactions must be settled in under 10 seconds
No need to worry about APIs and authentication, FAPI or whatever else	Capability URLs + central registry of digital certificates
Any bank is at one integration away from being able to send and receive funds from any other bank	Centralized Settlement System
Every account holder can expect a baseline level of usability using the Pix rail, regardless of their account service provider	All PSPs need to comply with basic UX requirements issued by BACEN
No PSP started operating on Pix without a baseline quality integration to Pix's infrastructure	BACEN created both a test and an homologation environment to streamline integration
No need to hire intermediaries for a PSP to operate on Pix, reducing its operational cost	Pix adopted well-known technology with open standards and created a sandbox to guide the process of integrating to the infrastructure, and BACEN allowed from the start any regulated entity to connect directly to Pix.
No need to change regulation to evolve the system	For most of the rail operations, BACEN avoided inserting specific use cases in the regulation itself, creating a more flexible setting for PSPs to innovate on top of Pix without the need to update the regulation first.

A. Participants

Any account service provider under BACEN supervision can join the Pix rail as a payment service provider (PSP). PSPs must go through a rigorous technical homologation process and uphold a number of usability and service-level requirements. The BACEN, however, was cautious not to allow these requirements to effectively exclude any potential participant from the rail. In an active effort to reduce implementation cost, all of the requirements were designed so that any institution could reasonably implement them and, whenever possible, they were tuned to the relevance each player has in the ecosystem.

For instance, service-level requirements such as the participant availability index[141] are different depending on the financial volume they operate. The required index value ranges from 95% (smallest participants) to 99.5% (biggest participants). BACEN also made a point avoiding any design that would require participants to implement APIs so that the only APIs in the rail were implemented by BACEN, requiring PSPs to consume these APIs only.

In the early days of Pix, unregulated payment institutions could also join the Pix rail. With time, however, BACEN decided to mandate all payment institutions to formalize their status as supervised entities. Now Pix is undergoing a transition process to mandate all participants to be under BACEN's regulatory authority[142].

Pix Payment Service Providers coverage[144]	
Number of participants	904
Number of institutions in the application process	91
Percentage of account holders that have used Pix[145]	97%
Percentage of accounts connected to Pix[146]	>90%
Mandatory participants[147]	39
Voluntary participants[148]	865
Account service providers	885
Payment Initiation Service Providers	15
Participants with direct connection to SPI	187
Participants with indirect connection to SPI	703

Type of regulated entity[149]	Number of participants	Application pending	Participation rate
Payment Institution	102	16	77%
Direct Credit Society	42	9	43%
Credit, Financing and Investment Society	13	2	21%
Savings and Loan Association	1	0	100%
Securities Distribution Company	6	2	8%
Commercial Banks and Multipurpose Banks	72	1	45%
Microentrepreneur Credit Society	7	0	30%
Securities Brokerage Company	4	0	7%
Credit Cooperative	582	5	75%
Peer-to-Peer Lending Society	1	1	17%

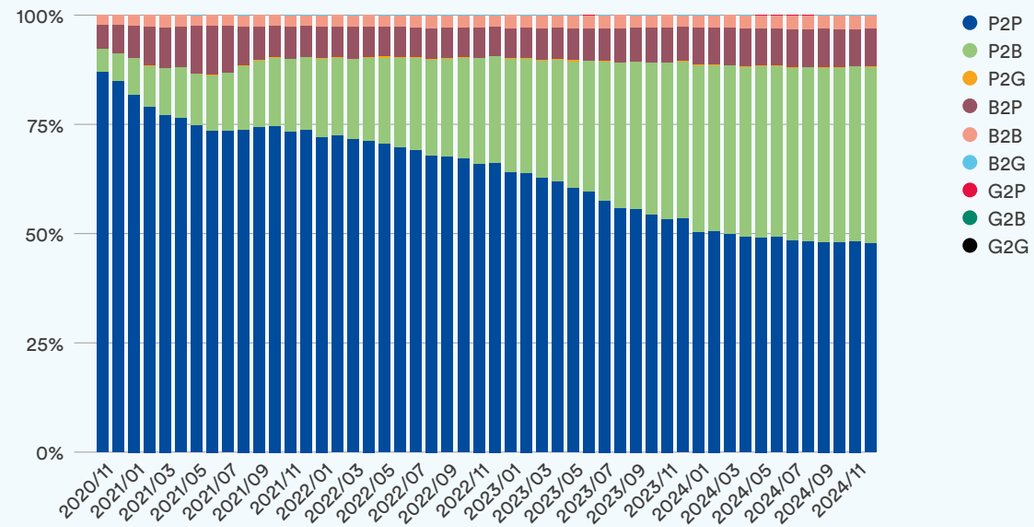
There are two modes of participation on Pix and four roles these institutions may perform. They can be either mandatory participants or voluntary. In the first category are all account service providers managing over 500.000 active (checkings or pre-paid) accounts. That meant that since launch Pix was guaranteed to cover over 90% of all accounts in the country[143]. In the second category are all the other regulated account service providers and payment initiation service providers.

As to the roles participants can perform, there are three: (i) account service provider, (ii) liquidity provider, and (iii) payment initiation service provider. Account service providers can either be directly connected to the settlement system's interface or connect via another participant directly connected. Over 180 PSPs (about 20% of participants) have a direct connection.

B. Users

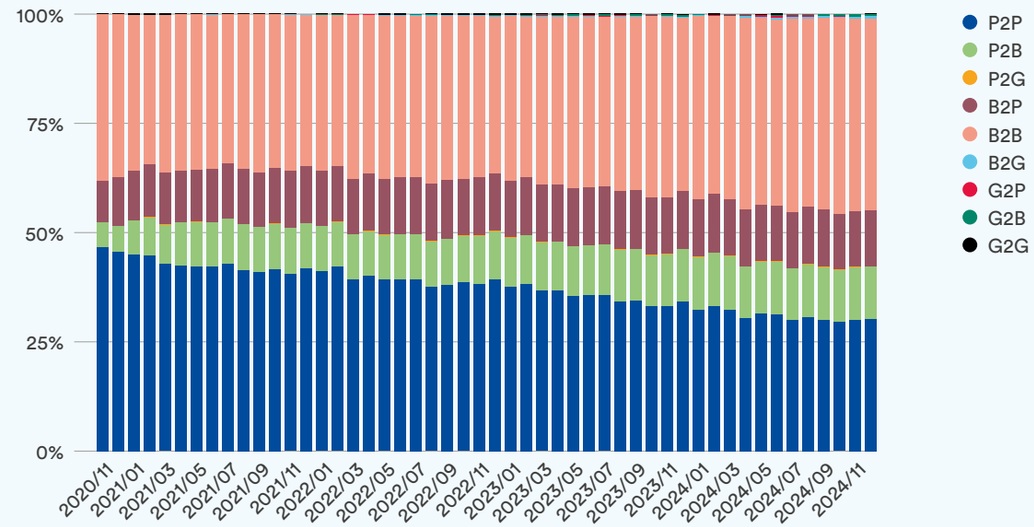
Pix was designed to be able to incorporate any kind of payment use case, welcoming users of every nature. That means it's suited for P2P, P2B, P2G, B2P, B2B, B2G, G2P, G2B, and G2G. As expected, Pix P2P and B2P were the first to take off, since they were more similar to the traditional transfers rail Brazilians were used to. As familiarity with the rail and features like Dynamic QR Codes gained traction, so did Pix P2B, which has been in exponential growth for many quarters.

Pix use cases distribution - From launch to december 2024 (number)



Source: Brazilian Central Bank[150]

Pix use cases distribution - From launch to december 2024 (value)



Source: Brazilian Central Bank[151]

C. Architecture and payment flow

The Settlement System: Sistema de Pagamentos Instantâneos – SPI. In the payment systems theory, the concept of payment is defined as the movement of funds between two accounts with metadata associated to that transaction[154]. And any kind of payment method can be reduced down to two layers: a money flow and a data flow. While many rails, like payment cards, the money flow and the data flow are completely separated, Pix has built one core payment flow that incorporates both the transfer of funds and the communication of metadata between payers and payees.

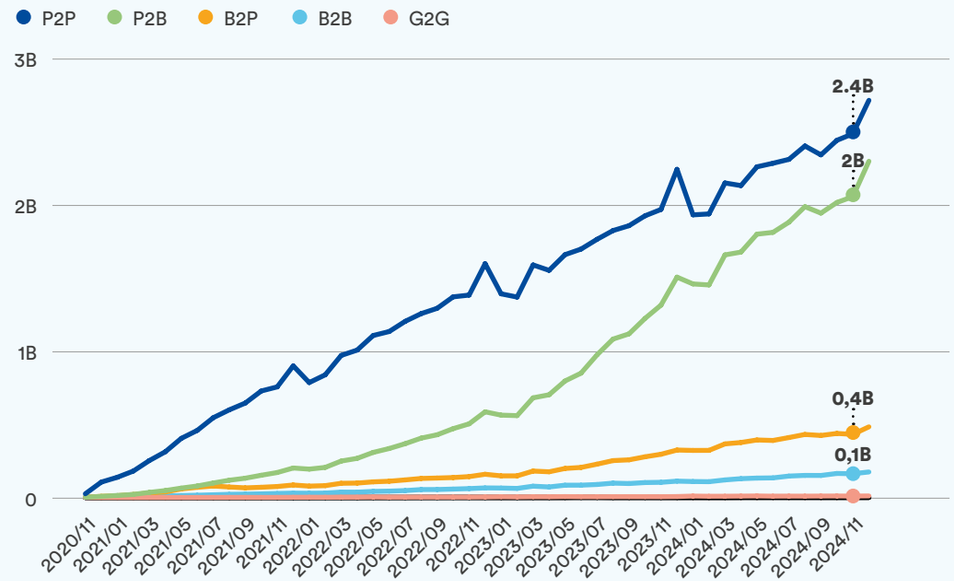
This dual-purpose flow is orchestrated by Pix's centralized Settlement System, called the Instant Payments System (SPI). SPI was built and is operated by BACEN and is the backbone of Pix. Every financial or payment institution participating in the Pix rail is connected to SPI – either directly or through a partner participant. The firms that are directly connected to SPI hold a special kind of liquidity account with BACEN called "Instant Payments Account" (IP Account), which is used to settle transactions on the rail. Transactions on SPI are grossly settled in real time and are always final and irrevocable.

Because of its data-rich payment flow, SPI is both a Settlement System and a communication channel that connects any two banks in Brazil. Therefore, as long as SPI messages can accommodate arbitrary metadata, the complexity of creating any kind of interbank service is greatly reduced. But more on that later.

A typical payment flow[155] in the Pix rail starts with the payer end-user sending its PSP a payment instruction. How that is done and what is in a payment request will be discussed in the following sessions. The Payer PSP then sends a payment order to SPI with a unique identifier, an end-to-end ID. SPI in turn blocks the funds from the

Pix use cases: From launch to december 2024 (number)

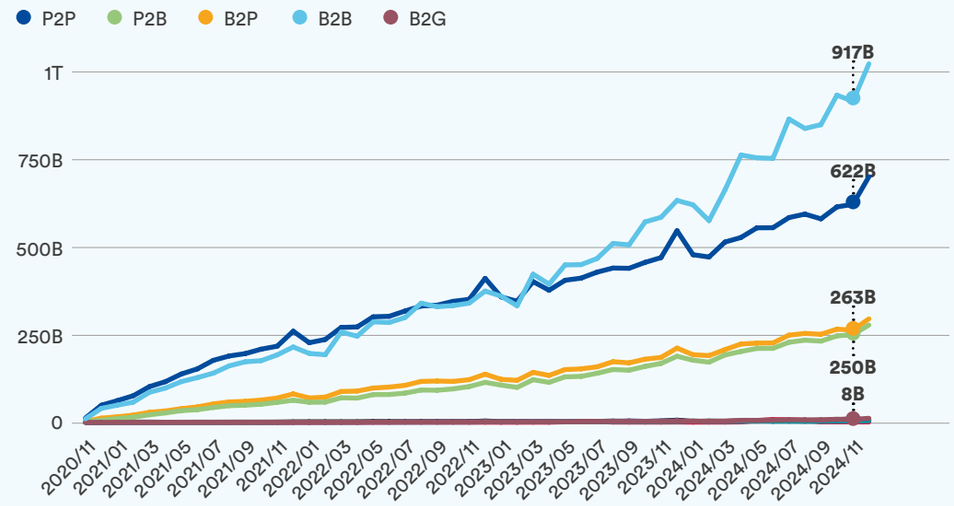
*The numbers for the P2G, G2P, G2B, and B2G use cases are too small to show up on this chart



Source: Brazilian Central Bank[152]

Pix use cases: From launch to december 2024 (value)

*The numbers for the P2G, G2P, G2B, and G2G use cases are too small to show up on this chart

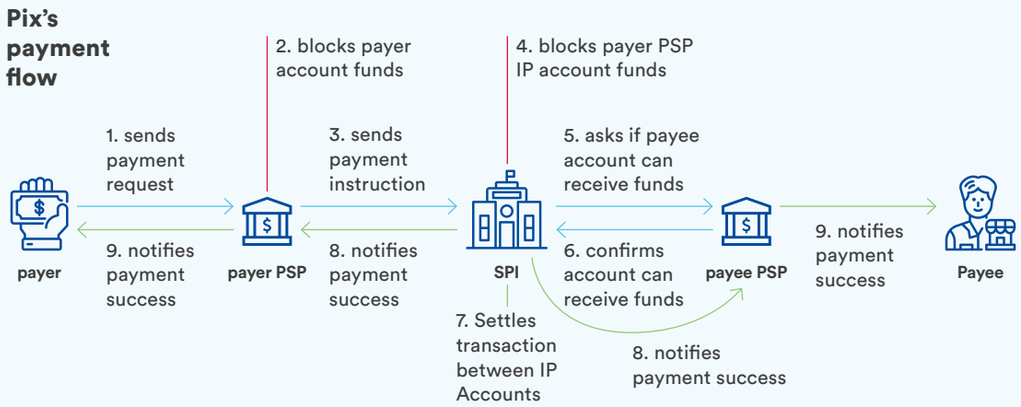


Source: Brazilian Central Bank[153]

Payer PSP IP Account and consults the Payee PSP if the payee account is available to receive funds. After the Payee PSP confirms it, SPI settles the payment between the two PSPs' IP Accounts and sends the confirmation of payment success to each of them. The PSPs then notify their respective end-users the transaction was completed. Every operation is signed with digital certificates, guaranteeing the undeniability of every operation. If, for some reason, SPI is unable to complete the settlement in the settlement window defined in Pix's rules, it drops that transaction and notifies the PSPs it has failed. PSPs are also mandated to notify payment failure to their end-users.

To reduce liquidity risk in the system and improve efficiency, BACEN extended a rediscount line for participants with IP Accounts and created specific rules to pay interest on at least a portion of IP Accounts' balance[157]. To increase system reliability in the payment flow, Pix uses best practices of distributed systems like idempotency, a single source of truth, timeouts, and eventual consistency tied to strong requirements for availability of all systems. These might seem technical minutia, but they're actually pivotal to the success of any payment system and should be addressed even on non-technical forums. A payment system like Pix functions as what computer science calls a "distributed system"[158].

Pix's payment flow



Source: Brazilian Central Bank[156]

That means a variety of computers (clients, servers, nodes) are involved in the same operation. For a distributed system to be reliable it has to account for a number of issues that may occur in the communication between these computers. How the system deals with these issues has a great impact on user experience and the trust users deposit on the system. If, for example, there's a slight connectivity oscillation after Payer PSP sends the payment order to SPI and SPI never gets it. What should happen then?

Some systems are built in a way that the whole operation must be discarded and the user must be asked to try again. Some others run the risk of performing double payments if, in the absence of a reply from the payment system operator, the Payer PSP resends the payment instrument. Some others yet run the risk of missing track of transactions when one of the steps of the operation is lost in a network fluctuation, for example. So, the transaction never reaches its destination and no one is notified about what happened.

To avoid all these risks, every transaction is assigned a universal unique end-to-end ID that is big enough to be effectively impossible to ever assign the same ID to two different transactions[159]. That way, every PSP can generate end-to-end IDs without coordination and be sure never to assign the same ID to two different transactions. This end-to-end ID then is used by SPI to verify if a payment order has already been processed or whether it's new. So, if a Payer PSP sends a payment order and never hears back from SPI, it can send the same order again and be sure SPI will not process two orders with the same ID. This is what is called idempotency – the property that one operation can be retried any number of times without ever risking a different result.

Another important aspect of how Pix's payment flow works is that SPI has total control over the status of any transaction. A transaction is only ever completed when SPI transfers funds between IP Accounts. That means SPI is the only source of truth about the status of a transaction. Thanks to the end-to-end ID, if a network issue prevents a PSP from

receiving a message confirming the settlement, it can query SPI about what happened to the transaction. To make sure an unavailability of one of the participants doesn't halt SPI's operation for too long – which would also make end-users unsure of what happened to the transaction –, SPI computes timeouts for every step of the transaction.

If one PSP fails in performing an operation in the designated time, SPI cancels the transaction and communicates the final status to all participants. That sets a time bound to how long end-users can wait without knowing if the transaction succeeded or failed. Because all operations are time-bounded, the state of a transaction always converges to a final state defined by the SPI, achieving eventual consistency, meaning that once the connection is restored all participants and end-users receive the same status about the transaction. Due to the strong availability requirements, the wait from an end-user perspective is never too long. SPI is required to deliver 99.9% availability and frequently delivers 99.99% of availability[160], meaning it's usually not offline for longer than 5 minutes in a month.

This architecture and payment flow bring four important consequences for the payment system:

1. One integration to connect to the whole country: because any account service provider can connect to Pix, every PSP is one integration away from reaching effectively any account in the country, which greatly reduces integration costs.

2. System reliability: thanks to the implementation of idempotency, timeouts, eventual consistency, and strong availability assurance from SPI and mandates for PSPs.

3. State transparency: a transaction is never lost and both payer and payee can get the latest information about a transaction status.

4. Competition: New entrants can offer effective payment services to their clients irrespective of their size without the need to join a private network like the card rails. Besides, the mere transfer of funds capability was commoditized, preparing the field for competition on experience and added value in the market.

The payment alias database: DICT. The second core infrastructure provided by BACEN is the Transaction Accounts Identifier Directory (DICT). DICT is an infrastructure for registering and retrieving payment routing information using any of the four possible payment aliases: (i) Tax ID (CPF or CNPJ), (ii) phone number, (iii) e-mail address, or (iv) an universal unique identifier – UUID[161], which is used as a kind of Virtual Payment Address – VPA, for privacy-concerned users. DICT is built on top of a write-ahead, events log[162], which means it doesn't need programmed downtime to synchronize the database with all Pix PSPs. Pix PSPs can be connected directly to DICT or via another partner PSP. In any case, PSPs register payment aliases at the request of their clients and associate them to one specific account.

The payment aliases can be updated, by the user, to point to a different account, including accounts in a different PSP. Since all events of registering, updating, and deleting a Pix payment alias are registered in the DICT log and the log events associated with PSPs are replicated to them, PSPs can be sure they have all the appropriate events in the right order on their own replica, ensuring consistency.

After its launch, DICT has evolved and gained a second function, as an anti-fraud information database where PSPs can share information helpful to spot and prevent fraudulent behavior in relation to the Pix users[163] .

D. Payment initiation

The payment flow is always the same, no matter what metadata or the specific payment product that's running on top of Pix's infrastructure. It always starts with the Payer PSP sending a payment order to SPI. That's a system invariant. In computer science, setting invariants plays a role in reducing the complexity of a solution. That's true at the code level and also true at the high-level design. Setting one single payment flow guarantees SPI always has to execute the exact same set of operations to settle any given transaction, irrespectively of what that payment looks like for their end-users. It reduces costs, margin for errors, and security vulnerabilities.

