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Abstract[¶]

Instant payment systems have rapidly gained global traction by enhancing transaction efficiency, yet evidence remains limited on how their design—particularly interoperability—shapes market structure. We exploit Peru's 2023 interoperability mandate as a quasi-natural experiment using a difference-in-differences design. Mandated interoperability increased deposit market concentration by approximately 2%. Incumbent banks linked to the dominant digital wallet expanded their deposit market share by nearly 10% and reduced deposit interest rates by 50–80 basis points. We also observe, in high-adoption areas, declining microcredit and more branch closures. A model explains these results as due to a boost to digital wallet convenience for all adopters. Because of network externalities, the largest incumbent wallet captures a disproportionate share of new users in dual-platform markets, which ultimately increases concentration. By contrast, in single-platform regions, interoperability lowers barriers for new providers, which spurs competition and erodes incumbent dominance. Our results show that the former effect in dual-platform cities outweighs the latter effect elsewhere. Overall, our findings show that competitive effects of interoperability mandates critically depend on initial market structure and the distribution of platform market shares.

JEL Codes: E42, J31, O33

Keywords: Digital Payments; Wage Inequality; Payment Frictions; SMEs

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1 Introduction

The rapid expansion of instant payment systems promises substantial economic benefits, including lower transaction costs and enhanced financial inclusion. Central to realizing these benefits is interoperability: seamless connectivity among banks, digital wallets, and fintech providers. Increasingly, regulators worldwide are mandating interoperability to foster competition, stimulate innovation, and facilitate market entry (Bianchi et al., 2023; Brunnermeier et al., 2023).[1] However, whether mandated interoperability genuinely enhances competition or unintentionally strengthens incumbent market power remains empirically unresolved and theoretically ambiguous. On the one hand, interoperability could reduce entry barriers, encourage consumer switching, and promote competition. On the other hand, it might disproportionately advantage incumbents by amplifying existing network effects, thereby increasing market concentration. Understanding these outcomes is critical given their direct implications for regulatory policy and financial inclusion.

This paper provides the first empirical analysis of mandated interoperability's economic impact, exploiting Peru's recent policy intervention as a quasi-natural experiment. Prior to 2023, Peru's digital payments market was fragmented into two dominant but non-interoperable mobile wallets: Yape, launched by Banco de Crédito del Perú (BCP) in 2016, and Plin, introduced in 2020 by Interbank, BBVA, and Scotiabank. In March 2023, Peru's central bank, Banco Central de Reserva del Perú (BCRP), mandated interoperability between these platforms via mobile numbers, extending the mandate in September 2023 to include all banking apps and QR payment systems.

Our research addresses three unanswered questions. First, does mandated interoperability enhance competition by lowering entry barriers and reducing incumbent market power? Second, how does interoperability influence banks' market strategies, particularly regarding deposit pricing and branch-network decisions? Third, what are the unintended distributional effects of mandated interoperability on financial inclusion? These questions remain open, as prior studies largely focus on native interoperability scenarios—such as India's Unified Payments Interface and Brazil's Pix—which typically demonstrate positive outcomes (Sarkisyan, 2023; Alok et al., 2024a), leaving the effects of mandated interoperability largely unexplored.

Empirically, we employ a difference-in-differences framework leveraging Peru's

[1]European regulators share similar expectations. The European Central Bank, for instance, identifies efficiency gains and pan-European market integration as key benefits of payment-system interoperability while recognizing operational and cyber risks of interconnected systems (European Central Bank, 2020). Its TARGET Instant Payment Settlement exemplifies such an approach (Cipollone, 2024).

nationwide interoperability rollout in March 2023. Our exposure measure is the prepandemic (2019Q4) combined deposit share of Yape- and Plin-affiliated banks in each municipality, capturing the latent potential for cross-platform transactions. Since the mandate took effect uniformly across the country, cross-city differences in these ex ante deposit shares isolate variation in treatment intensity. We include city fixed effects to control for time-invariant municipal attributes, and we incorporate region-by-time and population-quintile-by-time fixed effects to accommodate differential trends across geographic areas and city sizes. Our analyses reveal no evidence of differential pre-trends, supporting the identifying assumptions of our design.

Our main estimates show that mandated interoperability increases deposit market concentration by about 2%. Interoperability disproportionately benefits dominant incumbents, enabling them to expand their deposit market share by nearly 10% at competitors' expense and reduce deposit interest rates by 50–80 basis points, reflecting enhanced market power. These findings contrast with the usual expectation that interoperability fosters competition. To understand these findings, we develop a model in which mandated interoperability acts as an amenity shock, enhancing digital wallet convenience for all adopters. In dual-platform markets—in which both Yape and Plin operate—dominant incumbents benefit disproportionately because of stronger network effects and established consumer relationships, leading to higher market concentration (the *amenity effect*). By contrast, in single-platform regions, interoperability lowers barriers for new providers, stimulating competition (the *entry effect*) and reducing the incumbent's dominance. Our empirical results show that the amenity effect outweighs the entry effect in dual-platform markets, ultimately consolidating market power rather than fostering competition.

Additionally, we document significant financial-inclusion trade-offs. While interoperability boosts digital transactions and deposits for adopting banks, it simultaneously leads to notable branch closures and reductions in microcredit in areas with high mobile penetration. These unexpected effects underscore potential risks of financial exclusion, particularly for populations dependent on traditional banking services.

We make three primary contributions. First, we extend the growing literature on instant payment systems and their economic impacts. Research documents how digital payments enhance financial inclusion (Jack and Suri, 2014; Ouyang, 2021) and influence broader economic outcomes (Chodorow-Reich et al., 2020; Crouzet et al., 2023; Dubey and Purnanandam, 2023). Studies on instant payment systems highlight important competitive dynamics: Systems with native

interoperability foster deposit market competition (Sarkisyan, 2023), banks strategically adopt payment technologies to protect their market position (Sampaio and Ornelas, 2024), and incumbent banks use network effects to accelerate adoption (Higgins, 2024). Related work on open banking demonstrates that mandated financial infrastructure significantly affects credit access (Alok et al., 2024b). Our project contributes by examining a critical but unexplored dimension: the consequences of mandating interoperability in previously fragmented payment systems.

Second, we provide novel causal evidence on the impact of mandated interoperability in instant payment systems, challenging prevailing theoretical perspectives. Prior theoretical work typically emphasizes interoperability's procompetitive potential (Matutes and Padilla, 1994). However, our empirical setting fundamentally differs from both mobile money markets (Brunnermeier et al., 2023) and payment systems designed with native interoperability from inception (for example, Brazil's Pix, India's Unified Payments Interface). In our context, instant payment platforms are bank-led, deeply integrated account-to-account systems, in which mandated interoperability directly influences market structure and market power. Leveraging Peru's 2023 interoperability mandate as a quasi-natural experiment, we demonstrate that mandatory interoperability can enhance market concentration, particularly in dual-platform markets. Incumbent banks disproportionately benefit, capturing larger market shares through strengthened network effects and subsequently reducing deposit interest rates, thus highlighting a nuanced regulatory trade-off.

