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Adoption and welfare effects of payment innovations: The case of digital wallets in Peru*

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Abstract

Digital wallets like Yape and Plin have gained widespread popularity in Peru, allowing users to make instant payments through quick response (QR) codes or mobile phone numbers. This paper examines the drivers of their adoption and their impact on everyday life. Using market share data for six digital payment instruments and cash from January 2019 to April 2024, we estimate the demand for payment instruments and find that features such as lower fees, 24/7 immediate payments, QR code payments, and interoperability with point-of-sale (POS) terminals are key to their success. Our estimates suggest that a PEN 0.01 (USD 0.003) increase in payer fees would reduce the market share of the digital wallets by 0.31 percentage points (pp), while debit cards and cash would gain usage. Simulations further indicate that removing 24/7 immediate transfers would reduce digital wallet usage by 15.75 pp, discontinuing POS payments by 26.01 pp, and eliminating QR code functionality by 4.45 pp. Furthermore, our findings suggest that the adoption of digital wallets has contributed to a sustained increase in consumer welfare per transaction among banked individuals over time.

Keywords: Consumer welfare; Demand estimation; Digital payments; Digital wallets; Innovation; Peru

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

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1 Introduction

Digital payments are instrumental in promoting financial inclusion. Financial inclusion, defined as the accessibility and affordability of financial services provided by formal institutions, is known to stimulate economic growth (Fabregas and Yokossi, 2022; Qiu, 2022; Aguilar et al., 2024), curb poverty (Aker et al., 2016), and reduce income inequality by gender (Suri and Jack, 2016) and education level (Grohmann and Menkhff, 2018). Digital payments, in particular fast payments, have the potential to expand access to the financial system beyond payments, in the form of access to savings and credit (Aurazo and Franco, 2024; Aurazo et al., 2025).

In Latin America, most countries are moving towards a wider use of digital payments, with Brazil and Chile being notable examples. In 2022, Brazilians made an average of 396 retail payments per capita,[1] up from 166 in 2018. Chileans made 279 payments per capita in 2022, up from 117 in 2018. Other countries are experiencing rapid growth from a low base. In 2018, Peru had one of the lowest use of retail payments in the region, with 25 payments per capita, but increased to 99 payments in 2022. This makes it the country with the largest increase in Latin America (Banco Central de Reserva del Perú, 2024).

This rapid expansion in Peru's digital payments is partly due to the success of two domestic digital wallets, Yape and Plin. Since Yape's launch in February 2017 and Plin's in May 2020, both have exhibited remarkable adoption rates. By December 2023, these two wallets accounted for over 50% of total retail cashless transactions in Peru, surpassing card payments (23%) as the primary cashless payment method.[2] Compared to 2019, digital wallets and ACH immediate transfers are the only payment instruments that increased their market shares, while credit and debit cards, intra-bank transfers, and ACH non-immediate transfers lost relevance. These digital wallets are used for several daily transactions, including payments to micro and small merchants whose average value per transaction is very small, around PEN 50 (USD 13). In contrast, the average value of an ACH immediate transfer is PEN 856 (USD 220), while that of a credit card is PEN 210 (USD 55).[3]

Barrantes and Alzamora (2023) and Aurazo and Gasmi (2024) discuss a couple of success factors of Yape. These include the successful communication strategy with young people, the application's convenience and ease of use and the large network of micro and small businesses. We complement this work and suggest a combination of enablers, catalysts and key design features. First, the enablers such as financial accounts penetration, mobile phone and internet coverage were improved. The Covid-19 pandemic acted as a catalyst due to mandatory lockdowns, social distancing, and disbursement of social subsidies through the financial system. However, design features such as ease of use, free-of-charge transactions, interoperability with other payment methods, as well as a large network of micro and small merchants were key for increasing popularity of Yape and Plin.

This paper makes two key contributions to the current literature on digital payments and consumer welfare. First, we adapt the framework introduced by Berry (1994) to estimate the demand of payment instruments. Moreover, we incorporate network effects and address price endogeneity in the model. Second, we quantify consumer surplus gains from digital wallet adoption, providing one of

[1] This calculation includes the entire population, not just adults. Retail payments are the sum of the operations with retail transfers, direct debits, checks, payment cards, and e-money.

[2] Retail cashless payment instruments in Peru include: (i) debit and credit cards, (ii) funds transfers within the same financial institution (intra-bank transfer), (iii) funds transfers between different financial institutions through Automated Clearing House (ACH) (ACH immediate and non-immediate transfers), (iv) funds transfers with e-money through APDE Bim and (v) funds transfer through digital wallets.

[3] These digital wallets are even used by the government for accepting tax and fee payments and making transfers for social programs and subsidies.

the first empirical estimates of welfare impacts in this context. These contributions build on recent studies of payment choice models and fast payment systems (Frost et al., 2024; Shy, 2020) and offer important insights for policymakers and central banks.

Our paper focuses on six digital payment instruments available in Peru: digital wallets (Yape and Plin), intra-bank transfers, ACH immediate and non-immediate transfers, debit cards, and credit cards. We also include cash as the "outside option" or default alternative.[4] To better reflect the behavior of banked consumers with access to this set of payment instruments, we calculate the market shares of payment methods in two steps, using both the value and number of transactions. This approach captures the shift in consumer preferences, with cash usage declining from 40% of transactions in January 2019 to 18% in April 2024, while digital wallets have surged to 50% during the same period.

Our analysis also considers how the features of payment methods have changed over time. Our logit model for estimating market shares suggests that lower payer fees increase demand, while the 24/7 immediate availability of funds makes a payment instrument more attractive. Other features, such as the ability to pay with a quick response (QR) code or at point-of-sale (POS) terminals are associated with higher preference. These findings align with economic theory and help explain the success of digital wallets like Yape and Plin. Importantly, our results remain robust across different methodologies for calculating market shares, alternative measures of cash payments, and when accounting for network effects. These insights could be valuable for designing and introducing new payment methods.

Indeed, our estimates indicate that a PEN 0.01 (USD 0.003) increase in payer fees for digital wallets per transaction would result in a 0.31 percentage point reduction in their market share, with debit cards (+0.11 percentage points) and cash (+0.11 percentage points) benefiting the most. Furthermore, simulation exercises reveal significant impacts on digital wallet adoption under various scenarios: removing immediate and 24/7 transfers would reduce their market share by 15.75 percentage points; discontinuing interoperability with POS payments would lead to a 26.01 percentage point decline; and eliminating QR code scanning functionality would decrease their market share by 4.45 percentage points.

Regarding the second contribution of our paper, we simulate the change in consumer surplus per transaction among banked individuals when Yape and Plin are available.[5] Following Train (2009) and Shy (2020), our findings reveal a significant and steady increase in consumer welfare per transaction over time with the availability of digital wallets. The increase in consumer welfare starts at a modest 0.5% in January 2019 and rises substantially to 68% by April 2024. This upward trend is attributed to the broader adoption and usage of digital wallets, driven not only by the introduction of new functionalities (e.g., the ability to pay at card POS terminals since April 2021) but also presumably by other factors, such as larger network effects.

The paper is organized as follows. Section 2 discusses how Yape and Plin operate. Section 3 analyses qualitatively the enablers, catalysts and key design features behind the success of Yape and Plin in Peru. Section 4 describes the database and econometric strategy. Section 5 discusses the demand for payment instruments and the impact on market shares of changes in fees and other attributes.

[4] Checks and electronic/mobile money are excluded from the analysis because they are rarely used for person-to-person (P2P) and person-to-business (P2B) transactions.

[5] Consumer surplus is a measure of the total benefit that banked consumers derive from having access to and using a set of payment methods. It is calculated based on the expected maximum benefit that consumers can achieve from their choice set, which includes all available digital payment instruments and the outside option (cash).

Section 6 discusses the consumer welfare gains from the availability of digital wallets and section 7 discusses the role of the Central Reserve Bank of Peru (BCRP). Finally, section 8 summarizes the main insights of the paper.

Related literature. Our paper relates to two strands of literature. Regarding consumer payment choice, the reasons for choosing cash over digital payments cover a wide range, including informality (Aurazo and Vega, 2021b; Aurazo and Gasmi, 2022), tax evasion (Aurazo and Vega, 2021a) and lack of trust in financial institutions. In addition, lack of access to the internet and mobile phones hinders the adoption of mobile money and potentially other financial services (Grzybowski et al., 2023; Mothobi and Kebotsamang, 2024). Adoption is also influenced by a number of demographic variables, including age, race, gender, education, place of residence, marital status and household size, as well as a range of economic factors, such as income, savings, debt and employment status (Arango et al., 2015; Aurazo and Vega, 2021b; Klee, 2008; Shy, 2020; Stavins and Shy, 2015). Certainly, financial education is pivotal, as it might influence the level of trust users place in both the instrument and the institutions providing the service, as well as the technology and procedures underlying transactions (Ha et al., 2023). In addition, payment attributes (e.g., costs, speed, safety) as well as transaction features (e.g., amount of transaction, type of product purchased, discounts and surcharges) are relevant when a person chooses how to pay at a POS terminal. (Chen et al., 2019; Klee, 2008; Stavins, 2018; Świecka et al., 2021; Wang and Wolman, 2016)

Regarding demand estimation, the literature suggests two approaches: i) using micro data (e.g., surveys) and ii) using aggregate-level information on market shares. We will focus on the second one. Berry (1994) is the pioneer in this regard, and motivated a new avenue for research. Under certain assumptions, market shares could reflect consumer preferences. Demand can be estimated as a function of the price and observable product characteristics. Logit demand models are widely used to do so, but suffer from determining more realistic price elasticity. To allow for a flexible substitution pattern among products, nested-logit demand and random-coefficient logit demand models are preferred (Berry et al., 1995). The application of these models is widespread and includes several industries such as automobiles (Berry et al., 1995), ready-to-eat cereal (Nevo, 2001), banking (Dick, 2008), and digital technologies (Shreeti, 2024), among others. Our paper is based on Berry (1994) and is not intended to go into detail on the other more complex models. The main reason for this is the limited availability of data on payment instruments. This does not allow us to identify more granular groups of transactions (e.g., P2P vs P2B transactions, intra-bank vs inter-bank transactions, or small vs medium-ticket transactions) or markets (e.g., at the sub-national rather than national level). Our analysis also relates to recent work on the adoption and design of digital payment systems, including studies on fast payment systems and digital platforms (Cornelli et al., 2024; Frost et al., 2024, 2025). These studies emphasize the importance of interoperability and network effects, which are central to our analysis of digital wallets in Peru.

