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“Digital payment systems in emerging economies:
Lessons from Kenya, India, Brazil, and Peru”

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Digital payment systems in emerging economies: Lessons from Kenya, India, Brazil, and Peru*

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Abstract

Digitization of retail payments has facilitated the promotion of financial inclusion recognized to stimulate growth, alleviate poverty, and address gender disparities in the financial sector. This paper closely examines four prominent payment solutions in the developing world, which are M-Pesa in Kenya, UPI in India, Pix in Brazil, and Yape in Peru. We employ a descriptive approach to identify the main factors that have contributed to the success of these digital payment systems, focusing on the role played by: i) private digital platforms developers and providers; ii) regulators and central banks and iii) the degree of the payment system interoperability. Although, to some extent, these varied experiences suggest that there is no one-size-fits-all solution, they highlight the necessity of active public-private sector cooperation and placing the end user at the center of such initiatives.

Keywords: Digital payments; Financial inclusion; Interoperability; Regulation.

JEL Classification: G23; G28; L51; L96; O16; R11.

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1 Introduction

Despite the great efforts made by policymakers to promote financial inclusion in developing countries, there is still a notable gap regarding access to transaction accounts and use of digital payment services. In 2021, 76% of the world adult population had an account with a formal financial institution, while in developing countries this figure was close to 71%.¹ Moreover, only 57% of adults made or received a digital payment in developing countries, compared to 64% worldwide (Demirgüç-Kunt et al., 2022).² Some reasons for choosing cash over digital payments, thus staying outside the formal financial system, are related to informality (Aurazo and Vega, 2021; Aurazo and Gasmi, 2022), tax evasion, and mistrust in financial institutions.

In recent years, digitization of payments and financial services has been accelerated in many developing countries due to the diffusion of information and communication technology, thus enabling them to promote financial inclusion known to stimulate growth (Fabregas and Yokossi, 2022; Qiu, 2022), curb poverty (Aker et al., 2016), and bridge gender (Suri and Jack, 2016) and education (Grohmann and Menkhoff, 2018) divides. Empirical analyses have shown that digital transformation of financial services has been beneficial for users allowing them to transfer massive amounts of funds in a ubiquitous way (Jack and Suri, 2014; Munyegera and Matsumoto, 2016), in addition to improving tax collection (Apeti and Edoh, 2023) and boosting consumption while reducing the destabilizing effects of remittances (Apeti, 2023).³ Yet, given the diversity of experiences in developing countries, it seems appropriate to examine their key characteristics and assess their relative merits.

This paper uses a descriptive approach to closely examine four digital payment schemes that share the prominence they gained in the developing world but differ sufficiently enough in their key characteristics so as to allow us to draw useful lessons from their successful implementation. These systems are M-Pesa, UPI, Pix, and Yape respectively in Kenya, India, Brazil, and Peru, KIBP hereafter. These experiences drew our attention not only because of the respective dynamics of their development and the levels reached, but also the particular regulatory and market structure contexts in which they emerged. At this initial stage, the leading actors have been a private mobile network operator (MNO) in Kenya and the central bank in India and Brazil. Meanwhile, a group of commercial banks offering digital payment wallets have been the actors that played a significant role in Peru.

Pix is the most recent of these experiences, launched in November 2020 and becoming a reference for other central banks in the provision of public fast payment systems. M-Pesa is the oldest, launched in March 2007 and motivating the emergence of e-money issuers in

¹A formal financial institution can be a bank or any regulated institution such as a credit union, a microfinance institution, or a mobile money service provider.

²For information on the evolution of financial inclusion, see the Global Findex database that covers more than 140 countries. Launched in 2011 by the World Bank, with funding from the Bill & Melinda Gates Foundation, the initial survey round was followed by a second in 2014, a third in 2017, and a fourth in 2021.

³This is especially true for mobile money (m-money). A sizeable literature on the economics of m-money exists including, among others, Aker et al. (2016), Bair and Triah (2019), Batista and Vicente (2020), Fabregas and Yokossi (2022), Jack and Suri (2014), Jack et al. (2013), Ky et al. (2018), Munyegera and Matsumoto (2016, 2018), Paelo and Roberts (2022), Qiu (2022), Suri (2017), Suri et al. (2021), and Tyce (2020).

Africa and around the world. UPI was launched in April 2016, while Yape began to be used smoothly by Peruvians in February 2017 and then skyrocketed during the Covid-19 pandemic. For the purpose of comparing these schemes at a formal level, we choose to examine them through the lens of three dimensions of the characteristic space of digital payment systems.⁴

The first key aspect is the role played by private developers and providers as they are the main actors in the last mile before reaching the end user. The second important aspect is the role of regulators and central banks, whose intervention, whether light or heavy, is essential to the creation of a regulatory framework that paves the way for a robust and efficient payment system. The third key aspect we have identified is the role played by the degree of interoperability of payment systems, in particular platform and data interoperability.⁵ This feature, either partial or complete, is relevant in both the early and mature stages of development of the digital payment system and could be the "conductor's baton" with which regulators and central banks can promote competition, lower costs for end-users, and increase the adoption of cashless payments.

To some extent, the analysis of these diverse experiences suggest that there is no one-size-fits-all solution to digital payment. However, key lessons were learned, highlighting the importance of active cooperation between the public and private sectors and placing the end user at the center of any initiative. The analysis also opens the door to some future challenges related to universal access, ensuring price sustainability over time, and realizing the full importance of data value, privacy, and sharing.

This paper is organized as follows. Section 2 discusses the situation in terms of access to and use of digital payment services in the host countries of the digital payment systems analyzed and citizens' interest in these systems as suggested by data extracted respectively from *2021 Global Findex* and *Google Trends*. Section 3 presents each of the four digital payment systems in turn by providing a narrative of both their emergence and development stages. Section 4 provides a discussion of the systems that focuses on the three-dimensional space used to characterize them. Section 5 briefly discusses three forward-looking concerns in digital payment systems and section 6 summarizes the main insights of the paper. The appendix gives a list of acronyms used in this paper.

2 Access to and use of digital payment systems in KIBP

This section gives a brief account of advances in the adoption of digital payment tools in KIBP, more specifically, access to financial institution/mobile money accounts and payment cards and use of these instruments instead of cash to make transactions. Figure 1 shows some figures taken from the *2021 Global Findex Database*. Chart (a) of this figure illustrates

⁴While the characteristic space of digital payment systems is certainly of a much higher dimension, the descriptive analysis performed in this paper demonstrates that the three aspects considered are key to understanding the digital payment experiences discussed.