Third, we evaluate interoperability's broader implications for financial inclusion. Beyond its impact on market structure, we explicitly examine how interoperability mandates affect traditional banking infrastructure and credit provision, with particular attention to microcredit. Our preliminary findings suggest these effects are highly contingent on initial market conditions. This nuanced result contrasts with uniform regulatory approaches, underscoring the critical need for regulators to carefully consider preexisting market dynamics when designing financial-inclusion policies.

2 Institutional Background

Prior to the country's move toward interoperability, Peru's digital payment landscape was dominated by two prominent instant-transfer applications that operated in separate silos. In 2017, the largest Peruvian bank introduced Yape, a mobile application enabling peer-to-peer transfers

through cellphone numbers (Banco Central de Reserva del Perú, 2023c). Although initially limited to the bank's customers, Yape rapidly expanded its reach, partly by integrating additional financial institutions over time. In 2020, Peru's other leading banks launched Plin, a similar service tailored to their own clientele (Banco Central de Reserva del Perú, 2023a). Both Yape and Plin fostered the adoption of cashless payments, but each maintained a closed network, preventing users from sending or receiving money across the two platforms (Banco Central de Reserva del Perú, 2023c). This fragmentation reflected the broader challenge of financial inclusion in Peru, where the share of adults with formal transaction accounts remained comparatively low and reliance on cash persisted.

Beginning in late 2022, the BCRP initiated a phased strategy to modernize Peru's retail payments framework, citing heightened competition, cost efficiencies, and deeper financial inclusion as key policy imperatives (Banco Central de Reserva del Perú, 2022). Despite incremental progress in expanding digital wallet usage, the existence of mutually exclusive networks for instant transfers was viewed as a critical barrier to broader electronic payments adoption. The BCRP therefore announced a plan to integrate these separate systems under a common clearing arrangement so a user of Yape could seamlessly send funds to a user of Plin, and vice versa (Banco Central de Reserva del Perú, 2022). The BCRP emphasized that long-standing fragmentation not only undermined the potential scale advantages of digital payment solutions, but concentrated market power within a few dominant banks, and deterred entry by new players.

In April 2023, the pilot phase of mandated interoperability commenced, allowing early adopters of Yape and Plin to transact across platforms on a limited basis (Banco Central de Reserva del Perú, 2023b). The two sets of banks facilitated these cross-network payments through the national automated clearinghouse, further testing technical protocols and user experience. While part of the regulatory compliance schedule, the pilot received broad publicity as a first tangible step toward a truly open digital ecosystem. The BCRP communicated that this pilot was intended to reveal any operational or security gaps before full-scale interconnection. The network operators reported that user adoption in the initial months exceeded expectations, underscoring pent-up demand for cross-platform transactions (Banco Central de Reserva del Perú, 2023b).

Building on this trial, the complete interoperability mandate took full effect by January 2024 (Banco Central de Reserva del Perú, 2024). From that date onward, major banks and affiliated digital wallets were required to ensure full cross-platform operability, with the BCRP

providing oversight and penalty mechanisms to enforce compliance. According to the official timeline, the directive also extended to new entrants, guaranteeing that all forthcoming financial technology platforms could join the same unified infrastructure (Banco Central de Reserva del Perú, 2024). This phased approach sought to mitigate implementation hurdles while affording the industry time to upgrade core systems, finalize legal agreements, and align on technical standards. By January 2024, policymakers expected end users to experience uniform, frictionless P2P transfers regardless of wallet or underlying bank.

3 Conceptual Framework

We develop a framework to analyze how mandated interoperability affects market outcomes through changes in the relative attractiveness of banks' digital services. The model demonstrates how forcing payment platforms to interconnect can either increase or decrease market concentration depending on the preexisting market structure.

Consumers. There is a representative consumer with Constant Elasticity of Substitution preferences over amenity-adjusted deposits. The aggregate utility from deposits is given by

$$D = \left(\sum_b (A_b D_b)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where D_b denotes consumer deposits in bank b. The parameter $\sigma > 1$ is the elasticity of substitution, whose size ensures that deposits at different banks are substitutes. The amenity term A_b captures all nonprice attributes that make deposits at bank b attractive, with a key example in our context being the digital convenience offered by services like instant payments and digital wallets. Consumers aim to maximize their utility given the interest rates r_b offered on deposits. This utility maximization yields the following demand for deposits at bank b:

$$D_b = D\left(\frac{A_b r_b}{R}\right)^{\sigma} \tag{2}$$

where $R \equiv \left(\sum_j \left(A_j r_j\right)^{\sigma}\right)^{\frac{1}{\sigma}}$ is an aggregate interest rate index. This formulation implies that consumers prefer banks offering higher deposit rates (r_b) and superior amenities (A_b). Bank b's market share is $s_b = \frac{(A_b r_b)^{\sigma}}{\sum_j (A_j r_j)^{\sigma}}$.

Banks. The banking sector consists of n banks competing for deposits in Cournot fashion.[2] Each bank b sets its deposit rate r_b to maximize profits, $\pi_b = (r - r_b)\, D_b$, where r is the bank's marginal cost of funds (for example, the interbank rate), taking into account the deposit rates set by competitors. The equilibrium deposit rate offered by bank b is

$$r_b = \frac{\sigma \times r}{\sigma+1}\left(1 - \frac{s_b}{\sigma(\sigma+1)}\right). \quad (3)$$

Banks endowed with higher amenities (A_b) attract larger market shares (s_b). A greater market share, in turn, confers stronger market power, leading banks to offer lower deposit rates (r_b). Consequently, higher market concentration, as measured by the Herfindahl-Hirschman Index (HHI), enables banks to exercise greater market power through larger deposit rate markdowns.

The market setting and differential effects of interoperability. The impact of interoperability is theorized to vary significantly with the preexisting digital payment landscape. We conceptualize distinct market types based on the presence of major digital platforms (for example, Yape and Plin) prior to the mandate (in 2019):

- *Dual-platform cities:* cities where owners of both major digital platforms were operating
- *Single-platform cities:* cities where only one major digital platform owner was operating
- *Zero-platform cities:* cities where neither major digital platform owner was operating

A concise summary of these differential effects is provided in Appendix Table A.1. Our model posits that the amenity shock from interoperability and its effect on market competition will be most pronounced in cities with substantial preexisting potential for cross-platform transactions. This potential will be quantified empirically using an ex ante measure of interoperability exposure, detailed in Section 4. The underlying assumption, supported by Alok et al. (2024a), is that deposit market shares are a key driver of digital wallet adoption and thus reflect the initial conditions for platform interaction.

Model predictions. Interoperability acts as an amenity shock enhancing the value of digital wallets (A_b) for consumers, but its impact on market structure depends critically on the initial competitive landscape. We model this shock as an increase in A_b for banks with digital platforms after interoperability, where the magnitude of this increase can depend on the potential for cross-platform transactions inherent in each market, as captured by the interoperability exposure of city c, $IO\text{-}exposure_c$.