The different payment products that can be built on top of Pix and its various user experiences available are a matter of defining how the payment information gets to the Payer PSP at the beginning of the payment flow. That's what it means to define a payment initiation process. Pix transactions can fit into six broad categories of payment initiation methods. For the purpose of this study, we consider four of them payer-initiated and the other two, third-party-initiated. The difference is defined by whether it's the payer or a third party (e.g., the payee or a wallet) who sends the payment information to the Payer PSP[164].

Payer-initiated payments

Payer-initiated payments are a major inversion of experience compared with now more traditional payment methods such as credit cards. In the cards rails, it's the payee PSP (the acquirer) who initiates the payment, sending the payment details and authorization (chip + pin or magnetic stripe) to the payer PSP. In this situation, the merchant controls the device where the transaction is being processed. Because of that, concerns about fraud and PoS compromise are frequent in the industry as a single compromised PoS can be the cause for frauds to multiple payers[165] .

Payer-initiated payments, on the other hand, are operated on the payer user's device. The payment interface is on the payer's smartphone, while logged into their PSP's app. That experience puts the payer in control and may help to increase trust on more users more skeptical of digital payments[166]. Pix's first payment initiation methods to launch were payer-initiated, which may have contributed to increase the trust in the ecosystem itself.

Manual insertion. That's when the payer is logged to their PSP interface (app, web browser, ATM, etc.) and types in all the information required to make a transaction. That is: value, time (if immediate, scheduled, or recurrent), payee account information, and payee Tax ID. That way, the payer does all the work of inputting the payment information directly into the payer PSP's controlled environment for it to start the payment flow.

The UX in this case is not very different from many RTGS transfer rails out there. However, Pix's manual insertion payment initiation played a crucial role in Pix's adoption, offering the chance for new users to start using the new rail without even noticing any difference from the previous model. That allowed Pix to bridge the technology-adoption chasm[167]. Pix's numbers started to grow without requiring any change in behavior from the Brazilian population. As the numbers grew, so did the confidence in the system. Even today, manual insertion is the third most used payment initiation method (12%) and the second one in financial volume (38%)[168].

Payment alias. The second form of payer-initiated payment represents a huge improvement in usability, swiping the need to type in all routing information for the use of a simple payment alias. Those aliases can be registered by Pix users at any time through their PSP app and are used to facilitate receiving Pix transfers. They can be the users' phone number, e-mail, tax ID, or a privacy-friendly alternative, which is registering a VPA (UUID) to be the payment alias. The keys are stored in BACEN's centralized payment alias database (DICT) so that any PSP can query DICT using the payment alias to retrieve the full routing information to an account. This way, the payer user needs only to inform the payment alias, the value, the time, and any additional message they want.

From a security point of view, the routing information for transactions involving Pix aliases always comes from a trusted source: BACEN's DICT, which gets its information directly from a participating PSP. And payer PSPs are mandated to always present a confirmation screen for the payer with all payment information, including payee's information they retrieved from DICT. This is how Pix users can always be certain they are sending money to the intended payee. Pix payment aliases are the most popular payment initiation method, both in terms of number (42%) and value (51%) of transactions.

QR Code. In essence, QR Codes are a way to encode text into an image. Its wide application is due to the capability of transferring data from one means (ex: paper or a screen) to another (ex: a smartphone) by using a camera to decode the image and extract the text. This capability is especially powerful considering it's possible to encode URLs as QR Codes, giving the image the ability to transmit an indefinite amount of data or even trigger any kind of action URLs can perform.

In the case of payments, QR Codes are valuable and widely used because they allow payees to insert all relevant payment information in the QR Code (or an URL in the QR Code) so that payers can retrieve them by scanning the image with their bank apps. This way, payees can be sure that the information sent to the payer PSP is correct and the payer is saved from the hassle of typing everything on the app themselves because the PSP app retrieves all relevant information directly from the payee's QR Code. So, defining the standard for QR Codes is to define how to make the payment information go from the payee to the payer PSP for it to start the payment flow.

QR Codes are text encoded as image

Inserting links on QR Codes are a widely used strategy to employ QR Codes effectively.

The larger the text, the more detailed the image, and the harder it is to scan it successfully with low-end cameras.

The Pix rail implemented three types of QR Codes. Pix's **Static QR Codes** are the simplest form. They convey essentially an payment alias, an optional field that's for the value of the payment and another optional field for any message or information the payee wants to send the payer. When they scan a Static QR Code, the payer PSP retrieves all routing information from DICT and presents them for confirmation on the screen. The payer can type in a value for the transfer if the QR Code didn't have one and also send the payee a message with the transfer. Using the payment alias in association with the Static QR Code is crucial for security. This way, the information that's presented for confirmation to the payer comes from a trusted source, avoiding the risk of someone swapping a legitimate QR Code for another one with a different payee account. Besides, payees can change the account associated with a Pix key without needing to replace any QR Code they created using that Pix key. The same QR Code with the Pix key will continue to work, routing the transfer to the new account of choice of the payee.

Pix's **Dynamic QR Codes** use the concept of inserting an URL on the QR Code to make a more versatile communication channel between payees and payers. The URL uses a clever combination of what is called a capability URL and verified domains. It's a quite simple arrangement: the payee PSP generates a URL on a domain they control, such as "https://psp.example.com/", and inserts an UUID so that no one could guess or try to enumerate the URL. So, the URL ends up looking like "https://psp.example.com/26e9634f-3117-4e49-baae-50bb70c91e29". The size of the UUID makes it effectively impossible for anyone who hasn't scanned the QR Code to access that URL (the chance of 1 in a few quintillions – or millions of millions of millions). And the domain from the payee PSP is an assurance for the payer that the information retrieved from the URL comes from a trusted source.

So when a payer user scans a Dynamic QR Code with their PSP app, the payer PSP accesses the URL and retrieves all payment information directly from the payee PSP servers. That has two major consequences for payments: (1) payee PSPs can now add arbitrary information on the QR Code because they have a direct connection to the payer PSP, and (2) payee PSPs can update the information they send to the payer PSP whenever appropriate.

Another unique aspect of Dynamic QR Codes is in the format of the data payee PSPs send payer PSPs. The specification defines basic fields such as value and payee's information, but also adopts what is called metamodeling to encode arbitrary metadata. Its power is once again in its simplicity: Pix defined a structure for PSPs to create new fields to send any kind of information through Dynamic QR Codes. That means payee PSPs can add any information they want in the message they send the payer PSP and be sure that the payer PSP will be able to read it and present it to the payer user at the confirmation screen. That's what allows features such as sending the shopping list so the payer can check what they are paying for at the payment confirmation screen or even sending links with contracts that can be signed upon payment.

What makes Pix's Dynamic QR Codes the most powerful in the world

What	Why
[1] Use of capability URLs with registered domains and digital certificates	• **It creates a safe channel between any two PSPs for sending payment information without the need to build APIs.** • **It allows more complex forms of payments, with more metadata than it would have been feasible to add to a QR Code, such as "due date", "late fees", "SKU", "loyalty membership", etc.** • **It allows the QR Code to update with time, to avoid double payment, to update total due with late fees, to create a live QR Code payment bill on restaurant tables, etc..**
[2] Adoption of a metamodeling for sharing data between payee PSP and Payer PSP	• **Pix not only defines mandatory and optional fields for standard payment information but also defines the structure (schema) to create arbitrary new fields to adapt to different payment use cases without the need to change even one line of code from Pix's infrastructure or the payer PSPs implementations.**

These two features – use of secure URLs and arbitrary field creating – mean Pix can create as many specific payer-initiated payment products as policymakers or market players want without ever needing to change one line of code from its core infrastructure. That being said, Pix did create specific standards for Dynamic QR Codes for bill payments ("Pix Collection"), and a whole other type of QR Code for recurring payments, the Compound QR Code.

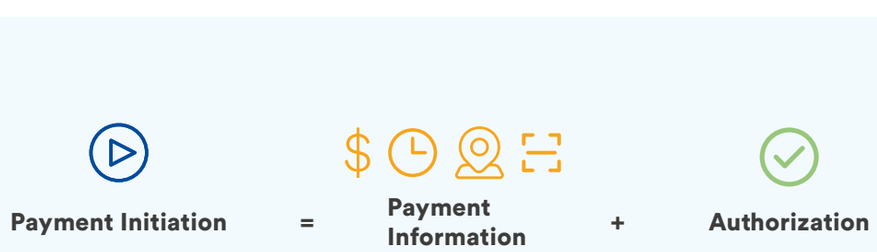
Compound QR Codes were created in the context of Pix Automatic Payments, one of the third-party-initiated payment initiation methods native to Pix and that is due to launch later this year. Compound QR Codes differ from Dynamic QR Codes in that they incorporate one additional URL to communicate information specifically about the recurrence of Pix Automatic Payments.

Pix QR Codes, as any payment QR Code in Brazil, follow the standard of BR Codes, an implementation of the EMVCo standard for merchant-presented QR Codes. That means, besides the information required for the payment initiation on the Pix rail, all QR Codes must include additional fields to comply with BR Code that are then discarded by the payer PSP to maintain the assurance of receiving relevant information from a trusted source instead of a plain-text QR Code.

NFC Pix payments have been on the Pix Forum radar since its early days. In fact, once the standard for sending information from payee PSP to payer PSP has been established in the QR Codes specification, the issue about adding any other payment initiation method is just a matter of establishing the communication tunnel itself because the content of the communication could (should) be exactly the same Although some market players have announced implementations of NFC for Pix[169], the official specification of Pix NFC hasn't yet been published.

Third-party-initiated payments

In any payment initiation method, two elements are always in place: (i) the payment information that must reach the payer PSP's servers, and (ii) the payer's authorization to perform that transaction. In the first four payment initiation methods above, the payer user used the payer PSP app or interface in an authenticated environment (logged in) to feed all payment information to the PSP. So, the authorization part of this equation was quite easy for the payer PSP to perform and control.



However, in the case of third-party-initiated payments, when the payer PSP receives the payment information without the direct interaction of the payer user, authentication and authorization become an issue to be addressed. BACEN solved that issue by building two overlays on top of Pix. By overlay we mean they are sub-systems that add capabilities to Pix but require separate enrollment and integration from PSPs. Apart from the two third-party-initiated payment overlays, Pix also has a cash withdrawal overlay that also requires specific integration and enrollment since it doesn't use the same messaging as payer-initiated payments.

Here's how Pix solves the third-party-initiated payment issue in the two payment initiation methods of the sort it offers today.

API payment initiation (Open Finance). Parallel to the development of Pix, another BACEN team oversaw the development of the Open Finance ecosystem in Brazil. The two initiatives intersect when Open Finance APIs are used as a method of Pix payment initiation. Often referred to as third-party payment initiation (3PI), it typically is implemented in three distinct settings: (i) by wallets, who function as an alternative interface for the payer user to operate their accounts without opening their PSP apps, (ii) by PSPs, who use the APIs to implement same-account owner features, like account top-up and sweep accounts, (iii) by pay-in service providers, who use the APIs to give an e-commerce the ability to ignite a payment from the customer's account to one of their own.

Labrys and Zetta published a dedicated study about open finance with detailed information about Open Finance Pix payments[170]. Here, we'll focus on the issue of authentication and authorization. Initially, Open Finance Pix payments required all payments to be confirmed by the payer on the logged in environment of the payer PSP. That meant no matter where the payment started, the payer user had to be redirected to the payer PSP app to make the authentication and payment authorization. As mentioned above, and in a few other analyses, that's something that can be achieved using URLs instead of APIs[171].

However, the Open Finance ecosystem in Brazil evolved to allow one time authorization for future payments, what's being called the no-redirect user journey. This new kind of user experience allows an "account on file" experience, where payers authorize a third party to make future transfers from their account once and don't have to confirm any future payment again for as long as the authorization lasts. One of the most anticipated applications is for Google Pay to use NFC to communicate with card PoSs and use the "account on file" to execute the payment from the payers' account.

Pix Automatic Payments (Recurring Request Pay) is the latest promise to profoundly transform the Pix rail. Much like a direct debit, it's the payment initiation method that allows payee PSPs to send payment requests to payer PSPs directly through SPI, without the need for the payment information to travel between the payer and payee users. Here, it's worth mentioning that although the payment initiation starts at the payee PSP, the payment flow still hasn't changed. It's just another way of making the payment information reach the payer PSP so it can start the payment flow normally. Payers will be able to authorize future payments once and their PSP will store the information about this authorization. So, when future transfers arrive from the payee PSP, they can check against the parameters of the authorization and, if they match, the payer PSP can initiate the payment flow without requiring another interaction with the payer user.

Pix Automatic Payments launched on June 2025[172] with some important restrictions to meet BACEN's concerns with security: (i) it will only be available for business payees, although any payer (individual or business) can use it, (ii) it will only be available for recurring payments with a specific periodicity, not for creating an "account on file" experience nor to send one-time payment requests, (iii) it will not be mandatory for Pix PSPs nor are there guidelines for usability on the payee PSP environment, (iv) it will not leverage Pix payment aliases, so no portability mechanism will be inherently available from the start, and (v)it will have limited control options for the payer, since it won't contemplate a mechanism to block payment requests, to advance any future payment, to decide if late payments should be processed, or to allow a one-time payment above the authorized limit to avoid it being rejected[173].

E. Usability

BACEN also ensured a baseline user experience while using each of the payment initiation methods above. The three main moves to achieve this were: (1) requiring the offer of Pix services on the main digital channel of all mandatory participants, (2) creating a technical manual with the minimum UX requirements for each Pix functionality, and (3) standardizing the APIs third-party providers can use to access Payee PSP services.

The requirement of offering Pix on the main digital channel ensured that unmotivated large PSPs couldn't bury Pix functionalities on inconvenient service channels such as ATMs or obscure applications. The minimum requirements took it a step beyond by preventing PSPs from hiding functionalities within the app itself, making sure end-users could easily start using the new rail with the least amount of friction.

Finally, the Payee PSP APIs were created to simplify the integration of third-party providers interested in offering and/or automating business-focus services such as QR Code generation, payment status notification, etc. The goal was to standardize the interface between account service providers and Enterprise Resource Planning – ERP services and other business-level integrations.

F. Security-by-design

Pix was built with security-by-design front and center. First, all participants are mandated to uphold minimum information security requirements within their systems and to report relevant incidents. Second, the connection to Pix's infrastructure goes through dedicated links that connect the whole financial system, the National Financial System Network (RSFN)[174]. The system is built on top of strong security standards and supports all critical data traffic in the financial system[175]. Third, the settlement flow was designed to guarantee the idempotency of all transactions[176]. That means preventing the risk of the same transaction being performed multiple times. Fourth, the settlement flow implemented high quality error handling mechanisms, setting the settlement system (SPI) as the unique source of truth about the status of a payment, which prevents disputes about whether payments were completed or not.

Fifth, Pix's first payment initiation methods implemented were all payer-initiated, which removed a whole cluster of attacks typical of third-party-initiated payments[177]. In essence, the fact the transaction is started in the payer's trusted device circumvents the risk of a compromised PoS modifying or multiplying the transaction or stealing the payer's credentials.

Sixth, Pix's payment initiation via Static QR Codes, Dynamic QR Codes and payment aliases implemented an additional security layer by making sure the critical information about who will receive the payment comes from a trusted source. Because the three use Pix payment aliases instead of using traditional account information, the information about the payee account always comes from the alias database, DICT. That means when a payer scans a QR Code, they can be sure the payee information that appears in their confirmation screen is verified. This mechanism prevents errors and attacks where the QR Code is tempered with to change the destination account. With Dynamic QR Codes, all information rendered to the payer in the confirmation screen comes directly from the Payee PSP, which adds yet another layer of security and trust. Seventh, the fact that all payer-initiated payments present all relevant information for payer confirmation before initiating the money flow also contributes with an additional security trust-enabling mechanism.

Eighth, Pix uses universal unique identifiers – UUIDs to improve security of the system. UUIDs are a long, random sequence of characters that are used as secured identifiers. Because they are long and random, it's virtually impossible to guess or predict a UUID, which deepens the security of the underlying service. The fact an attacker cannot find a resource by predicting or brute forcing its location (ID) means its security does not depend solely on the access control in place[178]. In the Pix rail UUIDs are employed as privacy-preserving and security-enhancing Pix keys[179] (the "random key" or VPA, as mentioned above) and in the QR Code URL[180], implemented as *capability URLs*[181]. Ninth, Dynamic QR Codes have an additional security feature: using registered domains and SSL digital certificates to ensure the authenticity of the payment information payer PSPs present to the payer for confirmation[182].

G. Anti-fraud mechanisms

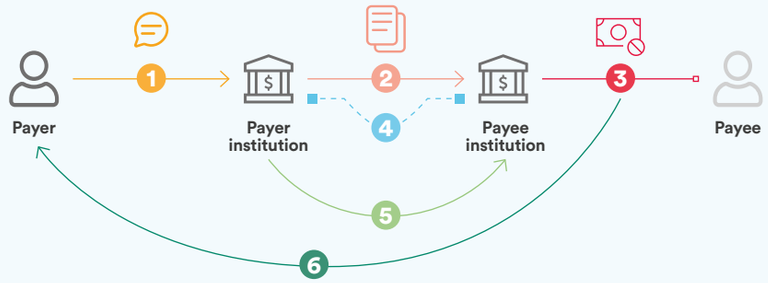
As a result of its security-by-design approach, Pix was able to launch and scale at an extremely low fraud rate. And, as a testament to the quality of Pix's security-by-design approach, the main issue regarding Pix's security is social engineering attacks, where criminals target individuals instead of the system itself[183]. This scenario has driven the development of multiple complementary fraud prevention and user protection mechanisms, which are continuously enhanced through proposals from the Pix Forum's Security working group (GE-SEG).

In 2021, BACEN started implementing additional measures to prevent fraud and reduce the participants' risk exposure. These measures included: (1) creating a mandated standard transaction limit for operations by night at around USD 170.00 and by day at the same transaction limit applied for the traditional account-to-account transfer rail (TED), regardless of the use case being transfer or payment[184] (starting 08/2021); (2) allowing Payee PSPs offering services to natural persons to implement the cautionary freezing of funds in case there are suspicion of fraud (starting 11/2021); (3) implementing the Special Refund Mechanism – MED[185]; (4) implementing a fraud prevention information database on top of DICT, the payment alias database[186].

Regarding MED, it is a process that allows funds to be quickly blocked in the account of the payee upon a fraud complaint from the payer. The funds can then be returned to the payer after the complaint analysis is complete, if it's deemed valid. MED can also be used if an operational failure in the involved institution's systems results in an undue credit transfer.

MED enables institutions to use the Pix infrastructure to facilitate communication between the parties and while imposing standardized procedures within strict deadlines set by the Central Bank. This brings greater speed and efficiency to the process, thereby increasing the fraud victim's chances of recovering their funds in cases their institution isn't liable for the restitution. In addition, once a complaint is accepted by the Payee PSP, the user and their payment alias are flagged in the DICT. All Pix participants can access and use this information to strengthen risk controls and implement additional fraud prevention measures.

Special Refund Mechanism (MED) - High level flow



1 Payer: Contacts their PSP to report the fraud

2 Payer PSP: Opens an infraction notification

3 Payee PSP: Blocks the funds

4 Both PSPs: Analysis of the report's validity.

If deemed valid, the Payee is flagged in DICT and:

5 Payer PSP: Requests the refund

6 Payee PSP: Processes the refund

Fraud rates in the Pix rail are extremely low

	% of Transaction Number	% of Transaction Value
2022	0.008% (0.8 bps)	0.03% (0.3 bps)
2023	0.007% (0.7 bps)	0.03% (0.3 bps)
2024	0.009% (0.9 bps)	0.03% (0.3 bps)

In June 2022, estimations about fraud losses were not greater than USD 51 million per month[187]. According to BACEN data, the amount of money involved in fraudulent transactions was closer to USD 38 million per month, or USD 459 million in the whole year. It represented 0.03% of all transaction value in that period. That means for every USD 1.00 spent with Pix, around USD 0.00029 was lost to fraud. In 2024, as transaction volume grew, a total of USD 1.2 billion were involved in fraud[188]. Although the absolute number may sound alarming, the raise solely reflected the growth of the rail maintaining the level of 0.03% of all transaction value.

