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Mobile Money and Financial Inclusion in a Bank-Led Regulatory Regime: Evidence from a Provincial Panel in Pakistan

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ABSTRACT

Purpose: This study examines the relationship between mobile money penetration and financial inclusion across Pakistani provinces, offering evidence from a bank-led regulatory environment, unlike the telecom-led systems dominating existing research.

Design/Methodology/Approach: A province-year panel of Pakistan's four provinces and the Islamabad Capital Territory (five provincial/territorial units), 2017–2024 ($N = 40$), was constructed from the World Bank Global Findex, State Bank of Pakistan, GSMA, and national statistical sources. Fixed-effects panel estimation with robustness and sensitivity analyses evaluated the association between mobile money penetration and financial inclusion.

Findings: Mobile money penetration is positively associated with formal account ownership, though the estimate remains statistically imprecise given the panel's limited cross-sectional dimension. The estimated association is descriptively larger for digital payment usage than for formal savings participation, although the two outcomes capture distinct dimensions of financial inclusion, suggesting mobile money may contribute more to transaction-based inclusion than to deeper financial engagement. Rural provinces show relatively stronger associations, while gender-related differences remain weak and

inconclusive. Given the effective sample of five provincial/territorial units, findings should be interpreted as descriptive and hypothesis-generating rather than confirmatory.

Research Limitations/Implications: *The study is constrained by the small number of cross-sectional units, the correlational design, and interpolation/extrapolation of some indicators. Larger datasets and causal identification strategies are needed.*

Originality/Value: *This study offers one of the first provincial panel analyses of mobile money and financial inclusion in Pakistan's bank-led regulatory context, extending evidence beyond the telecom-led experiences reported in Sub-Saharan Africa and providing a foundation for future research and policy.*

Keywords: *Financial inclusion; Mobile money; Digital wallets; FinTech; Pakistan; Emerging markets; Panel data*

Paper type: *Research paper*

1. INTRODUCTION

Financial inclusion — access to and use of useful, affordable, and responsibly delivered financial products — continues to be at the heart of sustainable economic development (Ozili, 2021; World Bank, 2022). Formal financial access has been shown to have substantial welfare implications: transaction account-holding households are more resilient to economic shocks and invest more in education, allowing them to achieve better long-term welfare outcomes (Beck et al., 2007; Bharadwaj et al., 2019). But with 1.4 billion adults worldwide still unbanked, South Asia remains home to the highest share of financially excluded populations (Demirgüç-Kunt et al., 2022). Pakistan exemplifies this challenge acutely. However, only 35% of adults aged 15 years and above had a formal account by the end of 2021 (State Bank of Pakistan, 2022a). Globally, account ownership varies substantially across population groups, with women and rural populations continuing to face greater barriers to formal financial access (Demirgüç-Kunt et al., 2022). Geographic dispersion, low populations density and high costs of providing banking services to remote communities have always been challenging even for conventional brick-and-mortar banks (Beck et al., 2007). This structural pressure leads to an increased interest in digital financial services as an instrument of inclusion (Gomber et al., 2017). Regulations were introduced for Branchless Banking by State Bank of Pakistan in 2008. Registered accounts for mobile money platforms saw tremendous growth since (mainly JazzCash and Easypaisa) and crossed the 50 Million mark by 2023 (State Bank of Pakistan, 2023). Theoretically, these platforms could reduce the centuries-old cost of distance and documentation (Lashitew et al., 2019), while further reducing liquidity constraints that have plagued rural and low-income households. However, theoretical advantages only become practical one with certain institutional underpinnings: regulatory architecture, market structure and competitive behavior, human capital endowments all condition how digital finance translates into live finance (Arner et al., 2016; Ozili, 2018). Financial inclusion should not be a zero-sum game with a binary yes or no; rather it should be several dimensions that are separately defined but instead related. Access is the presence of a formal account; usage tracks whether that account is actually used for transactions, savings or credit; and quality indicates whether the products on offer are affordable, reliable and appropriate to the needs of individual households (Allen et al., 2016). The dimensions do not necessarily shift in tandem: a household may obtain a formal account without behaviorally changing savings or borrowing, particularly when trust, literacy, or product design remain weak (Ozili, 2021). This distinction is

particularly important when it comes to Pakistan, where the inclusion gap is far less about account ownership and more about structural barriers. Even minor reform to branch-based banking infrastructure continues to be largely confined to urban centers, making large rural populations depend on informal savings and credit mechanisms that offer little defense against income-shocks (Beck et al., 2007). Identified structural barriers are further compounded by gender gaps: documentation requirements that assume access to identification documents, household decision-making norms that channel financial control through male relatives (when they exist in a household), and restrictions on rural women's mobility undermine their autonomy to financially self-manage—barriers that can only be partially reached simply through expanding physical or digital access points (Demirgüç-Kunt et al., 2022). Fourth, to understand how and whether mobile money is successful at addressing these compounding barriers—or simply the headline account-ownership gap—one must pay close attention to which dimension of inclusion is examined and for whom.