[2] In Peru, banks often set uniform deposit rates nationwide rather than varying them locally. Consequently, local competition among banks may be better approximated by quantity choices, justifying our Cournot assumption in each city.

In *dual-platform* cities (where *IO-exposure*$_c$ > 0), interoperability primarily enhances the amenities of existing digital wallet providers (*adopter banks*). By allowing users of one platform (for example, Yape) to transact seamlessly with users of another (for example, Plin), interoperability expands the effective network for all users, making digital wallets significantly more convenient. This increased value is expected to draw more customers to adopter banks, potentially leading to a consolidation of market share.

In *single-platform* or *zero-platform* cities (where *IO-exposure*$_c$ = 0), the primary effect of interoperability is to lower entry barriers. For a new entrant (for example, the previously absent platform in a single-platform city, or any platform in a zero-platform city), interoperability means they can immediately tap into the user base of any existing (or concurrently entering) interoperable platform. This reduces the incumbent's network advantage and makes market entry more viable for competing digital payment providers or banks offering such services.

Based on these mechanisms, the model yields the following predictions:

1. *Increased amenities and market share for adopters in dual-platform cities:* Interoperability is predicted to enhance the nonmonetary amenities (A_b) of adopter banks in dual-platform cities. This improvement makes these banks more attractive to consumers, leading to an increase in their market shares (s_b).

2. *Increased market concentration (HHI) in dual-platform cities:* The rise in market shares of adopter banks is expected to increase overall market concentration (HHI) in the deposit market of dual-platform cities.

3. *Lower deposit rates by adopters in dual-platform cities:* The increased market share and consequent market power for adopter banks in dual-platform cities (from equation 3) will likely lead them to offer lower deposit rates (r_b) to consumers.

4. *Deposit redistribution in dual-platform cities:* Enhanced amenities (A_b) for adopter banks are predicted to cause a shift in deposits from non-adopter banks toward adopter banks within these cities.

5. *Potential for decreased concentration in single- and zero-platform cities:* In single- and zero-platform cities, by reducing the network advantage of any single incumbent (or first mover) and facilitating entry, interoperability is expected to foster competition. This may lead to a reduction in the HHI as new players gain traction or existing smaller players become more competitive.

Finally, while our model focuses on market structure, the welfare effects depend on the trade-off between potentially reduced deposit rates in some segments (a consumer loss) and enhanced payment convenience from a larger, unified network (a consumer gain). The net effect is theoretically ambiguous and likely heterogeneous across consumer types and market structures.[3]

4 Research Design

We exploit Peru's interoperability mandate as a quasi-experimental shock to examine how forcing payment platforms to interconnect affects market structure. Under this requirement, all digital payment platforms must allow cross-platform transactions, effectively unifying previously separate user networks. This policy shift, together with ex ante differences in platform coverage across cities, provides plausibly exogenous variation to identify the mandate's causal effects.

Our key empirical measure is the interoperability exposure of city c, $IO\text{-}exposure_c$. This measure captures the latent demand for cross-platform transactions based on the preexisting market structure:

$$IO\text{-}exposure_c = \left(\frac{Deposits_c^{YAPE}}{Deposits_c}\right) \times \left(\frac{Deposits_c^{PLIN}}{Deposits_c}\right) \quad (4)$$

$Deposits_c^{YAPE}$ and $Deposits_c^{PLIN}$ represent deposits held at banks owning Yape and Plin, respectively, and $Deposits_c$ is total deposits in city c. This product structure captures an important economic intuition: The value of interoperability depends on having substantial users on both platforms who can now transact with each other. For example, a city where each platform holds 50% market share has *IO-exposure* = 0.25, representing maximum cross-platform potential. In contrast, a city dominated by one platform (for example, a 90%–10% split) has *IO-exposure* = 0.09, reflecting limited interoperability benefits despite both platforms being present. Single-platform cities have *IO-exposure* = 0 by construction, serving as natural control groups. We compute this measure using 2019Q4 data, before the COVID-19 pandemic and well before the interoperability mandate. Following Alok et al. (2024a), we rely on ex ante deposit shares of early-adopter banks as a strong predictor of wallet usage, reflecting the bank-account requirement and resulting network effects.[4] Appendix Table A.2 provides detailed examples illustrating how this measure varies across market

[3] Our theoretical framework provides a deliberately stylized characterization, explicitly emphasizing the amenity channel in dual-platform markets, consistent with our empirical findings. We do not formally model entry effects, as our empirical analysis indicates no significant entry in single-platform markets. Consequently, abstracting from explicit entry considerations does not materially alter our main theoretical predictions.

[4] Similar evidence that preexisting deposit or branch presence drives digital payment adoption is found in Higgins (2024) for Mexico and in Sampaio and Ornelas (2024) for Brazil. Both studies further highlight the importance of incumbent banks' footprints in accelerating network uptake.

structures.

Our main econometric specification is:

$$Y_{ct} = \sum_{k} \beta_k \times IO\text{-}exposure_c \times \delta_k + \delta_c + \delta_{x(c),t} + u_{ct} \quad (5)$$

where Y_{ct} represents outcomes of interest in city c at time t, including market concentration (HHI), deposit rates, digital transaction volumes per capita, bank branches per capita, and microcredit per capita. The term δ_k denotes time-period indicators, typically quarterly dummies or a post-interoperability indicator. City fixed effects δ_c control for time-invariant city characteristics. The term $\delta_{x(c),t}$ captures region-by-time and population-quintile-by-time fixed effects, accounting for differential trends across geographic areas and city sizes. The coefficients β_k identify the differential effect of interoperability based on preexisting exposure levels.

This empirical approach directly tests predictions from our theoretical framework. The model predicts that in dual-platform cities (where $IO\text{-}exposure_c > 0$), interoperability enhances amenities for banks with digital platforms, leading to increased market concentration. Specifically, we expect $\beta_k > 0$ when Y_{ct} represents HHI in periods following the mandate. Conversely, for deposit rates, the model predicts $\beta k < 0$, as increased market power enables larger markdowns. The specification allows us to trace dynamic effects through the β_k coefficients across different periods. To examine heterogeneous effects, we stratify our analysis by mobile penetration levels, measured as cellphones per capita from the 2017 census, focusing primarily on high-penetration cities where digital wallet adoption is meaningful. The key identifying assumption is that absent the interoperability mandate, outcomes would have evolved similarly across cities with different *IO-exposure* levels after controlling for city fixed effects and flexible time trends by region and city size. This parallel-trends assumption is plausible because *IO-exposure* is determined by 2019 market structure, predating both the pandemic and the policy announcement. The product form of our exposure measure ensures variation comes from the interaction of two platform market shares rather than the dominance of a single platform, mitigating concerns about correlation with unobserved city characteristics. Additionally, the discrete timing of the mandate provides a sharp discontinuity for identification. We examine pre-trends in our event-study specifications to validate this assumption empirically, expecting flat β_k coefficients in pre-mandate periods.