Pix's fraud levels are very low when compared with other payment rails too. Its fraud per transaction rate in 2022, 2023 and 2024 was lower than 0.01%[189], while the card network's rate was at 1%[190] in 2023. This data is consistent with the Global Fraud Report 2023, which placed *card testing*[191] as the number 1 fraud attackers use in LATAM[192].

Since Pix's launch, a little over 1 million payment aliases were impacted by security breaches in Pix participants, but that number represents only 0.12% of all registered aliases[193]. Finally, in January 2025, the rate of transaction fraud in Pix was around 0.006% (0.6 bps)[194], down from 0.009% (0.9 bps) in 2024[195]. For reference, Visa's new threshold for disputed transactions rate is currently at 90 bps in LATAM and 150 bps in the US, Canada, Europe, CEMA, and Asia Pacific[196].

Generally speaking, the rise of digital payments – with Pix as a catalyst – has been pushing for a shift in the criminal profile prevalent in Brazil. Although fraud cases are on the rise in absolute terms in later years, violent crimes related to cash and robbery like bank robberies[197] and mugging[198] (including mobile phones[199]) have been on significant decline.

With the assistance of GE-SEG, BACEN keeps working on mechanisms to reduce the exposure and the impacts of fraud on Pix. By the end of 2024, BACEN increased the security controls by mandating payers to register their mobile devices with their PSPs before being able to transfer more than USD 34.00 at a time and USD 170.00 daily[200].

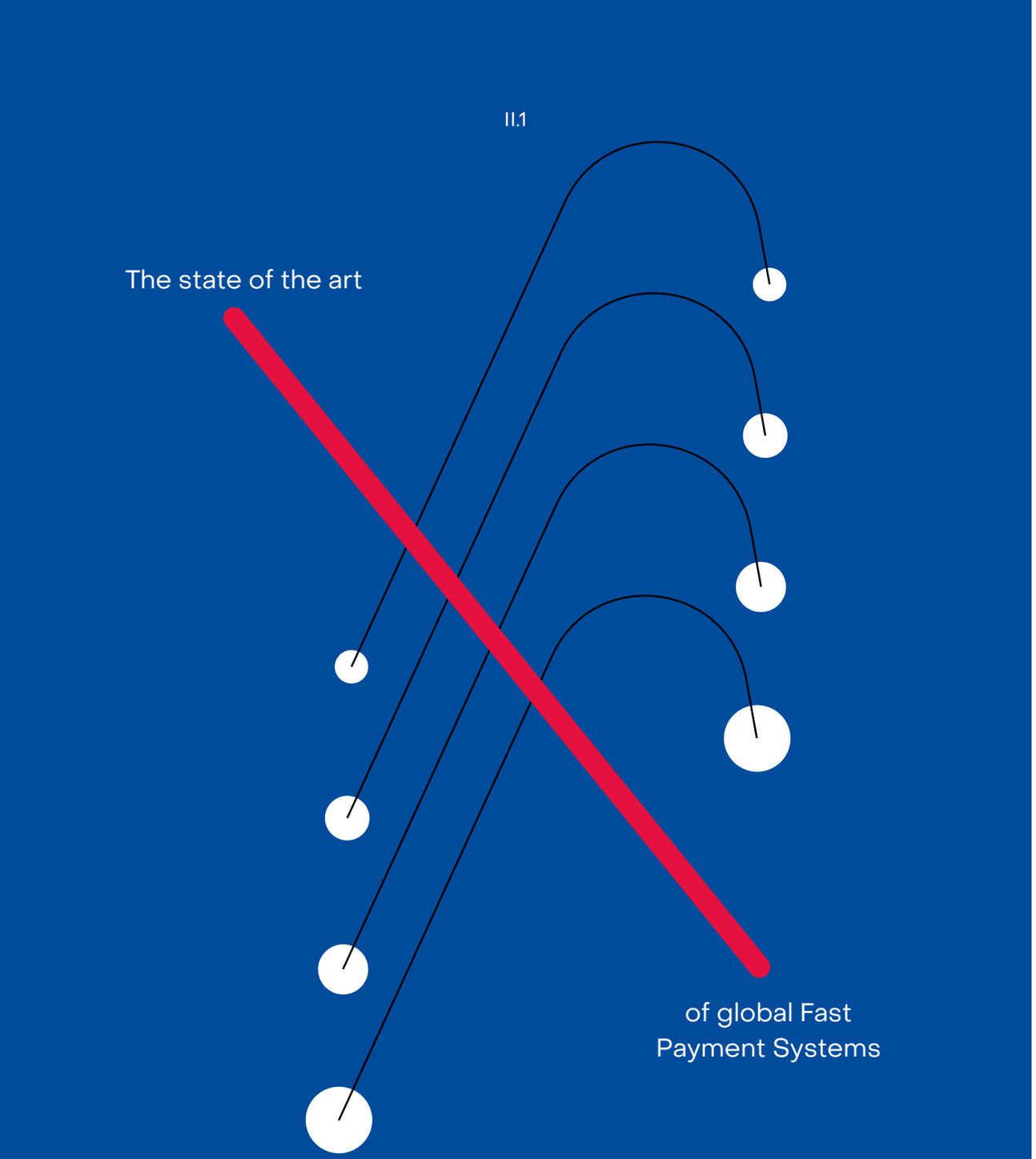
Questions Pix users never have to ask

Question	Explanation
Should I take cash in case they don't accept Pix?	**Anyone can open a bank account in 5 minutes and accept Pix payments**
Have I typed the right number to send money to my friend?	**Before confirming the transfer, payers get the information about who is the owner of the account they are sending money to. This information comes straight from the alias base and is therefore always credible information.**
The shop clerk said the transaction didn't go through. Is it true? Am I double paying?	**Both payer and payee receive a notification about the status of the transaction and they both get this information from the single source of truth: the Settlement System itself.**
Will my rent payment reach my landlord before the due date? Will the online shop take too long to receive payment confirmation? Will this delay the shipment of my purchase?	**Pix payments are settled in under 10 seconds.**
If I decide to change my account service provider, will I have to learn a different interface to make Pix transactions?	**All account services providers participating in the Pix rail need to comply with basic UX requirements that guarantee a baseline usability throughout the whole market.**

II
The global trend in Fast Payment Systems: selected case studies from the Americas, Asia, Africa, Europe, and Oceania

II.1

The state of the art



A. Fast Payment Systems as a world-wide movement

The global payments market has gone through some major transformations in the last few decades, but arguably none is as tangible and impactful as the revolution of account-to-account real-time payment infrastructures. Fast Payment Systems – FPS is one of the applicable terms commonly used to describe a payment system that delivers real-time transfer of funds 24/7/365[201].

Speed of payments became an important economic policy issue back in the 1980s. The sheer volume of money wholesale payment infrastructures transacted started to pose pressure over the traditional way of building this kind of IT systems. Until then, interbank transactions worked in a Deferred Net Settlement – DNS model. That means they were settled in batches – usually once a day – making single transfers with the difference between what a bank had to pay and what it had to receive from each of the counterpart banks, a process called netting. That meant at any given time the financial system of each of those jurisdictions was dealing with exposure to credit risk that was as large as the outstanding balances during the netting window.

To mitigate the settlement risk of netting large amounts of currency, central banks started to shift from DNS to a Real-Time Gross Settlement model, where each interbank transaction is settled one by one, in a queue, on their original value. The term real-time in this context doesn't have much to do with speed per se, but rather with the organization of the payment queue: instead of waiting for the netting window to finish and be balanced with other operations, each transaction goes straight for settlement.

In the mid 1990s the shift from DNS to RTGS started to become enforced through supranational policies, as it became a prerequisite to join the EU's Euro Zone[202]. In 2001, The Bank of International Settlements – BIS, through its Committee on Payments and Market Infrastructures – CPMI[203] published the Core Principles for Systemically Important Payment Systems, which highlighted the importance of reducing credit risk associated with netting the settlement of large volumes and nudged central banks to move towards RTGS systems. Shortly after, the International Monetary Fund – IMF and the World Bank included[204] the Core Principles into their Financial Sector Assessment Program – FSAP[205]. By 2021, the World Bank's Global Payment Systems Survey revealed that 97% of the jurisdictions were integrated to at least one RTGS system[206].

As RTGS systems developed throughout the world, a parallel trend started to emerge in the early 2000s: the concept of a fast end-user settlement system available 24/7[208]. This is when the idea of a timely transfer of funds to the end-user started to come into the scene. Back then, however, the ideas of a fast payment and of an RTGS system were not linked. For instance, the Republic of Korea – ROK was the first country to implement a fast payment system (EBS, in 2001). To this day, its interbank settlements follow a DNS model, although the transfer between end-users is processed in real-time (see more in the topic dedicated to ROK on Part II). Today, many jurisdictions opt for a RTGS model for their fast payment systems, consolidating the concept of real-time transfers for both end-users and their institutions, as is the case of Brazil's Pix, for instance. We'll go through the systemic implications of these choices on Part III.

Since Korea's pioneering implementation, the emergence of FPSs has become a world-wide trend that's been accelerating over the last few years. According to the World Bank, there are 123 countries with Fast Payment Systems live today, including 15 in Latin America[209], with a particular strong momentum in emerging economies[210]. This widespread adoption underscores the significant economic benefits associated with Fast Payment Systems usage, including greater access to accounts and credit, as well as a reduction in informality.

Core Principles for Systemically Important Payment Systems[207]

I. The system should have a wellfounded legal basis under all relevant jurisdictions. .	**VI. Assets used for settlement should preferably be a claim on the central bank; where other assets are used, they should carry little or no credit risk and little or no liquidity risk.**
II. The system's rules and procedures should enable participants to have a clear understanding of the system's impact on each of the financial risks they incur through participation in it.	**VII. The system should ensure a high degree of security and operational reliability and should have contingency arrangements for timely completion of daily processing.**
III. The system should have clearly defined procedures for the management of credit risks and liquidity risks, which specify the respective responsibilities of the system operator and the participants and which provide appropriate incentives to manage and contain those risks.	**VIII. The system should provide a means of making payments which is practical for its users and efficient for the economy.**
IV. The system should provide prompt final settlement on the day of value, preferably during the day and at a minimum at the end of the day.	**IX. The system should have objective and publicly disclosed criteria for participation, which permit fair and open access.**
V. A system in which multilateral netting takes place should, at a minimum, be capable of ensuring the timely completion of daily settlements in the event of an inability to settle by the participant with the largest single settlement obligation.	**X. The system's governance arrangements should be effective, accountable and transparent.**

B. Objectives and implementation: what makes a Fast Payment System successful

The policy goal behind each of these initiatives may vary, but they are typically related to fostering competition in the payment market, financial inclusion, innovation, and digitalization of the economy[211]. Moreover, fast, digital payments are associated[212] with economic growth and development[213] by: (i) providing a cheaper, more efficient, faster alternative to paper payments[214]; (ii) helping more individuals and companies create a digital financial footprint[215]; (iii) improving access to credit and other financial services beyond payments[216]; (iv) creating incentives against informal activities and the shadow economy, which can have significant direct impact on the GDP[217-218]; (v) reducing informal employment; (vi) improving the efficiency of the whole economy by reducing the transaction cost for every transaction when compared with traditional transfer rails, cash, or cards[219]; (vii) increasing firms' working capital by reducing the time cash isn't neither with payer nor with payee[220].

All these consequences are magnified depending on how FPSs are implemented. The lower the development, implementation, and operational cost of the system, the greater the potential upside in efficiency. These costs are impacted by choices like the technology employed, the governance model, the policy approach, and the number of use cases the system can absorb. The larger the scale of application of the same system, the lower the cost per transaction, and the larger the benefits for the economy. Besides, these decisions can also unlock new classes of economic impact. If the FPS is reliable, it can reduce costs associated with failed transactions[221]. If it is mandated across major account service providers, an FPS can increase the competitive pressure[222] for better services and lower costs for payment and financial services by removing the network externality of incumbents' larger client bases[223].

The way inefficiencies in payments work, penalizes every single person and business, every day, for as long as that payment system is used. The opportunity in developing the most efficient and versatile payment system possible is in that it can be the glue that connects every economic agent and drives them towards a better-functioning economy.

To illustrate the importance of how implementations come to life, the following topic digs deeper into the case study of nine diverse jurisdictions and two cross-border projects that implemented Fast Payment Systems and compares their numbers and economic impacts with Pix.

II.2

Selected case studies from countries across **5 continents**

A.

méxico

Mexico's fast payments implementation consists of a RTGS infrastructure, SPEI[225], that's been around since 2004[226], and two overlays[227]: CoDi[228], launched in 2019[229], and DiMo[230], live since 2023[231]. We'll go into the specifics of what an architecture built on overlays means for the FPS in Part 3 below, but for now it's enough to know overlays are sub-systems that add capabilities to an underlying system and typically require separate enrollment and integration from PSPs. SPEI is the central electronic payment network in Mexico, operated by Banco de México (México's Central Bank)[232]. It allows transfers in under 30 seconds using either account reference or debit card numbers, while CoDi and DiMo offer additional payment initiation functionalities on top of SPEI, namely: QR Codes and push notification payments (CoDi)[233], and payment using phone numbers as a payment alias (DiMo)[234]. CoDi is free to pay and receive payments[235] and SPEI is free to receive, but PSPs may apply fees to send payments through SPEI and DiMo[236].

Mexico Overview	
Adult population (>18, 2024)	98.60 million
% Banked population in country	80.90%
Accounts in the country	141.85 million
Accounts connected to the internet	98.54 million
Accounts per capita	1.44
Number of regulated PSPs	356
GDP (2024E)	USD 1.82 trillion

Source: INEGI, BIS, CNBV[224]

Since 2015, SPEI is available 24/7/365[237], but only on mobile apps[238]. For internet browser applications, the operation is restricted to banking hours[239]. Participating PSPs can also set limitations on transaction value and require additional steps to allow a new account to start receiving funds. Distinctions on clearing time and account registration requirements may also vary if the transaction is considered to be of a "low amount" (under ~USD 630)[240]. PSPs are required to send payment confirmation to both payer and payee, but Banco de México also offers two separate services for end-users to look up the status of a transfer after 30 minutes: the electronic payment receipt (CEP), and the MI-SPEI[241].

Regulated institutions under the jurisdiction of one of the financial system regulators in Mexico are eligible to participate in SPEI, as well as the federal government agencies and international foreign exchange settlement schemes[242]. Only institutions participating in SPEI can offer payment services on CoDi, but third-party developers can build solutions for payees to request payment through QR Codes, NFC or the internet[243]. To do so, though, developers must apply for an authorization, submitting a business case before even getting access to the documentation[244].

On top of SPEI, CoDi and DiMo[245] require both payer and payee users to enroll to the service before starting using it[246]. The signup for DiMo is simpler, though, requiring only linking an account to a phone number. CoDi requires the Banco de México to validate the user's account and register their device beforehand[247]. DiMo has a limitation of one-account-per-phone-number, which means that even if someone has multiple accounts, they can choose only one to be associated with their primary phone number.

Until the end of the year 2024, CoDi didn't manage to register more than 16.5 million accounts, while only about 1.06 million accounts were used to receive CoDi payments and only about 2.16 million accounts made CoDi payments[248]. Several factors have contributed to this, including a limited initial reach focused on traditional banks, limited merchant adoption, and less intuitive user experience. DiMo account registration was at 12 million accounts by the end of 2024[249] but data about actual use isn't broadly available. According to Mexico's Instituto Nacional de Estadística y Geografía (INEGI), 4.49% of the adult population declares having used CoDi (for registration or payments), while DiMo lingers at 1.15%[250].

Still, over 38 million people (40.57% of the adult population and over 60% of savings account holders) reportedly prefer to use their bank apps to manage their account[251], which could indicate a fertile space for growing digital payments. According to BANXICO, 60% of the population uses SPEI to send or receive transfers[252]. In 2024, SPEI moved USD 8.5 trillion[253], which is 5.5 times the total of household spending in the country[254]. However, the average number of transactions per year at 53 per adult[255] (65 per banked person[256]) show a tendency of use for low frequency, high value transfers.

Brazil and Mexico side-by-side

	Pix	SPEI/CoDi/DiMo
Years since launch	4	20 (9 since it's 24/7, 5 since CoDi, 2 since DiMo)
Transactions (value, 2024)	USD 4.49 trillion	USD 8.5billion (SPEI), USD 0.0002 billion (CoDI)
Transactions (number, 2024)	63.44 billion	5 billion (SPEI), 0.0042 billion (CoDI)
Users (% adult population[257])	96%	60% (SPEI), up to 3.4% (CoDI)
Transactions per capita	373.17	52.96 (SPEI), 0.04 (CoDI)
Transactions (% of GDP)	225.65%	465.24% (SPEI), 0.01% (CoDI)
Average transaction value	USD 70.75	USD 54.08
Architecture	Platform + 3 overlays (Pix Withdrawal, Open Finance API Payment Initiation, and Pix Automático)	Infrastructure with overlays
Generativity	Participants can create new functionalities using Pix's extensibility	Participants can only use services defined and built by BANXICO
Friction	No enrollment to pay	Enrollment to use CoDi and DiMo
Usability	Full account information, Standard QR Code, URL-based QR Code, Payment Alias (multiple), API	Full account information (SPEI), Standard QR Code (CoDi), Push Notification payment (CoDi), Payment Alias (phone number only) (DiMo)
Cost	Free of charge: (i) for all users for receiving transfers and making payments; (ii) for natural persons also for making transfers. Fees may apply for natural persons receiving payments and businesses making transfers and receiving payments[258].	Free to receive, fees may apply to pay (except CoDi)
Settlement + clearing	10s, mandatory notifications to end-users	30s, may require checking the status of a transfer 24h-48h later

B.

costa rica

The Sistema Nacional de Pagos Electrónicos – SINPE (Nacional Electronic Payment System, in English) is the network infrastructure that connects most payment services in Costa Rica. It was launched in 1997 and incorporated new overlays as the Costarrican payment market evolved: from cheque clearing and settlement[260] to foreign exchange[261], from fast payments[262] to public transit payments[263]: everything goes through SINPE[264].

Due to such a large scope, participants of SINPE come from a wide range of banking and non-banking institutions under the regulatory umbrella of the Consejo Nacional de Supervisión del Sistema Financiero – CONASSIF[265] (National Counsel for the Financial System Supervision)[266]. Furthermore, since 2018[267] BCCR also allows the participation of payment service providers – PSPs, which are not regulated financial institutions, but are required to get registered before the financial regulator (SUGEF[268]) and be subjected to its supervision[269].

Costa Rica Overview	
Adult population (>15, 2024)	**4.16 million**
% Banked population in country (2023)	**91%**
Accounts in the country (2022)	**12.57 million**
Accounts per capita (2022)	**3.03**
Number of regulated PSPs	**41**
GDP (2024E)	**USD 0.09 trillion**

Source: INEC, World Bank, BCCR, Labrys Analysis[259]

In 2004, the BCCR introduced the Sistema Interbancario de Liquidación – SIL (Interbank Settlement System, in English)[270] as SINPE's exclusive settlement system. SIL manages both real-time gross settlements (RTGS) and deferred net settlements (DNS), depending on the payment service overlay operating on top of it[271]. In 2006, SINPE had its operation extended to a 24/7/365 basis[272], along with SIL's settlement schedule.