The empirical research on this issue continues to be largely concentrated in Sub-Saharan Africa, where studies of M-Pesa in Kenya are by far the dominant subject matter of the scientific literature (Jack & Suri, 2014; Suri & Jack, 2016). Research from that perspective shows that mobile money adoption is linked to consumption smoothing, poverty reduction and improved risk-sharing (Bharadwaj et al., 2019). Whether these results extend to South Asia is unclear. In the case of Pakistan, its bank-led regulatory model, combined with centralized supervision through the State Bank of Pakistan and different socio-cultural norms around gender and financial independence are fundamentally incompatible with Kenya's telecom-led ecosystem (Arner et al., 2016). However, the only studies available in Pakistan are mere small cross-sectional surveys which do not allow for generalizable or longitudinal analyses. To our knowledge, existing studies in Pakistan have not examined mobile money penetration and multiple dimensions of financial inclusion using a province-level panel over time. To fill this gap, the study addresses three research questions: (1) What is the relationship between mobile money penetration and formal account ownership in Pakistan between 2017 and 2024? (2) How are the associations between mobile money penetration and financial inclusion outcomes—account ownership, formal savings participation, and digital payment usage—distributed across Pakistani provinces? (3) Do these associations vary systematically with provincial rural and female population shares? Our analysis is organized using frameworks of technology acceptance and financial capability (Davis, 1989; Johnson & Sherraden, 2007). These frameworks imply that the role of digital financial services in expanding inclusion is mediated by regulatory quality enabling trust, availability or proxy for a physical infrastructure where banking networks are absent and most importantly realized where users have literacy and confidence to engage productively with formalized financial products (Oliveira et al., 2016; Ozili, 2018). Our contribution is threefold. We contribute (1) unique panel evidence from a bank-controlled mobile money context and (2) early description of the role of province-level heterogeneity in rurality, literacy, and economic development as conditioning factors for digital finance outcomes; and (3) descriptive estimates and hypothesis to guide future causal research in South Asian digital finance. The rest of the paper is organized as follows. Section 2: surveys the conceptual and empirical literature, which lays out our analytic framework and hypotheses. In Section 3, we describe the data and variables along with estimation strategy to be employed. Section 4 presents the results. Section 5 discusses how the results relate to theory and prior evidence, as well as the institutional context. Finally, in the

conclusion, during section 6, we summarize our results with implications and propose future work.

2. CONCEPTUAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

2.1 Theoretical Framing: Technology Acceptance and Financial Capability

This study is guided by two complementary theoretical lenses. According to Technology Acceptance Theory, if digital services are adopted and effectively utilized, it is expected that perceived usefulness, perceived ease of use and trust in institutional environment would have a positive relationship (Davis, 1989; Oliveira et al., 2016). The perceptions of such phenomena in financial services context are not only the states of individual's psychology but also regulatory quality, platform reliability and integrity of agent network (Ozili, 2018) While the service is technically offered, value-based perceived service availability of mobile money falls due to severe liquidity shortages at agent outlets (transaction failures) or an insufficient level of regulatory protection (Gomber et al., 2017). In line with this perspective, Financial Capability Theory argues that the welfare benefit of financial products only accrues to users who adequately know, understand and can use them (Johnson & Sherraden, 2007). This view especially highlights a critical distinction between access and extent of usage: some households may own mobile money accounts only to receive remittances or government transfers, never actually engaging with savings, credit, or insurance products that offer long-run financial security (Ozili, 2021). According to the capability perspective, the relationship between mobile money penetration and basic access indicators is likely to be stronger than for deeper usage measures, especially in low literacy provinces among individuals with limited prior financial experience (Ozili, 2021). All in all, these frameworks suggest that the effectiveness of mobile money on inclusion is key to various institutional infrastructure, human capital and regulatory environment (Arner et al., 2016). In fact, they do not expect a systematic uniform impact: There has been anticipation of systematic heterogeneity across contexts with some variation based on province traits (Lashitew et al., 2019). Both of these frameworks supplement and do not compete against each other to explain the inclusion outcomes of digital financial services. You are working in a set of geographic data as of October 2023 where Technology Acceptance Theory almost solely stays at the acceptance stage: it is logical to ask why someone would open an account or start transacting on a mobile money platform. Compared to what is available as alternative — not only a bank branch but informal savings groups, family networks, cash-based transactions for much of rural Pakistan (Oliveira et al., 2016) Perceived usefulness and ease of use Financial Capability Theory works on an interface further down utilization continuum: it explains why an account after opening is a basic transactional account but not used for saving products, or credit and insurance products which are based on sustained engagement and longer time planning horizon (Johnson & Sherraden, 2007). Both frameworks combined indicate a stepwise adoption process, where institutional trust and perceived usefulness influence the initial margin of usage, while human capital and financial capacity determine how much further beyond that margin. The logic of affecting only one kind of outcome justifies the approach taken in this study that looks at ownership and usage-depth (savings & payments) as different dependent variables rather than a composite measure of financial inclusion. The concept of trust in this institutional context is actually a two-layer vertical trust relationship: firstly, between consumer and platform provider (i.e. JazzCash / Easypaisa) regarding the successful execution of transactions, secondly, consumers inevitably have to trust in the regulatory regime which protects them against fraud/agent default or failure by credit card/PayPal/e-wallet providers (Gomber et al., 2017). Where the latter is