5 Data

Our analysis combines administrative microdata from Peru's financial regulators with publicly available statistics to examine how payment-platform interoperability affects market structure. The study period for our main analysis runs from 2021Q3 through 2024Q2, with 2019Q4 data used to construct baseline exposure measures.

We employ three primary datasets. First, we use the Bank-Branch Level Data dataset from the Superintendencia de Banca, Seguros y AFP. This publicly available dataset provides aggregate information at the bank-branch level, disaggregated by city, on credits and deposits. Specifically, it includes credit and deposit amounts differentiated by currency (local and foreign) and deposit types, including checking accounts, term deposits, and savings accounts. These data facilitate the analysis of bank responses to instant payment technology adoption, including branch closures and shifts in deposit behaviors.

Second, we use the Lender Type–Credit Type Data dataset, also from the Superintendencia de Banca, Seguros y AFP. This publicly accessible dataset offers detailed information aggregated by financial institution categories—such as commercial banks, rural banks, municipal banks, financial companies, and credit companies—and by credit types: microenterprise, small-business, medium-sized-enterprise, large-enterprise, corporate, consumer, and mortgage loans. This dataset, available at the city level, allows us to differentiate between traditional banking entities and microfinance institutions, supporting our investigation of credit allocation dynamics across distinct financial segments.

Third, we incorporate the Credit Registry dataset provided by the BCRP. This administrative dataset includes monthly bank-client-level information on outstanding loans from 2019 through 2024. It contains data on total loan values and fractions of loans experiencing repayment delays exceeding 30, 60, 90, and 120 days. Additionally, the dataset includes details on the originating city, a proxy for individual borrower age, and the industry associated with business loans. We use these data primarily to observe delinquency patterns and to analyze the impact of instant payments on borrower screening efficiency across different cities, age demographics, and business sectors.

6 Main Results

6.1 First Stage: Interoperability Exposure and Digital Payment Adoption

We begin by validating our research design by examining whether our measure of interoperability exposure effectively predicts differential adoption of digital payment systems. Our theoretical framework predicts that areas with higher exposure to interoperability—measured as the interaction of preexisting Yape and Plin deposit market shares—should experience greater increases in digital payment usage following the April 2023 interoperability mandate. To test this hypothesis, we estimate a first-stage regression in which the dependent variable captures Yape transaction activity and the key explanatory variable is our interoperability-exposure measure, defined as the product of preexisting Yape and Plin deposit market shares using 2019Q4 data.

Table 1 presents first-stage results examining the relationship between our interoperability-exposure measure and digital payment transactions. The estimates reveal a strong positive association between preexisting dual-platform presence and subsequent transaction activity. Specifically, the coefficients of 5.281 for transaction volume and 5.387 for transaction value indicate that cities where both platforms operated prior to interoperability experienced substantially higher digital payment usage.[5] These large coefficients reflect the multiplicative nature of our exposure measure and confirm that areas with established dual-platform presence saw the greatest increases in digital payment activity following the interoperability mandate.

6.2 Effect of Interoperability on Deposit Market Concentration

Our theoretical framework generates clear predictions about how interoperability affects market competition. In dual-platform cities, interoperability acts as an amenity shock that enhances the convenience of digital wallets by expanding the effective network size. This should increase market shares for banks offering digital wallets (adopter banks), leading to higher concentration. Conversely, in single-platform cities, interoperability may facilitate entry by reducing barriers, potentially increasing competition.

To test these predictions, we estimate a difference-in-differences specification in which the dependent variable is the logarithm of the HHI of deposit concentration, and our coefficient of interest captures the differential effect of interoperability exposure on market concentration.

Figure 1 presents our core results for interoperability's impact on deposit market concentration.

[5] Because of data-availability constraints, we are unable to include transaction volumes from Plin in the analysis.

Panel A shows results for cities with high mobile penetration, while Panel B shows results for cities with low mobile penetration. The results demonstrate a significant increase in deposit market concentration following the interoperability mandate, but only in cities with high mobile penetration.

In high-mobile-penetration areas, we observe an approximately 2% increase in HHI following interoperability, with the effect arising immediately after the April 2023 mandate and persisting through the end of our sample period. Importantly, there are no significant pre-trends, supporting the validity of our identification strategy. In contrast, Panel B shows no significant effects in cities with low mobile penetration, where digital payment adoption remains limited. This heterogeneity supports our theoretical framework: Interoperability's effects on competition are only manifest in markets with meaningful adoption of digital payments.

Table 2 provides additional evidence by examining deposits for adopter and non-adopter banks. The results reveal significant deposit redistribution following interoperability: Adopter banks gain 9.6% in deposits, while non-adopters lose 4.8%. This deposit redistribution helps explain the increased concentration documented in Figure 1.

6.3 Effect of Interoperability on Deposit Market Concentration

Our theoretical framework predicts that interoperability's effects should be strongest for the specific financial services most directly affected by digital wallet functionality. Since digital wallets in Peru operate exclusively in soles, concentration effects should manifest only in local currency deposits, not foreign currency deposits.

Figure 2 presents the results of interoperability's effect on deposit market concentration in foreign currency, separately examining cities with high (Panel A) and low (Panel B) mobile penetration. Unlike the significant effects observed for local currency deposits (Figure 1), interoperability does not significantly alter market concentration for foreign currency deposits, regardless of mobile penetration level. In both panels, the estimates fluctuate around zero without clear trends before or after the mandate.

This currency-specific pattern provides compelling evidence for our proposed mechanism. The fact that interoperability only affects concentration in the currency segment served by digital wallets strongly supports the interpretation that enhanced digital wallet amenities drive our main results. If our findings reflected broader competitive dynamics unrelated to digital payments, we would expect to see similar effects across both currency types.

6.4 Market-Share Dynamics: Leaders vs. Followers

To better understand the mechanisms driving increased concentration, we examine how interoperability affects the market-share distribution among banks with different initial positions in the digital wallet market.

Figure 3 decomposes our concentration results by examining market-share changes for leader banks (those with the largest digital wallet presence in each city) versus follower banks. Panel A shows that leader banks experience significant market-share gains of approximately 1.0% following interoperability. Panel B shows that follower banks experience corresponding losses of approximately 0.6%.

This asymmetric pattern reveals an important insight about interoperability's effects on competition. Rather than benefiting all digital wallet providers equally, interoperability disproportionately advantages market leaders, likely because of network effects and first-mover advantages in the newly unified system. This winner-take-more dynamic helps explain why overall concentration increases despite the theoretical possibility that interoperability could enhance competition.[6]

6.5 Differential Impact of Interoperability on Deposit Interest Rates: Market Power Effects

Our theoretical framework predicts that increased market concentration should translate into greater market power, allowing adopter banks to reduce deposit rates relative to non-adopters. To test this prediction, we estimate a specification in which the dependent variable is the deposit interest rate offered by each bank, and we compare the differential rate-setting behavior of banks offering digital wallet services (Yape or Plin) relative to banks without such services. The specification includes bank-city fixed effects to control for time-invariant bank-location characteristics and city-time fixed effects to absorb local economic shocks.