By then, BCCR had already implemented a real-time payment service called Transferencia de Fondos a Terceros – TFT (Funds Transfers to Third-Parties). In 2021, it got renamed as Pagos Inmediatos – PIN (Immediate Payments[273]) but according to BCCR, some version of the service has been in operation since 2000[274]. The only native payment initiation method is inserting all payment information (IBAN, payer, and payee ID, etc.)[275], but it allows payments in Colóns and in dollars[276].To date, it's still the SINPE overlay that moves the largest amount of money, reaching about 173% of the country's GDP in 2024 at an average of over USD 6,000.00 per transaction[277]. As a side note, there are many other overlays on top of SINPE and more information can be found in BCCR's website[278]. For the purposes of this study, we'll focus on one more specific overlay: Sinpe Móvil.

In 2015, two major developments took place: the creation of a simplified banking account to reduce the requirements to open a low-risk account and boost financial inclusion[279], and the launch of SINPE Móvil[280]. Both of them are credited with the impressive expansion of financial inclusion in the latest years in Costa Rica[281]. In 2011, it was estimated that only 50% of the adult population had an account[282]. In late 2024, that number skyrocketed to 91%[283]. According to SUGEF, Costariquens now own an average of 3 accounts, reaching over 12 million regulated accounts in 2023, 3 times the number registered 10 years before[284].

SINPE Móvil allows end-users to associate their accounts with a mobile phone number to simplify low-value payments for individuals and businesses[285]. This association is operated by a centralized database administered by BCCR[286]. Participation is open to all regulated financial institutions that maintain a funds account with BCCR within the SINPE system (associates) and PSPs. For clarity, both associates and PSPs are collectively called "account service providers". Although all payments must be cleared and the payee user's account must be funded in real-time, the settlement between the account service providers involved goes through a DNS system[287].

Provision of payer and payee services to individuals is mandatory for all participants, as it is for payee services to businesses, while payer services to businesses is optional[288]. End-users are assured communications from their account service provider regarding events like registration and transactions[289], via SMS to the registered phone number[290]. Account service providers may create limits to the amount of money end-users can send and receive using SINPE Móvil, but there are minimum amounts all providers must ensure: 100 thousand Colóns (USD 200.00) daily to send funds and 2 million Colóns (USD 4,000.00) monthly to receive[291]. Under these thresholds, all transactions must be free of charge for end-users[292].

Since 2016, SINPE Móvil showed a steady growth of 2x every year, until it got to 3x in 2019 and, as the COVID-19 pandemic hit, the number of transactions grew almost 10x[293], from 1.5 transactions per capita in 2019 to over 13 transactions per capita in 2020[294]. Since then, the growth rate has reduced, but its use keeps increasing (28.38% growth rate between 2023 and 2024[295]). That puts SINPE Móvil as the SINPE overlay with the highest frequency of use with over 150 transactions per capita in 2024[296]. Estimates account for 76% of penetration in the adult population[297]. The average transaction value, however, is the lowest, at around the equivalent to USD 30.00[298], reaching only 24.2% of the country's GDP[299], which is consistent with the DNS approach to SINPE Móvil interbank settlement.

Brazil and Costa Rica side-by-side

	Pix	SINPE Móvil
Years since launch	4	9
Transactions (value, 2024)	USD 4.49 trillion	USD 0.02 trillion
Transactions (number, 2024)	63.44 billion	0.65 billion
Users (% adult population)	96%	76%
Transactions per capita	373.17	156.40
Transactions (% of GDP)	225.65%	24.20%
Average transaction value	USD 70.75	USD 33.60
Architecture	Platform + 3 overlays (Pix Withdrawal, Open Finance API Payment Initiation, and Pix Automático)	Infrastructure with overlays
Generativity	Participants can create new functionalities using Pix's extensibility	Participants can only use services defined and built by BCCR or create their own network on top of SINPE
Friction	No enrollment to pay	No enrollment to pay
Usability	Full account information, Standard QR Code, URL-based QR Code, Payment Alias (multiple), API	Payment Alias (phone number only) (SINPE Móvil)
Cost	Free of charge: (i) for all users for receiving transfers and making payments; (ii) for natural persons also for making transfers. Fees may apply for natural persons receiving payments and businesses making transfers and receiving payments[300].	SINPE Móvil: free for low-value transfers (<USD 200.00) PIN: fees may apply
Settlement + clearing	10s, mandatory notifications to end-users	End-user transfer in real-time, interbank settlement in DNS

C.

India

UPI is India's 24/7 instant payments rail. It was launched in 2016 as the result of a joint effort between the Reserve Bank of India – RBI and the National Payment Corporation of India[302]– NPCI. NPCI is depicted as an initiative from both the RBI and the Indian Bank's Association – IBA. It takes the form of a non-profit organization controlled by India's largest banks to operate "retail payments and settlement systems in India" . Since 2012, it was a declared mission of RBI to boost interoperable digital payments and reduce the reliance on cash in the country[303] and NPCI received the responsibility to develop and operate a unified infrastructure for instant payments.

As in most countries, India has many infrastructures for different purposes, like NACH[304], IMPS[305], AePS[306], NEFT[307]. UPI wasn't built to unify those systems, but to cover specific P2B and P2P needs and reduce the use of cash. UPI was developed with P2P and P2B use cases at heart, although some third-party apps have been exploring the B2B space[308].

India Overview	
Adult population (>15, 2024)	**1,092.81 million**
% Banked population in country (2023)	**90%**
Accounts in the country (2025)	**2,500.00 million**
Accounts per capita (2025)	**2.29**
GDP (2024E)	**USD 3.89 trillion**

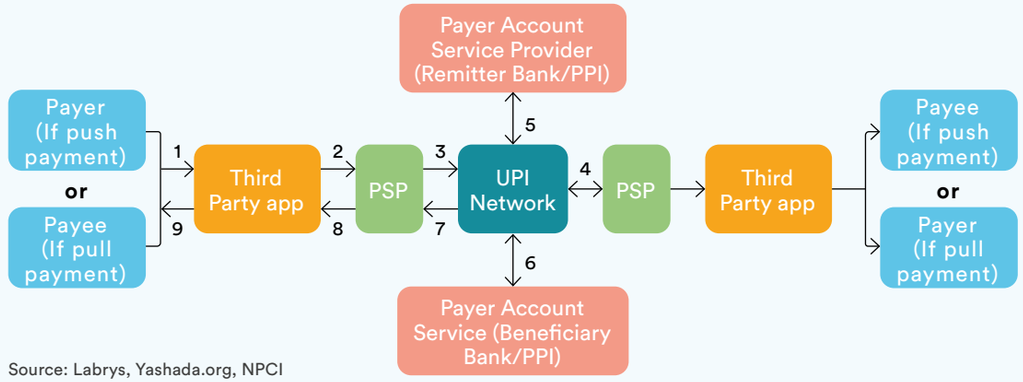
Source: UNFPA, RBI, NSSO, World Bank, IMF, Labrys Analysis[301]

UPI was built as an overlay of NPCI's Immediate Payment Service – IMPS, the 24/7/365 real-time gross settlement system launched in 2010[309]. UPI clears and transfers end-user funds in real-time, but the system itself works in a deferred net settlement – DNS base[310], netting interbank transfers before settling the score on IMPS ten times a day[311]. Its basic architecture involves the end-users – payer and payee –, their account service provider (a bank or a pre-paid payment instrument issuer – PPI[312]), and two kinds of intermediaries[313]: the payer and the payee payment service providers (a bank that intervenes in the data flow on both ends of the payment flow, functioning as "interface provider"[314]), and a third-party app (the app chosen by the payer to initiate the transaction)[315-316].

PSPs work as gateways to connect either end-users directly or third-party apps – 3PA to the UPI Network[317]. Upon registration, end-users may utilize 3PAs, PSP apps, or their own bank app to create their UPI ID, also known as a Virtual Payment Address – VPA. That's a payment alias that's composed of a username followed by a "@" sign and a handle that signifies the app being used for registration[318]. To complete the registration, the end-user creates a password (UPI Pin) that will be later used to authorize payments[319].

UPI, therefore, relies on data gateways (PSPs) to resolve payment alias queries to initiate transfers, instead of a centralized database like in Mexico, Costa Rica, and Brazil. The whole payment flow may take different forms depending on how many parts are involved – i.e., whether PSPs and account service providers are the same entity[320]. In its most complete form, the flow starts either with the payer (payer-initiated payments) or with the payee (payee-initiated payments) using an UPI-registered app (a bank/PPI or a third-party app) to initiate either the payment or the collection (1). The app then communicates with its partner PSP (2) which, in turn, resolves the initiating end-user VPA and forwards the payment details to the UPI Network (3).

UPI | Four-party payment flow



Source: Labrys, Yashada.org, NPCI

The UPI Network routes the message to the counterpart PSP (4), to resolve the remaining VPA and send the full account information back to the UPI Network. Then, the UPI Network sends the payment information to the payer account service provider (remitter bank), which makes the appropriate checks and debits the payer account (5). Then, the remitter bank sends the payment confirmation to the UPI Network, which forwards it to the payee account service provider (beneficiary bank) (6). Their job is to credit the payee account and send back a confirmation to the UPI Network, which forwards it to the initiating PSP (7), which forwards it to the initiating app (8)[321].

From the VPA, payers and payees can generate UPI QR Codes to facilitate payment initiation[322]. In 2020, RBI issued a ban on any new QR Codes issued outside the rails of payment cards (Bharat QR[323]) or UPI (UPI QR[324]) and mandated all closed-loop rails using QR Codes to migrate to one of these NPCI-led standards[325]. In practice, challengers like PhonePe[326], Google Pay[327], and PayTM[328] were barred from using QR Codes to initiate payments on their closed loops[329].

Besides VPA and QR Codes, end-users can also use account number[330] or Aadhaar[331] to initiate UPI transactions[332]. There's also a service to initiate payments without access to the internet, including through feature phones, called UPI 123Pay[333]. In any case, UPI transactions have a daily limit of a little over USD 1.1 thousand[334].

In terms of transaction cost, UPI transfers are mostly free of charge for both payer and payee users[335-336], although the debate around the re-introduction of MDR has been gaining traction[337]. In that case, the merchant may face charges[338]. To further incentivize adoption, the Indian government runs programs to pay UPI acquiring entities an MDR-like incentive for certain types of transactions, including bonuses if their technical performance reaches certain standards[339].

The absolute number of transactions is impressive, reaching 172 billion in 2024. At a closer look, however, UPI still holds much opportunity for development. More than 8 years after its launch, adoption of UPI is still below a third of India's adult population[340], even while digital payments in general reached closer to two thirds[341], mobile phone subscriptions reach over 80% of the total population[342] (105% of the adult population) and smartphone penetration is at about 55%[343] (73.21% of the adult population).

UPI also transactioned around 76% of the country's GDP in 2024, which is consistent with a DNS system, which typically requires value caps to reduce systemic risk exposure. Finally, UPI reached 157 transactions per capita in a year, which is around the same level of Costa Rica's SINPE Móvil and much lower than Pix's over 370 transactions per capita, PromptPay's 397, EBS's 209 or Uganda Mobile Money's 270.

Brazil and India side-by-side

	Pix	UPI
Years since launch	**4**	**8**
Transactions (value, 2024)	**USD 4.49 trillion**	**USD 2.96 trillion**
Transactions (number, 2024)	**63.44 billion**	**172.21 billion**
Users (% adult population)	**96%**	**32.03%**
Transactions per capita	**373.17**	**157.58**
Transactions (% of GDP)	**225.65%**	**76.11%**
Average transaction value	**USD 70.75**	**USD 17.19**
Architecture	**Platform + 3 overlays (Pix Withdrawal, Open Finance API Payment Initiation, and Pix Automático)**	**RTGS Infrastructure with DNS overlays**
Generativity	**Participants can create new functionalities using Pix's extensibility**	**Participants can only use services as defined and built by NPCI**
Friction	**No enrollment to pay**	**Enrollment to send and receive payment**
Usability	**Full account information, Standard QR Code, URL-based QR Code, Payment Alias (multiple), API**	**Payment alias (username@bank-or-app), account number, QR Code, Aadhaar, feature phone.**
Cost	**Free of charge: (i) for all users for receiving transfers and making payments; (ii) for natural persons also for making transfers. Fees may apply for natural persons receiving payments and businesses making transfers and receiving payments[344].**	**Free**
Settlement + clearing	**10s, mandatory notifications to end-users**	**Real-time end-user funds transfer, DNS system for inter-bank settlement**

D.

thailand

Thailand's PromptPay was launched in 2017 and allows account-to-account real-time payments using payment aliases (ID numbers or mobile phone) or bank account number[346]. To start using the service, payers don't need to go through any registration process, but payees must first register with their banks to create their payment alias. Banks are allowed to charge a progressive fee per transaction for transfers above approximately USD 145.00[347] (1 baht = 0.029 USD). The fee can go from USD 0.06 up to USD 0.29, depending on the value, but banks can also waiver such charges[348].

PromptPay can be used for a wide range of transactions between persons, businesses, and the government across multiple use cases, including P2M QR Codes, P2P transfers, tax reimbursement, wallet top-up, request pay (third-party-initiated payments)[349], and government welfare payments[350]. Additional functionalities may be added through overlays third-parties can build on top of PromptPay[351].

Thailand Overview	
Adult population (>15, 2024)	**61.12 million**
% Banked population in country (2023)	**96%**
Accounts in the country (2024)	**117.84 million**
Accounts per capita (2024)	**1.93**
GDP (2024E)	**USD 0.53 trillion**

Source: UNFPA, BOT, World Bank, IMF, Labrys Analysis[345]

PromptPay's architecture includes a DNS system and a payment alias lookup database[352].The service is operated by a Thai corporation called National ITMX and was built in partnership with Vocalink[353], a Mastercard subsidiary[354]. The time between inception and deployment was 12 months[355]. The Bank of Thailand – BOT regulates and supervises PromptPay, while also providing the interbank settlement service through its RTGS system BAHTNET[356]. Banks and third-party non-banks can join PromptPay, although only banking institutions can connect directly to BOT's settlement infrastructure, which means non-banks must use a bank as an intermediary partner[357].

In the 8 years of operation, PromptPay managed to reach the milestone of USD 1.5 trillion of annual financial volume (283.60% of Thailand GDP) and 24.32 billion transactions/year, getting close to the mark of 400 annual transactions per capita[358]. PromptPay's database counts with almost 80 million registered users, which is already 1.3 times the number of Thailand's adult population[359].

Brazil and Thailand side-by-side

	Pix	PromptPay
Years since launch	4	8
Transactions (value, 2024)	USD 4.49 trillion	USD 1.50 trillion
Transactions (number, 2024)	63.44 billion	24.32 billion
Users (% adult population)	96%	130%
Transactions per capita	372.63	397.92
Transactions (% of GDP)	225.65%	283.60%
Average transaction value	USD 70.75	USD 61.68
Architecture	Platform + 3 overlays (Pix Withdrawal, Open Finance API Payment Initiation, and Pix Automático)	DNS infrastructure with overlays connected to a RTGS infrastructure
Generativity	Participants can create new functionalities using Pix's extensibility	Participants can create overlays on top of PromptPay
Friction	No enrollment necessary	No enrollment to pay, enrollment to receive payment
Usability	Full account information, Standard QR Code, URL-based QR Code, Payment Alias (multiple)	Payment alias (username@bank-or-app), account number, QR Code, request pay (third-party-initiated payments)
Cost	Free of charge: (i) for all users for receiving transfers and making payments; (ii) for natural persons also for making transfers. Fees may apply for natural persons receiving payments and businesses making transfers and receiving payments[360].	Free for low values, up to USD 0.29 charge for transfers above USD 2,900.00
Settlement + clearing	10s, tied to notifications	Real-time end-user funds transfer, DNS system for interbank settlement

E.

south korea

According to the Bank of Korea – BOK, the Electronic Banking System holds the title of world's first fast payment system, processing "customers' payments in real time, around the clock, every day of the year, via internet or mobile banking"[362]. It's a DNS payment system that runs on top of BOK's RTGS, Wire+, funding the payee's account in real-time, but settling the interbank operation in the next business day[363].

BOK -Wire+, in fact, settles transactions for a number of retail payment systems, generically referred to as the Interbank Shared Networks[364]. They are operated by the Korea Financial Telecommunications and Clearings Institute (KFTC), a bank-owned non-profit institution[365], and "process funds transfers at bank counters (the Interbank Funds Transfer System), deposits and withdrawals at ATM machines (the CD/ATM System), [and] funds transfers via the internet or mobile phone banking (the Electronic Banking System)"[366]. Among others Interbank Shared Networks is also an open banking system[367]. In the broader Retail Payment System, there's also services allowing the "the exchange of promissory notes between banks for customers using promissory notes (the Checks Clearing System)"[368] and "the payment of various utilities, such as electricity bills and water bills (the Giro System)"[369].

South Korea Overview	
Adult population (>15, 2024)	**46.01 million**
% Banked population in country (2021)	**99%**
Accounts in the country (2023)	**93.52 million**
Accounts per capita (2024)	**2.03**
GDP (2024E)	**USD 1.87 trillion**

Source: UNFPA, BOK, World Bank, IMF, Labrys Analysis[361]

EBS is responsible for 89% of the financial volume and 64% of the transaction number of the whole Retail Payment System[370]. It enables real-time transfers through multiple channels, including internet, mobile, and firm[371] banking. Currently, 64 institutions participate in EBS[372] and it processes an impressive amount of USD 22.49 trillion/year through 9.65 billion transactions/year. That's over 12 times Korea's GDP and an average of over 200 transactions per capita in a year.

BOK is now working on upgrading the infrastructure by introducing ISO 20022 to BOK-Wire+, as per BIS CPMI's[373] guidelines and is studying how to migrate the country's fast payment system to an RTGS model to reduce credit risk[374]. Just like Brazil and Costa Rica, Korea has also invested in promoting a pro-competition landscape by creating new kinds of financial service licenses[375]. The results were also favorable, with Korea experimenting a great development in service and innovation as a result[376].

Brazil and Republic of Korea side-by-side

	Pix	EBS
Years since launch	4	23
Transactions (value, 2024)	USD 4.49 trillion	USD 22.49 trillion
Transactions (number, 2024)	63.44 billion	9.65 billion
Users (% adult population)	96%	98%[377]
Transactions per capita	372.63	209.72
Transactions (% of GDP)	225.65%	1202.73%
Average transaction value	USD 70.75	USD 2,330.57
Architecture	Platform + 3 overlays (Pix Withdrawal, Open Finance API Payment Initiation, and Pix Automático)	DNS overlay on top of an RTGS infrastructure
Generativity	Participants can create new functionalities using Pix's extensibility	-
Friction	No enrollment to pay	-
Usability	Full account information, Standard QR Code, URL-based QR Code, Payment Alias (multiple)	Full account information
Cost	Free of charge: (i) for all users for receiving transfers and making payments; (ii) for natural persons also for making transfers. Fees may apply for natural persons receiving payments and businesses making transfers and receiving payments[378].	-
Settlement + clearing	10s, tied to notifications	Real-time end-user funds transfer, DNS system for interbank settlement

F.

sweden

Swish was launched in 2012 as a P2P app service from the six largest banks in Sweden[380]. Since then, it evolved to connect other banks and technology partners and now offers a number of additional functionalities and services. Swish uses Sveriges Riksbank's[381] RIX-INST to settle interbank transactions. RIX-INST is the Riksbank's 24/7 RTGS settlement system based on Eurosystem's TIPS, although Swish uses a special settlement model called Single Instructing Party – SIP[382]. The way it works is that Swish's owner and operator, Getswish AB, works as a gateway agent between the participating banks and RIX-INST, so the settlement messaging is handled solely by Getswish AB[383].