weak, even a technically robust platform may struggle to turn access into sustained use as users rationally discount the value of holding balances in an account whose regulatory coverage is ambiguous (Ozili, 2018). Although the REGQUAL index of Section 3.3 is not directly testable since it reflects a State Bank of Pakistan-rated regulatory quality score that does not reflect how users perceive their own trust, this distinction is a handy caveat when interpreting REGQUAL's role among the controls in the regression.

2.2 Mobile Money and Financial Inclusion: Evidence from Sub-Saharan Africa

The evidence base regarding mobile money and financial inclusion is predominantly based on Sub-Saharan African countries (and predominately used by the Kenyan case of M-Pesa). M-Pesa adoption raised per capita consumption and removed 194,000 households from poverty (Jack & Suri, 2014). Suri and Jack (2016) documented long-run improvements to savings and risk-sharing for mobile money users. Bharadwaj et al. (2019) found that digital credit enhances household resilience to shocks, though this may also lead to over-indebtedness among some borrower cohorts. These impacts seem to be more marked where the density of conventional banking institutions is reduced, and mobile system coverage is highest (Lashitew et al., 2019). Nevertheless, such a direct extrapolation from Kenya to Pakistan has institutional problems on at least three grounds. First, regulatory architecture differs fundamentally. In Kenya, the country operates a dual regulatory framework wherein telecom providers and banks are able to coexist as mobile money issuers, whereas in Pakistan, mobile money operates within a predominantly bank-led regulatory and institutional model, under centralized supervision by the State Bank of Pakistan. This differs from telecom-led models observed in countries such as Kenya (Arner et al., 2016; State Bank of Pakistan, 2008). Hence, while commercial banks are concerned with how they can mobilize deposits in bank-led models and maintain deposit-taking compliances by the Bank of International Settlements (BIS), telco-led models focus on various aspect of transaction functionalities but rely on concepts including volume of transactions (Gomber et al., 2017). So, if institutions differ in their incentives to be inclusive, we could easily end up with polarizing inclusion results: Bank-led platforms may excel at account opening and Know-Your-Customer compliance but grossly underinvest in savings product innovation or user financial education (Ozili, 2018). Second, market structure varies. For example, the JazzCash-Easypaisa duopoly in Pakistan faces agent banking and interoperability constraints that do not exist today in a more fragmented early ecosystem such as Kenya (State Bank of Pakistan, 2022b). Moreover, one-way platform competition can increase transaction efficiency but under weak coordination may also reduce price transparency or product differentiation (Gomber et al., 2017). Third, socio-cultural contexts differ. These gender norms are trained on what a person experiences in Pakistan with respect to financial autonomy, mobility and who takes the decision in their household not necessarily the same region or country (which is relevant for East Africa) through which they see such barriers differently (Ozili, 2018). Gender norms and restrictions on women's mobility and financial autonomy may affect whether account ownership translates into meaningful financial use (Ozili, 2018; Bharadwaj et al., 2019). Because of these institutional differences, the literature needs to contextualize into South Asian bank-led environments before definitive conclusions can be made about mobile money's impacts on inclusion (Arner et al., 2016). The book lays out the institutional underpinnings to M-Pesa's success, and provides a useful reference point for evaluating Pakistan's "bank-led" alternative. As a mobile network operator (not a licensed deposit taking institution), Safaricom could build an agent network quickly and with fewer prudential constraints than would likely be possible in a bank-led model,

while Kenya's regulator took an intentionally liberal approach to the platform's nascent growth (Buku & Meredith, 2013). The low-friction entry to markets and the hands-off approach on regulation, enabled M-Pesa's agent network to expand rapidly in both urban and rural geographies a prerequisite for the access improvements documented in the literature. This access-usage distinction that motivates this study is further illustrated with firm evidence on savings behavior in Kenya, such as the findings of Dupas and Robinson (2013) who note that low-income households only use formal or informal savings devices when they are designed to encourage take-up and sustained use rather than merely making availability possible. This result is consistent with our expectation that mobile money's effects on savings participation should be smaller and more conditional even on complementary product design than its effect on basic account access or payments, a pattern which Section 2.1 called out as coming from the Financial Capability framework, and which we formalize in the hypotheses of Section 2.5. The difference between bank-led and telecom led models not just rests on product design. Countries that have extended banking regulation or supervision to mobile operators provide yet another comparative test, revealing capital adequacy, loan-loss provisioning and even consumer-protection requirements imposed on banks whose telecommunications-led twin need not internalize unless explicitly bring the same provisions into play (Arner et al., 2016). This asymmetry provides a possible rationale for why bank-led platforms have cautiously prioritized low-risk transaction and remittance products over higher-risk micro-credit or micro-insurance products, despite consumer demand in the latter cases. As described in Section 2.3 above, Pakistan is experiencing an evolution of regulation that has gradually brought branchless banking into a similar prudential architecture, and more recently (as discussed below) digital banks— suggesting that the product mix possible through mobile money platforms may itself evolve as licensing categories mature (State Bank of Pakistan, 2022b).