2 Institutional background

Before we take a closer look at the enablers, catalysts and key design features of Yape and Plin, it is necessary to explain what they are and how they work. The main similarities and differences are shown in Table A.1 in the Annex.

Yape is a digital wallet launched in February 2017 by the country's largest commercial bank, *Banco de Crédito del Perú* (BCP). Initially, this payment instrument was only available for BCP customers to transfer funds among them using mobile phone numbers or QR codes instead of lengthy bank account information. Later, Yape integrated with other financial institutions. Yape offers a set of services that includes micro-loans, discounts in selected stores, foreign exchange, utility payments and international remittances. Using their bank account, customers can send up to PEN 500 (USD 130) per transaction and up to PEN 2,000 (USD 520) daily. They can receive up to PEN 25,750 (USD 6,700) monthly. P2P and P2B transactions are free of charge for both individuals and merchants.[6] As of February 2025, Yape reached 17 million users in Peru. [7]

On the other hand, Plin was introduced at the start of the COVID-19 pandemic in May 2020, replicating the ease of use of Yape with mobile phone numbers and QR codes. Unlike Yape, Plin is not a stand-alone mobile application but it is embedded in the mobile banking application of three out of the four largest banks, namely BBVA, Interbank, and Scotiabank, and seven other financial institutions. Users can send without cost up to PEN 500 PEN (USD 130) per transaction and PEN 1,500 (USD 390) daily and can receive up to PEN 20,000 (USD 5,200) monthly. By the end of 2023, Plin reached more than 13 million users. [8]

It is important to note that Yape and Plin are different from other payment platforms such as ApplePay. With the latter, users store their debit or credit card information within the application for future purchases. With Yape and Plin, funds are transferred directly from bank accounts. The underlying payment infrastructure is Visa Direct, owned and operated by Visa International, which enables real-time funds transfers.[9] As the owner of the infrastructure, Visa International sets the fees for participants.

3 A qualitative analysis

This section examines the factors that have led to the success of digital wallets in Peru. We propose a group of enablers, catalysts and key design features. Enablers are the foundational elements required for digital payments, such as telecommunications and payments infrastructure, internet and smartphone coverage, etc. Catalysts, such as the COVID-19 pandemic, also triggered the shift towards digital payments. However, what made Yape and Plin stand out among Peruvians were their design features, such as ease of use, zero fees, a large network of micro and small merchants and interoperability with other payment methods. Figure 1 gives an overview of this idea.

3.1 Enablers

The adoption of digital payments in Peru has been enabled by several key factors. First, telecommunications infrastructure saw significant improvements. Smartphone ownership increased from 78% in 2019 to 81% in 2022, while internet access rose from 43% to 63%. This boosted digital wallet usage, especially in rural areas. Second, payments infrastructure was improved as well. Innovations like payment facilitators and multi-acquiring expanded POS networks and enhanced merchant adoption, by reducing costs and improving user experience. The density of POS terminals grew significantly, with the number of terminals per 1,000 adults increasing from 26 in 2019 to 58 in 2023. Additionally, new payment methods such as contactless and QR code payments further facilitated interoperability, exemplified by Yape and Plin integration. As a third enabler, government initiatives like the National

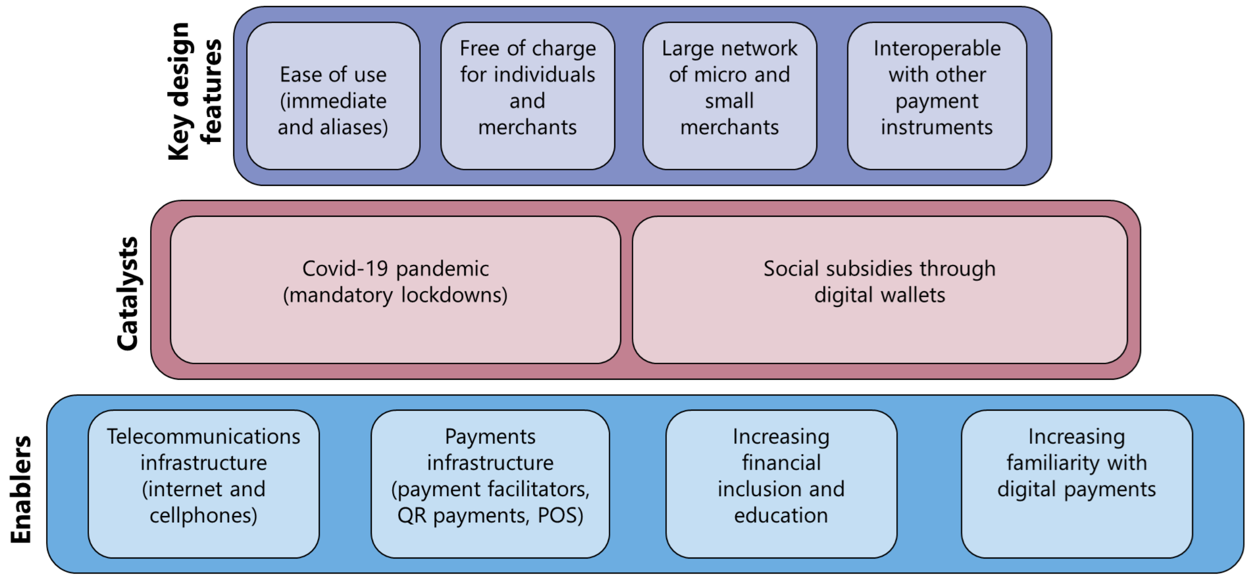
[6] In April 2024, Yape introduced *Yape Empresa* which allows merchants to accept payment cards and receive transfers above PEN 25,750 monthly and send money up to PEN 3,000 (USD 780) per transaction. Since May 2024, merchants have to pay 2.95% of the value of transactions.

[7] Source: https://www.yape.com.pe (last access: 07/02/2025)

[8] Source: https://gestion.pe/tu-dinero/finanzas-personales/plin-alcanza-a-yape-en-numero-de-usuarios-quien-gana-con-interoperabilidad-yape-plin-bancos-billeteras-digitales-noticia (last access: 07/02/2025).

[9] Domestically, Niubiz - one of the main acquirers in Peru - plays the processing/switching role.

Figure 1: Yape and Plin: enablers, catalysts and key design features



Source: Authors' elaboration.

Financial Inclusion Policy (PNIF) encouraged financial inclusion, leading to an increase in account ownership from 35% in 2015 to 56% in 2023. Finally, end users have become more familiar with digital payments. Digital payments per adult rose from 29 in 2015 to 266 in 2023,[10] with digital wallets being the main payment method. The banked population has increasingly adopted digital payments, a trend accelerated post-pandemic (Vega and Paliza, 2024).

3.2 Catalysts

The COVID-19 pandemic acted as a catalyst, as it was a disruptive event that changed people´s payment habits. First, social distancing and mandatory lockdowns accelerated the digital transition because of fear of viral transmission through cash (banknotes and coins). This provided an opportunity to use payment methods that did not require physical contact (Auer et al., 2020). According to the World Bank's Findex database, 44% of adult Peruvians who made a digital payment for P2B transactions in 2021 did so for the first time during the pandemic (García and Andía, 2022). Second, social subsidies provided by the Peruvian government were disbursed through digital wallets. This encouraged the adoption of digital wallets, especially among the unbanked population.

3.3 Key design features

We now discuss four key design features that could have acted as success factors, namely the ease of use, zero fees, the large network of micro and small merchants and interoperability with other payment instruments.

[10]This is calculated as the ratio of BCRP's Digital Payments Indicator to the total population. The Digital Payments Indicator includes customer transactions made by participants in the BCRP's Real-Time Gross Settlement System (RTGS) and digital retail payments such as ACH immediate and non-immediate transfers, intrabank and interbank transfers through wallets (including interoperable wallet transfers), and other digital channels, which include payment cards, direct debit, and electronic money transfers

3.3.1 Ease of use

Digital wallets emerged alongside technological innovations that enable the use of aliases for account identification. Specifically, using mobile phone numbers and QR codes instead of traditional account details streamlines transfers via digital wallets. This improves the user experience and significantly reduces transaction time. For instance, paying with Yape or Plin is much faster than using ACH immediate transfers. Yape transactions take between 15.9 and 21.4 seconds, while ACH immediate transfers take over 40 seconds, even when using mobile phone numbers instead of interbank account details (Figure 2.a).[11] These time lags can have an important impact in settings where payment confirmation is important (e.g., in retail shops, public transport or food and drink transactions).

3.3.2 Free of charge for individuals and small merchants

Payments with digital wallets were free of charge for both the payee and the payer, regardless of the type of user, until April 2024.[12] In the case of payment cards, merchants pay a fee to the acquirers known as merchant discount rate (MDR), which is a percentage of the transaction value and usually varies by the merchant segment, type of card and the transaction channel. Consumers, on the other hand, usually receive rewards for using payment cards (especially credit cards), such as cashback, points, miles, or discounts. In the case of ACH transfers, the payer assumes all charges. Intra-bank transfers, i.e. transfers within the same bank, are also usually free of charge.

To make a comparison between the different instruments, let's take a transaction of PEN 500 (USD 130). When the payer uses cards, the benefit obtained is on average a cashback of PEN 2.5, while the merchants should pay a MDR equivalent to PEN 10.25.[13] When using an ACH immediate transfer, the payer would be charged on average PEN 3.45.[14] Finally, paying with Yape or Plin is free of charge, except in the case of "Yape Empresa" in which large merchants pay 2.95%, or PEN 14.75 in this case (Figure 2.b).[15]

3.3.3 Large network of account holders and micro and small merchants

As a result of the growing adoption by both individuals and merchants, direct and indirect network effects emerged and increased the value of joining these platforms.[16] By December 2023, Yape had registered 8 million individual users,[17] while the total number of cards issued was 65 million.[18] Yape had 2.7 million merchant users, surpassing the number of merchants affiliated with card schemes

[11]Transaction times for the different instruments were measured under similar conditions (connectivity, smartphone, others) as an internal exercise. These may vary under other connectivity circumstances.