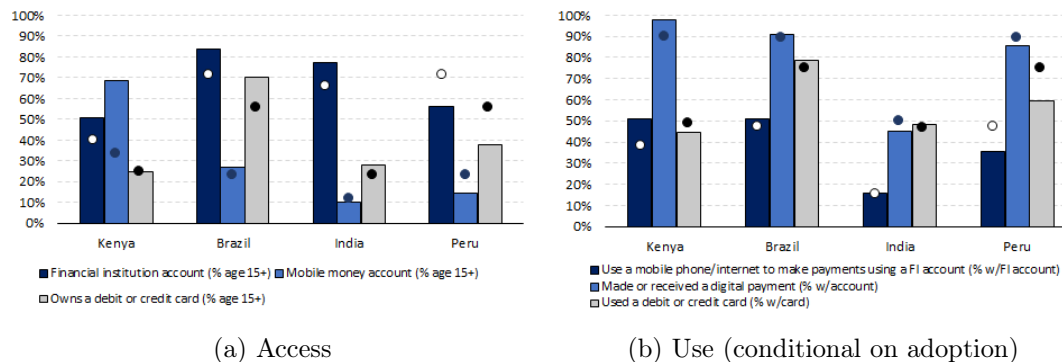
⁵In a nutshell, platform interoperability exists when a customer of a given payment service provider can send money to a customer of another provider. This customer makes an "off-network" transaction. Data interoperability exists when information on the customer who makes the transaction can be transferred and used by the other payment service provider (Bianchi et al., 2023).

the access to digital payment tools while Chart (b) focuses on the use of digital payment services.

Chart (a) highlights the importance of mobile money accounts in Kenya. We indeed can see that the number of such accounts is significantly higher than the average in sub-Saharan Africa. Brazil and Peru lag behind in terms of e-money account penetration, while India has the lowest level of access to mobile money accounts. In terms of access to accounts with financial institutions, Brazil and India are ahead of Kenya and Peru, which, with the exception of Peru, are above the average for their respective regions. Debit/credit card ownership, the main substitute for cash in recent decades, remains significant only in Brazil and Peru, with Brazil’s level well above the average in the Latin America and Caribbean (LAC) region.

In terms of digital payment use (conditional on adoption), chart (b) shows that Brazil and Kenya are still high performers. Brazilian and Kenyan citizens use a mobile phone/Internet to make payments, make or receive a digital payment (including for on-site channels and remittances), and use a debit/credit card at a higher rate than the average in LAC and Sub-Saharan Africa regions, respectively. Surprisingly, India has low levels of digital payment use, barely close to or even below the South-Asian regional average. As for Peru, while it shows levels below the LAC average, the recent launch of digital wallets like Yape is expected to boost the adoption and use of digital payments among the population.

Figure 1: Access to and use of digital payments in KIBP



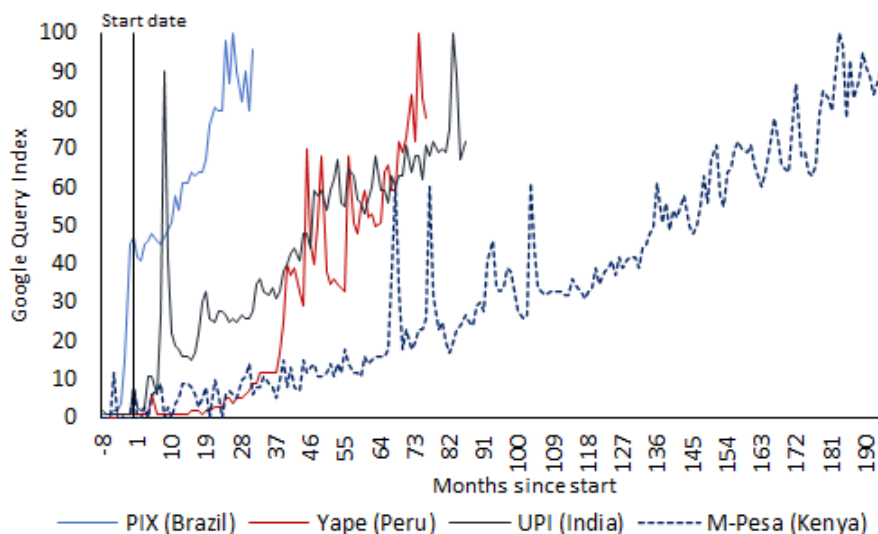
Notes: Values corresponding to the dots are averages in the regions to which KIBP belong, namely, Sub-Saharan Africa for Kenya, Latin America and Caribbean for Brazil and Peru, and South Asia for India, excluding high-income countries of these regions; Figure constructed by the authors using *Global Findex 2021* data.

Figure 2 exhibits the level of the *Google Query Index* that gives the percentage of queries on each digital payment system as a function of the number of months since the system was launched.⁶ This figure shows that interest in M-Pesa, UPI, Pix, and Yape has steadily grown since their respective years of introduction. Interestingly, while Pix caught the attention of Brazilians just a few months after its launch (in November 2020), Yape, launched much

⁶This index is constructed based on *Google Trends* search data providing *Search Volume Indices*. These indices measure search intensity, i.e, the number of searches for a given keyword as a proportion of total searches, by location and period. Queries can be made by keyword, category of keywords, or topic.

earlier (in February 2017), attracted interest from Peruvians only 36 months later, which coincided with the Covid-19 pandemic during which the government imposed numerous lockdowns.

Figure 2: Interest in digital payment solutions M-Pesa, UPI, Pix, and Yape



Notes: Start dates are March 2007 for M-Pesa, April 2016 for UPI, February 2017 for Yape, and November 2020 for Pix; Figure generated by the authors from *Google Trends*.

3 Digital payment initiatives in KIBP

3.1 Kenya’s M-Pesa

Launched in March 2007 by Safaricom, M-Pesa, an electronic-money/mobile money (e-money/m-money) wallet, made a stunning take-off.⁷ The service allows mobile-phone owners to deposit, transfer, and withdraw funds even if they don’t have a bank account or a connection to Internet. Safaricom started business in 1997 as the sole operator in the Kenyan mobile phone market and currently controls more than 65% of this market. Thanks to its iconic M-Pesa, Safaricom has dominated the m-money market with more than 95% of market share in 2021. Only two years after its launch, M-Pesa reached 5 million users, i.e., more than the client base of all Kenya’s banks combined, and its explosive growth continued ever since (Tyce, 2020). In 2022, fifteen years after its launch, 30.53 million active customers transfer annually more than 85% of Kenya’s GDP. Similarly, the population of M-Pesa agents jumped from just over 4000 in 2008 to about 16,000 in 2009 (Jack and Suri, 2011). In 2022, Safaricom maintained and operated a network of no less than 260,000 active agents (Safaricom, 2022).

In Kenya, e-money issuers (EMIs) are regulated by the Central Bank of Kenya (CBK) through the National Payment System Act 2011 that requires them to apply for a license

⁷The letter M in M-Pesa stands for mobile and pesa is a Swahili word for money.

before operating. For all e-money in circulation, an equivalent amount must be held as ring-fenced trust account in the form of bank balances within commercial banks or in government of Kenya securities (Defina et al., 2021). The agents associated with an MNO earn a commission on each deposit or withdrawal transaction that they close as their compensation by the MNO. The pricing policy of EMIs seek to give customers incentives to retain funds in e-money units. On the one hand, the exchange of cash into e-money is free of charge for the client, despite the fact that the MNO pays a commission to the agent, and transactions in e-money are subject to very low, sometimes even zero, fees. On the other hand, the exchange of e-money into cash entails a significant fee. Thus, users who have already acquired e-money units have incentives to transact within this e-market sphere, thereby contributing to the creation of even more e-money transactions.