2.3 The South Asian Context and the Pakistan Gap

Comparative evidence from economies in South Asia that are close neighbors Bijoy (2017) documents that the wide coverage of India's Pradhan Mantri Jan Dhan Yojana combined with its recent expansion through UPI resulted in very high levels of payment usage but, as the research shows, conversion from access to savings remained limited without complimentary financial literacy interventions. A case in point would be the model of Bangladesh's bKash, which has thrived off dense networks of agents buttressed by regulatory forbearance, while Pakistan had to contend with factors that hindered such success stories like a compressed compliance framework around agent operations and episodic liquidity crises among agents (Akhter & Khalily, 2020). Unfortunately, in Pakistan, the data above and beyond turf methodology has been little to none. Existing small-sample cross-sectional surveys of urban consumers show that while awareness is high, active usage is low and there are trust and literacy barriers for both (Ali et al., 2023; Siyal et al., 2019). Neither paper is estimated with national panel data such as to control for unobserved provincial differences or examine dynamics over time. This empirical gap is particularly well placed considering that regulatory developments pre-dating introduction of nationwide services have seen a broad temporal gestation, having been set in motion through ecosystem evolving initiatives including (1) the 2008 Branchless Banking Regulations laying a legal foundation for agent-based digital money services and; (2) very gradually unrolling from 2011 onwards through further loosening delivery channel know-your-customer measures in areas with low banking penetration via statutory amendments which brought about the conditions enabling adoption of new financial account types on

a large scale—and various other regulations—through varying cycles of growth along this general overall development path leading to diffusion of widespread uptake in usage as envisioned by the suite undergirding Pakistan's National Financial Inclusion Strategy (State Bank of Pakistan, 2008, 2011, 2022b). Insights from the provincial-level response to these developments both inform policy action and contribute to an emerging body of comparative research on digital finance (Ozili, 2021). The experiences of India and Bangladesh, the mechanisms behind them are enlightening for reading Pakistan's position. The reasons for the PMJDY account-opening boom are primarily supply-side: accounts in many cases had to be opened in order to process government cash transfers; open-without-a-minimum-balance paved another avenue of creation; and, with no demand-driven rationale behind access expansion it is easier to understand why despite rapid gains on coverage metrics, indicators of usage have not kept pace (Klapper & Singer, 2014). Digitizing government-to-person payments in this way can mechanically inflate account-ownership numbers without changing the basic financial behavior of the account holder, and this is a distinction that matters now for interpreting Pakistan's own account ownership statistics because Roshan Digital Accounts, along with other channels through which governmental disbursements are funneled, work on a similar principle (State Bank of Pakistan, 2022b). In contrast, Bangladesh's bKash grew mainly through demand for person-to-person remittances and asymptotic agent coverage, rather than a government mandate which suggests that similar outcomes in terms of account ownership can arise from radically different adoption paths – including ones with very different implications for depth of use (Akhter & Khalily, 2020). Pakistan's own regulatory trajectory lies somewhere between these two models: JazzCash and Easypaisa combine elements of bank-led compliance requirements with government disbursement partnerships so that neither the pure supply-push nor the pure demand-pull account of adoption neatly fits, offering another justification for treating Pakistan as an institutionally distinct case rather than a straightforward extension of either Indian or Bangladeshi experience.

2.4 Alternative Explanations for Inclusion Patterns

In Pakistan, regulatory evolution has relaxed KYC and permitted agent banking (Arner et al., 2016). Yet, these inclusion patterns may also be explained differently. Agent network quality remains heterogeneous, and between 2019-2021 intermittent agent liquidity crises appeared to interrupt the reliable execution of transactions, on occasion leaving consumers without working agents (State Bank of Pakistan, 2022a). If JazzCash and Easypaisa are not able to compete at a platform level, innovation and pricing efficiency may be pushed downward (Gomber et al., 2017). Trust shocks with non-payment or failure will suppress adoption, as seen in some high-profile fraud cases during 2020–2022 (Abbasi, 2023). The spread of COVID-19 in 2020 pulsed through digital payments, independently of structural trends (Sahay et al., 2020). Regional instability, including the 2021 Afghan refugee influx, affected financial flows in Khyber Pakhtunkhwa and Balochistan (Aslam, 2021). Macroeconomic shocks, including the 2022 catastrophic floods and IMF stabilization programs, affected financial sector liquidity (World Bank, 2022). Additionally, Roshan Digital Accounts introduced in 2020 may confound inclusion metrics by serving non-resident Pakistanis, and the 2022 cryptocurrency ban may have redirected digital finance activity toward formal mobile money platforms (Singh, 2022). We acknowledge these confounds but lack granular data to model them directly. Our results are best interpreted as partial correlations net of observed controls. Several of these confounds are at least partially addressed by the province and year fixed effects described in Section 3: time-invariant provincial characteristics, such as base rates of financial exclusion