[12]Since May 2024, Yape started charging a commission of 2.95% to merchants affiliated under the new user profile "Yape Empresa", which offers a bundle of exclusive benefits, such as the capacity to receive monthly above PEN 25,750, transfer up to PEN 3,000, accept card payments, among others.

[13]Calculations are based on a cashback of 0.5% and a merchant discount rate equals to 2.05% (this is the average fee in Peru´s market for payment cards in 2023).

[14]Calculations are based on the fees charged by the four largest banks in Peru, considering that the payer and the payee are located in the same place (*transferencia misma plaza*). For funds transfers where the banks of the payer and the payee are based in different locations, the fee is usually a percentage of the transaction value. Also, most payment providers in the ACH system charge zero fee for transactions below PEN 500.

[15]Yape and Plin have a maximum daily limit on the value of transactions of PEN 2,000 and PEN 1,500 respectively. In the case of ACH immediate transfers, the daily limit is PEN 30,000.

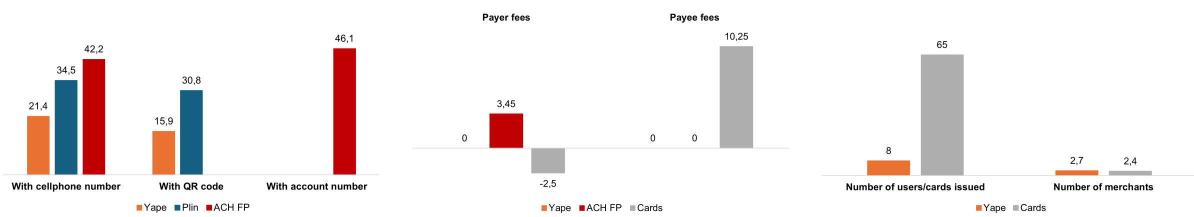
[16]Direct network effects occur when the value of a product or service increases as more individuals use it. Indirect network effects occur when the value of a product or service increases as more complementary products or services are available (e.g., merchants value more individuals, and individuals value more merchants).

[17]The number of Yape´s users and merchants consider only BCP´s clients.

[18]Includes prepaid, debit and credit cards.

(2.4 million)(Figure 2.c). As shown in the next subsection, interoperability with card POS terminals increased the indirect network effects, as digital wallet users have a greater number of merchants where they can pay.

Figure 2: Key design features, by payment instrument



(a) Transaction time (in seconds) (b) Fees (in PEN) (c) Users and merchants (in millions)

Source: BCRP; authors' elaboration.

A key segment driving the growth and adoption of digital wallets has been micro merchants, particularly taxi drivers, small and minimarkets, motorbike taxis, and street food vendors, among others (Barrantes and Alzamora, 2023). The ease, speed, and immediate settlement of funds associated with wallet payments are crucial for micro merchants, whose businesses are characterized by a high volume of small transactions and a strong need for liquidity. Notably, while funds from card purchases are typically deposited two business days later, digital wallet payments are deposited immediately. This can give micro merchants, who are typically credit-constrained, important benefits as they can use the funds for working capital, inventory, etc.

3.3.4 Interoperability with other payment instruments

At the beginning, digital wallets were closed payments schemes, which only allowed fund transfers between their own users. This situation changed in April and June 2021, when Yape and Plin users benefited from market-driven interoperability with card schemes. This meant that digital wallet users were able to pay at card POS terminals by scanning the QR code provided by acquirers (POS or e-commerce). In addition, interoperability between Yape and Plin, mandated by the BCRP, was also pivotal (see section 7.1). Since April 2023, the use of digital wallets for interoperable payments had increased dramatically. By December 2024, interoperable transfers accounted for a total of 3.5 million daily transactions.

4 A quantitative analysis: estimating the demand for payment instruments

With enablers, catalysts, and key design features in hand, we now seek to provide a formal study of the design factors from an end-user perspective that drive the usage of payment instruments. To do so, we estimate the demand for payment instruments using aggregate-level data on the market shares of the six available digital payment instruments (i.e., digital wallets (Yape and Plin), intra-bank transfers, ACH transfers, ACH immediate transfers, debit cards, and credit cards) and cash.[19] [20]

[19]Alternatively, the demand can be estimated using micro data obtained directly from consumers. Other approaches to measure adoption include the volume of transactions (Frost et al., 2024), app downloads (Cornelli et al., 2024), etc.

[20]To correctly estimate demand using market shares, we need to include an outside good. In this paper, we choose cash as the outside good. In a standard demand estimation, the outside good consists of a no-buying option, but

4.1 Database and market shares

Our database contains information on the market shares of the six available digital payment instruments mentioned above (s_j) and cash payments (s_0). The analysis period is January 2019 - April 2024, resulting in a total of 384 observations at the payment instrument-month level. Our database also contains dummy variables on the attributes of each payment instrument, namely whether funds are available immediately and on a 24/7 basis (*instant*), whether payments can be made using a mobile phone number (*mobile phone*), using a QR code (*qr*), or at a POS terminal (*pos*).[21] It also contains data on payer fees ($payer - fee$) and payee fees ($payee - fee$), most of which are zero.[22] Additionally, our database contains a set of variables to measure the size of each payment instrument's network, namely (i) an index of people´s interest ($google - trend$), from 0 to 100 using Google Trends,[23] (ii) the number of potential users ($ln - network$, in logarithms) for each instrument,[24] and (iii) the average ticket ($ln - ticket$, in logarithms). Table 1 shows the descriptive statistics of the variables.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std Dev	Min	Max	Source
s_j	384	12.01	11.07	0.29	50.46	BCRP
s_0	384	27.92	6.46	17.71	40.38	BCRP
payer-fee (in PEN)	384	0.85	1.75	-1.99	4.97	BCRP
payee-fee (in PEN)	384	1.34	2.33	0	8.37	BCRP
instant	384	0.44	0.50	0	1	Local news and PSP's websites
qr	384	0.36	0.48	0	1	Local news and PSP's websites
mobile phone	384	0.19	0.39	0	1	Local news and PSP's websites
pos	384	0.43	0.50	0	1	Local news and PSP's websites
google-trend	384	52.9	23.6	0	100	Google Trends
ln-network	372	16.4	1.05	13.3	17.6	BCRP, SBS
ln-ticket	384	6.10	1.60	3.8	9	BCRP

Calculation of market shares. The calculation is done in two stages: first, we calculate the share of digital payments (the six available digital payment instruments) and cash payments using the value of transactions. There are two measures for cash payments: i) currency in circulation or ii) cash withdrawals at automated teller machines (ATMs). We choose the second measure for two

this does not apply to our paper as individuals always make payments. See section 4.2 for more details.

[21] We are aware that other attributes might be relevant (e.g., whether the payment instrument allows users to pay using bank account details, how end users access the payment instrument, whether there are transaction limits), but we just focus on these four attributes given that they vary over time and across payment instruments, and given data availability. Table A.2 in the Annex shows the date when the attributes (i.e., instant, qr, mobile phone and POS) changed across payment instruments.

[22] The payer fees for digital wallets, intra-bank transfers and debit cards are assumed to be zero. The payer fees for credit cards are assumed to be negative, given an average of 0.5% cashback. The fees for ACH transfers and ACH immediate transfers are estimated as the simple average of all fees charged by participants to the payer for a transfer in the same location (*transferencia misma plaza*).

[23] The search terms were carefully selected for each payment instrument. For intrabank transfers, the term used was the name of the largest bank in Peru; for ACH credit and immediate transfers, the names of the instruments were chosen (i.e., immediate transfer and non-inmediate transfer); for debit and credit cards, the term was the acquirer with the largest market share; and for digital wallets, the most widely used digital wallet in the country.

[24] For intrabank transfers, ACH credit, and immediate transfers, we use the number of deposit accounts (from the largest bank in the country and the total number of accounts across all banks, respectively). For debit and credit cards, the variable selected was the number of issued cards, while for digital wallets, we considered the number of monthly downloads

reasons. First, ATM withdrawals are primarily used for payments, excluding other uses such as hoarding or transactions related to informal or illegal activities. Second, the value of ATM cash withdrawals is a flow variable rather than a stock, which means it is adjusted for the turnover of cash for payments (Khiaonarong and Humphrey, 2023).[25] [26] Next, in the second stage, we estimate the 'actual' market share of each digital payment instrument based on the market share calculated using the transaction volume.[27]

This two-stage calculation leads to a more realistic estimate of consumer behavior among banked people, with market shares reflecting the actual preference for each payment instrument.[28] First, the use of cash in retail transactions (orange line) has steadily declined over time, dropping from 40% in January 2019 to 18% by April 2024.[29] In contrast, digital wallets (green line) have experienced rapid adoption, particularly since the pandemic, and accounted for 50% of retail transactions as of April 2024 (Figure 3.a). Other payment instruments have shown mixed trends, with intra-bank transfers (black line), ACH transfers (blue line), and credit cards (red line) all seeing a decline in their market shares.[30] Meanwhile, the market shares of debit cards (light blue line) and ACH immediate transfers (purple line) remained relatively stable. Figure 3.b provides a clearer comparison of the use of each payment instrument relative to cash (represented by the x-axis). Notably, digital wallets (green line) are preferred over cash, while debit cards (light blue line) show a similar level of preference as cash by the end of the study period.

4.2 Econometric strategy

4.2.1 Logit demand model

To estimate demand using aggregate information on market shares, we employ a logit demand model. Rooted in random utility theory, the logit demand model assumes that consumers derive utility from the available options, which is composed of a deterministic component (based on observable attributes such as price, quality, or brand) and a random component (capturing unobservable factors and idiosyncratic preferences). The probability of a consumer selecting a particular option is modeled

[25] Several studies argue that the value of cash withdrawals is a good proxy for the value of cash payments. As we do not have data on the number of cash payments, we use the value of cash withdrawals relative to the value of overall payments as a first-step estimate. Implicitly, this assumes that cash withdrawn is spent in the month and that any inflows into or out of "cash under the bed" net to zero within a month.