When Safaricom introduced m-money as the sole provider, it did so in an unclear and somewhat risky regulatory environment. However, this MNO benefited from some opportunities that were exclusively open to it. Indeed, while there was some hesitation on the part of the authorities as to whether MNOs should be allowed to access Kenya's national payment infrastructure and issue e-money, Safaricom obtained in 2007 a no-objection letter from CBK. This allowed it, as a monopoly provider, to fully benefit from network effects and achieve a dominant position in the Kenyan digital payment market. As of July 2019, 90% of Kenyans over the age of fourteen have made transactions through M-Pesa. M-Pesa's share of mobile money subscriptions was 98.8% in the first quarter of 2020. The closest competitors, Airtel Money and T-Kash, recorded market shares of only 1.1% and 0.05% respectively (Defina et al., 2021).⁸

Another key enabling regulatory initiative that significantly contributed to the success of M-Pesa is the agent-exclusivity agreements whereby m-money agents were allowed to serve only one m-money provider. During the early stage of the market development, these agreements gave Safaricom incentives to invest in the expansion of its network of agents, thus substantially strengthening its market dominance and power. In 2014, to encourage entry, the competition authority put an end to this exclusivity, although this led only to moderate entry and Safaricom still remained the largely dominant operator in the Kenyan m-money market.

As the m-market was gaining in maturity, it became clear that competition was necessary to improve its efficiency. Interoperability of m-money platforms owned by Safaricom and other MNOs and banks was introduced in order to allow these providers to effectively compete for the provision of affordable and inclusive digital means of payments. In 2014, the Communication Authority of Kenya (CAK) licensed three new mobile virtual network operators (MVNOs), namely, Mobile Pay, Finserve Africa, and Zioncell Kenya with the goal of disrupting the country's m-money market. This measure was however not enough to reduce Safaricom's market power. In 2018, CBK implemented a full m-money interoperability measure, but due to the delay in its implementation, this measure did not challenge Safaricom's dominance in the e-money market (Central Bank of Kenya, 2021).⁹

⁸In 2020, Safaricom partnered with Visa to enlarge access to digital payments for M-Pesa consumers and merchants and further stimulate network effects.

⁹The second largest mobile network, Airtel, is also in the second position regarding m-money services. It

Exogenous shocks, such as social violence or sanitary crises, have also played a role in the development of digital means of payment in Kenya. Less than a year after the launch of M-Pesa and following a contested general election, a widespread population uprising broke out resulting in the closure of many Automatic Teller Machines (ATMs) and bank branches. This has led to a sharp uptick in m-money use. The same phenomenon happened during the Covid-19 sanitary crisis that led to a significant shift of the Kenyans from standard to digital means of payments (GSMA, 2021). During this crisis, one in four consumers began purchasing essential goods and services using m-money. This behavioral change has been exacerbated by some urgent financial decisions including increasing transactions' limit, eliminating charges on some basic transactions, and facilitating transfers between m-money and bank accounts (Central Bank of Kenya, 2021).

3.2 India's UPI

The Unified Payments Interface (UPI) was launched in April 2016 by the National Payments Corporation of India (NPCI), a division of the Reserve Bank of India (RBI), in association with the Indian Banks Association (IBA).¹⁰ Being largely open, this system has created a level-playing field to participants wishing to provide end users with the ability to make instant real-time payments. This interface facilitates interbank peer-to-peer (P2P) and person-to-business (P2B) transactions. In 2019, UPI has been used to make 12 billion retail transactions provided through 143 providers. In February 2022, 304 banks were available on UPI and close to 4,527.49 million transactions were made representing a volume of 8,26,843.00 Cr. In September 2023, these figures jumped to 492, 10,555.69, and 15,79,133.18 respectively.¹¹

In 2014, RBI developed India Stack which has profoundly transformed the digital payments ecosystem in the country. Designed on the basis of open-banking standards, India Stack is a set of Application Programming Interfaces (APIs) and digital public goods that allows banks as well as non-bank institutions to operate on a common infrastructure. RBI initiated this project and monitored the associated payment and settlement system in a heavily regulated financial market that was traditionally dominated by public commercial banks. The 2007 Payments and Settlement Act gave it the authority to conduct a deep reform of the market and regulatory framework. The central bank had thus all the latitude to play, and it did, a central role in adapting the regulatory framework to the new conditions of the digital market in order to increase its efficiency.

Key components of India Stack, including those that enable authentication, payment, and user's consent are connected to each other, in particular a digital payment module that allows for full interoperability among providers. This was the context in which UPI emerged. UPI allows customers to use a single provider's mobile application to make all financial transactions. There are no charges for P2P transactions but since April 2023 interchange fees were set for P2B transactions above INR 2000 using prepaid payment instruments

is followed by Equity Bank which offers m-money services via its own MVNO, Equitel, the latter operating by agreement on Airtel's mobile network (Paolo and Roberts, 2022).

¹⁰NPCI is under the jurisdiction of the Ministry of Finance and is regulated by RBI.

¹¹See for more detail <https://www.npci.org.in/what-we-do/upi/product-statistics>

(PPI)¹². Moreover, UPI is connected to the Indian biometric identity platform, Aadhaar, which is also a component of India Stack. This digital identification platform has played a role at various stages of the payment system development process, in particular by allowing for digital verification.¹³ This digital identification system has also been considered as having contributed to the increase of financial inclusion driving adults account ownership from 35% in 2011 up to 80% in 2017.

UPI has significantly contributed to fostering competition by allowing contestable entry in the digital payment market in the sense that, besides banks, payment service providers (PSPs) can transfer funds within UPI (D’Silva et al., 2019). This has improved the market’s efficiency and gave the private sector incentives to compete for the provision of affordable and inclusive services. Moreover, MNOs as well as the postal system can operate as payment banks since 2016 and offer their digital payment services through UPI. Six of the eleven companies that have been approved in 2016 are still operational. In just over three years after its creation, UPI has become the most common interface for retail transactions deployed on India Stack.

Exogenous shocks have also impacted the development of digital means of payment in India. In this country where four out of six people live in poor areas where making daily transactions by cash is the rule rather than the exception, the implementation of the demonetization policy has reduced drastically the volume of cash in circulation. To curtail the shadow economy, increase cashless transactions, and reduce the use of illicit and counterfeit cash to fund illegal activity and terrorism, the Indian government announced on November 8, 2016 the demonetization of 86% of its currency in circulation.¹⁴ Although this reduction of money supply had an ambiguous effect on the global economy (Lahiri, 2020), the impact on digital payment adoption turned out to be positive (Chakrabarty et al., 2020). Costa et al. (2022) show that in states with less formal labor markets, i.e., where workers are more likely to be affected by demonetization, the use of platforms increased more significantly than in states with more formal labor markets. Also, as a consequence of the Covid-19 pandemic, government-to-person (G2P) direct benefit transfers have reached a record and more than 80 million adults made their first digital merchant payments during the pandemic (Demirgüç-Kunt et al., 2022).