Sweden Overview	
Adult population (>15, 2024)	**8.88 million**
% Banked population in country (2023)	**100%**
GDP (2024E)	**USD 0.61 trillion**

Source: UNFPA, BOK, World Bank, IMF, Labrys Analysis[379]

Swish today offers, besides P2P transfers via mobile phone payment alias, P2B payments via QR Code and payment alias, third-party-initiated payments (payment request for individuals and recurring payments for companies), an API suite for business including business payouts, e- and m-commerce integrations, cash register integration, and QR Code-enabled invoices[384]. Recently, the Swish app also added a wallet functionality to allow Android users to register their payment cards and use them on the app via NFC[385], reinforcing their goal to become a one-stop-shop for payments in Sweden.

Swish has reached a sign-up rate of over 100% of Sweden's estimated adult population. There are also 318.947 businesses registered to receive payments via QR Codes or mobile phone number and 27.333 businesses using the API suite.

Brazil and Sweden side-by-side

	Pix	Swish
Years since launch	4	13
Transactions (value, 2024)	USD 4.49 trillion	USD 0.05 trillion
Transactions (number, 2024)	63.44 billion	1.05 billion
Users (% adult population)	96%	100.90%
Transactions per capita	372.63	118.04
Transactions (% of GDP)	225.65%	8.61%
Average transaction value	USD 70.75	USD 50.02
Architecture	Platform + 3 overlays (Pix Withdrawal, Open Finance API Payment Initiation, and Pix Automático)	Real-time funds transfer on top of an RTGS infrastructure
Generativity	Participants can create new functionalities using Pix's extensibility	-
Friction	No enrollment to pay	Enrollment to send and receive payment
Usability	Full account information, Standard QR Code, URL-based QR Code, Payment Alias (multiple)	Payment alias (mobile phone number), QR Code, third-party-initiated payments, API payouts.
Cost	Free of charge: (i) for all users for receiving transfers and making payments; (ii) for natural persons also for making transfers. Fees may apply for natural persons receiving payments and businesses making transfers and receiving payments[386].	Free
Settlement + clearing	10s, tied to notifications	Real-time end-user funds transfer, RTGS interbank settlement

G.

australia

The New Payments Platform – NPP is Australia's fast payments infrastructure[388]. It went live in 2018 with the goal "to enable households, businesses and government agencies to make simply addressed payments, with near real-time funds availability to the recipient, on a 24/7 basis"[389]. The plan to develop such an infrastructure originated in 2010, when the Reserve Bank of Australia – RBA concluded the Australian payment market needed to be more innovative[390]. Since then, there were 2 years of RBA market consultation, 1.5 years of KPMG project planning, and about 3 years of development to launch NPP. NPP's development was funded by market players, who came together as shareholders of the NPP Australia Limited – NPPA with the guidance of RBA[391].

NPP was built in three independent layers: NPP's Basic Infrastructure – BI, built and operated by SWIFT, the Fast Settlement System – FSS, built and operated by the RBA, and the overlay service layer, the first of which, called Osko, was built and is operated by BPay[392]. NPP's BI includes a messaging network of Payment Access Gateways and a centralized payment alias database, called PayID[393].

The Payment Access Gateways exchange clearing messages with each other, and settlement messages with RBA's FSS[394]. The NPP, therefore, runs on a decentralized, 1-to-1

Australia Overview

Adult population (>15, 2024)	**21.95 million**
% Banked population in country (2023)	**99%**
Accounts in the country (2024)	**123 million**
Accounts per capita (2024)	**5.6**
GDP (2024E)	**USD 1.80 trillion**

Source: UNFPA, BOK, World Bank, IMF, Labrys Analysis[387]

clearing infrastructure, although it has a centralized 1-to-n settlement system. This dual-message infrastructure resembles traditional card rails, with specific messages for clearing and settlement. PayID supports phone numbers, e-mail addresses, and IDs as payment aliases[395]. NPP's BI allows for payments via full account information and via PayID alias[396].

The FSS operates in an RTGS model and NPP doesn't do any additional netting operations, reducing the systemic risks[397]. Finally, the overlay layer contains additional services that are built on top of NPP. They may include simple scheme rules or add additional messaging and integration to external services. The first one built was Osko, a P2P payer-initiated payment service with optional 280 characters of arbitrary data. The original goal was to have multiple third-party overlays complementing each other on this layer, but in 7 years Osko was the only one deployed[398].

On the contrary[399], in 2022 the NPPA merged with BPay and a third Australian payment company (eftpos) to create Australian Payments Plus – AP+, consolidating NPP and its overlay under a single corporate umbrella[400]. Also in 2022, NPPA launched PayTo, a third-party-initiated payment NPP overlay with the mission to replace[401] the incumbent rail Bulk Electronic Clearing System – BECS's direct debit capability[402].

Since launch, NPP added some other capabilities, like standardized QR Codes, and API-enabled payments. Participation in NPP, each of its capabilities and its overlays is voluntary. So far, over 100 institutions participate in the rail[403], while around 50 having opted to offer Osko[404] and PayTo[405].

Adoption and performance of NPP, however, have not yet met RBA's expectations[406]. A little under 70% of the adult population registered to PayID, the transfer per capita is at 75 transactions/year and the financial volume transacted is at around 70% of the country's GDP[407]. In comparison with BECS, NPP is still at 32% of the total transfers in the account-to-account market (NPP + BECS) and 10% of the financial volume[408-409-410], amid concerns about the technical reliability[411] and overall cost[412] of the platform.

Brazil and Australia side-by-side

	Pix	NPP
Years since launch	**4**	**7**
Transactions (value, 2024)	**USD 4.49 trillion**	**USD 1.28 trillion**
Transactions (number, 2024)	**63.44 billion**	**1.65 billion**
Users (% adult population)	**96%**	**68.35%**
Transactions per capita	**372.63**	**75.28**
Transactions (% of GDP)	**225.65%**	**70.77%**
Average transaction value	**USD 70.75**	**USD 771.88**
Architecture	**Platform + 3 overlays (Pix Withdrawal, Open Finance API Payment Initiation, and Pix Automático)**	**RTGS Infrastructure with overlays**
Generativity	**Participants can create new functionalities using Pix's extensibility**	**Participants can only use services as defined and built by AP+ or build their own overlay**
Usability	**Full account information, Standard QR Code, URL-based QR Code, Payment Alias (multiple), APIs.**	**Payment alias (mobile phone number, email, ID), account number, QR Code, third-party-initiated payments, APIs.**
Cost	**Free of charge: (i) for all users for receiving transfers and making payments; (ii) for natural persons also for making transfers. Fees may apply for natural persons receiving payments and businesses making transfers and receiving payments[413].**	**Fees may apply**
Settlement + clearing	**10s, tied to notifications**	**Real-time end-user funds transfer and interbank settlement**

H.

uganda

The phenomenon of mobile money has been defining the payments experience in many African countries. In this context, mobile money refers to financial services provided by telecommunication companies, or "mobile network operators" – MNOs. These companies typically offer a range of services like P2P transfers, P2M payments, bill payments, cash-in and cash-out (CICO) through mobile payment agents[415] and the use of mobile phones – regardless of internet access[416]. These agents "deliver last mile mobile money services to consumers on behalf of the MNOs"[417], while MNOs employ mobile telecommunication technology like USSD[418] to enable mobile banking capabilities on feature phones[419].

Uganda Overview	
Adult population (>15, 2024)	**27.94 million**
% Banked population in country (2023)	**81%**
Accounts in the country (2022)	**34.11 million**
Accounts per capita (2022)	**1.22**
GDP (2024E)	**USD 0.06 trillion**

Source: UNFPA, BOK, World Bank, IMF, Labrys Analysis[414]

According to 2023 data from GSMA, in Africa alone, there were 169 Mobile Money providers, over 800 million registered accounts, of which over 230 million monthly active, moving almost USD 1 trillion in 62 billion transactions[420]. Some of these mobile money schemes are regarded as instant payment systems when they have "common scheme rules and standards that form the basis for clearing and settlement of transactions between customers of the participating MMOs [mobile money operators] (...) based either on a centralized infrastructure or based on some form of bilateral and multilateral arrangements between participating MMOs"[421]. That is the case of countries like Kenya, Madagascar, Tanzania, and Uganda. According to 2023 data from AfricaNenda, the World Bank, and the United Nations (UNECA), mobile money schemes were the largest type of rail in the African fast payments market[422].

In Uganda, the operation of mobile money started in 2009, with the first service being provided by the telco MTN Uganda[423]. In 2013, the Bank of Uganda – BOU issued a first set of guidelines on the topic[424], but jurisdiction over MNOs (and, therefore, MMOs) was held by the telecommunications regulator, the Uganda Communications Commission – UCC[425]. One notable item from these guidelines which was successfully implemented was that mobile money operations should be backed by cash deposits on escrow accounts MMOs must maintain with a regulated bank[426].

In 2017, the BOU created the "National Payment System (NPS) Policy Framework" to encourage MMOs to implement an interoperable network, allowing payments between users of different mobile money services[427]. In response, the two largest MMOs leveraged a third party called Pegasus to integrate both systems and achieve BOU's policy goal and, later, other MMOs joined the network[428]. At least some of these 1-to-1 integrations have since migrated to APIs[429]. By 2020, the Parliament of Uganda issued the National Payments System Act, determining that mobile money services would be under the Bank of Uganda regulation, separating it from telecommunication services and the regulatory umbrella of UCC[430]. Nowadays, mobile money accounts are considered a major instrument for financial inclusion, since they forgo the need for smartphones and PoS devices for electronic payments by relying on USSD technology[431].

In 2016 and 2017 Uganda laid out another important legal framework for financial inclusion in the country[432]. The Financial Institutions Amendment Act of 2016 and the Bank of Uganda – BoU regulation that followed laid out the rules for greater geographical penetration of banking services: the use of agents to deliver services on behalf of banks across the country[433].

The Uganda Bankers' Association – UBA, the institution Financial Sector Deepening Uganda – FSD, and World Bank's Consultative Group to Assist the Poor – CGAP joined forces to build a unified, shared infrastructure for agent banking in Uganda. They helped establish, in 2018, the Agent Banking Company, operator of the Shared Agent Banking System – SABS[434]. Initially focused on cash in, cash out services (CICO)[435], the SABS now offers bill payments and account-to-account fast transactions[436]. From 2017 to 2018 the number of banking agents in the country was multiplied by ten-fold[437]. As of 2022, the network included 22 out of Uganda's 25 banks[438]. It also reached over 3 million banking end-users[439], accumulated 4.6 million transactions that moved a total amount equivalent to USD 1.4 billion by the end of 2020[440].

Finally, it's worth mentioning that the Bank of Uganda – BOU offers an RTGS system for interbank settlement called Uganda National Interbank Settlement – UNIS, that is also integrated to two regional payment systems: the East African Community – EAC's East African Payment Systems – EAPS, and the Common Market for the East and Southern Africa – COMESA's Regional Payments and Settlement Systems – REPSS[441]. Uganda also has an Automated Clearing House – ACH, which adds netting capability to the system[442].

To this day, mobile money is still king in Uganda[443]. According to the 2023 Finscope Uganda, 83% of the population use mobile money[444]. Based on data from the Bank of Uganda, Labrys' estimates[445] there were around 89 million accounts by the end of 2024. Of those, BOU data shows that over 32 million were active accounts with a total balance of a little over USD 462 million[446], and over 914 thousand mobile money agents (as a reference, there were around 3.3 thousand banking agents). Also according to Labrys' estimates[447], there were over 7.5 billion transactions in 2024, that moved the equivalent of over USD 75 billion. Accompanying this upward trend in mobile money, since 2013, the number of adults with at least one type of regulated deposit account grew by almost 5x, reaching over 22 million people, from 17.08% to 81% of the current adult population[448].

Brazil and Uganda side-by-side

	Pix	Mobile Money Uganda
Years since launch	4	16
Transactions (value, 2024)	USD 4.49 trillion	USD 0.075 trillion
Transactions (number, 2024)	63.44 billion	7.57 billion
Users (% adult population)	96%	83%
Transactions per capita	372.63	270.98
Transactions (% of GDP)	225.65%	125.70%
Average transaction value	USD 70.75	USD 9.96
Architecture	Platform + 3 overlays (Pix Withdrawal, Open Finance API Payment Initiation, and Pix Automático)	Interoperable closed loops based on e-money accounts
Generativity	Participants can create new functionalities using Pix's extensibility	There is no shared infrastructure
Friction	No enrollment to pay	Open account associated to getting a mobile line
Usability	Full account information, Standard QR Code, URL-based QR Code, Payment Alias (multiple)	App and feature phones (USSD)
Cost	Free of charge: (i) for all users for receiving transfers and making payments; (ii) for natural persons also for making transfers. Fees may apply for natural persons receiving payments and businesses making transfers and receiving payments[449].	Fees may apply
Settlement + clearing	10s, tied to notifications	Real-time end-user funds transfer, settlement at the intermediary bank-level

I.

Tanzania

Much like Uganda, Tanzania is also an important jurisdiction for mobile money[451] (or mobile payments, which is the term more commonly used in the country). The first service of the sort launched in 2008[452] and, since then, it has been a main driver for financial inclusion[453]. Under the regulatory oversight of the Bank of Tanzania – BOT, mobile network operators offer services through about 1.5 million mobile money agents[454] and across a number of use cases, including P2P, P2B, P2G, and G2P[455].

Tanzania Overview	
Adult population (>15, 2024)	**39.56 million**
% Banked population in country (2023)	**52%**
Accounts in the country (2022)	**165.68 million**
Accounts per capita (2022)	**4.19**
GDP (2024E)	**USD 0.08 trillion**

Source: UNFPA, BOK, World Bank, IMF, Labrys Analysis[450]

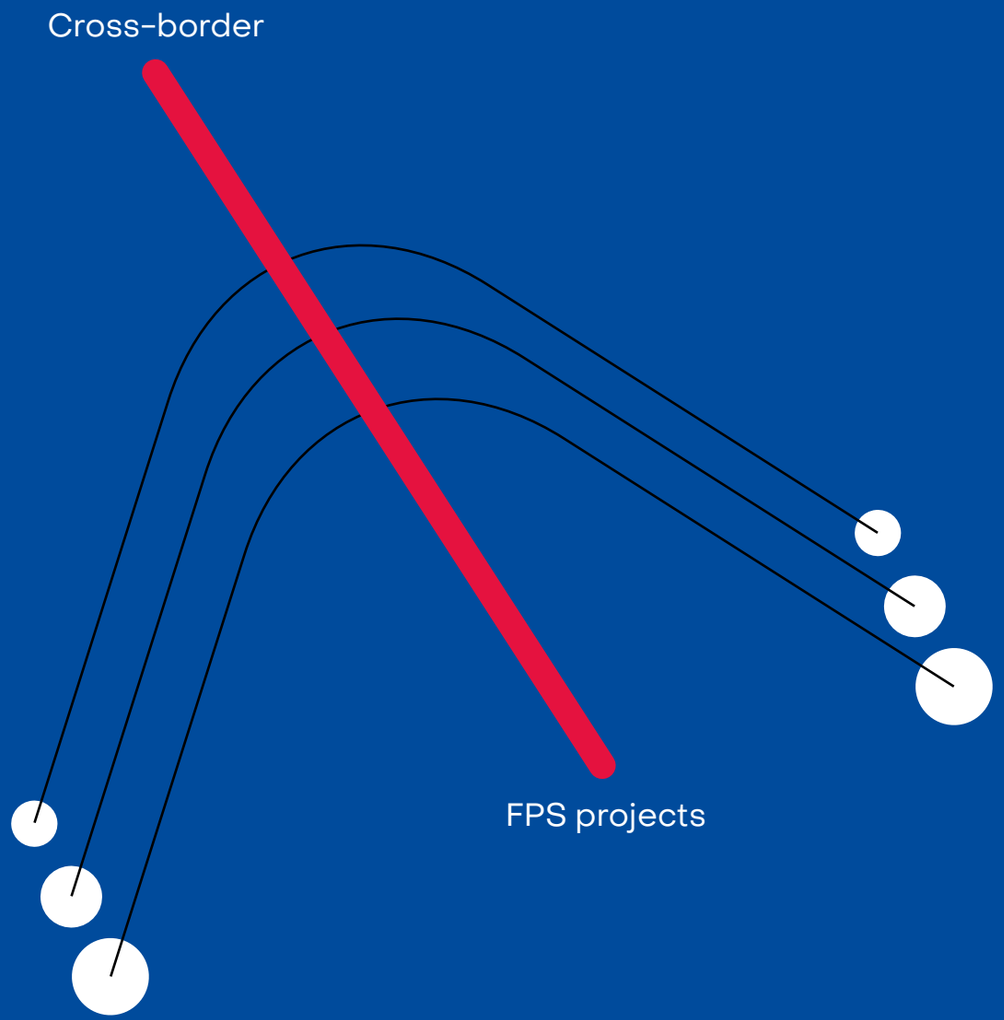
As in Uganda, the industry players were nudged by the regulator to develop an interoperability arrangement for transfers across networks[456] and maintained bilateral agreements to that end since 2014[457]. In Tanzania, however, the BOT decided to create a centralized infrastructure for transfers between different service providers, the Tanzania Instant Payment System – TIPS, launched in 2024[458]. TIPS is agnostic to the payment initiation method used (USSD, QR Code, etc) and connects banks and non-banking service providers, including MMOs, alike[459]. Tanzania also created a unified QR Code standard, TAN QR, in an effort to improve interoperability in the market[460].

Mobile money services reached over 166 transactions per capita in 2024 and moved around about 95% of the country's GDP. There was a total of 60 million active accounts in the country with a total balance of a little over USD 784 million. That makes for 1.15 active mobile money accounts per capita while data account 80% of the population using mobile money[461], showing the remarkable penetration of these networks[462].

Brazil and Tanzania side-by-side

	Pix	Mobile Money (TIPS)
Years since launch	4	17 (1)
Transactions (value, 2024)	USD 4.49 trillion	USD 0.08 trillion
(USD 0.01 trillion)	63.44 billion	7.57 billion
Transactions (number, 2024)	63.44 billion	6.60 billion
(0.45 billion)	372.63	270.98
Users (% adult population)	96%	80%
Transactions per capita	372.63	166.96 (11.47)
Transactions (% of GDP)	225.65%	95.70% (0.03%)
Average transaction value	USD 70.75	USD 11.57 (USD 25.04)
Architecture	Platform + 3 overlays (Pix Withdrawal, Open Finance API Payment Initiation, and Pix Automático)	Closed loops with interoperability scheme (RTGS infrastructure)
Generativity	Participants can create new functionalities using Pix's extensibility	-
Friction	No enrollment to pay	Open account associated to getting a mobile line
Usability	Full account information, Standard QR Code, URL-based QR Code, Payment Alias (multiple)	App, feature phones (USSD), standardized QR Codes
Cost	Free of charge: (i) for all users for receiving transfers and making payments; (ii) for natural persons also for making transfers. Fees may apply for natural persons receiving payments and businesses making transfers and receiving payments[463].	Fees may apply
Settlement + clearing	10s, tied to notifications	Real-time end-user funds transfer, RTGS interbank settlement

II.3



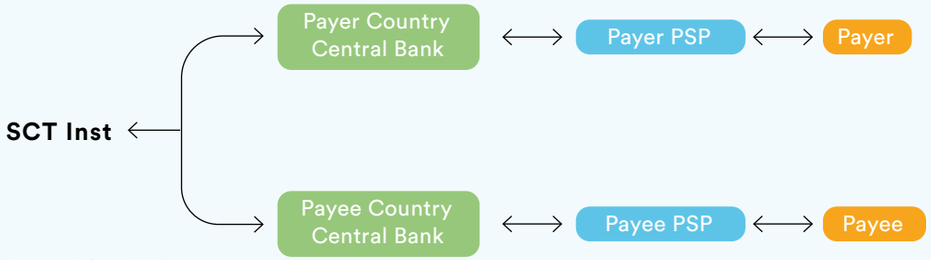
A. SEPA Instant Credit Transfer – SCT Inst

In Europe, the main payment scheme is the Single Euro Payments Area – SEPA[464]. SEPA is the scheme that allows transfers (SCT – SEPA Credit Transfer)[465] and direct debit (SDD – SEPA Direct Debit)[466] between banks across the European Union as a whole and some non-EU countries. Settlement is expected "[n]o longer than one business day for electronic payment orders [or] two business days for paper-based payment orders"[467].