[26] During the COVID-19 pandemic, aggregate currency in circulation increased sharply due to precautionary hoarding, while the market share of cash withdrawals declined significantly. This divergence underscores the importance of using cash withdrawals, rather than aggregate currency in circulation, to capture changes in cash use for transactions. While no proxy is perfect, cash withdrawals provide a closer approximation of actual retail payment behavior.

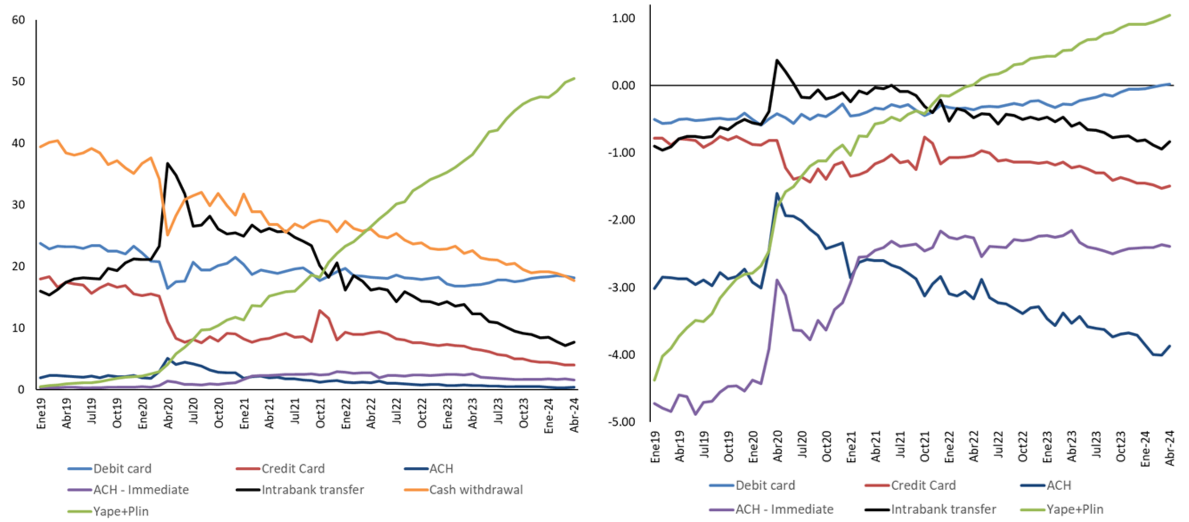
[27] For instance, let's suppose that using the value of transactions, we can calculate in the fist stage that digital payments account for 70% and cash for 30% at period t. In the second stage, we calculate the actual market share of each digital payment instrument using the market shared obtained with the volume of transactions. Let's suppose that digital wallets account for 50% of transactions with any digital payment instrument at the same period t, then the estimated market share for digital wallets is 35% at period t.

[28] Estimates based solely on the value of transactions may result in market shares that fail to accurately reflect consumer preferences. Specifically, digital wallets appear underrepresented, ranking as the fourth most-used payment instrument—behind intra-bank transfers, cash, and ACH transfers—due to their predominant use for small-ticket transactions. This outcome appears somewhat misaligned with their actual usage in real-life scenarios.

[29] This share should be understood as the preference for cash among the banked population, whereas cash remains the only payment instrument for the unbanked. Recent surveys reveal a significant decline in cash usage. According to the Global Payment Reports 2025, cash usage fell by nearly half over five years, dropping from 60% in 2019 to 31% in 2024.

[30] For intra-bank transfers, certain transaction channels were excluded from the calculations as they primarily serve wholesale (business) purposes. For digital wallets, we consider both intra and inter-bank transactions.

Figure 3: Yape and Plin have seen increased adoption since the pandemic



(a) Market share (%), by payment instrument

(b) Market share in logs (relative to cash withdrawals), by payment instrument

Source: BCRP; authors' elaboration

as a function of the relative utility that option provides compared to others in the choice set.[31] By linking observed market outcomes to underlying consumer preferences, the logit demand model provides valuable insights into demand estimation, pricing strategies, and market share predictions (Berry, 1994).

Let's consider the utility function of banked consumer i when choosing the payment instrument j to pay as:

$$U_{ij} = X_j \eta - \beta p_j + \xi_j + \epsilon_{ij} \tag{1}$$

Where X_j is a set of observable characteristics of the payment instrument j and p_j is the price of using payment instrument j. The term ξ_j measures unobserved payment instrument characteristics and ϵ_{ij} is an error term distributed i.i.d extreme value.[32]

Given the assumption of the error, we can write the choice probabilities as a conditional logit probability:

$$Pr(y_{ij} = j) = \frac{exp(\delta_j)}{\sum_{k=0}^{J} exp(\delta_k)} = \frac{exp(\delta_j)}{1 + \sum_{k=1}^{J} exp(\delta_k)} \tag{2}$$

where $\delta_j = X_j \eta - \beta p_j + \xi_j$ is the mean utility of product j and $j = 0$ is the outside good.

Since the utility of the outside good is normalized to zero, the denominator of Equation 2 consists of two components: 1 and the sum of the utility of the remaining alternatives. In our context, the

[31] A key feature of the logit demand model is its adherence to the independence of irrelevant alternatives (IIA) property, which implies that the relative odds of choosing between two options remain unaffected by the presence or absence of other options.

[32] The i.i.d. assumption ensures that the choice probabilities are proportional to the relative utility of the options. In other words, it guarantees that the logit model reflects the trade-offs consumers make based on the attributes of the alternatives.

outside good is cash. That said, Equation 1 describes the situation of a banked individual, who has a bank account and access to various payment instruments, and decides to choose which one to use, with cash being the default option. In other words, Equation 1 models the usage decision rather than the adoption decision. The focus is on which payment instrument the consumer chooses to use for a given transaction, given that they have already adopted the available payment instruments. While this approach provides valuable insights into consumer preferences for payment instruments, it does not capture the extensive margin of whether consumers choose to adopt digital wallets. Future research could complement this analysis by explicitly modeling adoption dynamics.

The choice probability given by Equation 2 can be transformed into a predicted market share. Thus, the market share of product j is:

$$\tilde{s}_j = Pr(y_{ij} = j) = \frac{exp(\delta_j)}{1 + \sum_{k=1}^{J} exp(\delta_k)} \tag{3}$$

The predicted market share for the outside good (i.e., cash) is:

$$\tilde{s}_0 = Pr(y_{ij} = 0) = \frac{1}{1 + \sum_{k=1}^{J} exp(\delta_k)} \tag{4}$$

We can then use these predicted shares to make a linear equation by taking logs as:

$$log(s_j) - log(s_0) = X_j \eta - \beta p_j + \xi_j \tag{5}$$

Since we actually observe the market shares of each product in each market, we can construct the actual values of δ_j. Let s_j be the actual market share of product j, then the actual mean utility of product j is

$$\hat{\delta}_j = log(s_j) - log(s_0) = log\left(\frac{s_j}{s_0}\right) \tag{6}$$

In our paper, we consider the six available digital payment instruments in the Peruvian market: digital wallets (Yape and Plin), intra-bank transfers, ACH transfers, ACH immediate transfers, debit cards, and credit cards. The outside good is cash, which gives zero utility to the consumer. We acknowledge that while some payment instruments are primarily used for P2B transactions, such as debit and credit cards, others are mainly dedicated to P2P transactions, or can be used for both (eg digital wallets). Given that our dataset does not allow us to distinguish between P2P and P2B transactions, we consider the six available digital payment instruments (plus cash) as the set from which the consumer chooses one to pay. Our data have a time dimension, and we specify the following regression to estimate the demand for payment instruments:

$$log\left(\frac{s_{j,t}}{s_{0,t}}\right) = \alpha + \beta p_{j,t} + \eta' x_{j,t} + \gamma_j + \phi_t + \xi_{j,t} \tag{7}$$

where the dependent variable is the difference between the market share of instrument j and the outside good (i.e., cash) in logs in period t. We exploit the fact that some attributes have changed across payment instruments over time, and include a set of design features $x_{j,t}$ of instrument j in period t such as whether the payment instrument allows end users an immediate availability of funds (instant), and payment functionalities with QR codes (qr), with mobile phone numbers (mobile phone), and at a card POS terminal (pos), where each variable takes a value of 0 and 1. We include payer fees p (i.e., fees charged to the transaction's sender) in the demand estimation. To capture the same developments across instruments over time (e.g., developments in the telecommunications and payments infrastructure, including interoperability, and the pandemic) we include time-fixed effects denoted by ϕ_t. Instrument-fixed effects are also included and denoted by γ_t. Finally, $\xi_{j,t}$ denotes the error term.

As theory predicts, we should expect a negative effect of the payer fees on demand (i.e., $\beta < 0$). On the contrary, the payment-specific attributes included in the model (i.e., instant, qr, mobile phone and pos) should have a positive effect as they improve user experience and thus create value for the user (i.e., $\eta' > 0$).

4.2.2 Price endogeneity and instrumental variables

Demand estimation suffers from price endogeneity, as the price is correlated with the error term (omitted variable bias), or the price is simultaneously determined by demand and supply (simultaneity). For instance, the price in our demand estimation—the payer fee—can be correlated with the quality or security of each payment instrument, which are unobserved. Then, the higher the quality, the higher the price. This will lead to the estimate of β being biased towards zero. We thus need to solve this issue with instrumental variables. Potential instruments include cost shifters, characteristics of products of close competitors, and the price of the same product in other markets, among others (Berry et al., 1995).