Figure 4 presents the dynamic effects of interoperability on the differential pricing behavior of adopter versus non-adopter banks. The results provide strong evidence that interoperability increases market power for banks offering digital wallet services.

Following the April 2023 interoperability mandate, adopter banks reduce their deposit rates by 50–80 basis points relative to non-adopter banks. This effect arises immediately after the

[6] One concern is that rather than experiencing an amenity effect, cities with only one wallet may reflect unsaturated demand that attracts entrants. In untabulated results, we add two measures of pre-policy city-level deposit growth (2018–19 and 2018–22) as controls and interact *IO-exposure* × *Post* with an indicator of above-median growth. We find that the main *IO-exposure* × *Post* coefficients are stable and the triple interaction is small and nonsignificant.

mandate and persists throughout our sample period. The pretreatment period shows no systematic differences in rate-setting behavior between adopters and non-adopters, supporting the parallel-trends assumption. Appendix Table A.3 provides the corresponding estimate for this analysis.

7 Financial-Inclusion Effects

While our analysis has focused primarily on competitive dynamics in deposit markets, interoperability may also have important implications for financial inclusion through its effects on bank-branch networks and credit access. Our theoretical framework suggests that digital payment adoption may reduce banks' incentives to maintain physical branches, potentially creating trade-offs between digital convenience and physical access.

7.1 Growth Rate of Bank Branches by Platform Presence

To examine interoperability's effects on financial-inclusion infrastructure, we analyze how the mandate affects bank-branch networks across cities with different platform presence, comparing network evolution in cities where both platforms operate, cities where only one platform operates, and cities with no platform presence.

Figure 5 shows the growth rate of bank branches by platform presence in high-mobile-penetration areas. The results reveal significant heterogeneity in branch-network evolution following interoperability. Panel A shows that in cities where both platforms operate, branch networks experience a decline in their physical footprint after the interoperability mandate is implemented. Panel B shows that cities with no initial platform presence maintain more stable branch networks.

Figure 6 decomposes these effects by examining branch density for adopting banks specifically. The results show that branch reductions are concentrated among adopter banks in dual-platform cities. Panel A compares dual-platform and single-platform cities, while Panel B compares dual-platform cities and all others. Both panels show negative coefficients following the interoperability mandate, suggesting that banks offering digital wallet services reduce physical infrastructure investments in response to increased digital adoption. Table 3 quantifies these effects. Column 1 shows that in high-mobile-penetration areas, moving from single-platform to dual-platform presence is associated with a 0.68 percentage point reduction in branches per capita

among adopter banks, though this effect is not statistically significant at conventional levels. Column 2 shows a similar pattern when comparing dual-platform cities to all other cities, with a statistically significant 0.80 percentage point reduction (significant at the 10% level).

While the magnitudes are modest, these results suggest that interoperability may create tension between digital financial inclusion and physical access to banking services, particularly in areas where digital adoption is high.

7.2 Effect of Interoperability on Microcredit Volume: Examining Credit-Access Effects

Beyond infrastructure effects, interoperability may affect financial inclusion through its impact on credit provision. Enhanced digital payment data and improved cash flow management could facilitate credit access, while branch closures might reduce relationship lending. We examine these effects by analyzing microcredit provision, comparing cities with different levels of interoperability exposure.

Figure 7 presents the effects of interoperability exposure on microcredit provision across comparison groups. Panel A compares dual-platform cities (with high interoperability exposure) to single-platform cities, while Panel B compares dual-platform cities to all other cities. Both panels show negative effects of interoperability exposure on microcredit volume, with the effects emerging around the time of the interoperability mandate.

Table 4 provides quantitative estimates of these effects. Column 1 shows that high interoperability exposure is associated with a 20% reduction in microcredit volume compared to single-platform cities. Column 2 shows a 13% reduction when compared to all other cities. These results suggest that interoperability may have reduced certain forms of credit access, possibly because of branch closures or changes in lending practices among adopter banks. The effects are economically meaningful and raise important questions about the distributional consequences of digital payment-system integration.

However, these findings should be interpreted cautiously. The reduction in traditional microcredit volume could reflect substitution toward digital lending products offered through payment platforms rather than a net reduction in credit access. Further research would be needed to distinguish between these competing explanations.

8 Conclusion

This paper demonstrates that mandated interoperability in instant payment systems can produce outcomes contrary to regulators' intentions. Exploiting Peru's 2023 mandate connecting the Yape and Plin platforms, we found that interoperability increases rather than decreases market concentration, with banks offering digital wallets gaining market power.

We arrived at three key findings. First, in dual-platform markets (where both Yape and Plin operated before the mandate), deposit market concentration increases markedly following interoperability. Banks with the largest digital wallet presence strengthen their market position, while follower banks experience notable share erosion. This enhanced market power translates directly into pricing behavior, as adopter banks implement substantial deposit rate reductions compared to non-adopters, capturing rents at depositors' expense.

Second, the mechanism operates through network effects amplified by interoperability. Connecting platforms enhances the amenity value of digital payments, but these benefits flow disproportionately to banks with established digital wallet infrastructure.

Third, these digital gains coincide with reductions in traditional financial infrastructure. Banks offering digital payment platforms reduce branch networks in dual-platform cities, while microcredit provision falls in these same regions. The results show a substitution effect between digital financial services and traditional banking infrastructure.

Our findings challenge the prevailing view that interoperability uniformly promotes competition and inclusion. Instead, we show it can create winner-take-more dynamics when network effects dominate, particularly benefiting banks with first-mover advantages in digital payments. For policymakers, this implies that mandating technical connections between platforms is insufficient without addressing how such mandates amplify existing digital advantages.

Our evidence speaks directly to ongoing policy debates in countries considering similar mandates. The concentration effects we document suggest regulators should couple interoperability requirements with explicit provisions protecting banks without digital infrastructure and maintaining physical footprints. Otherwise, the pursuit of digital efficiency may inadvertently exclude populations dependent on traditional banking services.