3.3 Brazil’s Pix

Brazil’s digital fast payment system, Pix, has profoundly transformed the way Brazilians make payments.¹⁵ Since its launch by the Banco Central do Brasil (BCB) in November 2020, it has experienced remarkable growth, becoming the dominant electronic means of payment in the country. Pix has replaced other prominent options such as Boletto Bancario, TED, direct debits, and even credit and debit cards, having been used to make about 20%

¹²PPIs are payment instruments storing specific monetary value. They can be payment wallets, smart cards, magnetic chips, vouchers, mobile wallets, and similar instruments.

¹³Electronic knowing your customer (e-KYC) was possible since 2012 and electronic signature (e-Sign) since 2015.

¹⁴This demonetization initiative concerned all the 500 INR and 1,000 INR banknotes delivered under the Mahatma Gandhi Series that were exchanged against new 500 INR and 2,000 INR banknotes.

¹⁵Pix is an abbreviation for plataforma para instant payment exchange.

of all retail transactions including cash by the end of 2022 (Sarkisyan, 2023). In just over a year, it registered about 121 million users representing more than 50% of the Brazilian adult population, now this is close to 80%, whereas while 60% of all businesses have used this fast payment means. Today, Pix processes nearly 3 billion transactions every single month.¹⁶

Pix is a public digital payment infrastructure that allows users to send and receive transfers using quick response (QR) codes and aliases such as mobile phone numbers or email addresses for authentication. This feature circumvents the sharing of details on users' personal accounts and service providers when making transactions, sometimes creating meaningless frictions for a user-friendly experience. Pix has been developed and is owned, operated, and regulated by BCB. The electronic payments law of 2013 gave BCB the authority to regulate digital retail payments, which put the central bank in a position that allowed it to promote the exploitation of network effects by participants as well as competition among them.

Since 2018, BCB has issued guidelines for the creation of a Fast Payment System (FPS) with the main objective of promoting an open competitive platform on which, besides public banks, non-bank institutions and PSPs may operate. To foster entry, BCB mandated large banks as well as financial institutions with more than half a million transaction accounts to participate (Duarte et al., 2022). Furthermore, in its vocation to provide a public digital payment infrastructure, BCB has required that Pix transactions carried out by individuals be free of charge, but allowed banks and PSPs to freely set fees to be charged to merchants, both for sending and receiving funds, these fees being however lower than those charged for card transactions. Only PSPs must pay fees which are used to recover the cost of operating the platform.

Full interoperability has been a key feature of Pix. This system was designed on the basis of an open architecture with common technical and data management standards. Only less than 2 years after its launch, nearly 800 participants shared the platform to provide various digital means of payment. Also, when BCB developed Pix, it did so in a highly concentrated financial market dominated by three major banks. Two of these banks were public (Caixa Economica Federal and Banco do Brasil) and one was private (Bradesco). These banks enjoyed substantial rents as they had the opportunity to exploit the significant network effects stemming from their respective webs of business/agent-correspondents then considered as the largest in the country.¹⁷ This correspondent-banking network allowed these banks to extend their scope to areas where branches and ATMs were less present by making partnerships with non-bank establishments to act as their correspondents (De la Torre et al., 2017).

As the launch of Pix coincided with the outbreak of the Covid-19 pandemic, BCB took the opportunity to put in place a mandatory measure according to which funds received via this platform can be used to make transfers within it and cannot be withdrawn in cash until at least one month after these funds have been actually received (Block, 2022). This measure allowed about 30 million users not only to become more familiar with Pix during the sanitary crisis, but also discouraged them from immediately returning to cash-based

¹⁶See <https://thefintechtimes.com/the-story-of-pix-and-what-us-banks-can-learn/>

¹⁷A customer had simply to open a basic bank account and hold a bank card to benefit from affordable transfers available at these agent-correspondents.

transactions after the crisis. In addition, Pix has been demonstrated to have had positive impacts on deposit and loan markets through fostering competitive pressure from small banks and non-bank establishments (Sarkisyan, 2023).

3.4 Peru's Yape

Yape was launched in February 2017 by the country's largest bank, Banco de Crédito del Perú (BCP), but was truly leveraged during the 2020 pandemic.¹⁸ At first, this digital payment method only allowed BCP customers to transfer funds to each other using mobile phone numbers or QR code scans instead of bank account information. Later, Yape integrated eight other financial institutions. As of April 2023, Yape reached 12 million users in Peru, representing approximately 35% of the country's population. This digital payment system plans to become the first "super app" in Peru, with a portfolio of services expected to cover micro-loans and discounts in selected stores, including restaurants, fast food outlets and gas stations (Barrantes and Alzamora, 2023). The maximum amount per transaction is 500 PEN, around 130 USD, and there are no charges for P2P and P2B transactions.¹⁹

Cashless payments have increased significantly in Peru since the Covid-19 pandemic, mainly due to the introduction of the two digital wallets Yape and PLIN.²⁰ By March 2023, these two digital wallets accounted for more than 50% of total retail cashless transactions in Peru, replacing card payments as the main means of payment which just accounted for 22% (Banco Central de Reserva del Perú, 2023).²¹ Given the wide adoption of the Peruvian digital wallet-based payment system, there are at least three aspects related to its development that, in our sense, deserve to be pointed out. First and foremost, the system has clearly emphasized easiness and user-friendliness. Before the introduction of Yape and PLIN, the Peruvian population had access to a "quasi-fast" payment system since instant inter-bank transfers were only allowed from Monday to Friday and from 8am to 5pm.²² In addition, users were required to introduce bank account information of the destination account to make an instant transfer. With the advent of these digital wallets, customers were happy to use just a cell phone number or to scan a QR code to make a payment.²³

Second, the Covid-19 pandemic has clearly boosted the adoption and use of these digital wallets. Yape and other digital payment initiatives such as BIM and Agora, were used

¹⁸Yape is a Peruvian slang abbreviation of "ya pues," which means "come on, do it."

¹⁹For more details, see Barrantes and Alzamora (2023).

²⁰Yape and PLIN are different from other digital wallets such as ApplePay or Paypal because in the latter users store their own debit/credit card information within the application for subsequent purchases whereas in the former the funds directly come from bank or e-money accounts.

²¹PLIN was introduced at the start of the coronavirus pandemic in 2020, thus offering a handy means of making contactless payments, especially, P2P and P2B transactions, using cell phone numbers or scanning QR codes. Unlike Yape, however, PLIN is not a stand-alone mobile application, but is embedded in the mobile bank application of the 3 out of 4 largest banks in Peru, namely, BBVA, Interbank and Scotiabank, and 4 other financial institutions. The maximum amount per transaction allowed is PEN 1500, around USD 390, and, similarly to Yape, there are no charges for P2P and P2M transactions. PLIN has reached out more than 10 million users, which represents around 30% of the population of Peru.