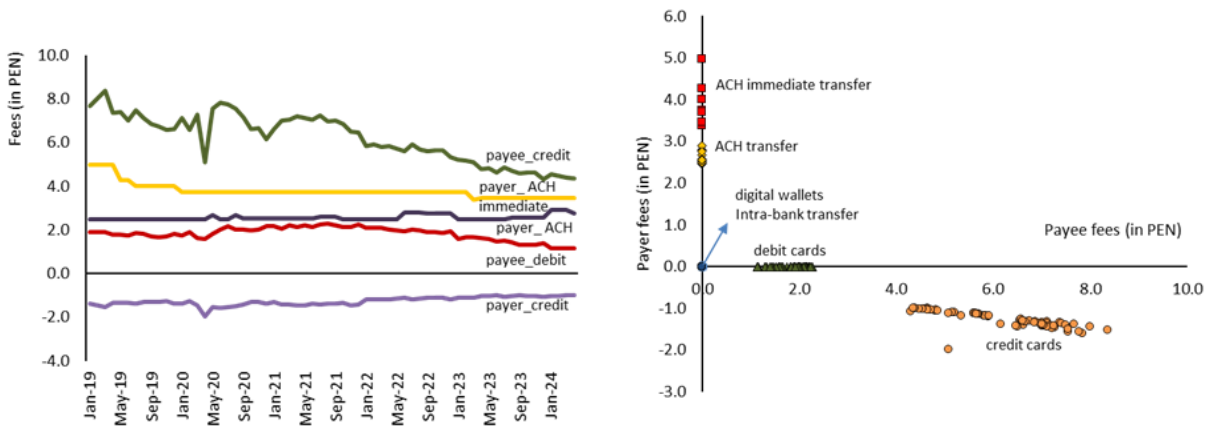
As the payments market is characterized by network effects and most payment instruments exhibit two-sidedness, connecting individuals and merchants, we propose using the payee fee (i.e., how much the beneficiary pays) as an instrument for payer fees (i.e., how much the sender pays). In every payment, there are two sides: the payer, who sends or initiates the transfer of funds, and the payee, who receives the funds. In most payment instruments in Peru, the common practice in P2P transactions is that the payer does not pay the payee fees. In the case of P2B transactions, merchants are forbidden to levy a surcharge or pass the merchant discount rate (MDR) on to consumers; however, some merchants may ignore this rule.

Regarding data availability, similar to payer fees, most payee fees are zero. For all payment instruments except for debit and credit cards, the payee pays nothing. In the case of debit and credit cards, the payee, who is the merchant, pays the MDR to acquirers. We use the average MDR (expressed in percentage) to calculate the payee fee in PEN (by multiplying it with the average value of debit and credit card transactions, respectively). For debit and credit cards, this has fallen since 2019 (Figure 4.a). The correlation between payer and payee fees is -0.61. (Figure 4.b).

To be a good instrument, payee fees should be exogenous and relevant. An instrument is exogenous if it is not correlated with the error term in the regression model. This means that the instrument should not be influenced by the unobserved factors that affect the dependent variable. We argue that payee fees are exogenous because they are determined by contractual arrangements between payment service providers and beneficiaries (individuals or merchants) and are generally not influenced by individual payer behavior or unobserved factors that directly affect payer fees. The sender only takes into account her own (payer) price when considering which payment instrument to use. This exogeneity ensures that payee fees provide an unbiased source of variation for estimating the effect of payer fees on consumer behavior.

Second, the proposed instrument should be relevant. An instrument is relevant if it is correlated with the endogenous explanatory variable. This means that changes in the instrument should lead

Figure 4: Payer and payee fees



(a) Payer and payee fees over time (b) Payer versus payee fees, by payment instrument

Source: BCRP; authors' elaboration

to changes in the endogenous variable. We argue that our instrument (payee fees) is relevant as both payer and payee fees are taken into consideration when the pricing scheme is designed. These fees should cover costs but are also interconnected due to indirect (and direct) network effects. Therefore, if one fee changes, the other should also be affected, typically in the opposite direction. This strong correlation between payee fees and payer fees ensures that payee fees have substantial explanatory power in predicting payer fees, making them a relevant instrument.

To test the strength of our instrument, we check the critical values proposed by Stock and Yogo (2005). Additionally, we will examine the results of the first stage of IV estimation, where the payer fee is modeled as a function of the payee fee. A statistically significant payee fee in this stage would support the relevance of the instrument, suggesting that payee fees are a valid and robust instrument for payer fees in our analysis. By using payee fees as instruments, we can isolate the variation in payer fees attributable to exogenous changes in payee fees, thereby mitigating potential endogeneity issues and providing more reliable estimates of the impact of payer fees on consumer behavior and welfare.

4.2.3 The role of network effects

Another potential source of endogeneity is the omission of network effects, as more widely adopted and used payment instruments tend to have higher prices. To ensure the reliability of our estimates and the validity of the instrument, it is crucial to account for network effects. They play a significant role in enhancing the convenience and accessibility of a payment instrument during usage stage. For P2B transactions, a larger number of merchants accepting the payment instrument increases its convenience, encouraging more frequent consumer use. Similarly, for P2P transactions, a greater number of users makes it easier to transfer money between peers, thereby increasing the instrument's utility. If network effects are not explicitly included in the model specification, they may be absorbed into the error term, potentially leading to biased estimates. To address this, we include three variables to capture network effects: (i) people's interest, (ii) the total number of users, and (iii) the average transaction ticket, all lagged by one period.[33] However, these proxies could be also correlated with unobserved quality changes, potentially biasing the results. Due to data limitations, alternative measures, such as merchant acceptance density, could not be included in this analysis. Future research should aim to incorporate more comprehensive data to refine the measurement of network effects.

5 Results

5.1 Logit demand results

Table 2 shows the main results of our econometric regressions. These consider the log of market share of different payment instruments (relative to cash) as the dependent variable, as a function of fees and a set of attributes. First, fees negatively affect the demand for payment instruments and are robust to several specifications, including those with more design features. Second, immediate deposit of funds on a 24/7 basis increases the demand for a payment instrument and is robust to several specifications. In addition, paying with a QR code (qr) or at a card POS terminal (pos) are associated with higher preference. All our regressions include time- and instrument-fixed effects to control for some factors that are time-invariant across instruments and instrument-invariant over time, respectively.[34] These results are robust when network effects are included.[35] Our findings shed some light on why Yape and Plin have been so successful. Zero fees, the immediate deposit of funds and the use of QR codes make a transaction more convenient and faster. In addition, the ability to pay at a card POS increases network effects, which in turn may increase the demand for a payment instrument.

As anticipated, our regression suffers from price endogeneity. To solve this, we use payee fees as an instrument for payer fees. The results of an IV estimation without network effects (column (7)) and with network effects (column (8)) suggest that the instrument used is right, since the coefficient of payer fees is now higher in absolute value. Additionally, the coefficient associated with *instant* is statistically significant and positive. The other two design characteristics (i.e., *pos* and *qr*) are also statistically significant and positively affect the demand for payment instruments. In contrast, we do not find evidence that *mobilephone* is statistically significant.[36] To test the weakness of our instrument, we use the critical values proposed by Stock and Yogo (2005) and the Cragg-Donald (CD) Wald F statistics. The CD is much higher than the 10% maximal IV size value, which means that the null hypothesis of weak instruments is rejected. We also ran the first stage of the IV estimation which shows that payee fees negatively affect payer fees (see Table A.3 in the Annex).

5.2 Robustness checks

We now make three robustness checks. First, we estimate the demand for payment instruments using cash in circulation as the outside good (instead of cash withdrawals). This measure is broader as it contains total cash that individuals hold not only for transactional purposes.[37] Second, we estimate

[33] For details, see footnotes 23 and 24.

[34] The results are robust when we include quarter-fixed effects instead of month-fixed effects.

[35] The results also show that the larger the people´s interest or the larger the number of users, the larger the demand for that payment instrument, while a smaller average transaction ticket increases the preference for a given instrument.

[36] The possibility of sending an ACH immediate transfer using a mobile phone number occurred in September 2023, near the cut-off period for our data. If we include more recent data, this result may change.

[37] The divergence between cash withdrawals and aggregate currency in circulation during the pandemic supports the validity of our proxy. While cash in circulation increased due to precautionary behavior, the market share of cash withdrawals declined sharply, reflecting a genuine reduction in cash use for transactions. This trend aligns with the

Table 2: Econometric results

	Dep. var.: ln (s_j/s_0)							
	OLS						IV	
	1	2	3	4	5	6	7	8
payer fee	-1.36***	-0.79***	-0.43***	-0.50***	-0.50***	-0.42***	-1.02**	-1.23***
	(0.19)	(0.21)	(0.15)	(0.15)	(0.16)	(0.10)	(0.41)	(0.42)
instant		0.94***	1.61***	1.71***	1.71***	0.92***	1.49***	0.65***
		(0.15)	(0.13)	(0.15)	(0.15)	(0.10)	(0.21)	(0.18)
pos			2.73***	2.88***	2.88***	1.22***	2.86***	1.15***
			(0.22)	(0.23)	(0.23)	(0.11)	(0.21)	(0.11)
qr				0.33***	0.33***	0.18***	0.38***	0.18***
				(0.10)	(0.10)	(0.07)	(0.09)	(0.06)
mobile phone					0.02	0.16**	-0.14	-0.05
					(0.12)	(0.07)	(0.17)	(0.13)
Instrument FE	✓	✓	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓	✓	✓
Network effects						✓		✓
N	384	384	384	384	384	366	384	366
Adj. R^2	0.728	0.739	0.895	0.898	0.898	0.915	0.658	0.836
CD							51.58	41.75
10% max IV SV							16.38	16.38

Robust standard errors in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

the demand for payment instruments using market shares calculated on the number of transactions (instead of the two-stage calculation with value and number explained above). Third, we estimate the demand for payment instruments using market shares calculated on the value of transactions. In both the second and third exercises, the outside good is measured by cash withdrawals. Interestingly, all three exercises show that cash use has decreased over time while the adoption of digital wallets has increased notably, even when we use the value of transactions (see Figure A.1 in the Annex).

The main econometric results remain robust: fees reduce demand, while the immediate availability of funds on a 24/7 basis boost demand. Features such as the ability to pay with a QR code or at a card POS terminal are associated with higher preference. Furthermore, the results suggest that the instrument used (i.e., payer fees) proves to be relevant across all robustness checks. For detailed results, see Table A.4 in the Annex.