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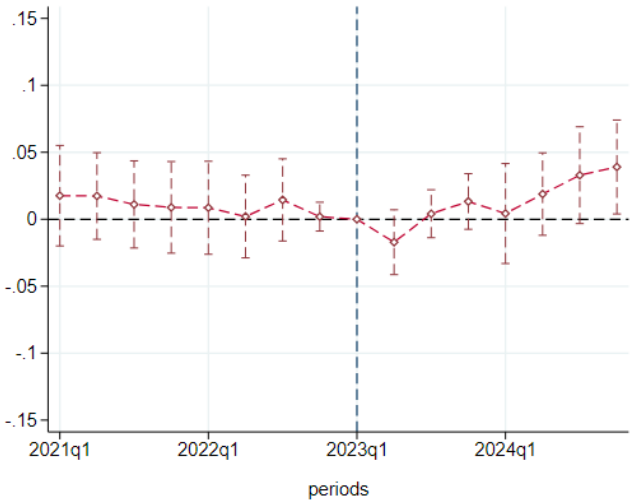
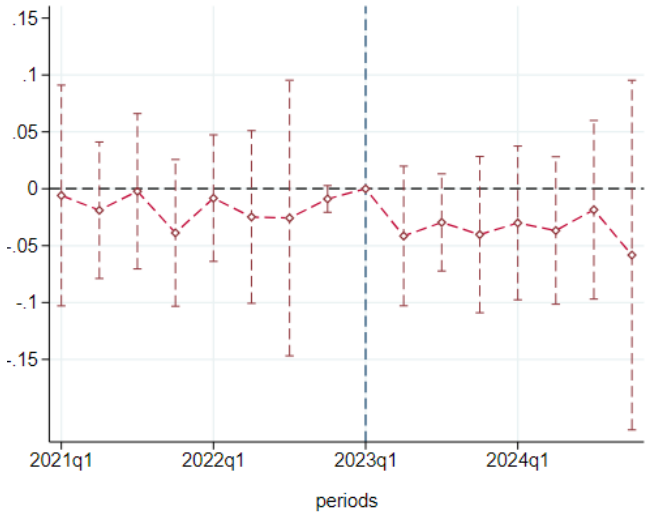
Figure 1 Effect of Interoperability on Deposit Market Concentration



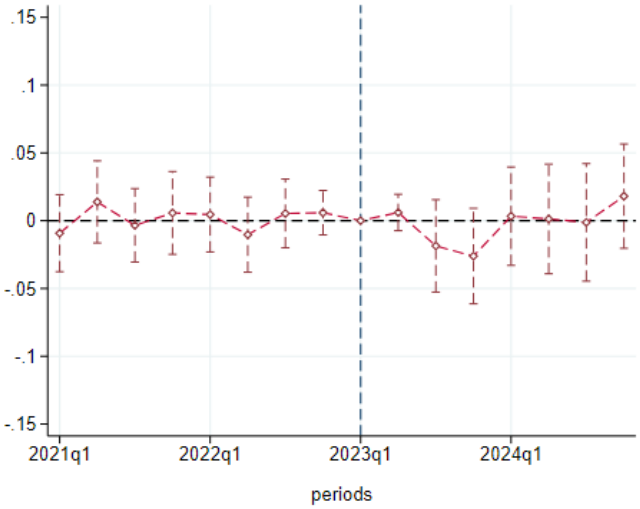
A. High mobile penetration



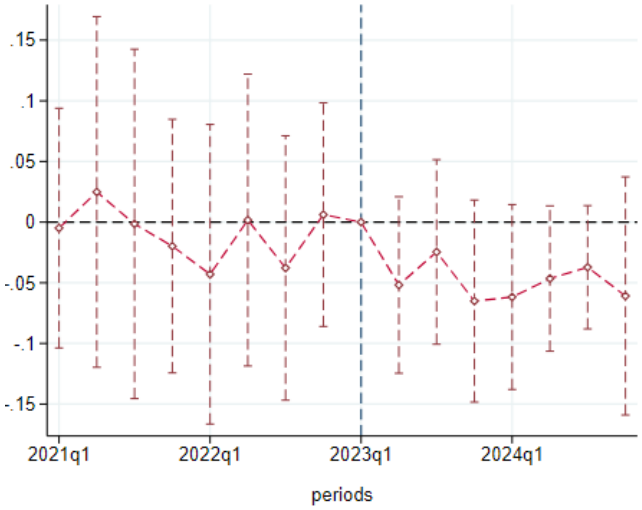
B. Low mobile penetration

This figure presents event-study estimates of the effect of interoperability on deposit market concentration in local currency across cities with varying levels of mobile penetration. Coefficients come from a difference-in-differences specification with the logarithm of the deposit Herfindahl-Hirschman Index (HHI) as the dependent variable. The treatment is the interaction between interoperability exposure—measured as the product of pre-mandate Yape and Plin deposit market shares—and post-mandate indicators. Panel A covers cities with above-median mobile penetration; Panel B, below-median. The vertical dashed line marks the interoperability mandate (March 2023). Specifications include city, region-by-period, and city size-by-period fixed effects. Standard errors are clustered by city.

Figure 2 Effect of Interoperability on Deposit Market Concentration in Foreign Currency



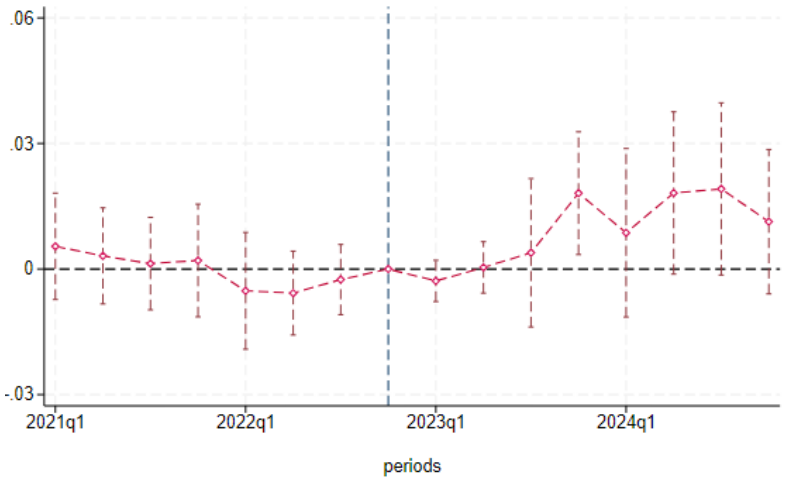
A. High mobile penetration



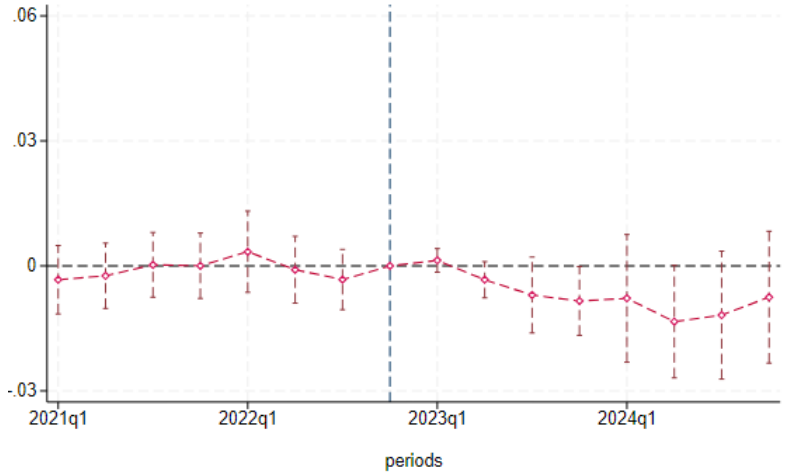
B. Low mobile penetration

This figure presents event study estimates of interoperability's effect on deposit market concentration across cities with different mobile penetration levels, focusing on deposits in foreign currency (USD). Coefficients come from a difference-in-differences specification with the logarithm of the deposit Herfindahl-Hirschman Index (HHI) as the dependent variable. The treatment is the interaction between interoperability exposure—measured as the product of pre-mandate Yape and Plin deposit market shares—and post-mandate indicators. Mobile penetration is measured as the number of cellphones per capita, as reported in the 2017 census. Panel A covers cities with above-median mobile penetration; Panel B, below-median. The vertical dashed line marks the interoperability mandate (March 2023). Specifications include city, region-by-period, and city size-by-period fixed effects. Standard errors are clustered by city.