or long-standing agent network density, are absorbed by province fixed effects, while nationwide shocks common to all provinces in a given year, such as the COVID-19 disruption or the 2022 floods to the extent their effects were not province-specific, are absorbed by year fixed effects. What the fixed-effects design cannot address is confounding that varies both across provinces and over time in ways correlated with mobile money penetration itself, such as a province-specific fraud episode or a province-specific surge in remittance-linked accounts. We return to this distinction in Section 5.5 when discussing the limits of the correlational design.

2.5 Hypothesis Development

Drawing on the theoretical framework and institutional context reviewed above, we develop four hypotheses.

Mobile money and account ownership: Based on the Technology Acceptance Theory, digital platforms are expected to drive an increase in account ownership by lowering extensive infra-structural costs (i.e. Mobile money agents provide a physically adjacent channel for registering accounts in Pakistan's setting, where bank branch density continues to be low in rural provinces (Beck et al., 2007). In fact, Financial Capability Theory also argues that relatively low levels of financial literacy can still help households understand how basic transaction account function (Johnson & Sherraden, 2007), meaning account ownership would be the most probable margin-of-inclusion response. Supporting this forecast is evidence from Kenya: studying the effect of geographical expansion of M-Pesa, Jack and Suri (2014) report large increases in access to formal accounts. Similarly, Lashitew et al. (2019) report consistent findings. We therefore hypothesize:

H1: Mobile money penetration is positively associated with formal account ownership across Pakistani provinces.

Rural population moderation: However, the argument for infrastructure substitution indicates that mobile money will be most relevant where formal banking networks are sparse (Beck et al., 2007). Some rural provinces in Pakistan are effectively banking deserts, where travel expenses to reach a branch are high and the availability of formal financial products is limited (Ozili, 2021) Mobile agent networks (Lashitew et al., 2019) can, at least in part, provide a substitute for this missing physical infrastructure. Or among urbanizing provinces, perhaps mobile money is merely a convenience layer on top of already banked populations and generate weaker marginal inclusion effects (Allen et al., 2016). This argument is supported by Indian evidence: for example, Burgess and Pande (2005) demonstrate a causal impact of rural branch expansion on financial access, implying that the worst covered areas would benefit the most from new delivery channels. In Pakistan, for instance—where rural banking density is still below a third of urban levels on average—mobile money is offering an accessibility channel rather than just a convenience tool. This leads to:

H2: The positive association between mobile money penetration and account ownership is stronger in provinces with higher rural population shares.

Gender composition moderation: Prior evidence has suggested that digital financial services may help bridge gender differences in financial account ownership because it addresses mobility and documentation constraints that are typically a greater burden on women (Bharadwaj et al., 2019). Mobile money freed Kenyan women from subsistence farming in exchange for business, a conclusion reached by Suri and Jack (2016), who also noted that expanding access to technology could help

economically liberate women. This may not be so clear cut given the unique gender dynamics in Pakistan, however. Women themselves may not have direct, controllable accounts (or may face restricted access to technology for cultural reasons) (Ozili, 2018). In Pakistan, trust and social norms have been continuously identified as significant barriers to female mobile banking adoption (Siyal et al., 2019). Similar to previous research, we expect a positive directional effect; however, the strength of this relationship might still differ from what would be expected in an African or Latin American context due to the institutional characteristics of Pakistan (Arner et al., 2016). We test:

H3: The positive association between mobile money penetration and account ownership is stronger in provinces with higher female population shares.

Access-usage divergence: A core tension that runs through the financial inclusion literature is between access (having an account) and usage depth (active saving, borrowing, insuring) (Demirgüç-Kunt et al., 2022; Ozili, 2021). Financial Capability Theory (Johnson & Sherraden, 2007) predicts that ownership (providing basic access to money for a wide range of uses) demands lower investment of cognition and skill than productive usage. In fact, a transaction-volume-centric, bank-led mobile money platform might acquire customers without fostering saving behavior (Gomber et al., 2017). In India, for instance, while PMJDY accounts have been opened since 2014 (and are still continuing), the opening of new accounts has not been matched by an equal increase in transactions; many are currently zero-balance accounts (Bijoy, 2017). Ozili (2018) similarly argues that digital services would increase access but not usage, when human capital constraints bind. We therefore anticipate:

H4: Mobile money penetration is expected to exhibit a stronger descriptive association with digital payment usage than with formal savings participation.