5.3 Marginal and discrete effects

Our findings so far suggest that fees tend to reduce demand, whereas payment attributes such as POS terminal or QR code functionality and 24/7 immediate payments are associated with higher preference. This observation raises a critical question: how do changes in fees and payment attributes

observed increase in digital wallet usage, further supporting the robustness of our results.

affect demand, specifically the market shares of each payment instrument? It is also important to note that these marginal effects are derived from the logit demand model, and the results may vary if alternative models, such as nested logit or mixed logit, are considered.

5.3.1 Marginal change of increasing fees

To assess the impact of a very small fee increase (e.g., PEN 0.01), we apply the following formulas:

$$ds_j/dp_j = \beta s_j(1 - s_j) \text{ and } ds_k/dp_j = -\beta s_j s_k \quad (8)$$

where β is the coefficient associated with payer fees as in Equation 7 and s_j and s_k are the market shares of payment instruments j and k. The left-hand equation represents the impact of a price change on the market share of the same payment instrument (own-price effect), while the right-hand equation captures the impact on the market shares of other payment instruments (cross-price effect).[38]

To calculate the marginal effect, we use the coefficients associated with payer fees from column (8) in Table 2 (i.e., $\beta = -1.23$), along with the market share of each payment instrument as of April 2024. Table A.5 in the Annex presents the own-price and cross-price effects in market shares. For example, increasing the payer fee for digital wallets by PEN 0.01 per transaction reduces their market share by 0.31 percentage points, while debit cards (+0.11 percentage points) and cash (+0.11 percentage points) would benefit the most.

5.3.2 Discrete change of removing/adding 24/7 and immediate payment features

The payment attributes included in our model are represented by a dummy variable, which takes a value of 1 if the payment instrument exhibits the attribute and 0 otherwise. Consequently, we cannot directly apply any equivalence of Equation 8 as it is designed for continuous variables. To assess the impact of this discrete change, we simulate the new hypothetical market shares for each payment instrument incorporating the new value on the attribute and compare these results with the current market shares as of April 2024.[39]

Table A.6 in the Annex illustrates the impact of adding or removing 24/7 and immediate transfer features from payment instrument j on its market share as well as the market shares of other instruments.[40] For example, if digital wallets no longer offered immediate and 24/7 transfers, their market share would decline by 15.75 percentage points. This reduction would primarily benefit debit cards, cash, and intra-bank transfers. Conversely, if debit cards were to introduce immediate and 24/7 transfer solutions, their market share would increase by 11.67 percentage points, largely at the expense of digital wallets and cash.

5.3.3 Discrete change of removing/adding POS functionality

Table A.7 in the Annex presents the impact of adding or removing POS functionality from payment instrument j on its market share and the market shares of other instruments. For example, if digital wallets no longer supported payments at POS terminals, their market share would decline by 26.01

[38] See Train (2009) for more details.

[39] To compute the market shares, we first calculate the utility for each payment instrument, using the coefficients associated to the model with network effects as shown in column (8) in Table 2, the fixed effects, the residuals and the constant. See section 6 for further details.

[40] It should be noted that, while this feature does not directly benefit the payer, its inclusion may lead to increased demand for the payment instrument if its use is encouraged or recommended by the payee.

percentage points. This reduction would primarily benefit debit cards, cash, and intra-bank transfers. Conversely, if ACH immediate transfers were made available for POS payments, their market share would increase by 3.31 percentage points

5.3.4 Discrete change of removing/adding QR code functionality

Table A.8 in the Annex highlights the impact of adding or removing QR code payment functionality on the market share of payment instrument j and other instruments. For instance, if digital wallets no longer support QR code scanning, their market share would decrease by 4.45 percentage points. Conversely, if ACH immediate transfers introduce QR code functionality, their market share would increase by 0.31 percentage points.

6 Consumer welfare gains

Now, we move to the second question of our research: how have digital wallets impacted people's lives? To answer this, we use the concept of consumer surplus. In the context of a logit demand model with payment instruments as in Equation 1, consumer surplus is a measure of the per-transaction benefit that banked consumers derive from using a set of available payment methods. It is calculated based on the expected maximum benefit that consumers can achieve from their choice set, which includes all available digital payment instruments and the outside option (cash).

To analyze the impact of the availability of digital wallets on consumer surplus, we compute and compare consumer surplus before and after the adoption of digital wallets. Let us consider two sets of payment instruments: without and with digital wallets, i.e., $J =$\{intra-bank transfers, ACH transfer, ACH immediate transfer, debit card, credit card, cash\} and $\hat{J} =$\{digital wallets, intra-bank transfers, ACH transfer, ACH immediate transfer, debit card, credit card, cash\}. Using the estimated coefficients of each variable included in the model, as shown in column (7) in Table 2, and considering instrument- and time-fixed effects, the value on each product characteristic and fees, and the residuals, we compute the consumer's estimated utility δ_j for using each payment instrument j.[41] [42] Then, we calculate the total welfare derived from having and using each choice set J and $\hat{J}$.

Next, following Train (2009) (chapter 3, page 56) and Shy (2020), the per-transaction rate of change in consumer surplus resulting from the addition of digital wallets is computed by:

$$\frac{\Delta CS}{CS} = \frac{E(CS)_{BDW} - E(CS)_B}{E(CS)_B} = \frac{ln(\sum_{j\in\hat{J}} e^{\delta_j}) - ln(\sum_{j\in J} e^{\delta_j})}{ln(\sum_{i\in J} e^{\delta_j})} \tag{9}$$

where, subscript BDW (banked with digital wallets) indicates the surplus with the six payment instruments (plus cash) after digital wallets are added (i.e., with payment choice set $\hat{J}$), and subscript B (banked) indicates the surplus with the initial five available payment instruments plus cash (i.e., with payment choice set J).

To observe any differences over time, we simulate the change in consumer surplus from January 2019 to April 2024. For illustrative purposes, we calculate the change in consumer surplus at the

[41] As we normalize the utility of cash (i.e., the outside good) to zero, the estimated utilities for the rest of the payment instruments are relative to cash.

[42] The estimated utility for each payment instrument, derived using the coefficients from the model with network effects (as shown in column (8) of Table 2), remain unchanged. This is because, by design, the estimated utility for each payment instrument is equivalent to the logarithm of the ratio between the market share of each payment instrument and the market share of cash, i.e., our dependent variable in Equation 7.

early beginning and end of our study period, i.e., in January 2019 and April 2024, respectively. Substituting the computed values of δ_j (including the residuals) into Equation 9 yields:

$$\frac{\Delta CS^{19}}{CS^{19}} = 0.5\% \text{ and } \frac{\Delta CS^{24}}{CS^{24}} = 68\% \tag{10}$$

According to the simulations, the initial increase in consumer surplus for banked consumers adopting and using Yape and Plin was modest, amounting to only 0.5% of the consumer surplus in the absence of digital wallets. However, by April 2024, the availability of digital wallets has significantly boosted per-transaction consumer welfare by 68%. It is important to emphasize that these simulated gains in consumer surplus represent relative changes derived from the logit framework, rather than absolute or aggregate impacts on household welfare. The logit model captures per-transaction surplus changes under the assumptions of user homogeneity and the independence of irrelevant alternatives (IIA). Consequently, the estimated welfare gains should be viewed as indicative of the model's internal consistency, rather than as precise measures of broader welfare effects.

Figure 5 illustrates the increase in per-transaction consumer surplus associated with the availability of digital wallets over time. It shows a notable rise in per-transaction consumer surplus gains, which began in April 2020 during the pandemic. The introduction of the option to pay with digital wallets at card POS terminals in April 2021 further accelerated these per-transaction gains. As previously discussed, this acceleration may be attributed to the increased acceptance of digital wallets by merchants. This functionality enabled digital wallet users to make payments at a broader range of merchants, including those accepting card payments. Since April 2023, Phase 1 of the interoperability regulation issued by the Central Reserve Bank of Peru has further reinforced these per-transaction welfare gains (see section 7.1).

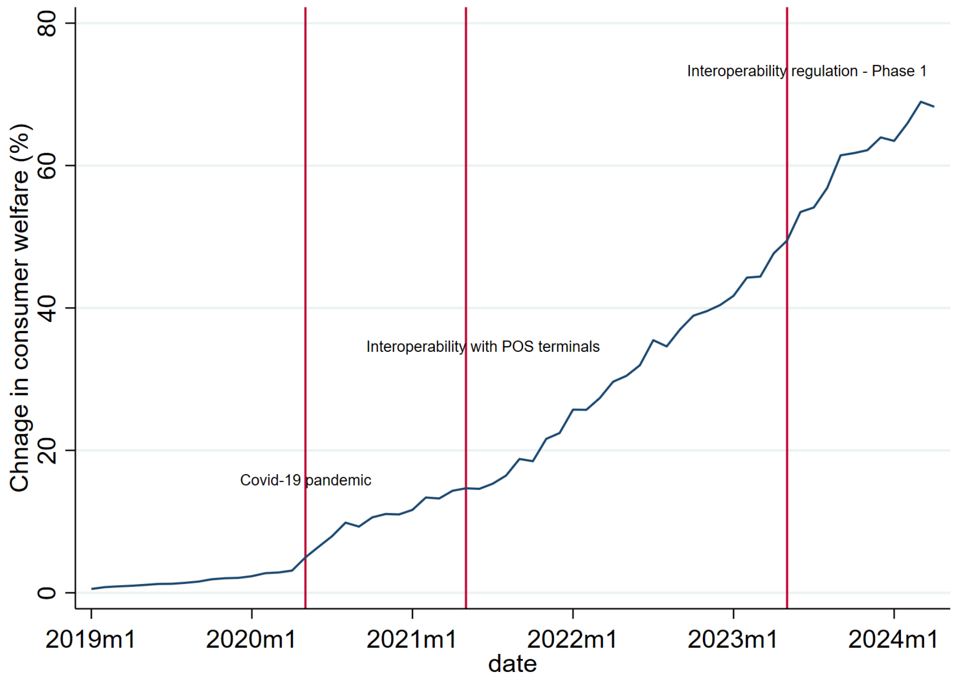
The positive and increasing impact of digital wallets on consumer welfare over time is attributed to their wider adoption and use as these payment instruments gained market traction. Digital wallets have enhanced convenience, accessibility, and flexibility, offering consumers more efficient payment methods. Additionally, the growing network effects over time have further reinforced their adoption and usage.