Figure 3 Market Share Dynamics Following Interoperability



A. Leader Market Share



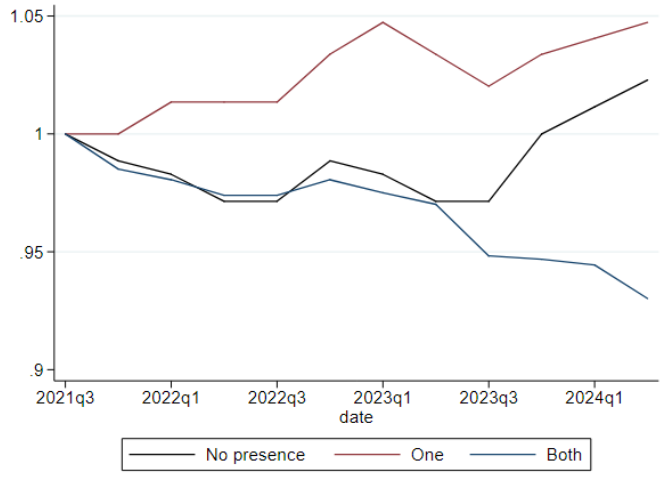
B. Follower Market Share

This figure shows the effect of interoperability on market shares of leading and following banks in cities with high mobile penetration. The leader is defined as the bank with the largest digital wallet presence (either Yape or Plin) in each city prior to interoperability, while the follower is the bank with the second-largest digital wallet presence. Panel A shows the dynamics for leader banks, while Panel B shows the dynamics for follower banks. The specification includes city fixed effects, region-by-period fixed effects, and city size-by-period fixed effects. Standard errors are clustered at the city level. The sample includes only cities where both digital wallet platforms were present prior to the mandate.

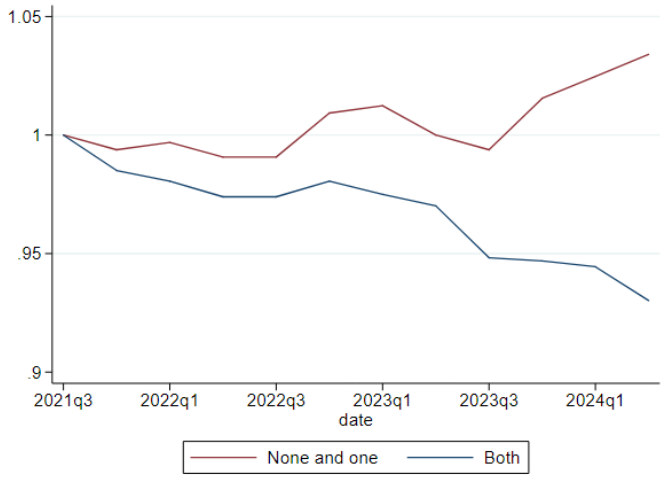
Figure 4 Differential Impact of Interoperability on Deposit Interest Rates

This figure presents the results from a difference-in-differences analysis examining how interoperability affects deposit interest rates offered by adopter banks relative to non-adopters. The dependent variable is the interest rate on short-term deposits (current and savings accounts). The coefficients represent the differential change in interest rates for banks with digital wallets (adopters) compared to banks without digital wallets (non-adopters) around the interoperability mandate. The specification includes bank-city fixed effects and city-time fixed effects to control for bank-specific characteristics and local economic conditions. Interest rates are set uniformly at the bank level and assigned to cities based on branch presence. Standard errors are clustered at the city level. The sample includes all cities where both adopter and non-adopter banks operate branches.

Figure 5 Growth Rate of Bank Branches by Platform Presence in High Mobile Penetration Areas



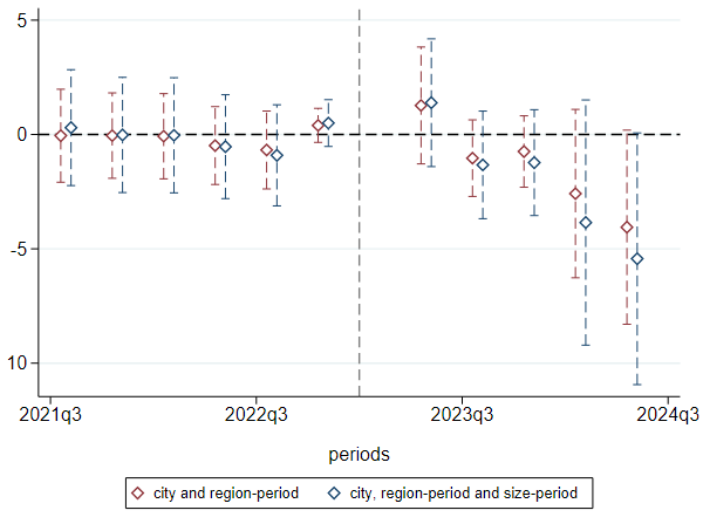
A. By platform presence



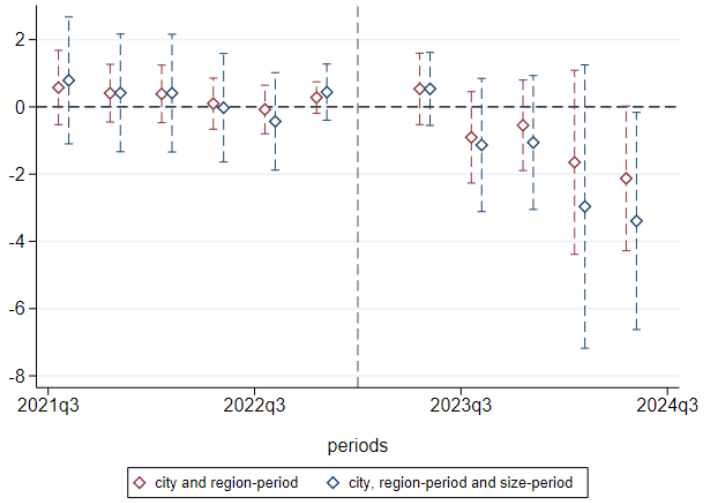
B. Grouped comparison

This figure shows the growth rate of bank branches in cities with high mobile penetration, categorized by digital platform presence. Panel A displays growth rates for cities where both digital platforms operated, where only one operated, and where neither operated. Panel B groups cities with no presence or one platform versus cities where both platforms operated. Growth rates are calculated relative to 2024Q1 values. The analysis focuses on areas with above-median mobile penetration to examine how platform competition affects physical banking infrastructure in digitally-enabled markets.