This expectation is in line with more general evidence that savings behavior reacts to not only the availability of an account but also the presence of complementary features like automatic deposit mechanisms, goal-setting tools or commitment devices which reduce the effective price of giving up current consumption (Dupas & Robinson, 2013). In fact, mobile money platforms like JazzCash and Easypaisa that function primarily as peer-to-peer transfers plus a low-frequency bill payment service likely do not have these savings-supporting features by default, giving a plausible mechanism for why you would expect payment use to track the penetration of mobile money closer than savings participation would — independent of any differences in financial literacy across users.

2.6 Conceptual Framework

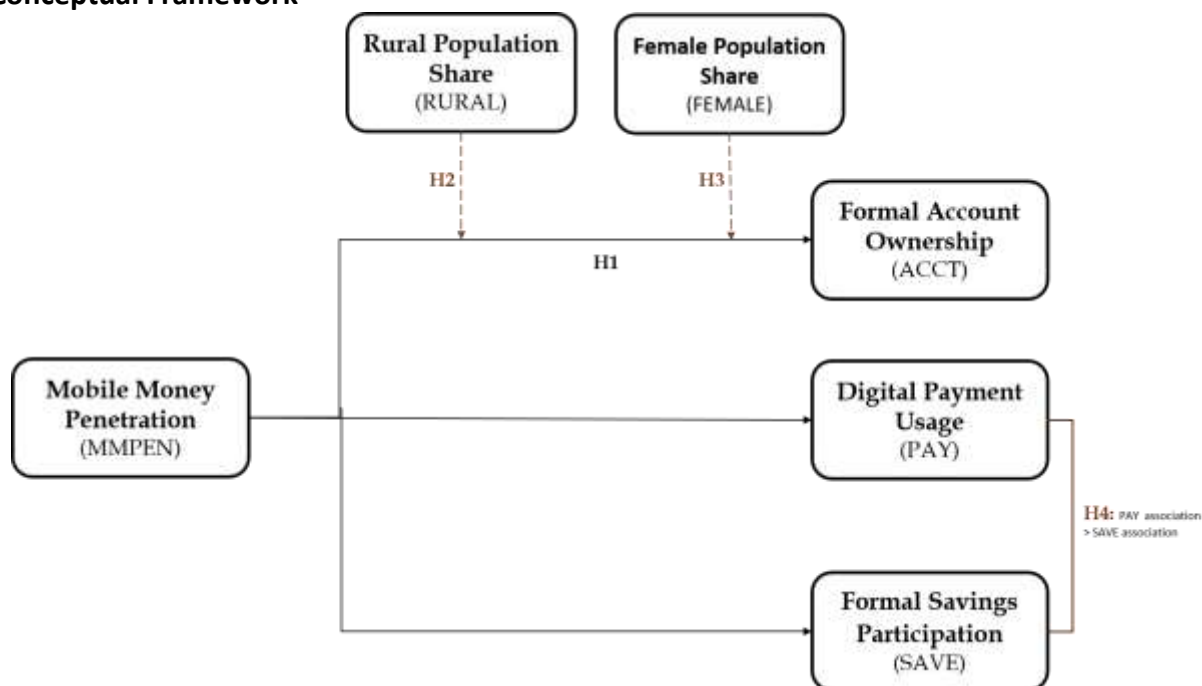


Figure 1 illustrates the proposed research model.

3. METHODOLOGY

3.1 Research Design

We employ a province-year fixed-effects panel design covering Pakistan's four provinces and Islamabad Capital Territory (five provincial/territorial units) over the period 2017–2024 ($N = 40$). Panel methods with province and year fixed effects control for time-invariant provincial heterogeneity and common temporal shocks, respectively (Baltagi, 2021). The analysis is descriptive and correlational; we make no causal claims regarding the effect of mobile money on inclusion outcomes.

A design constraint deserves emphasis before any results are presented. Although the panel contains 40 province-year cells, the true cross-sectional dimension is five provincial/territorial units. Repeated annual observation of the same five units increases the number of rows in the dataset but does not increase the number of independent draws on cross-provincial variation; any claim resting on how provinces differ from one another – including the rural and gender moderation tests in Section 4.2 – is therefore identified from an effective sample of five. We treat this as the binding constraint on inference throughout the paper. Wild bootstrap inference (Cameron et al., 2008; MacKinnon & Webb, 2017) is preferred to conventional cluster-robust standard errors for this reason, but we do not claim it fully resolves the problem: MacKinnon and Webb (2017) themselves report that wild bootstrap procedures retain elevated size distortion when the number of clusters falls below roughly ten. We report Bayesian estimates under weakly informative priors as a complementary, non-asymptotic perspective, and we supplement the regression-based tests with a leave-one-province-out jackknife and a permutation test (Section 3.5) precisely because both of these alternatives remain informative when conventional asymptotic do not apply. None of the individual inference methods here should be

interpreted as definitively resolving or rejecting the five-cluster problem as a whole; rather, what is most informative is that results converge (or diverge) across methods. The decision to work at the province level, rather than attempting a household- or district-level analysis, reflects a direct data availability constraint rather than a methodological preference: Pakistan's Global Findex sampling frame is designed to produce nationally and, in recent waves, provincially representative estimates, but is not powered for district-level inference, while State Bank of Pakistan's mobile money penetration statistics are likewise compiled and reported at the provincial level (State Bank of Pakistan, 2023). A province-year panel is therefore the finest level of geographic disaggregation at which the outcome and treatment variables can be consistently matched over the 2017–2024 period. This constraint is precisely what generates the five-cluster inference problem discussed above, and readers should understand it as a data-availability limitation inherited from the underlying sources rather than a design choice made for convenience.