²²In practice, intra-bank transfers, i.e. fund transfers between clients of the same PSP, were instant and usually free of charge for customers.

²³By the end of 2020, the Peru's Automated Clearing House (ACH) introduced a 24-hour/7-day fast payment service, and in the few past months inter-bank transfers are made using cellphone numbers.

by the government during the sanitary crisis to quickly make planned disbursements in the context of different social programs by depositing funds in bank or electronic money accounts. Third, there is a payment technology behind Yape that supports fast payments using cellphone numbers, namely, Visa Direct, a Visa payment infrastructure, which allows users to make real-time account-to-account (A2A) transfers between Visa customers who are also Yape’s. This infrastructure has provided the population with a user-friendly real-time payment service that was non-existent before the introduction of the digital wallets.

Although the availability of the digital wallets has significantly increased the use of digital payments among the Peruvian population, the Banco central de reserva del Perú (BCRP) became concerned with the fragmentation of the Peruvian payment system. In October 2022, BCRP issued a directive mandating the interoperability between Yape and PLIN starting in April 2023, thus allowing Yape’s clients to transfer funds to PLIN’s without the need to have an account at any of the financial institutions associated with PLIN and vice versa (Castillo et al., 2023). In later stages, this circular stipulated that interoperability should be also guaranteed among different payment services, including inter-bank instant transfers and QR codes scanning. It is expected that a greater degree of interoperability should foster adoption and use of digital payments, promote entry of new players, stimulate effective competition by reducing the network effects of the dominant players, and improve the efficiency of the Peruvian digital payment system.

To conclude this description of prominent digital payment initiatives in KIBP, we summarize some of their key parameters in Table 1. Of particular interest are the product design and the fees charged in each of these initiatives. Note that for instance, Pix has no limit per transaction whereas the three other initiatives are limited to relatively low-value transactions. In terms of pricing, P2P and P2B transactions are generally free for customers, while merchants have to pay a fee when they receive a payment. Only transactions made through Yape are free for both customers and merchants.

4 A three-dimensional space of key characteristics of digital payment systems

While informative, our account of the four digital payment system success stories presented in the preceding sections leaves us with the puzzle of identifying and collecting the fundamental characteristics that differentiate them. Besides, even if this endeavor gets carried out, a daunting question is whether one can establish, theoretically or empirically, causality relationships between these characteristics and the performance of each of the systems. This important research question goes however beyond the ambition of this paper whose scope is more preliminary. More specifically, we seek to learn more about M-Pesa, UPI, Pix, and Yape by focusing on what, in our opinion, are the three most important variables that could be used to characterize them.

The first variable represents the varying influence that developers or providers of digital platforms have in establishing the platform’s infrastructure and defining the details of its use for making payments. The second variable describes the range of roles played by regulators and central banks in digital payments, from issuing regulatory directives to actively developing

Table 1: Key descriptive features of M-Pesa, UPI, Pix, and Yape

| Descriptive feature | Kenya | India | Brazil | Peru |
|------------------------------|--|---|--|--|
| Commercial brand name | M-Pesa | UPI | Pix | Yape |
| Launch date | March 2007 | April 2016 | November 2020 | February 2017 |
| Liability money | Mobile money | Commercial bank money | Commercial bank money | Commercial bank money, E-money (earlier stage) |
| Type of infrastructure owner | Private MNO (Safaricom) | Public-private (RBI and IBA) | Public (CBB) | Private (VISA and BCP) |
| # of participants | 1 | 381 | 878 | 8 |
| Interoperable with | Card point-of-sale (POS), Other e-money issuers, Non-registered | PPI | Card POS | PLIN, Card POS |
| Aliases used | Cellphone number | QR codes | Cellphone number, email, QR codes | Cellphone number, QR codes |
| Per-transaction limits | KSHS 250k (\approx USD 1650) | INR 100k (\approx USD 1200) | No limits | PEN 500 (\approx USD 134) |
| Fees | P2P: Free, up to KSHS 100 P2B: Customers free, Merchants free up to KSHS250, then 0.55% and below KShs.200 | P2P: free for customer, P2B: free for customer and merchants, range of 0.5-1.1% using PPI and above Rs 2000 | P2P: Free, P2B: For customer, free, For merchants, from R\$ 0,89 to R\$ 1,20 | Free of charge |

Source: Own PSPs' websites, RBI, and BCB

and owning digital payment infrastructures. The third variable concerns the level of interoperability within and between payment systems, which is a key factor in increasing digital payment adoption particularly when markets have reached maturity. To add structure to our analysis of the four digital payment experiences, we re-evaluate them according to the perspectives of the three variables' dimensions. This enables us to synthesize our discussion of these experiences within a framework defined by the three-dimensional space formed by these variables.

4.1 The role of digital platform developers and providers

The digital platform developers have a critical role to play as enablers of digital payment systems development. They supply the essential retail infrastructure and technology for downstream activities, directly impacting the end user. They also determine the quality, pricing, and user- friendliness of financial payment services, the underlying technology, such as mobile applications, internet, or unstructured supplementary service (USSD) solutions, and service features, such as transaction limits and authentication procedures. The providers can develop their own digital payment solution, collaborate or co-invest in shared infrastructure, or utilize centralized payment systems such as real-time gross settlement (RTGS) systems or FPS, which are often operated by central banks and may require mandatory participation.

In Kenya, advances in access to digital finance have been largely driven by mobile money that has emerged in a highly concentrated market structure dominated by the private MNO Safaricom, which continues to hold a quasi-monopolistic position. In 2007, when M-Pesa

was launched, the experience with mobile money around the world was extremely scarce. In fact, this service started as a way to reduce the costs of micro-credit before its adoption revolutionized the way Kenyans undertake their financial transactions.

In Peru, Yape was introduced by the largest bank, later joined by a few other financial institutions, with the purpose of developing a disruptive payment solution that was non-existent. The objective was to provide users of this solution with the possibility of paying and transferring funds real-time using their cell phone number or scanning QR codes. In both cases, the digital platform providers established the access criteria as well as features of their payment solutions, including limits per transaction, authentication and verification processes, and clearing and settlement.

In contrast, despite an increasing involvement of non-bank establishments, state banks have led the development of the digital payment methods UPI in India and Pix in Brazil. Central banks have played a pivotal role in this development, actively designing and operating FPS, determining who is eligible to participate, setting transaction limits, and setting fees for end users. Regarding the providers of the digital payment service, it was necessary for them to establish appropriate standards to meet the criteria established by central banks. As a result, the platform providers were passive, since they did not take the initiative to develop their own payment solution.