Figure 6 Effect of Interoperability on Bank Branches per Capita for Adopting Banks



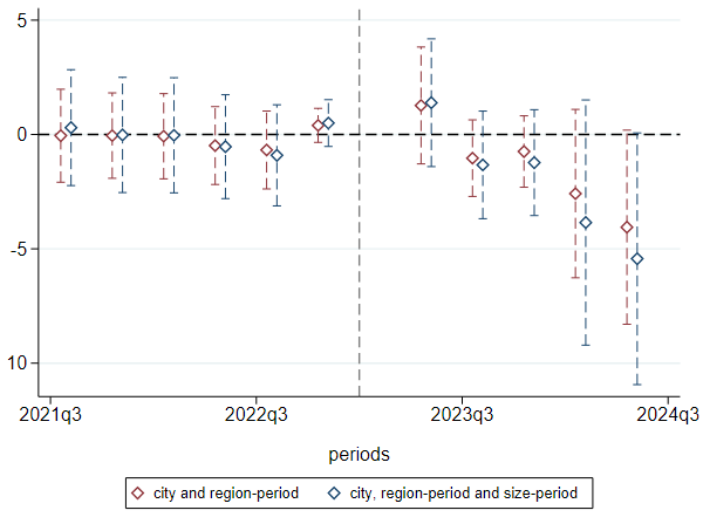
A. Dual-platform vs. single-platform cities



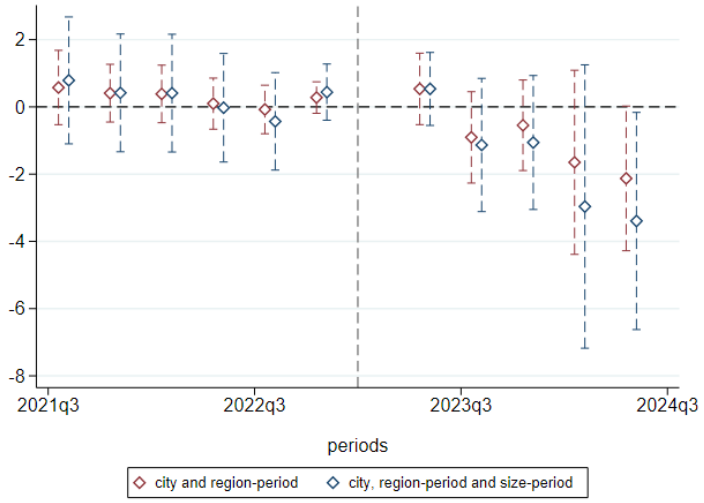
B. Dual-platform vs. all other cities

This figure presents event study estimates of the effect of interoperability on bank branches per capita for banks that adopted digital payment platforms (Yape or Plin). Panel A compares cities where both platforms operated pre-mandate (dual-platform) versus cities where only one platform operated (single-platform). Panel B compares dual-platform cities versus all other cities combined. The analysis focuses on high mobile penetration areas. The specification includes city and region-period fixed effects, with an additional specification including size-period fixed effects. Standard errors are clustered at the city level. The vertical dashed line indicates the implementation of the interoperability mandate in April 2023.

Figure 7 Effect of Interoperability on Micro-Credit Volume



A. Dual-platform vs. single-platform cities



B. Dual-platform vs. all other cities

This figure presents event study estimates of the effect of interoperability on bank branches per capita for banks that adopted digital payment platforms (Yape or Plin). Panel A compares cities where both platforms operated pre-mandate (dual-platform) versus cities where only one platform operated (single-platform). Panel B compares dual-platform cities versus all other cities combined. The analysis focuses on high mobile penetration areas. The specification includes city and region-period fixed effects, with an additional specification including size-period fixed effects. Standard errors are clustered at the city level. The vertical dashed line indicates the implementation of the interoperability mandate in April 2023.

Table 1 First-Stage Relationship between Interoperability Exposure and Digital Payment Transactions

This table presents the correlation between interoperability exposure and Yape transaction volumes in the last two quarters of the sample period. The dependent variables are the logarithm of the number of transactions (column 1) and the logarithm of transaction values (column 2). Interoperability exposure is measured as the product of pre-mandate Yape and Plin deposit market shares at the city level. The sample includes 300 cities. Robust standard errors are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

	Log (Yape Transactions)	
	Number	Value
	(1)	(2)
IO exposure	5.281***	5.387***
	(0.788)	(0.825)
Observations	3000	300
Region FE	✓	✓

Table 2 Effect of Interoperability on Bank Deposits

This table presents difference-in-differences estimates of the impact of interoperability on bank deposits. The dependent variable is the logarithm of deposits at the bank-city-period level. Adopters are banks that offer digital wallet services (either Yape or Plin), while non-adopters are banks without digital wallet offerings. The treatment variable is the interaction between interoperability exposure at the city level and a post-mandate indicator. Interoperability exposure is calculated as the product of pre-mandate Yape and Plin deposit market shares in each city, using 2019Q4 data. All specifications include city fixed effects, region-by-period fixed effects, and city size-by-period fixed effects. Standard errors clustered at the city level are reported in parentheses. The sample covers cities with high mobile penetration from 2021Q1 to 2024Q1. ***p<0.01, **p<0.05, *p<0.1.

	Log(Deposits)	
	Adopters	Non-adopters
	(1)	(2)
IO exposure × Post	0.096***	-0.048
	(0.048)	(0.022)
Observations	1,919	2,912
City FE	✓	✓
Region × Period	✓	✓
Size × Period	✓	✓

Table 3 Effect of Interoperability on Bank Branches per Capita

This table presents difference-in-differences estimates of the impact of interoperability on bank branches per capita for adopting banks in high mobile penetration areas. Column 1 compares cities where both digital platforms operated pre-mandate versus cities where only one operated. Column 2 compares cities with both platforms versus all other cities. The treatment variable is the interaction between interoperability exposure and a post-mandate indicator. The sample is restricted to banks that adopted digital payment platforms and cities with above-median mobile penetration. Robust standard errors are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1

	Dual vs Single Platform Cities	Dual Platform vs All Other Cities
	(1)	(2)
IO exposure × Post	-0.68	-0.80*
	(0.59)	(0.46)
Observations	1,535	2,277

Table 4 Effect of Interoperability on Micro-Credit Provision

This table presents difference-in-differences estimates of the impact of interoperability on micro-credit provision by all lenders in high mobile penetration areas. The dependent variable is the logarithm of micro-credit volume at the city-period level. Column 1 compares cities where both digital platforms operated pre-mandate versus cities where only one operated. Column 2 compares cities with both platforms versus all other cities. The treatment variable is the interaction between interoperability exposure and a post-mandate indicator. The sample is restricted to cities with above-median mobile penetration. Robust standard errors are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

	Dual vs Single Platform Cities	Dual Platform vs All Other Cities
	(1)	(2)
IO exposure × Post	-0.20*	-0.13***
	(0.12)	(0.05)
Observations	1,494	2,191