Overall, the substantial increase in per-transaction consumer welfare underscores the positive impact of digital wallets on banked individuals. It emphasizes the importance of continued support for such innovations through technological advancements. Moreover, as discussed in the next section, a robust regulatory framework has been essential in amplifying these network effects, thereby fostering greater adoption and use of these payment instruments.

7 The role of the Central Reserve Bank of Peru

Although the value and number of digital payments increased significantly between 2015 and 2022, cash remained the main payment instrument in retail transactions as of 2022 (Banco Central de Reserva del Perú, 2023). To advance the promotion of digital payments, the BCRP, as the regulator, supervisor, and catalyst of payment systems in Peru, aimed to address two key issues: lack of interoperability and low access to bank accounts, while ensuring the robustness, efficiency, and innovation of the retail payments market. In this section, we discuss the BCRP's interoperability strategy and ongoing projects to further increase the adoption and use of digital payments, especially among the unbanked.

Figure 5: Change in per-transaction consumer welfare from using digital wallets



Source: Authors' elaboration.

7.1 Interoperability strategy

The BCRP has been very active in promoting and enforcing interoperability in the payments market. Both Yape and Plin started their operations as closed payment systems and were not interoperable with each other.[43] The presence of such walled gardens could have led to the fragmentation of the payment market. To deal with this, the BCRP issued the Regulation of Interoperability of Payment Services (Circular No. 0024-2022-BCRP) in October 2022 to establish the conditions and opportunities for interoperability and the consequent improvement in the efficiency of the digital payments market in Peru.[44]

The regulation established four phases of implementation. Phase 1 enforced interoperability between Yape and Plin by April 2023. The implementation of Phase 1 significantly contributed to the mass adoption of interoperable digital payments (from Yape to Plin and vice versa). These peaked at 2.5 million transactions per day at the end of December 2023 (Vásquez, 2024). Also, these interoperable transactions represented approximately 51% of the total number of interbank transfers in December 2023. Phase 2 established an interconnection between Yape and Plin with financial institutions participating in the ACH as well as institutions listed in the BCRP QR Registry by September 2023. Phase 3 entailed the integration of electronic money accounts provided by Electronic Money Issuing Companies (EEDEs) and the APDE Bim electronic money transfer service. Finally, Phase

[43]As pointed out by Aurazo and Gasmi (2024) this was a key difference from other successful digital payment systems such as UPI in India and Pix in Brazil.

[44]The circular is available (in Spanish) at: `https://www.bcrp.gob.pe/docs/Transparencia/Normas-Legales/Circulares/2022/circular-0024-2022-bcrp.pdf`.

4 – currently being developed – will facilitate the entry of new players, such as fintechs and other non-financial institutions, into the retail payments ecosystem through a payment initiation model. In this regard, the BCRP established regulation for the incorporation of such entities in the ACH for the provision of inmmediate transfer services under a different model that incorporates the concept of "indirect participants". Mandatory interoperability has contributed to the digitization of payments, particularly among digital wallet users, thereby reducing their dependence on cash (García and Ancalle, 2024).

7.2 Other initiatives

Going forward, the BCRP is pursuing two key initiatives to drive innovation in the payments market: a retail central bank digital currency (CBDC) and a central bank-led fast payment system (FPS).

Regarding the retail CBDC, the BCRP issued the Regulation of Digital Money Innovation Pilots (Circular No. 0011-2024-BCRP) in April 2024. Subsequently, in July 2024, the BCRP announced that Bitel, a Peruvian mobile network operator and a subsidiary of Vietnamese company Viettel, would lead the first retail CBDC pilot in Peru (Vega and Andía, 2024). In October 2024, operations with digital money started as part of a two-month trial period to test technical and operational aspects before its complete deployment. Since March 2025, Bitel has been conducting a pilot using various communication strategies and advertising campaigns, enabling the BCRP to assess its impact. The primary objective is to evaluate the potential of a retail CBDC to expand the use and adoption of digital payments among the unbanked population, who solely rely on cash and may not own a smartphone.

The other initiative relates to a potential central bank-led fast FPS. In June 2024, the BCRP announced a partnership with the National Payment Corporation of India (NPCI) and the Reserve Bank of India to develop a new FPS like UPI. This new infrastructure is intended to complement retail payments infrastructure owned by the private sector and will be crucial not only for full interoperability, but also for open payments and the development of new use cases. According to the BCRP, this platform is expected to start operations by end 2026.

Finally, other key features such as security and quality are also pivotal in the adoption of payment instruments. Indeed, over 50% of the banked population consider security as the primary area for improvement (Vega and Paliza, 2024). In this regard, in March 2024, the BCRP issued the Regulation of Quality Levels for Interoperable Payment Services provided by Interoperable Payment Providers, Agreements, Payment Systems, and Technology Providers (Circular No. 009-2024-BCRP), addressing aspects such as performance, efficiency, availability, and incident management, among others. In addition, the BCRP recently issued additional user experience guidelines to improve the following aspects: visible access to the payment option selecting contacts, notifications of successful transfers, error messages and visible access to a help desk.

8 Conclusion

In this paper, we have examined the enablers, catalysts, and design factors that have contributed to the success of Yape and Plin in Peru. Improvements in telecommunications and payments infrastructure, coupled with increasing financial inclusion and familiarity with digital payments, provided a solid foundation for the consolidation of digital wallets during the pandemic. However, what made Yape and Plin stand out from other payment methods were their user-friendly interfaces, zero fees for P2P and some P2B transactions, interoperability with other payment instruments, and a large network of merchants accepting these payment methods.

From a quantitative approach, we estimate the logit demand for payment instruments using aggregate-level data on market shares of the six available digital payment instruments in Peru from January 2019 to April 2024. Considering cash as the outside good and using payee fees as an instrument for payer fees, we find that fees reduce demand, while the immediate availability of funds on a 24/7 basis has a positive effect. Furthermore, features such as paying with a QR code or at a card POS terminal are associated with a higher preference. In fact, a PEN 0.01 (USD 0.003) increase in payer fees would reduce the market share of the digital wallets by 0.31 pp, while debit cards and cash would gain usage. Simulations further reveal that removing 24/7 immediate transfers would reduce digital wallet usage by 15.75 pp, discontinuing POS payments by 26.01 pp, and eliminating QR code functionality by 4.45 pp. These findings remain robust across different methodologies for calculating market shares, alternative measures of cash payments, and when accounting for network effects. Although the results provide key insights into consumer preferences and may be important when designing the introduction of a new payment instrument, they do not directly address the adoption decision, which remains an important area for future research.

Additionally, we simulate the change in consumer welfare per transaction among banked individuals and observe a significant positive impact from the availability of digital wallets over time. In January 2019, each time a banked consumer made a payment using digital wallets, their consumer surplus per transaction was only 0.5% higher compared to a scenario without digital wallets. However, this surplus grew substantially, reaching 68% by April 2024. This upward trend can be attributed to the wider adoption and use of digital wallets, driven not only by the introduction of new functionalities (e.g., the ability to pay at card POS terminals since April 2021) but also presumably by other factors, such as larger network effects. While the estimated welfare gains highlight the positive impact of digital wallets on consumer surplus, they should be interpreted as relative changes within the model-implied framework, rather than as direct impacts on household-level welfare. The logit model's assumptions, including homogeneity and the IIA property, may influence the magnitude of these estimates. Future research could complement this analysis by incorporating more flexible demand models and exploring the distributional impacts of digital wallet adoption.

Finally, the role of the BCRP in fostering secure and efficient digital payments has been crucial. By mandating interoperability between Yape, Plin, and other payment instruments, the central bank enhanced network effects and promoted wider adoption and use of these payment methods. Going forward, the launch of a retail CBDC pilot and the partnership with NPCI to implement a central bank-led FPS aim to broaden access for unbanked individuals.

Annex

Table A.1: Similarities and differences between Yape and Plin

	Yape	Plin
Launch date	February 2017	May 2020
Access technology	Stand-alone mobile app	Embedded in mobile banking apps
Participants	BCP, Mibanco, Caja Cusco, Caja Trujillo, Caja Tacna, Caja Huancayo, Caja Piura and Caja Metropolitana	Interbank, BBVA, Scotiabank, Banbif, Caja Arequipa, Caja Ica, Alfin Banco, Caja Huancayo, Financiera Confianza and Ligo
Administrator	BCP	Interbank, BBVA, Scotiabank
Owner of the Directory	BCP	Yellow Pepper
Payment infrastructure	Visa Direct	
Registered users	17 MM	13 MM
Payment functionalities	QR codes, mobile phone numbers, POS payments	
Supported on	Bank account transfers	
Fees	No fees for P2P and P2B payments 2.95% for large merchants	No fees for P2P and P2B payments
Per-transaction limits	PEN 500 (USD 230)	
Daily limits	PEN 2,000 (USD 520)	PEN 1,500 (USD 390)
Receiving limts	PEN 25,750 (USD 6,700)	PEN 20,000 (USD 5,200)

Source: Authors' elaboration.

Table A.2: Product features (as of July 2024), by instrument

Instrument	immediate and 24/7	QR code	POS	mobile phone number
Digital wallets	✓	✓	✓ (April 2021)	✓
Intra-bank transfer	✓	-	-	-
ACH transfer	-	-	-	-
ACH immediate transfer	✓ (November 2020)	-	-	✓ (September 2023)
Debit card	-	✓ (April 2021)	✓	-
Credit card	-	✓ (April 2021)	✓	-

Note: Date in parentheses indicates date of change. Source: Authors' elaboration.