4.2 The role of regulators and central banks

The role played by regulators and central banks in supporting the emergence and development of digital payment systems has been a distinctive feature of the four experiences discussed in this paper.²⁴ Traditionally, central banks own, operate, and manage their high-value payment systems for interbank transfers, while also regulating and stimulating low-value retail payment systems for dedicated retail transactions among individuals and businesses, which are primarily operated by the private sector. However, in recent years certain central banks have extended their involvement from simply issuing regulatory guidelines to actually developing their own retail payment systems in order to encourage the use and adoption of digital payments. This was the case of RBI in India and BCB in Brazil that launched the UPI and Pix initiatives, respectively.²⁵

The highly adaptable regulation from the outset of m-money services provision in Kenya facilitated M-Pesa's rapid adoption. The regulatory intervention in India's digital payment market has progressed gradually towards greater flexibility, resulting in a sluggish uptake of UPI followed by a consistent and sustained development process. In recent years, regulatory measures in Brazil have breathed new life into the development of a modern FPS that has outperformed the traditional correspondent-banking model. This, in turn, has favored a surge in the adoption of Pix. In Peru, Yape was provided by financial institutions within a flexible regulatory framework that did not require obtaining a license from the main financial

²⁴One would expect that during the early stage of market development, light-handed regulation would give potential entrants incentives to invest in innovative platforms and exploit network effects, and as the market gains in maturity, closer regulatory oversight would be necessary to improve its efficiency.

²⁵This was also the case of the Mexican central bank, Banco de México, that developed in 2019 CoDi®), a platform to facilitate payment and collection transactions through mobile phone e-transfers.

sector regulator, Superintendencia de Banca, Seguros y AFP del Perú (SBS), or the central bank. Unlike ACH, which is directly regulated by BCRP, Yape and other digital payment initiatives have caught the attention of BCRP by involving several financial institutions in their payment arrangements. The central bank is currently enforcing interoperability of Yape with other payment methods such as PLIN as we will see in the next subsection.

Both the regulatory and competition authorities have contributed to the development of M-Pesa in Kenya, despite their divergent goals in the early development stages of the digital payment market. While the intervention of the central bank and communication authority heavily favored the innovative and dominant platforms supplied by MNOs, the intervention of the competition authority played an effective role in mitigating their market power. In India and Brazil, the central banks have been tasked with mandating and maintaining fair competition. Conversely, Indecopi, the competition authority in Peru, has taken a proactive approach towards the payments market in recent years. In 2021, it undertook a market study that proposed several recommendations to foster competition in the Peruvian market for payment cards, involving private agents and the central bank. Recently, Indecopi has launched a market analysis on Fintech in order to evaluate the market environment, incorporating the present condition of e-money issuers, digital wallets, and Yape.

4.3 The degree of interoperability of the payment system

Interoperability of payment systems enables the transfer of funds between different types of accounts, such as bank, e- money, debit, or credit accounts, regardless of the PSP managing the funds. This regulatory initiative has played a significant role in the triumph of digital payment systems by boosting social welfare through enhanced competition (?). These authors identify four levels/types of interoperability of m-money payments that we recall here.

The first type is interoperability at the mobile network level, a phenomenon known in the economic literature as "tying," which is intrinsic to m-money and refers to the possibility of having services with different MNOs. The second is interoperability at the network level, also known as "compatibility," which pertains to the capacity of users from one PSP to transfer funds to users of another PSP. The third is interoperability at the agent level, which refers to the ability of customers from a specific PSP to deposit and withdraw funds at the agency networks of this PSP and any other PSP. Last, the fourth type is data interoperability, commonly known as "open banking," which refers to the seamless utilization and sharing of data across various PSPs.

There are two primary methods to attain full interoperability at the network level in a country's payments market. One involves a centralized infrastructure integrating all financial institutions and PSPs within the country. The other is to cultivate interoperability among closed-loop payment schemes. Brazil and India have provided their own payment infrastructures and mandated banks and non-bank entities to integrate with these systems. Kenya has made attempts to promote interoperability amongst m-money issuers, but was unsuccessful. In contrast, Peru has recently enforced mandatory interoperability between Yape and PLIN, alongside other payment services in subsequent stages. Furthermore, Peru has also encouraged entry of new participants, including e-money issuers, into Peru's RTGS

and ACH. In terms of data interoperability, India and Brazil have made great strides in implementing open banking, a sort of data interoperability mandate in banking and payments markets.

Although interoperability has consistently been raised as a concern for the advancement of digital payment markets, it seems clear that it is neither a necessary nor a sufficient condition for the success of a system. For instance, the Kenyan private MNO Safaricom developed M-Pesa, regarded as the most successful m-money experience in the world, without any interoperability. Moreover, the Yape digital wallet was launched in Peru without interoperability with other digital wallets. However, it does offer interoperability among its own participants and with payment card networks, enabling users to pay at card POS terminals and e-commerce platforms. Yape has significantly replaced traditional payment methods, including cash and debit cards, among the Peruvian population, thereby promoting financial inclusion.²⁶ In contrast, India has invested in an open, public platform-based system that provides full interoperability not only within the FPS module but also between other modules in order to improve inclusive access to trusted identification systems. Pix, on the other hand, enables full interoperability among some 800 stakeholders within the FPS.

4.4 A three-dimensional representation of M-Pesa, UPI, Pix and Yape

In the previous subsections, we have discussed the four digital payment systems M-Pesa in Kenya, UPI in India, Pix in Brazil, and Yape in Peru by focusing on three regulatory and market structure dimensions, namely, the role played digital platform developers and suppliers, regulators and central banks, and interoperability. As seen, these experiences vary sufficiently across these three variables, allowing us to make meaningful comparisons and derive insights from examining their development from initial to maturity stages. We seek to synthesize our findings in terms of these three variables.

First, (private) digital platform providers have led Kenya’s M-Pesa and Peru’s Yape developments, resulting in more robust and user-friendly payment solutions than India’s UPI and Brazil’s Pix in which (public) central banks took the leading role. Despite these differences, all four experiences adhere to the principle that the end user is central to any digital payment ecosystem, necessitating solutions that are secure, user-friendly, smooth, and affordable. Second, regulators and central banks have taken a more active role in the cases of UPI and Pix by developing and designing their own FPS than in the cases of M-Pesa and Yape in which central banks have assumed the more traditional role of issuing regulatory guidelines and overseeing the efficiency and soundness of the payment schemes. Third, the M-Pesa and Yape experiences were clearly less focused on interoperability than UPI and Pix, particularly in the early stages of their development.