For instant payments 24/7, the European Payments Council created an adjacent rail called SEPA Instant Credit Transfer – SCT Inst[468]. Still, SCT Inst works as a credit transfer rail[469], not a payment rail. That means it wasn't built with the functionalities required for a payment rail in mind. It has no native payment initiation apart from full account information nor timely end-user notification capabilities.

There are privately-owned overlays on top of SCT Inst to aggregate payment functionalities, such as Spain's Bizum[470]. But, as it's usually the case with this kind of system architecture, the overlay operator must create a network of their own among the members of SCT Inst, which sometimes fail to cross their member state borders, as is the case with Bizum.

SCT Inst settles transactions via a settlement system dedicated to instant payments: the TARGET Instant Payment Settlement – TIPS[471]. TIPS settles transactions 24/7 in up to 20s in central bank money through settlement accounts held by the participating banks in their national Central Banks[472]. Even though it was launched in 2017, the usage of SCT Inst is still very low, at less than 18 transactions per capita[473], which is less than 5% of Pix's in 2024.



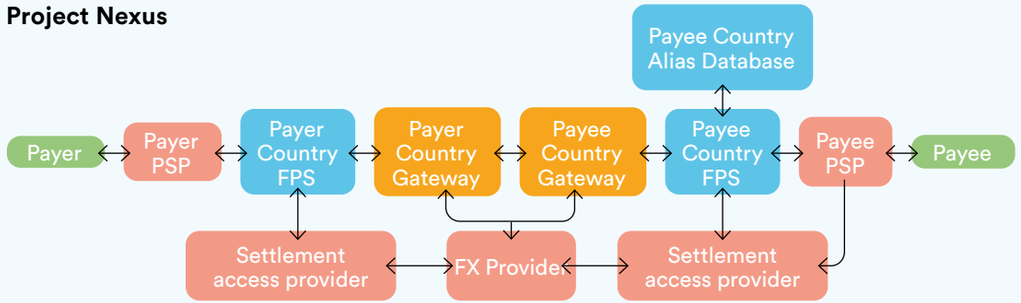
Source: Labrys, EPC

B. Project Nexus

Project Nexus is an initiative by the BIS Innovation Hub in Singapore[474]. Its goal is to connect domestic FPS and create instant cross-border payments[475]. According to BIS, "[c]onnecting these domestic payment systems internationally could improve the speed, cost and transparency of cross-border payments. Nexus is designed to standardise the way that these systems connect to each other"[476].

In 2022, the BISIH organized a proof of concept – POC between the Eurosystem, Malaysia and Singapore[477]. In March 2023, the project announced the successful integration[478] of the test environments[479] of the TARGET Instant Payment Settlement – TIPS[480], the Real-time Retail Payments Platform – RPP[481], and the Fast and Secure Transfers – FAST[482]. The POC also connected replicas of the three jurisdictions' payment alias systems: the Mobile Proxy Lookup – MPL, DuitNow, and PayNow, respectively[483].

Project Nexus



Source: Labrys, BIS

Following the success of the POC, the BISIH took it to the next level by bringing together FPS operators in Indonesia, Malaysia, Philippines, Singapore and Thailand to discuss a possible model[484]. Shortly after, the European Central Bank also announced it wanted to join the Nexus project as an observer, in line with its goal to explore connecting Eurosystem's TARGET to other FPS[485].

In July 2024, Project Nexus announced it had completed "the comprehensive blueprint" for phase 3[486]. It described (1) the "governance, scheme and oversight arrangements", (2) the "business and revenue model", and (3) the "technology architecture and operational model"[487]. The Bank of Indonesia decided to move to a special observer status, while the Reserve Bank of India decided to join as a full-fledged member. The Central Banks of the five countries agreed to create the Nexus Scheme Organisation – NSO[488], which will operate the system. In its role as a technical advisor[489], the BIS also published the technical documentation[490], ISO 20022 messaging and API specification[491].

The general approach to Project Nexus is to create a gateway network that will allow a 1-to-n integration between Fast Payment Systems around the world, both for payment messaging and payment alias resolution. The design involves five essential parts: (i) the domestic FPS's and the payment alias database from the payee's country, (ii) the Nexus gateways each domestic FPS is connected to, which will manage cross-border payment alias resolution connecting to the domestic databases, integrate with foreign exchange providers – FXPs and manage the interaction with these players (FX calculation, quotes, etc)[492], (iii) the end-user's PSPs, in whatever shape or form each domestic FPS describes them, (iv) a FXP that operates on both the payer and the payee's country, and (v) a settlement access provider – SAP, which comes in play when the FXP isn't integrated to one or both FPSs involved[493].

This arrangement is notably different from the approach taken by SEPA, since with SEPA the central banks are themselves connected to one single settlement system, while with Nexus the link in the payment flow is performed by a foreign exchange provider that operates in both the payer and the payee jurisdictions.

III

What's next for Fast Payment Systems: Pix as the new gold standard and paths for evolution

This topic discusses what the key learnings Pix brings to the global FPS debate and development. **First**, we'll go through the reasons why we can say Pix is the most performative FPS in the world today. In fact, we'll argue Pix's numbers suggest the Brazilian rail sets a new gold standard for what FPSs can aspire to accomplish. **Second**, we'll consolidate the key contributions Pix's success story brings to the global FPS debate and development by analyzing the innovative approach to FPS Pix validates. **Third**, we'll paint a picture of what the future could look like if more jurisdictions were to follow Pix's innovative model for their own FPSs and beyond.

III.1

A new gold standard for Fast Payment Systems

The comparative analysis above reveals many success stories. Across the world, many FPSs managed to achieve significant reach and make a significant impact in their countries' economies. SINPE Móvil, even with a limited payment initiation offering, connects most of the accounts in the country and has reached the same level of transactions per capita as India's UPI.

Uganda's and Tanzania's interoperable mobile money schemes circumvented a huge obstacle for financial inclusion by leveraging cheaper technology and now processes a total value larger than their respective country's GDPs. Uganda, in particular, even has more people with access to the financial system than to mobile internet[494].

Thailand's is another impressive example of speed of deployment, adoption, and financial relevance. In relative terms to the size of its population and its economy, although India is the FPS that processes the most transactions in absolute terms, Thailand's PromptPay is the selected case study that has reached the best relative metrics of transaction per capita (>15 years old) and financial volume as a percentage of the GDP: 397.92 transactions per capita and 283.60% of the GDP against UPI's 157.58 transactions per capita and 76.11% of the GDP.

UPI's numbers nevertheless are noteworthy when considering it's reached the same level of transaction per capita as Costa Rica's SINPE Móvil while reaching only about 30% of its adult population. This goes to show that while most of its adult population is still excluded from UPI, those who use it, rely heavily on it.

From all the selected FPS case studies, however, none presents data as groundbreaking as Pix. The most commonly used metrics to compare FPS systems are total transaction volume and total transaction value. Those metrics don't account for the relative weight of each jurisdiction's population and the size of its economy. A payment solution in India with 1% penetration would have more users than one in Sweden with 100% penetration. But it would be hard to argue the one with 1% penetration is more successful than the one with 100%. The transaction value and transaction number (volume) metrics reveal big numbers that always go up but they fail to say anything about the role the rail plays to a particular country or its people.

For that reason, we propose focusing on two metrics weighted against the size of the jurisdiction's adult population (its total addressable market) and its GDP (as a proxy for the rail's relative economic relevance): transaction per capita and transaction-value-to-GDP rate in %. The moment in the FPS's timeline should also be taken into account, as adoption tends to ramp up as rails mature. The charts below show the evolution of each FPS's transaction per capita and transaction-value-to-GDP rate in years since its respective launch. Therefore, data points at the same horizontal axis value compare different rails' statistics at the same stage of maturity.

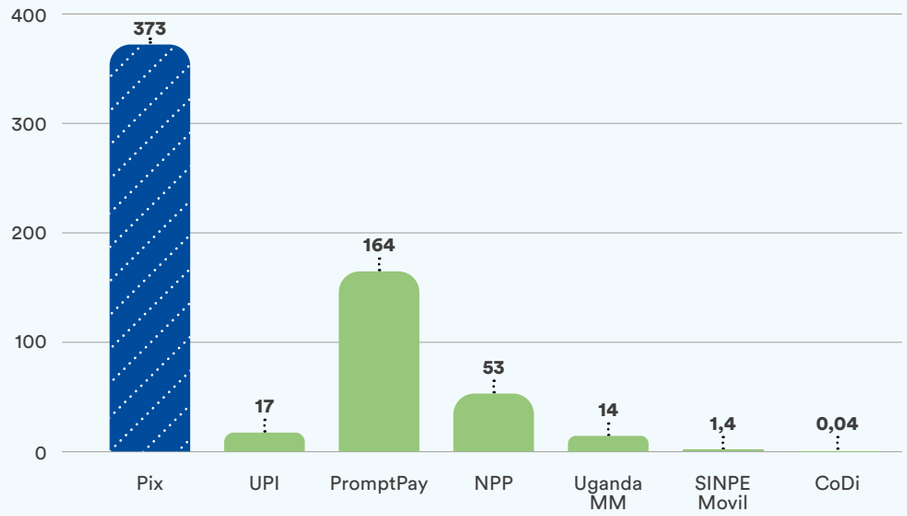
At any given time in Pix's four-year history, not one FPS got even close to Pix's statistics. Moreover, except for Thailand's PromptPay, which is three years older than Pix, no other rail, regardless of stage of maturity, meets Pix's transaction per capita. It's worth noting, though, how PromptPay's higher average ticket in its early years[495] put its transaction value as a % of current GDP much closer to Pix's. South Korea's EBS, with 23 years, has the highest % of current GDP, reaching over 1,200% of current GDP in 2024 – a figure so high in fact we had to exclude it from the chart above for better visualization.

Pix's numbers are impressive on their own and the impacts on Brazilian economy described on Item II above are enough to warrant it close attention. The comparison with other FPS around the world confirms the hypothesis that BACEN achieved something extraordinary no other country managed to reach. Understanding what Pix's success has to teach us about FPSs is therefore key to a stronger future for the global ecosystem.

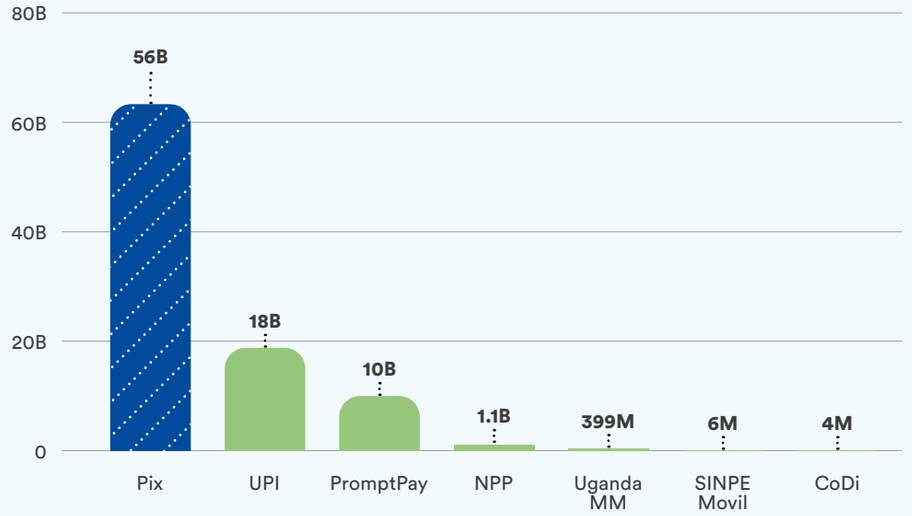
Before we go into the learnings and the theory behind it, one preliminary note is in order. One of the commonly raised success factors for Pix is good timing. I.e., the fact that Pix launched in 2020 amid the Covid-19 pandemic[496], which would have propelled the use of Pix as a contactless alternative to cash. Data from the selected case studies above[497] don't support that conclusion, though.

Except for Costa Rica's SINPE Móvil, there was no significant change on the rails' transaction per capita and value/GDP curves at the 2020 mark. Rather, PromptPay, UPI, NPP, Uganda MM and Tanzania MM[498] saw a decline in Year-on-Year Growth in 2019-2020 when compared to 2018-2019. That actually makes sense considering all commercial activities were severely reduced that year. More investigation is warranted on this topic, but it's safe to say that the contribution lockdowns and social distancing had on Pix's success may be overstated at this point. Which begs the question: if not solely good timing, what else explains the success of Pix? What do the global payment ecosystem have to learn from the Brazilian instant payments phenomenon?

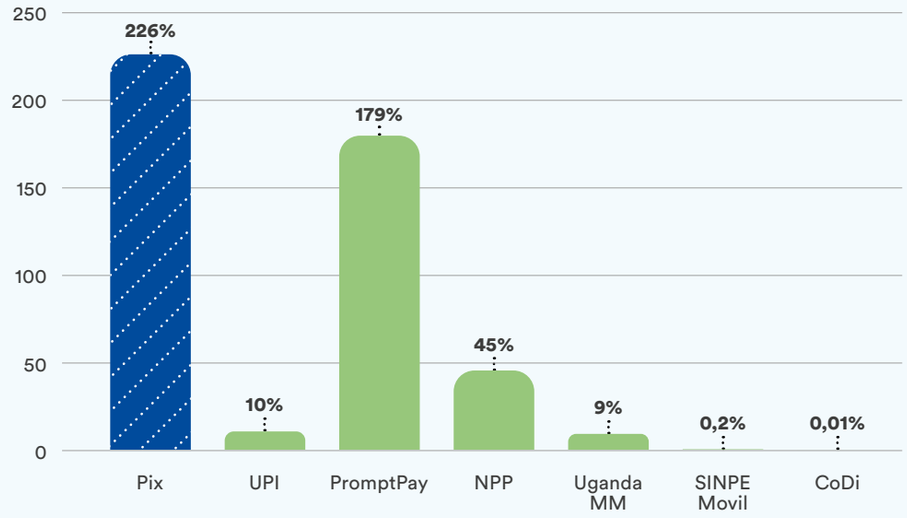
Transactions per capita at Year 4



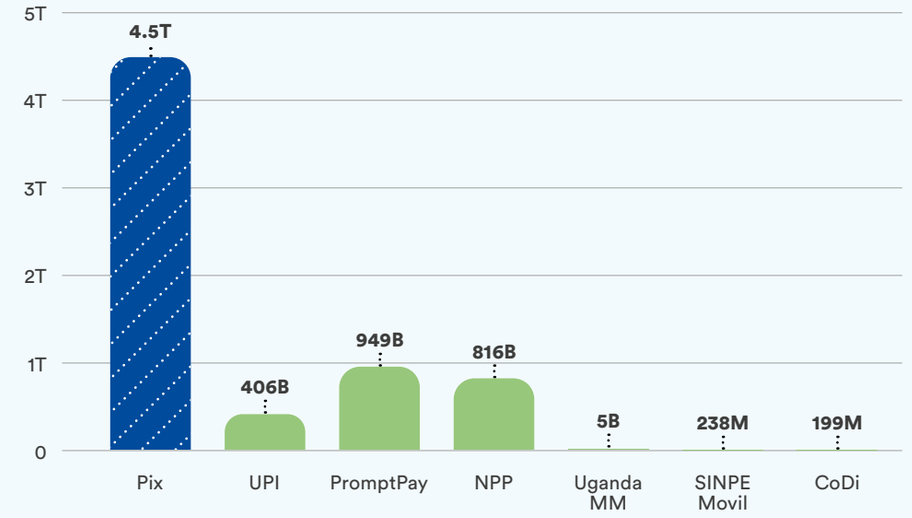
Transaction Volume (number of transactions) at Year 4



Transaction Value, % of current GDP at Year 4

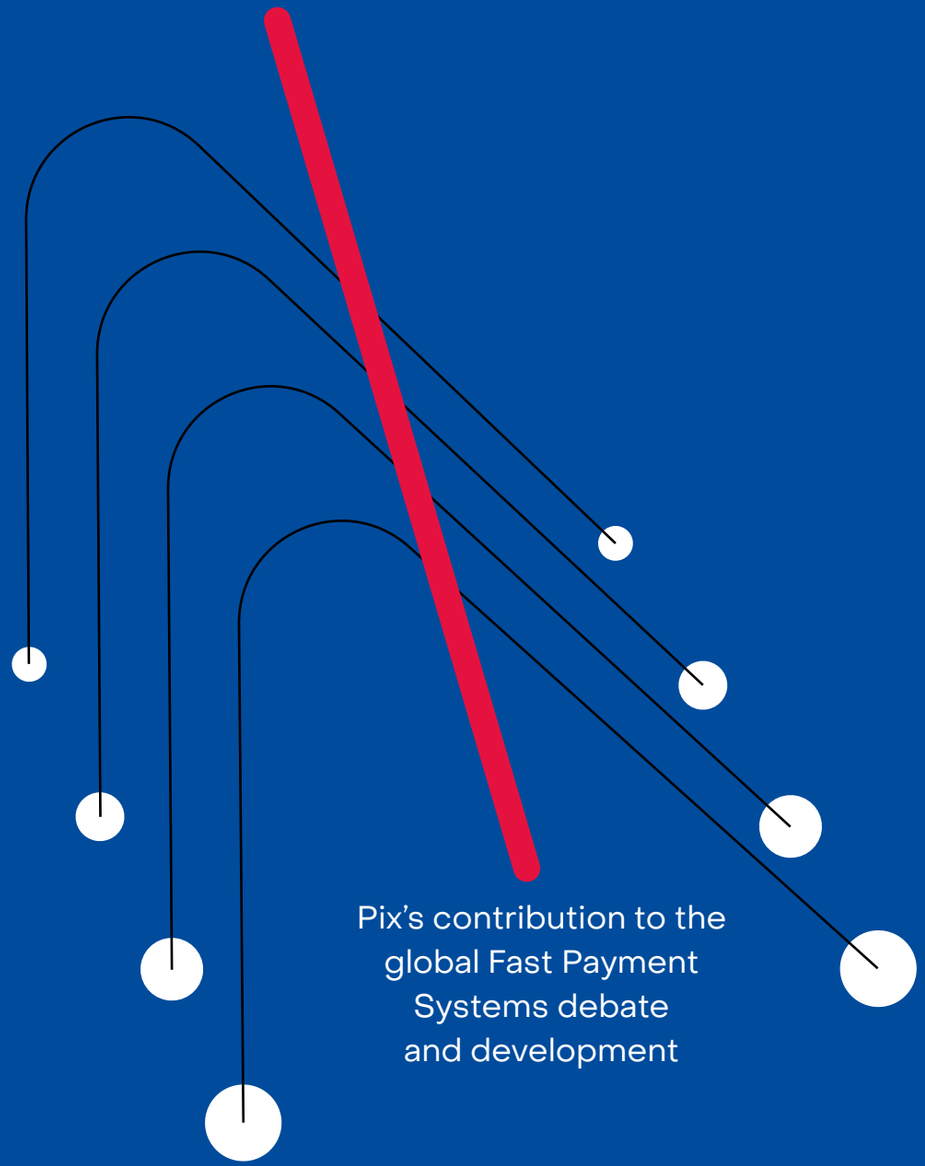


Transaction Value (value of transactions, USD) at Year 4



III.2

What's next for FPS:



Pix's contribution to the global Fast Payment Systems debate and development

In the Pix deep dive topic above, we went through the key decisions that prepared Pix to perform the way it does. Some of these decisions are fundamentally different from the typical path payment system operators take when developing a new rail. In short, Pix's greater contribution to the global FPS debate and development was to demonstrate the viability and economic impact of a whole different approach to payment systems.