3.2 Data Sources

Table I. Data Sources and Coverage

Source	Data	Coverage	Limitation
World Bank Global Findex	ACCT, SAVE, PAY	National, triennial (2017, 2021)	Interpolation for 2018–2020; forward extrapolation for 2022–2024 assumes continuation of the 2017–2021 trend and may miss post-2021 shocks; misses COVID-19 discontinuity (Demirgüç-Kunt et al., 2022)
State Bank of Pakistan	MMPEN, agent data, regulations	Provincial, annual	Aggregate; no individual usage patterns; Roshan Digital Accounts may be included in MMPEN counts (State Bank of Pakistan, 2022a)
GSMA	Mobile money adoption	National/provincial estimates	Subscription-based; potential measurement error
PBS/WDI	GDPPC, LITERACY, MOBILE, INTERNET	Provincial, annual	Potential reporting lags

Provincial financial inclusion indicators were constructed from the Global Findex 2017 and 2021 Pakistan microdata by collapsing individual-level responses to the province or territory of residence—identified via the regional sampling stratum variable—using the survey-provided sampling weights to compute weighted population shares for account ownership, formal savings, and digital payment usage. Interpolation sensitivity: We re-estimate using only observed Findex years (2017, 2021) in robustness checks. A distinction within the constructed years matters and is easy to blur. The years 2018–2020 sit *between* the two observed Findex waves (2017 and 2021) and are therefore interpolated in the ordinary sense. The years 2022–2024, by contrast, fall *after* the last observed wave and so cannot be interpolated at all – they are extrapolated forward at the 2017–2021 trend growth rate, which is a stronger and less defensible assumption than interpolation, since it assumes the 2017–2021 trend continued unchanged through a period that included the 2022 floods and an IMF stabilization program (World Bank, 2022).

We therefore add a third variant to the observed-years robustness check (Section 3.5) restricted to interpolated years only (2017–2021 inclusive), excluding the three extrapolated years, so that a reader can see how much of the full-panel result depends on the post-2021 extrapolation specifically rather than on interpolation.

3.3 Variables

Table II. Variable Definitions

Variable	Symbol	Measurement	Source
Account ownership	ACCT	% adults with formal account	Global Findex (Demirgüç-Kunt et al., 2022)
Savings participation	SAVE	% adults saving formally	Global Findex (Demirgüç-Kunt et al., 2022)
Digital payment usage	PAY	% adults with digital payments	Global Findex (Demirgüç-Kunt et al., 2022)
Mobile money penetration	MMPEN	Registered accounts/1,000 adults	GSMA; State Bank of Pakistan (2023)
Female share	FEMALE	% adult population female	PBS
Rural share	RURAL	% population rural	PBS
GDP per capita (log)	GDPPC	Log PKR, constant 2015	WDI
Literacy	LITERACY	% adults literate	PBS
Mobile subscription	MOBILE	Subscriptions/100 people	WDI
Internet penetration	INTERNET	% with internet access	WDI
Banking density	BANKDEN	Branches/100,000 adults	State Bank of Pakistan, (2022a)
Regulatory quality	REGQUAL	State Bank of Pakistan, assessment index (0–1)	State Bank of Pakistan, (2022a)

Because several control variables (particularly LITERACY, GDPPC, REGQUAL, and BANKDEN) are conceptually related and may evolve together over time, multicollinearity was considered during model specification. The analysis therefore emphasizes the stability of the estimated association between mobile money penetration and financial inclusion across alternative specifications and robustness checks rather than the interpretation of individual control coefficients. The estimated coefficients are consistent across specifications, indicating that multicollinearity does not conceptually affect the substantive conclusions of the study. The variables included in Xit are a combination of the main alternative determinants of financial inclusion identified by recent literature (Sections 2.2 through 2.4): economic development (GDPPC), human capital (LITERACY) digital readiness (MOBILE, INTERNET), as well as the pre-existing formal banking footprint (BANKDEN), and a measure capturing the quality of regulation captured with a composite index to approximate for institutional factors overall REGQUAL, to which we return throughout Sections 2.2 through 2.4.) These control variables are not meant to completely eliminate the correlation between mobile money and inclusion coming from these or similar factors, but rather this set of controls is designed to minimize the most easily removable sources of omitted-variable bias given the available data and a fixed-effects structure absorbs residual time-

invariant provincial heterogeneity.