For the purpose of synthesizing our comparison of the four digital payment systems along

²⁶Note that despite being interoperable with numerous financial institutions, telecom companies, and the government, and despite having competition within its platform, the Peruvian mobile money platform *billettera móvil* (BIM) has failed to achieve its lofty financial inclusion objectives since its launch in 2016. (Del Carpio Ponce, 2018). Some reasons put forward to explain this failure are related to, among others, the lack of access to a wide cash-in and cash-out network, a costly initial technology (based on USSD), a less user-friendly service, a stringent regulation on e-money issuers, and inadequate limits per transaction.

the three variables, it is convenient to adopt an ordinal approach. More specifically, let the functions $DIGP(sys)$, $REG(sys)$, and $INTOP(sys)$ capture the role of digital platform developers and providers, the role of regulators and central banks, and the role/degree of interoperability of the digital payment system $sys \in \{M\text{-Pesa, UPI, Pix, Yape}\}$, respectively. Then, from our discussion above, we may order the levels attained by these functions for the four experiences as follows:

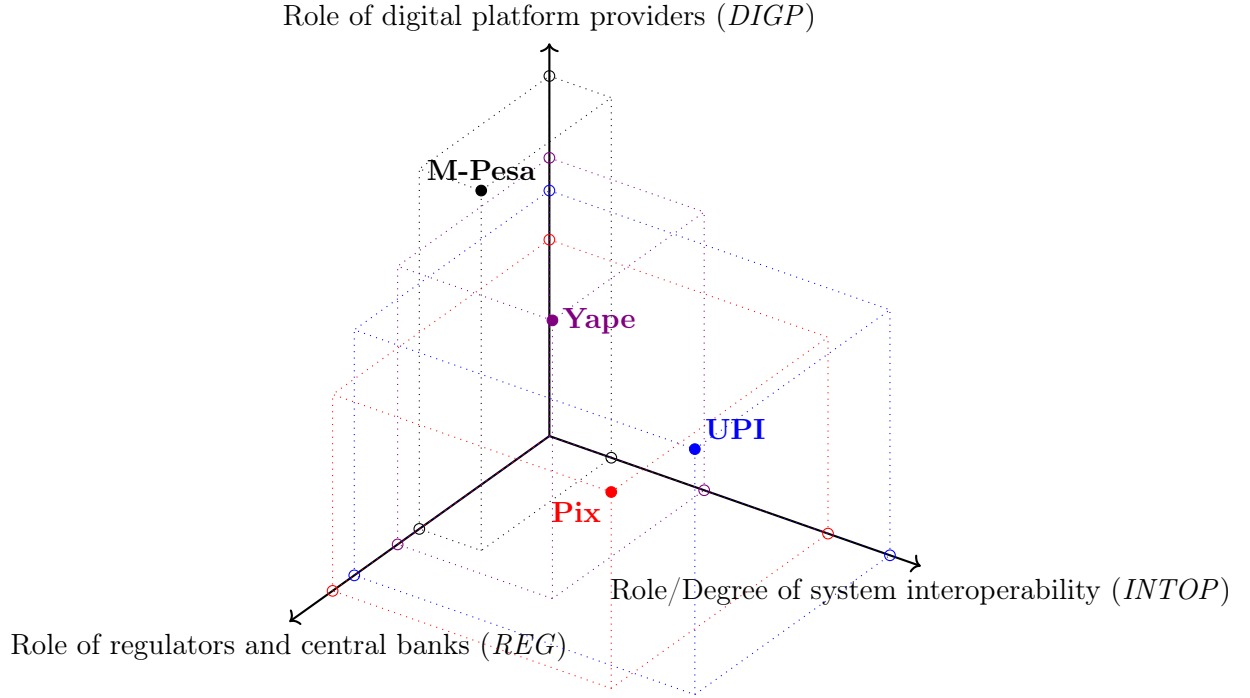
$$DIGP(\text{Pix}) < DIGP(\text{UPI}) < DIGP(\text{Yape}) < DIGP(\text{M-Pesa}) \quad (1)$$

$$REG(\text{M-Pesa}) < REG(\text{Yape}) < REG(\text{UPI}) < REG(\text{Pix}) \quad (2)$$

$$INTOP(\text{M-Pesa}) < INTOP(\text{Yape}) < INTOP(\text{Pix}) < INTOP(\text{UPI}) \quad (3)$$

Given these orderings, we may represent the digital payment systems M-Pesa, UPI, Pix and Yape in a 3-dimensional Euclidian space spanned by the variables discussed above as in Figure 3. In this figure, the convention is that moving away from the origin along any of the three dimensions reflects a higher intensity in that dimension and we see that the circled points on the axes satisfy the inequalities (1), (2), and (3).

Figure 3: A 3-dimensional space representation of M-Pesa, UPI, Pix and Yape



Source: Own authors' construction

5 Road ahead and challenges facing digital payment systems

To give a forward-looking dimension to our discussion which has so far been based on the particular history of M-Pesa, UPI, Pix, and Yape, this section briefly highlights three potential challenges that digital payment systems are expected to face in the future and which should therefore occupy a prominent place in the agendas of academics, policy makers, and public and private institutions. These issues relate to improving universal access, specifically through the adoption and usage of digital payment systems in remote areas, the sustainability of pricing over time, including cost recovery versus cross-subsidization, and issues that pertain to data externalities, data sharing, and users' privacy protection.

5.1 Universal access

The success of the four aforementioned experiences is noteworthy in major cities and urban regions. Nevertheless, it may prove challenging to implement in remote areas and possibly take longer than anticipated. In these areas, internet connectivity, smartphone coverage, and banking infrastructure (ATMs or POS devices) are limited. Due to this lack of availability and therefore familiarity with these methods, there tends to be a strong preference for cash-based transactions in these regions.

In order to achieve universal adoption and extend access to more users in remote areas, some offline payment capabilities must therefore be developed.²⁷ In this regard, some central banks have initiated discussions on including in their payment systems innovations with offline payment capabilities and even on issuing central bank digital currencies (CBDCs) based on a technology that would allow reaching out people in areas facing this type of connectivity constraints.

Payment systems that address this universal access concern exist in some emerging economies. For instance, Nigeria's CBDC, e-Naira, promotes universal access by facilitating transactions through unstructured supplementary service data (USSD) technology, used for text messaging, thereby eliminating the need for stable Wi-Fi connections. In India, the Aadhaar enabled payment system (AEPS) has the potential to reduce urban-rural disparities and boost financial inclusion by allowing rural inhabitants who lack formal identification papers to create a bank account and execute transactions based on their fingerprint or iris scans.

5.2 Sustainability of pricing

Several of the digital payment systems discussed in this paper can share a negative pricing bias towards merchants. While P2P and P2B transactions are free for users, merchants typically pay a fee when they receive a payment, although it is actually lower than current card fees. However, two of the four payment systems (UPI and Yape) are actually free for merchants. The pricing structure typically differs between private providers (M-Pesa and Yape) and public institutions such as central banks (UPI and Pix).

The MNO Safaricom sets zero fees for P2P but charges for P2B payments, while Yape is

²⁷An offline payment is defined as a transfer of value between devices that takes place without requiring connection to any ledger system ([Bank for International Settlements, 2023](#)).

completely free, even for interoperable transactions with PLIN. A reason for this is that while M-Pesa has a large network, Yape is still building it, and so it needs to attract more users and merchants to increase its network and thus its value through network effects. In addition, unlike Safaricom, BCP and the other Yape participants are financial institutions that are very keen on exploiting the data externalities of their users. With an accurate record of their users' transactions, financial institutions could offer personalized loans and diversify its financial product offer.