Of course, different FPSs may focus on different policy goals. In emerging economies, they typically include financial inclusion, digitalization of the economy, reduction of informal economy, improving competition, and innovation[499]. In the developed world, goals usually involve increasing speed and efficiency, reducing transaction costs, transitioning to a cashless society, and achieving payments sovereignty[500].

In any case, and as mentioned above, the decisions that can make or break a FPS come down to three axes: Governance (how to make decisions), Policy (the scheme rules), and Technology (how to build it)[501]. We argue that the learnings we can extract from Pix's approach to each of these decision axes can get jurisdictions closer to their policy goals, whatever they may be. In the following pages, we'll revert back to Pix's governance choices and dig deeper into the policy and technology aspects of the new approach to payment infrastructure that Pix validates.

A. Governance: the Central Bank role

Governance is the foundation of all other decisions during the course of designing, developing, and operating an FPS. The first of which is who will function as the overall payment scheme settler and who will build and operate the infrastructure. As mentioned above, BACEN decided to develop and operate Pix's infrastructure, as well as to take the role of payment scheme settler[502]; and much of Pix's success can be traced back to that fundamental decision. Consistently with our assertion, there are comparative studies correlating central bank ownership of the FPS with a greater adoption of the rail[503]. That is not to say there aren't or could never be cases of successful, privately owned FPSs. But there are at least **three reasons** why building FPSs as payment schemes based on Digital Public Infrastructures – DPIs can yield far better systemic results and better advance its public policy goals.

The **first** is that Central Banks are better positioned to collect local information from different players in the ecosystem – information that will be invaluable to making optimized decisions on technology and policy. Through Pix Forum, BACEN could open the doors for contributions from the industry in a safe, controlled environment. If the debates were mediated by a private party, its competitors may have been wary of sharing insights about how to improve its technology systems. In the course of the development process, there might have been legitimate apprehension with sharing proprietary information with potential competitors. Sharing concerns and proposals directly with the regulator, however, shielded market rivalries from getting in the way of a candid information exchange and ultimately a great design.

The **second** is that Central Banks are better positioned to balance opposing market interests and make decisions to reach the best systemic outcome. Decisions such as optimizing lower operating costs in the long term despite a larger integration cost for older, outdated systems may be hard to justify to shareholders. But that may also be the best decision in the eyes of the public interest. Another example is opening up participation to non-banking players, which is also correlated with larger FPS adoption[504]. The same goes to a number of efficiency and usability-driven tech and policy decisions that may position the new rail as a competitive alternative to cards and other intermediary-fees-based schemes.

The **third** and last is that Central Bank-driven processes have a clearer decision-making hierarchy, which is associated with more coherent and efficient designs[505]. Industry-driven decision-making often falls into the realm of design-by-committee[506], which is known to produce inconsistent, overengineered, and uninventive solutions[507]. Collective decision often involves compromises to ensure all participants leave the negotiation table feeling like they won something. When it comes to technical design, however, this dynamic gets in the way of coherent, lean, and simple solutions.

Central Banks, therefore, can work as the final decision-maker and are well positioned to best collect important information and balance potentially conflicting interests to make decisions based on its policy objectives and towards the best long-term, systemic outcome[508].

B. One Platform Approach

In terms of policy and technology, Pix's success makes the case for what we are calling the One Platform Approach. At its origin, BACEN's vision for Pix's design was that it should be a payment scheme able to encompass every payment use case in Brazil at the time[509]. Based on that mandate, debates within the Pix Forum, and in particular the proposals from technology-driven new entrants like Nubank[510], brought to life a design that defined Pix's infrastructure and first native payment initiation methods. That new design ended up being notably different from the way payment infrastructure used to be built – including in Brazil.

The concept of building one infrastructure that could be versatile enough to incorporate every payment product is powerful. For one, it allows for greater efficiency as payment systems typically have a high development cost and fixed operating cost but there is technology available today that makes them scale very well. That means the larger the platform, the lower the cost per transaction. Building platforms that can perform multiple functions drive down the cost for each of these functions.

Moreover, one infrastructure means less integration and operation costs for participants. If banks and payment providers can offer any payment solution in the country through one integration, the entry cost in the market is lower. For a PSP to decide to add a payment solution to its offerings can be significantly easier if it doesn't need to perform a new technological integration to start operating it.

Finally, because of the dynamics of network externalities at play in payments, the greater the participation of PSPs in the infrastructure, the greater the infrastructure value to its participants. Not fragmenting banks and payment providers into multiple rails has the additional benefit of supercharging the value of the infrastructure to everyone involved. Here, lower design, development, operation, and integration costs translates into lower end-user fees, greater economy of scale, and more competition.

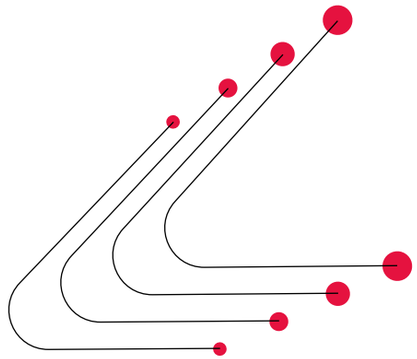
That doesn't mean the platform needs to replace all other infrastructure in the country. The One Platform Approach is about a mindset for how to build better, more evolvable, cheaper, and more efficient digital infrastructure. The choice of how to orchestrate different Financial Market Infrastructures – FMI comes later. Since Pix's launch only one traditional retail funds transfer scheme was discontinued[511]. But the way Pix was built sets Brazil up for decades of faster and more efficient development and innovation. BACEN also decided to build three overlays on top of Pix that require specific integration – but it was a choice, not a necessity out of stiffness of the underlying infrastructure.

One Platform Approach	**Building one infrastructure that could encompass every payment use case** **+** **Designing it as an innovative platform so that extending it can be cheap and easy**

As to how to build such an infrastructure efficiently without incurring in over-engineering and over-specification, modern software engineering has the answer. It's within the concept of platforms[512] in general, and generative platforms in particular. A platform is "the foundation on which entire ecosystems are built"[513]. Platforms are built based on abstractions[514] that (i) capture the core functionalities of a system[515], (ii) create extensibility points[516] where new products, services, and functionalities can be added quickly and efficiently[517], and (iii) provide the connection points (interfaces) through which different participating entities can interoperate[518].

In the case of FPSs, Pix is proof that a one platform approach is not only possible but extremely effective in terms of efficiency, adoption, and innovation. It's worth, then, going through how Pix achieved the vision of being able to process all kinds of payment products. In essence, it created a platform that enables payments anywhere, to anyone, for anything, at any time, and in an instant. In the next topic, we'll go through how Pix implemented each of these properties and how other jurisdictions can do the same.

C. Anywhere, to anyone, for anything, at any time, and in an instant



Anywhere

The first requirement is that the payment platform should allow end-users to make payments through multiple channels, including mobile devices. By guaranteeing a baseline mobile experience, FPSs can go a long way getting into individuals' day-to-day lives. Besides, as of today, it's the trend for the future of technology, so it's where payments should be as well[519].

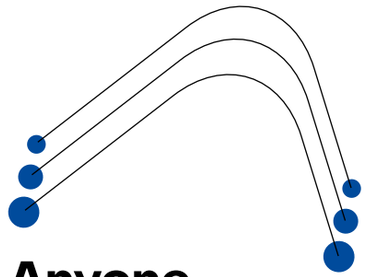
Allowing access to functionalities through more traditional channels like internet home banking, phone, ATMs, branches, etc. also plays a role by bridging the gap between old behavior and new technology. Although Pix only mandates participants to implement its functionalities through their main digital channel, there is nothing in its protocol nor in its regulation that prevents or hinders offering Pix in other channels. Moreover, the substantially lower cost per transaction created enough incentives for participants to privilege using Pix for account-to-account transfers over traditional (more expensive) transfer rails across multiple channels, lowering their costs while accelerating Pix numbers.

Another important aspect when discussing payment channels in FPSs is the specification of APIs to enable automation of processes for companies and individuals. In Brazil, Payer PSP APIs were defined by a self-regulation process under the Open Finance initiative, while Payee PSP APIs were incorporated into Pix's native payment initiation methods. In any case, APIs are the state of the art of third-party integration for transactional operations and should be incorporated.

It's worth saying, though, that creating functionalities available only via API – which happens sometimes, especially with business-focused functionalities – may create a dynamic where end-users can only access such functionalities via intermediaries, which increases cost and complexity related to the feature. This kind of dynamic has the potential to harm especially small businesses that may not have enough volume to justify API integrations, funds to pay for an intermediary, or expertise to do it themselves.

Pix: key decisions that enable payments *anywhere*

Technology	**BACEN standardizes payee PSP APIs to facilitate payment collections (although the functionality is available for businesses only)**
Policy	• **BACEN created guardrails to prevent less motivated PSPs from preventing rail penetration, for example: forbidding the charge of fees from natural persons, creating segmented SLA requirements based on PSP transactional volume, and mandating minimum usability standards.** • **Pix mandates all participants to implement its functionalities throughout every service channel they maintain with their users**



Anyone

To enable payments to anyone, an FPS must be able to connect any two accounts in the country, which means overcoming the Reach-Adoption Trifecta: (1) Access; (2) Network externalities; and (3) the Technology adoption chasm.

The issue of access comes down to two conditions. The first is whether individual users have the means to connect and use the payment service the FPS offers. FPSs must take into account the technologies that are readily available to the mainstream end-user to allow for payments on the move (in countries with low mobile internet connectivity, e.g., USSD-enabled usability may be a must). The second is whether access to the rail itself is automatic or requires some kind of enrollment. If payer users need to wait for recipient users to opt into the payment rail, they cannot, from the start, reach anyone in the country. Conversely, the higher the friction (i.e. cost) to enroll, the less likely it will be for an FPS to experience quick adoption from the start.

Using Pix doesn't require any kind of sign-up. Some payment initiation methods, such as the payment alias, require the payee user to make a simple registration to assign an alias to the desired account. But given (1) the fact any account is reachable regardless of the payment alias, (2) the healthy competitive environment in the payment market, and (3) the fact that each alias can be assigned to only one account (scarcity), banks and payment institutions get quite proactive in encouraging users to register their keys.

The network externalities issue is present because FPSs aren't valuable to its end-users unless it enables them to access any account at any bank in the country. In fast payment ecosystems, connecting every account is fundamentally different from connecting many accounts. End-users won't

move away from traditional solutions, such as cash, if they can't be sure, when they leave their houses in the morning, they will be able to pay anyone they encounter using the FPS. Pix managed to achieve this by mandating participation from every account service provider who operated over 500 thousand accounts, which amounted to over 90% of all accounts in the country. Once the largest players were in, smaller payment service providers had enough incentives to join too and give their smaller customer base the opportunity to make and receive payments from any one of the largest players' users.

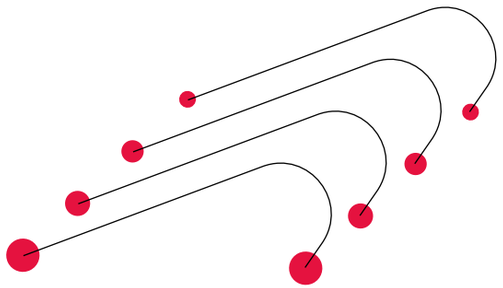
Finally, the technology adoption chasm is related to the behavior of end-users themselves. It is said that the adoption – or *diffusion* – of new technologies happens in stages, as it converts groups of users with different levels of openness to new technology[520]. In this sense, users can be classified[521] as: (i) innovators, or technology enthusiasts, (ii) early adopters, or visionaries, (iii) early majority, or pragmatists, (iv) late majority, or conservatives and (v) laggards, or skeptics.

The success of a new technology, a new FPS included, is predicated in its capacity to gather a minimal critical mass of users to cross the chasm between early adopters and the mainstream users (from early majority on)[522]. Enabling features that require no change in the way most people make payments or transfers (be it through internet banking, ATM, etc.) helps build that critical mass without depending on behavior shifts from mainstream users. It's fair to say that in the case of FPSs, reducing the cost of adoption to ramp up usage early on is even more important than for most technology because of the network externalities that characterize the payment industry.

Pix achieved this by allowing end-users to initiate Pix transactions using full account information, in the same channels as they would do with traditional rails. That meant no extra adaptation effort was required to start using Pix. So, as end-users kept the same behavior as ever, Pix gained traction, its numbers went up, and confidence in the new rail built up quickly.

Pix: key decisions that enable payments *to anyone*

Technology	• Pix created a 1-to-n information and settlement system • Adoption of open standards (cost, reliability and adoption) • Creation of testing and homologation environments (reliability, adoption) • Tech decision: Implementation of trust-enabling features, such as payer-initiated transfers, payment status transparency, etc.
Policy	• Mandatory participation for PSPs with over 500.000 active accounts. • End-users don't need to sign up to start using, so the activation cost to join the rail is extremely low. • Reduced adoption cost by allowing use of Pix without a specific registration and creating a bridge between the previous rails' usability and Pix. Apart from the improved usability mechanisms (QR Codes and payment aliases), BACEN also incorporated the exact same experience of traditional transfers rail, with the manual input journey, which also reduces the adoption cost for new users. • BACEN created guardrails to prevent less motivated PSPs from preventing rail penetration, for example: forbidding the charge of fees from natural persons, creating segmented SLA requirements based on PSP transactional volume, and mandating minimum usability standards. • Trust-enabling mandates, such as: Payer controls the interface, Payee gets confirmation from their own bank • BACEN also created a fertile terrain for competition over Pix payment aliases and created a buzz over which PSP would register more payment aliases by opening a registration window a month before Pix's launch and by publicizing the number of payment aliases each PSP managed to register. • BACEN created a form of indirect participation in the Pix rail, which allowed non-regulated players to connect through a regulated partner (direct participant) and gave an option for smaller regulated players to connect to the rail through a partner as well. • Creation of a strong brand Brazilians can recognize and trust



Anything

This is where the bulk of the technical decisions are made to enable any kind of payment through an FPS. There are three aspects of tech and policy decisions that can ensure this property. The first concerns cost. If the goal is that end-users make fast payments to buy anything from a loaf of bread to real estate, transactions must be very cheap. If the cost per transaction is above the microcents threshold, it will be hard to justify buying low ticket items usually reserved for cash payments. The decisions that amount for the cost per transaction are of course multifaceted, but we can cite as examples: (i) the technology employed in the communication layer between participants and the infrastructure, including how well it can scale, (ii) the decisions that impact the level of adoption of the rail and the number of transactions that share the infrastructure overhead, and (iii) how many intermediaries need to participate in the transactions.

The second aspect is how well can the FPS operator can extend the basic infrastructure to incorporate new use cases and whether third-parties (participating banks and other PSPs) have access to extension points to innovate on top of the FPS while also leveraging its network – i.e., without building a separate overlay. As we mentioned in the topic above, the answer modern software engineering and systems design bring to the table is the concept of a platform and its core properties: extensibility, evolvability, and generativity.

By extensibility we mean the property of a system[523] to add new functionalities "with minimal or no effects on its internal structure and data flow"[524]. This extensibility property is what enables one of the main features of any platform, which is evolvability, i.e., the ability to "adapt to unanticipated changes in the external environment"[525]. That way, "[t]he whole system does not have to be invented or rebuilt from scratch to generate a new product, accommodate heterogeneous tastes, or respond to changes in the external environment". Finally, extensibility is key to another property of platforms: generativity[526-527], which is defined as the capacity of a system "to produce unprompted change driven by large, varied, and uncoordinated audiences"[528], which means its users (PSPs or even end-users in the case of FPSs) can "generate new, valuable uses that are easy to distribute and are in turn sources of further innovation"[529].

Essentially, platforms are valuable because: (i) they "can be adapted at low cost without losing [their] identity or continuity of design"[530]; (ii) their benefits "are variety in the present and evolvability through time"[531]; (iii) they can reduce transaction costs and enable innovation[532]; (iv) they can "achieve the dual goals of being simultaneously stable and evolvable"[533]. The key to building an effective platform and tapping into its hidden potential is to identify what the core functionalities that are common to all uses of the platform are (the system's primitives) and where extensibility points can be added to allow for the adaptability and generativity of the platform in the long term[534].

That's the fundamental shift Pix brought to the FPS ecosystem to design an infrastructure with enough extensibility points that would allow Pix to incorporate any kind of payment method existent today or that could come to existence in the future. In essence, Pix was built on top of **two powerful abstractions**[535].

The **first** is that no matter the specific product, payments are the transfer of funds between certain accounts along with metadata. This metadata can refer to the time of the transaction, the frequency, the contextual information about the economic activity behind that payment, etc. To create a payment scheme that can represent any kind of payment that falls within that definition, the basic building blocks are (i) a settlement system capable of making the funds exchange in real time and (ii) a communication channel between all participants to exchange metadata.

The way Pix achieved this was by creating two communication channels between participating PSPs: (i) the settlement system itself functioned as a communication layer between participants, allowing information to flow between payer and payee PSPs along with the money flow; and (ii) the URLs specified to implement Dynamic QR Codes created a direct, efficient, and secure channel between the payer PSP's app and the payee PSP's servers, which allows for an information flow directly between payee and payer.

The **second** powerful abstraction was to segregate the payment flow from the payment initiation flow. Since the beginning of Pix's development, BACEN wanted to create multiple native features to enhance the rail's usability. Instead of creating a money flow for each new way of payment, though, Pix created a core money flow that starts with the Payer PSP sending the payment order to SPI, the settlement system, and ends with SPI sending the final state of the payment (successful or not) to both Payer and Payee PSPs.

No matter how the payment was initiated – QR Codes, payment alias, etc –, the money flow is exactly the same. What changes is how the Payer PSP gets all the necessary information to perform that first step of sending the payment order to SPI. Those are the payment initiation methods and they are specified independently of the money flow itself. In Pix's technical documentation, money flows and payment initiation flows are even separated in different technical manuals.

Having both abstractions combined means any new payment initiation service – from NFC to direct payments – could leverage the same Dynamic QR Code URLs to make the relevant payment metadata get to the Payer PSP for it to start the payment flow without the need for specifying new messaging with the same core content in it.

This approach saves time and money in design, development, and PSP integration, which revert to more efficiency, lower cost, and greater adoption.

Apart from these fundamental abstractions, which create powerful extension points for BACEN to expand Pix usability at a lower cost, the rail also exposes extensibility points to its PSPs. Besides using the HTTP protocol for communications between participants and the core infrastructure – which, in itself, is a famously extensible protocol –, the specification of Dynamic QR Codes also left a specific extensibility point for PSPs to leverage. When a Payer PSP accesses the Dynamic QR Code URL, the Payee PSP's reply contains mandatory information that is common to any kind of payment, but also allows Payee PSPs to create their own fields to add relevant information, which is then sent to the Payer PSP's app to be presented to the payer. That means any Payee PSP can create new functionalities for their clients that will automatically work for every Payer PSP without the need for a new integration[536].

For society to leverage the maximum benefit of such extensibility points, moreover, it's imperative that the number of PSPs participating in the rail and capable of extending it to create new features is the largest possible. Increasing the number of innovation agents is the only way to increase the probability of an innovation hitting the market. Here is another instance where BACEN's decision to make Pix as open as possible, create incentives for smaller players to join and keep the integration and operation cost low for participants pays off.