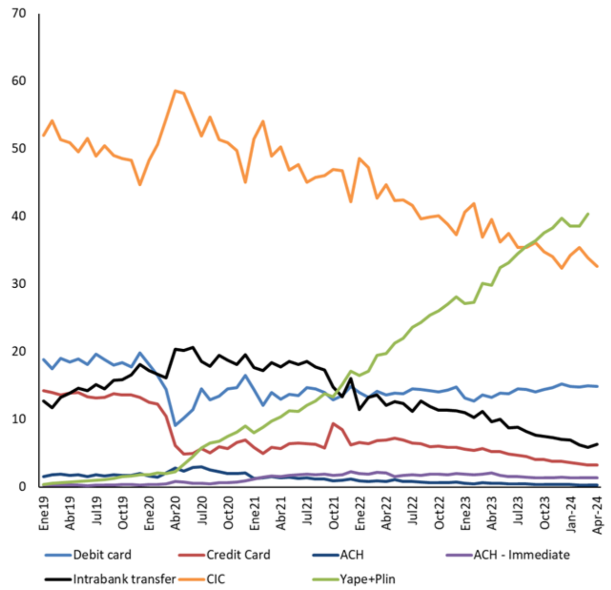
Table A.3: Results of first stage of IV estimation

Dep. var.: Payer fees		
payee fee	-0.14***	-0.13***
	(0.02)	(0.03)
instant	-0.44***	-0.29***
	(0.03)	(0.08)
pos	-0.03	-0.07**
	(0.03)	(0.03)
qr	-0.02	-0.04
	(0.03)	(0.03)
mobile phone	-0.24***	-0.22***
	(0.03)	(0.03)
Instrument FE	✓	✓
Time FE	✓	✓
Network effects		✓
N	384	366

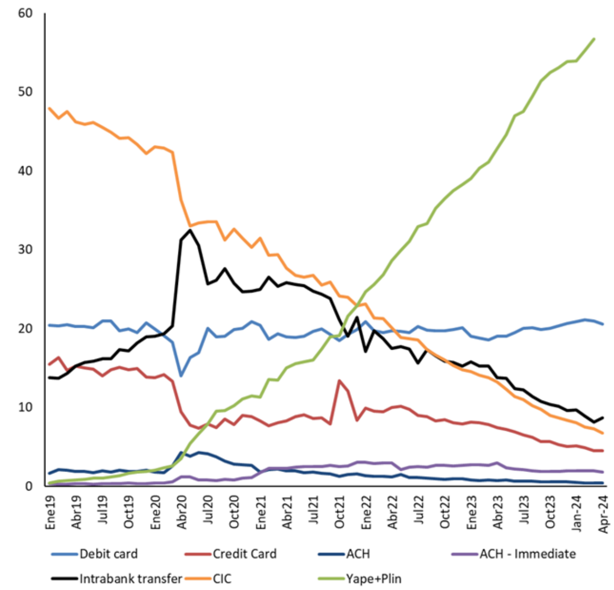
Robust standard errors in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

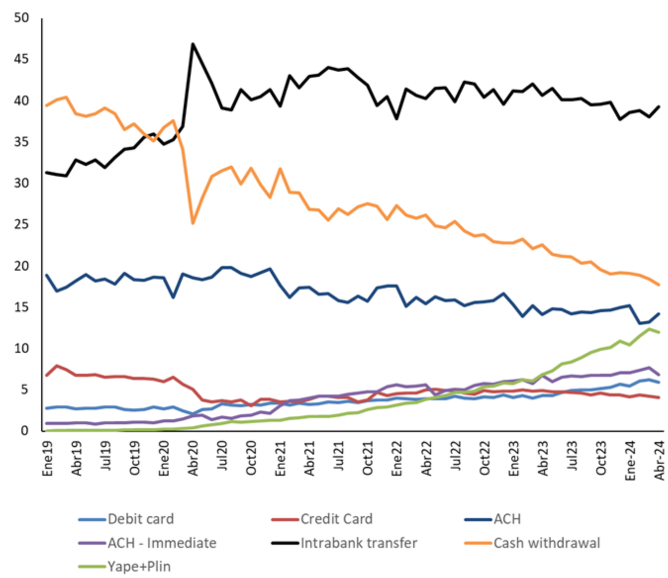
Figure A.1: Market shares (%), by methodology of calculation



(a) Using two-step calculation and cash in circulation (CIC)



(b) Using the number of transactions and cash withdrawals



(c) Using the value of transactions and cash withdrawals

Source: BCRP; authors' elaboration

Table A.4: Robustness check: econometric results

	Dep. var.: ln (s_j/s_0)							
	(I)		(II)		(III)		(IV)	
	1	2	3	4	5	6	7	8
payer fee	-1.02**	-1.23***	-1.02**	-1.22***	-1.02**	-1.22***	-1.56***	-1.22***
	(0.41)	(0.42)	(0.41)	(0.41)	(0.41)	(0.41)	(0.35)	(0.32)
instant	1.49***	0.65***	1.49***	0.65***	1.48***	0.65***	0.62***	0.53***
	(0.21)	(0.18)	(0.21)	(0.18)	(0.21)	(0.18)	(0.20)	(0.15)
pos	2.86***	1.15***	2.86***	1.15***	2.86***	1.15***	2.70***	1.07***
	(0.21)	(0.11)	(0.21)	(0.11)	(0.21)	(0.11)	(0.23)	(0.10)
qr	0.38***	0.18***	0.38***	0.18***	0.38***	0.18***	0.21***	0.10*
	(0.09)	(0.06)	(0.09)	(0.06)	(0.09)	(0.06)	(0.07)	(0.05)
mobile phone	-0.14	-0.05	-0.14	-0.05	-0.14	-0.05	-0.27*	-0.06
	(0.17)	(0.13)	(0.17)	(0.13)	(0.17)	(0.13)	(0.14)	(0.11)
Instrument FE	✓	✓	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓	✓	✓
Network effects		✓		✓		✓		✓
N	384	366	384	366	384	366	384	366
Adj. R^2	0.658	0.836	0.658	0.836	0.658	0.836	0.601	0.775
CD	51.58	41.75	51.58	41.75	51.58	41.75	51.58	41.75
10% max IV SV	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38

Robust standard errors in parentheses. Model (I) considers cash withdrawals and two-step calculation.
Model (II) considers cash in circulation and two-step calculation.
Model (III) considers cash withdrawals and number of transactions to calculate market shares.
Model (IV) considers cash withdrawals and value of transactions to calculate market shares.
All regressions use payee fee as an instrument for payer fees.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.5: Marginal change of increasing fees on market shares (ds_j/dp_j and ds_k/dp_j)

Mkt share		Digital wallets	Intra-bank transfer	ACH	ACH immediate	Debit card	Credit card	Cash
50.45	Digital wallets	-0.3065	0.0475	0.0023	0.0100	0.1125	0.0247	0.1095
7.68	Intra-bank	0.0475	-0.0869	0.0003	0.0015	0.0171	0.0038	0.0167
0.37	ACH	0.0023	0.0003	-0.0045	0.0001	0.0008	0.0002	0.0008
1.62	ACH immediate	0.0100	0.0015	0.0001	-0.0195	0.0036	0.0008	0.0035
18.18	Debit cards	0.1125	0.0171	0.0008	0.0036	-0.1824	0.0089	0.0395
3.99	Credit cards	0.0247	0.0038	0.0002	0.0008	0.0089	-0.0470	0.0087

Own price changes are calculated using: $ds_j/dp_j = \beta s_j(1 - s_j)$. Cross-price changes with: $ds_k/dp_j = -\beta s_j s_k$.
Results should be interpreted as a change in percentage points.

Table A.6: Discrete change of removing/adding 24/7 immediate transfer on market shares

instant		Digital wallets	Intra-bank	ACH	ACH immediate	Debit card	Credit card	Cash
1 → 0	Digital wallets	-15.74	2.44	0.12	0.51	5.77	1.27	5.63
1 → 0	Intra-bank	1.92	-3.52	0.01	0.06	0.69	0.15	0.67
0 → 1	ACH	-0.17	-0.03	0.34	-0.01	-0.06	-0.01	-0.06
1 → 0	ACH immediate	0.39	0.06	0.00	-0.77	0.14	0.03	0.14
0 → 1	Debit card	-7.20	-1.10	-0.05	-0.23	11.67	-0.57	-2.53
0 → 1	Credit card	-1.78	-0.27	-0.01	-0.06	-0.64	3.38	-0.62

Results are calculated by simulating the new market shares with the introduction or removal of *instant* and ceteris paribus. Results should be interpreted as a change in percentage points.

Table A.7: Discrete change of removing/adding POS functionality on market shares

pos		Digital wallets	Intra-bank	ACH	ACH immediate	Debit card	Credit card	Cash
1 → 0	Digital wallets	-26.01	4.03	0.19	0.85	9.54	2.09	9.30
0 → 1	Intra-bank	-7.14	13.07	-0.05	-0.23	-2.57	-0.56	-2.51
0 → 1	ACH	-0.40	-0.06	0.79	-0.01	-0.14	-0.03	-0.14
0 → 1	ACH immediate	-1.70	-0.26	-0.01	3.31	-0.61	-0.13	-0.60
1 → 0	Debit card	7.14	1.09	0.05	0.23	-11.59	0.56	2.51
1 → 0	Credit card	1.41	0.21	0.01	0.05	0.51	-2.69	0.50

Results are calculated by simulating the new market shares with the introduction or removal of *pos* and ceteris paribus. Results should be interpreted as a change in percentage points.

Table A.8: Discrete change of removing/adding QR code functionality on market shares

qr		Digital wallets	Intra-bank	ACH	ACH immediate	Debit card	Credit card	Cash
1 → 0	Digital wallets	-4.45	0.69	0.03	0.15	1.63	0.36	1.59
0 → 1	Intra-bank	-0.74	1.36	-0.01	-0.02	-0.27	-0.06	-0.26
0 → 1	ACH	-0.04	-0.01	0.07	-0.00	-0.01	-0.00	-0.01
0 → 1	ACH immediate	-0.16	-0.02	-0.00	0.31	-0.06	-0.01	-0.06
1 → 0	Debit card	1.54	0.23	0.01	0.05	-2.50	0.12	0.54
1 → 0	Credit card	0.33	0.05	0.00	0.01	0.12	-0.63	0.12

Results are calculated by simulating the new market shares with the introduction or removal of *qr* and ceteris paribus. Results should be interpreted as a change in percentage points.

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