As far as central banks are concerned, UPI and Pix have different pricing as well. On the one hand, being fully subsidized by the government, UPI is free for customers and merchants except for prepaid payment instruments where the merchant has to incur a cost to cover the processing, clearing, and settlement costs related to the card networks. On the other hand, BCB has determined that Pix P2P transactions are free but allows Pix participants to charge for P2B transactions, which are now set in a range of R\$0.89 to R\$1.20. Pix pricing is based on recovering costs rather than adopting a subsidy approach like UPI.

The question at hand pertains to the sustainability of the pricing structure in digital payment systems. Is it feasible to envisage a future scenario in which P2P and P2B transactions are conducted without any charges? This answer hinges on those who are responsible for bearing such costs. As will be discussed in the subsequent subsection, data externalities may have a significant bearing on pricing structures, provided they enable personalization of other products, thereby resulting in their sale to customers and merchants. Owners of a digital public infrastructure such as an FPS must strike a balance between maximizing the attractiveness of digital payments in relation to other methods of payment, such as cash, debit cards, credit cards, and e-money, and maintaining financial sustainability.

5.3 Data externalities, privacy, and sharing

Undeniably, data has become crucial in the digital age, serving as a primary source of value. Payment data, i.e., records of transactions involving number of transactions, amounts, frequencies, dates of payment, among other things, is of significant interest to both banks and non-bank entities since they enable the analysis of customer preferences and purchasing power, and facilitate personalized product and service recommendations. The value of data is particularly high in credit markets as financial establishments could use payment data to assess the risks of potential borrowers (Ghosh et al., 2021). In addition, the ability of leveraging data could affect competition in the payment market. For example, the greater the PSP, the greater the data externality, i.e. what information each consumer's data reveal about other consumers' data (Ichihashi, 2021), and thus the lack of interoperability could hinder competition in financial and payment markets. Moreover, the exploitation of data could facilitate cross-subsidization between payment services and other products such as loans.

Data interoperability in the payment markets entails data to move easily from one PSP to another, even though making this possible on a large scale and cost-effectively may require technologies such as APIs (Ghosh et al., 2021). This suggests that the challenge that data interoperability raises is not so much the cost of creating shared infrastructure, but rather the incentives to share data (?). Despite the potential benefits of expanding

payment markets to other financial products, the ongoing debate among policymakers has gone beyond ensuring data interoperability among PSPs, to more fundamental issues like determining the ownership and control of payment information, i.e., whether it should belong to the user, PSP, or the payment infrastructure owner or manager.

In practice, open-banking regulation aims to improve data sharing among banks and other companies. Different regions are at different stages in this regulatory agenda but a remarkable example is the European Union's revised payment service directive (PSD2) that requires banks to provide third-party firms, such as technology companies, with access to payment history using APIs, but only with the permission of customers. As far as KIBP, only India and Brazil have made significant progress in implementing open-banking or open finance amongst the countries analyzed, whereas in Peru and Kenya, open-banking is less developed, or even null.

6 Conclusion

The objective of this paper was to describe in as much detail as possible four services of digital payment that stand out from the experiences of developing countries in the area, with the aim of drawing useful lessons from both their launch and mature development stages. These systems are M-Pesa, UPI, Pix and Yape in respectively, Kenya, India, Brazil, and Peru. These payment solutions have significantly contributed to expanding digital payment adoption and promoting financial inclusion, known to be essential to economic development, in their respective countries.

In addition to being developed in emerging economies, these digital payment experiences aroused our interest for two main reasons. First, they can all be considered, to varying degrees, as "success stories." Second, these digital payment solutions exhibit enough differences to make for interesting comparative analysis. A dividing line between these payment systems is the type of money they are based on, namely mobile money for M-Pesa and commercial bank money for UPI, Pix, and Yape. In this paper, we suggest that these digital payment solutions may also be meaningfully differentiated along three other structural and fundamental dimensions.

The first key aspect we identified is the role played by private digital platform developers and providers as they are the main players involved in the last mile before reaching the end user. As such, they are responsible for providing a service with features such as user-friendliness, reliability, and security which are highly valued by end users and may contribute significantly to the success of a payment solution. The second is the role of regulators and central banks whose intervention, whether light or heavy, passive or active, is essential for the establishment of a regulatory framework paving the way for a robust and efficient payment system. The third aspect concerns the role and extent of system interoperability, a crucial feature at all stages of system development. Interoperability serves as the "conductor's baton" for regulators, guiding competition, reducing costs for end-users, and enhancing adoption of cashless payments that will foster financial inclusion.

By evaluating the four experiences across these three dimensions, we identified two key lessons. First, to some extent, there is no "one-size-fits-all" solution for the introduction

and promotion of digital payments in an economy. Second, any solution should involve active cooperation between the public and private sectors, on the one hand, and be focused on the end user, on the other. Regarding the future of digital payment systems, we suggest focusing attention to three challenges, namely, provision of digital payment services in remote regions, sustainability of pricing of these services, and data externalities, sharing, and privacy.

As it stands, the three-dimensional conceptual framework developed in this paper could provide policy makers with a (useful) benchmark tool to characterize in a simple way a digital payment system and hypothesize about expected impacts on adoption and usage of services, on the one hand, and potential consequences on financial inclusion, on the other hand. However, to be compelling and operational, this framework needs to be extended in at least two directions. First, the effort to quantify the framework that we initiated should be further pursued. For example, in the spirit of [Camara and Tuesta \(2018\)](#) data on a (possibly large) set of parameters that would fit reasonably well into each of the three variables used to characterize a digital payment solution can be collected and aggregated to construct three synthetic indices that would proxy these variables. Second, given the pervasiveness and diversity of digital payment systems across developing countries, it is timely to construct a database on these systems and attempt to estimate causality relationships between the characteristics of a system proxied by the three constructed indices and its performance proxied by measures of digital payment access and usage as well as financial inclusion. We intend to explore these two avenues of research in the near future.

Appendix

Selected acronyms

ACH: Automatic clearing house

AEPS: Aadhaar enabled payment system

API: Application programming interface

ATM: Automatic teller machine

A2A: Account-to-account

BCB: Banco Central do Brasil

BCP: Banco de Crédito del Perú

BCRP: Banco central de reserva del Perú

CAK: Communication authority of Kenya

CBDC: Central bank digital currency

CBK: Central bank of Kenya

EMI: E-money issuer

FPS: Fast payment system

G2P: Government-to-person

IBA: Indian Banks association

KIBP: Kenya, India, Brazil, and Peru

MNO: Mobile network operator

MVNO: Mobile virtual network operator

NPCI: National payments corporation of India

POS: Point-of-sale

PPI: Prepaid payment instrument

PSD2: European Union's revised payment service directive

PSP: Payment service provider

P2B: Person-to-business

P2P: Peer-to-peer

QR code: Quick response code

RBI: Reserve bank of India

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