Before moving on to the next topic, it's worth mentioning Pix's original design did not have an abstraction for payee-initiated payments. That is: Pix did not have the messaging needed for the Payee PSP to send the payment information to the Payer PSP without the intervention of the Payer. All original payment initiation methods in Pix required the payer to scan or type something on their payment app. In fact, the abstractions that were missing were: (1) a means of communication from Payee PSP to Payer PSP through Pix's infrastructure, i.e., that the communication layer that goes through the settlement system (SPI) worked both ways (Payer PSP - SPI - Payee PSP and Payee PSP - SPI - Payer PSP); and (2) the concept of payment authorization uncoupled from a single payment at the time of the payment.

With these two abstractions, payee payment initiation would be a matter of making payment information travel from the Payee PSP to the Payer PSP through Pix's infrastructure and either prompt the payer user to authorize the payment on the spot via push notifications or hold the payment request against previously stored authorizations to either authorize automatically, reject automatically or ask for specific authorization from the payer user.

In this case, though, BACEN decided to take the route of building overlays to solve for two specific use cases instead of enabling a broader payee-initiated payment capability: direct debit from businesses ("Pix Automático") and Open Finance API payment initiation (through "n x (n-1)" integrations, where n is the number of participants). These overlays require specific integration and messaging to operate but BACEN used mandated participation requirements to avoid the reduction of the network externality of creating a subgroup of participants. All account service providers are mandated to implement APIs to allow for third-party payment initiation and all Pix participants that operate as Payer PSP are mandated to implement direct debits through Pix Automático (Payee PSPs can choose not to offer automatic pay-ins to their business clients).

Finally, the **third** aspect of technology and policy that influences whether FPS users can use it for anything concerns security. Security has a double impact on the range of application of an FPS. The first is more direct: if users don't trust the system, adoption will be severely limited. The second, though, is more nuanced and is tied to the well-known tradeoff between security and user experience[537].

Security controls such as authentication, access control, and account validation may increase the friction in using a product or service. Furthermore, in the realm of transactional security validations, there is a wide spectrum of how to fine tune real-time transactions monitoring. The stricter the model, the higher the probability of false positive cases, where legitimate transactions are blocked. The looser the model, the higher the probability of false negatives, where fraudulent transactions are approved. Choosing how to dial these controls illustrates the tradeoff well. A higher risk appetite may allow for a more fluid experience for users but potentially opens up a larger flank for bad behaviors.

A modern approach to information security postulates that the relationship between user experience and security is not that binary[538]. It's not an *either or* situation since companies can invest in improving the quality of their models, incorporating better signals and nuance, reducing false negatives without compromising user experience[539]. Another example is investing in a better choice architecture to make it easier for users to make the safer choice[540]. This nuanced approach, although preferable, is not yet the norm, especially in the financial market[541], where security controls that negatively impact usability are very common.

Striking the balance between security and usability is crucial to the success of an FPS, though. Too much of one or the other means catastrophe to the rail. Not enough security controls may compromise trust in the rail, while too rigid controls may hurt the usability and equally hinder adoption.

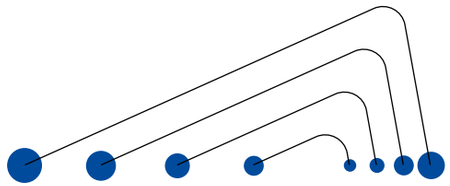
All risk mitigation involves costs – and its own risks[542]. It may be the cost of the implementation and operation of a new safety tool, such as pollution filters in factories. But it can also have less obvious costs. In software, the security-UX tradeoff means security controls can have a high cost in usability while keeping direct financial cost at a lower range. In these cases, the most significant potential risk comes from a competition perspective. If a player degrades its user experience to reduce its risk exposure at a low financial cost while competitors invest in system improvements that reduce risk without increasing friction, the first player risks losing business to the second.

Conversely, if FPS creates security controls that are too strict and unnuanced, the whole system may be at risk of limited adoption. There's no question FPSs need to work to reduce risk exposure of its participants. But there's a difference between trying to keep risk at a minimum while also committing to great usability, and degrading UX in the name of an impossible goal of moving the risk needle to zero.

It's the nature of risk mitigation that it has diminishing returns. After a certain point, each increase in prevention represents a greater cost increase than the previous one. The closer we get to zero risk, the more the cost tends to infinity. In the limit, removing all risk means the total inviability of the operation itself. A payment system with zero fraud risk is one where no payment ever occurs. It's crucial, then, for an FPS to define their accepted threshold for fraud rate, monitor the metric and make the necessary adjustments to make sure it's within the expected levels.

Some traditional payment rails, such as card networks, track levels of fraud chargeback and of transactions denied for fraud reasons. They keep both these metrics in check to make sure the rail is safe to its end-users and prevent overcorrection from hurting the rail usability. In Brazil, furthermore, all payment schemes are mandated to monitor the fraud rate levels of each of its participants[543]. More recently, Visa, for instance, launched a new program that flags merchants in LATAM with more than 90 bps of disputed transactions divided by their total transactions[544]. For reference, Pix's rail-wide metric is 0.6 bps[545].

BACEN created a good balance in regard to information security requirements by adopting a risk-based approach to regulation[546]. Instead of defining the specific tools and controls all institutions had to implement, the regulation defines the outcomes each of them must achieve, without specifying how. This approach allows different players to decide, for instance, how their strategy will impact user (and employee) experience and how much they will invest in more nuanced approaches. In regard to fraud mitigation on Pix, BACEN adopted a notably more direct approach and defined the specific controls every participant should adopt.



Any time + Instant

Finally, the last two properties that enable a one platform approach to FPSs are the two characteristics that define Fast Payment Systems to begin with: availability 24/7 and real-time transfer of funds. It's worth, though, getting a closer look into two aspects of what can make an FPS truly 24/7 and real-time. The first issue concerns technology design: depending on the choice of technology for the core infrastructure like the alias base, offering all the rail's functionality without programmed downtime may not be obvious.

The second issue is about usability and systems design. The rail can only offer a real instant payment experience if it can guarantee the end-users have accurate and timely information about the status of the transaction. That means the infrastructure must have an effective error-handling mechanism and a strict messaging flow for the status of the payment that goes all the way to the end-users. The idea is to allow individuals to enter a bakery, pay for the loaf of bread, and leave the shop in under a minute. So, it's imperative to implement timeouts, manage the source of truth about the status of the transaction, guarantee idempotency, assign unique identifiers to each transaction, and set strict mandates about the timing of each step of the transaction – from the start to the end-user notification[547].

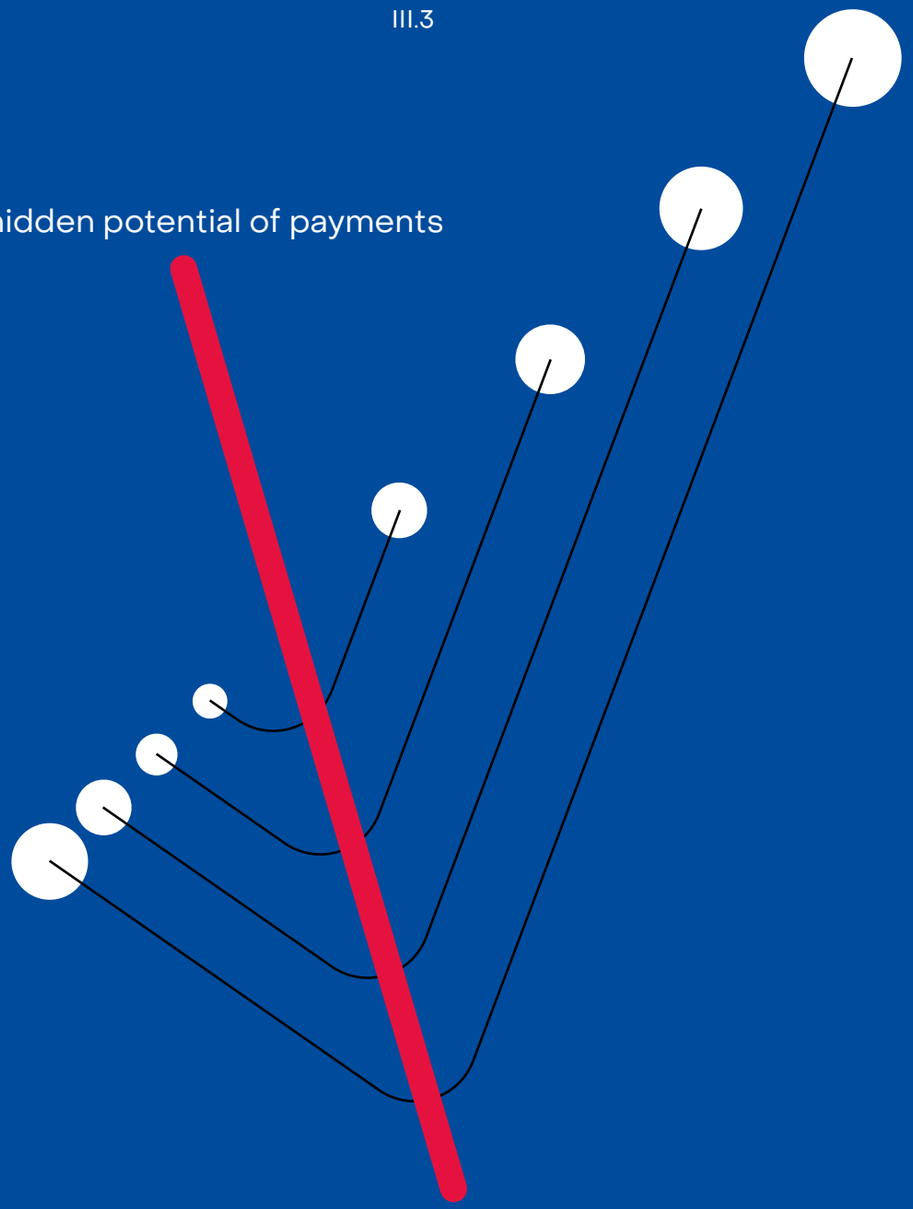
That second issue relates to the third one, which concerns reliability. None of it matters if the system or its participants aren't capable of performing correctly. Simple flows based on powerful abstractions and strict mandates of SLAs and non-functional requirements is the way Pix managed to achieve this.

Pix: key decisions that enable payments *for anything*	
Technology	• Use of powerful abstractions that reduce design, development, implementation, and operational costs. Ex: Payments = communication and transfer of funds. Payment information = value, time, destination, and payment-specific metadata. Payment initiation = payment information + authorization. • Pix created a 1-to-n information and settlement system • Implementation of versatile, evolvable design • Adoption of open standards (cost, reliability and adoption) • Creation of testing and homologation environments (reliability, adoption) • Implementation of trust-enabling features, such as payer-initiated transfers, payment status transparency, etc.
Policy	• Trust-enabling mandate, such as: Payer controls the interface, Payee gets confirmation from their own bank

Pix: key decisions that enable payments *at any time in an instant*	
Technology	• Adoption of good practices of distributed systems engineering • Adoption of open standards (cost, reliability and adoption) • Creation of testing and homologation environments (reliability, adoption). Implementation of trust-enabling features, such as payer-initiated transfers, payment status transparency, etc.
Policy	• BACEN created guardrails to prevent less motivated PSPs from preventing rail penetration, for example: forbidding the charge of fees from natural persons, creating segmented SLA requirements based on PSP transactional volume, and mandating minimum usability standards. Trust-enabling mandate, such as: Payer controls the interface, Payee gets confirmation from their own bank.

III.3

The hidden potential of payments



anywhere, at any time, to anyone,
for anything, and in an instant

Pix's experience as the most effective FPS in the world has contributed much to the global payment debate and development. In summary, Pix validates the idea that building a system that's able to incorporate any kind of use case yields returns in terms of cost, efficiency, PSP participation, end-user adoption, and rail adaptability. Some of Pix's keys to success are by now well known in the payments community, such as: Central Bank-led initiative, a broad payment initiation offering, mandated participation, minimum UX requirements and low costs for end-users, being free for individuals.

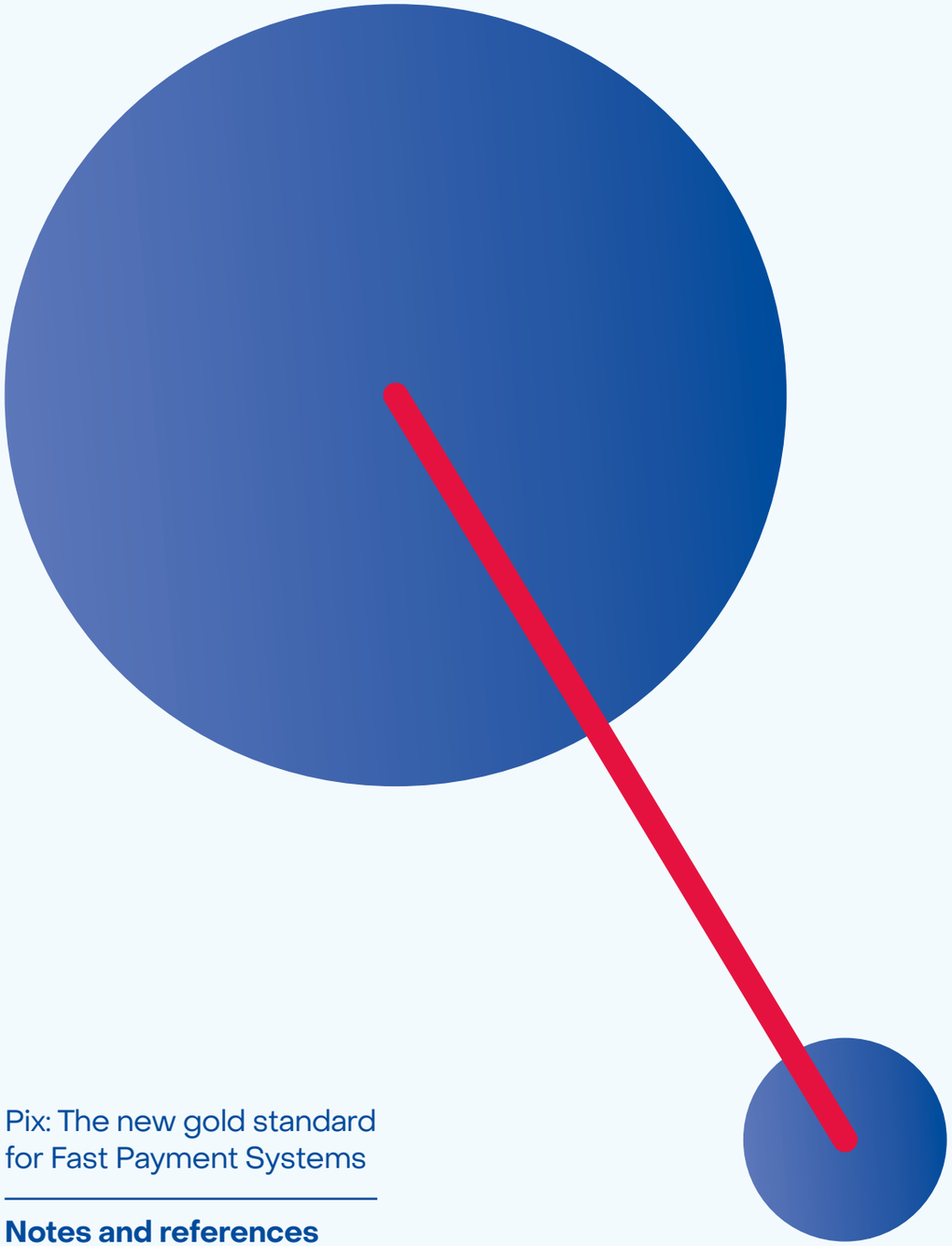
Digging deeper into the inner workings of Pix, it's clear the development of Pix as a platform instead of a single product by using abstractions to facilitate the original design, development, and integration and its evolution in the future also play a pivotal role. Pix created a means of arbitrary communication between payee and payers, as well as between PSPs, and segregated those from the core money flow that is always the same, no matter the use case.

Conversely, FPSs could segregate core payment capabilities from the payment initiation specificities from each use case. As much as possible, these payment initiation methods would use extensible standards so that the general structure of messaging between PSPs and end-users would be stable across multiple use cases. It's the idea that a URL used in Dynamic QR Codes can be used to make NFC payments, recurring payments, or a niche product that requires specific information to be shared with the Payer before payment confirmation. ISO 20022 would come into play to describe the messaging of the common capabilities to every payment product (the money flow).

An example of how that could play out is if SINPE Móvil became the source of payee information in a new Dynamic QR Code standard. Defining the URL standard, the authentication method to validate the information that comes from the URL, and the return messaging, including the Sinpe Móvil number, would allow Payer PSPs to get the payee PSP information from SINPE Móvil and present it, along with all the other information received from the URL, to the payer for confirmation. After confirmation, the payment would follow its normal route through SINPE as ever. Defining a metamodeling of the data that comes from the URL would allow new products to be created without needing to create new integrations between PSPs. Notice that no modification to the infrastructure would be required.

Cross-border schemes could also benefit from this approach. In national payment systems, striking the right balance between stability and evolvability of a rail is paramount, given the complex nature of having multiple participants integrated to the same system. With extensible platforms, since the core messaging structure is predefined, the integrations are more stable and the system can evolve more gradually. That is even more relevant in a scenario where not only national PSPs but also international PSPs can initiate payments on the rail. If the design isn't flexible and adaptable enough, any change in the rail would break the implementation of PSPs across the globe.

The best approach for both national and cross-border FPSs, in developed and developing jurisdictions, is to follow the path of Pix's original development and build an adaptable platform capable of operating payments anywhere, to anyone, for anything, at any time, and in an instant. Pix is, in fact, the gold standard.



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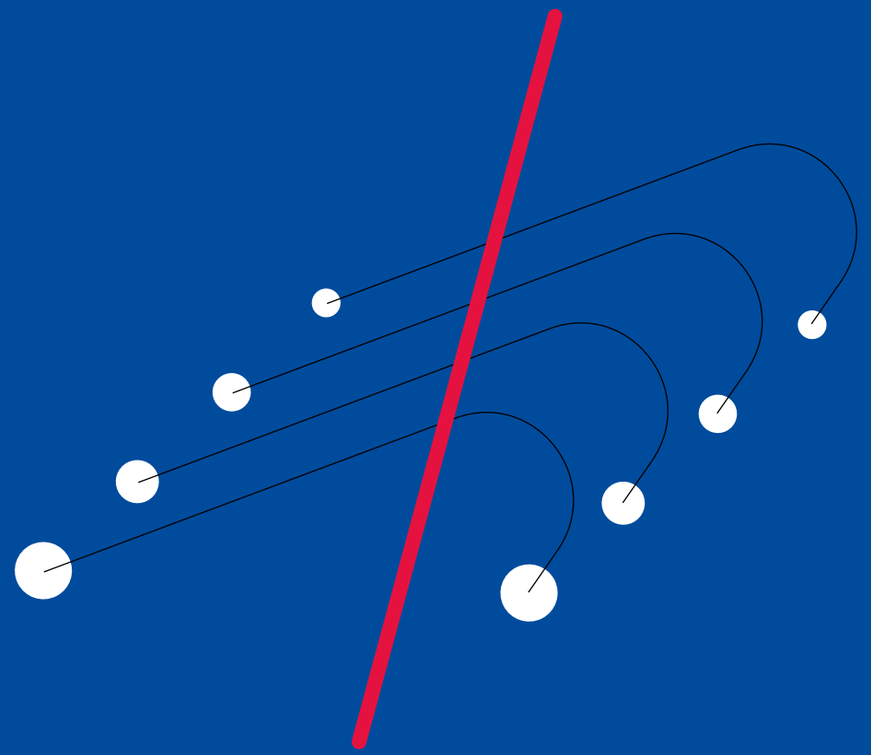
Graphic design: **Estúdio Irá**



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