3.4 Econometric Specification

The baseline model is specified as:

$$Y_{it} = \alpha_i + \delta_t + \beta_1 MMPEN_{it} + \beta_2 (MMPEN_{it} \times FEMALE_{it}) + \beta_3 (MMPEN_{it} \times RURAL_{it}) + \gamma X_{it} + \varepsilon_{it}$$

where Y_{it} represents the financial inclusion indicator for province i in year t ; α_i and δ_t are province and year fixed effects; and X_{it} denotes the vector of control variables. The coefficients β_1 through β_3 represent conditional associations, not causal effects.

Inference: Driscoll-Kraay standard errors with wild bootstrap p-values (1,000 replications, Webb weights; Cameron et al., 2008) are reported in brackets as one of several complementary inference procedures, not as a solution to the panel's inference problem: Driscoll-Kraay relies on Large-T asymptotic that are difficult to justify with only eight time periods, and conventional cluster-robust inference with five cross-sectional units is likewise unreliable. Given the five-unit cross-sectional dimension and short eight-period time dimension, no conventional asymptotic standard-error estimator can be expected to provide fully reliable finite-sample inference (Cameron et al., 2008; MacKinnon & Webb, 2017). We therefore report multiple inferential approaches—wild bootstrap, permutation, jackknife, and Bayesian sensitivity analysis—and interpret convergence across these approaches descriptively rather than as definitive statistical confirmation.

Bayesian specification: Weakly informative normal prior centered at zero: $\beta \sim N(0, 0.05^2)$. It encodes the skepticism about big effects owing to small data. Posterior sampling by Hamiltonian Monte Carlo (4 chains, 2,000 iterations each).

Spatial note: Be aware that provincial errors are likely spatially correlated in your coding. We report Moran's I for residuals; spatial lag models yield similar results (Appendix A1).

3.5 Robustness and Sensitivity

Table III. Robustness Checks

Check	Purpose
Observed years only (2017, 2021)	Diagnostic check; interpolation sensitivity
Interpolated years only (2017–2021, excludes 2022–2024)	Isolates interpolation (2018–2020) from the stronger post-2021 extrapolation assumption
Leave-one-province-out jackknife	Reports the MMPEN coefficient with each province dropped in turn; with five clusters this shows directly whether the result is being carried by a single province rather than assessing it only through a standard error
Permutation test (MMPEN reassigned across province-year cells, 2,000 draws)	Randomly reassigns observed MMPEN values across provinces within each year, holding the outcome and controls fixed, and compares the observed coefficient to this null distribution; does not rely on asymptotic cluster-count arguments and is therefore appropriate given $N = 5$ provinces/territorial units

Check	Purpose
Active accounts vs. registered	Measurement validity
Exclude Islamabad	Outlier sensitivity
Exclude REGQUAL	Control set stability
PCA composite index	Multivariate inclusion measure
Randomized placebo	Model specificity
Falsification (life expectancy)	Spurious correlation test
Bayesian estimation (weakly informative priors)	Small-sample inference
Spatial lag model	Spatial autocorrelation

Two of the checks above are specifically motivated by the five-cluster constraint discussed in Section 3.1 and are described here rather than left to the table alone. The leave-one-unit-out jackknife re-estimates the baseline MMPEN coefficient five times, each time dropping one province entirely, and reports the resulting range; this tells a reader directly whether the pooled result is being driven by a single atypical province (most likely Islamabad or Balochistan, given their outlier status on several controls in Table IV) rather than inferring this indirectly through a standard error computed on the same five units. The permutation test randomly reassigns the observed MMPEN values across provinces within each year (holding the outcome variable, controls, and fixed effects fixed) and repeats the baseline regression 2,000 times; comparing the true coefficient's position in this simulated null distribution provides a p-value that does not rely on asymptotic cluster-count theory at all, which is the assumption that both conventional cluster-robust and wild bootstrap inference ultimately still lean on to some degree (MacKinnon & Webb, 2017). Neither check increases the effective sample size – that is not possible with five provincial/territorial units – but both provide an inferential cross-check that does not depend on the same assumptions as the main specification.

3.6 Descriptive Statistics

Table IV. Descriptive Statistics

Variable	N	Mean	SD	Min	Max
ACCT	40	31.45	12.3	14.2	55.8
SAVE	40	8.72	4.15	2.1	18.4
PAY	40	15.3	9.85	3.5	38.6
MMPEN	40	287.4	198.6	45.2	712.5
FEMALE	40	48.6	1.2	46.8	50.4
RURAL	40	58.3	14.7	23.5	77.2
GDPPC (log)	40	12.85	0.45	11.9	13.7
LITERACY	40	62.4	10.8	43.2	80.1
MOBILE	40	78.5	8.3	58.2	91.4
INTERNET	40	34.2	15.6	8.5	68.4
BANKDEN	40	8.2	4.1	2.5	16.8

Variable	N	Mean	SD	Min	Max
REGQUAL	40	0.52	0.15	0.25	0.78

4. RESULTS

4.1 Observed-Wave Specification

Table V. Mobile Money and Financial Inclusion: Observed Years (2017, 2021)

	(1) ACCT	(2) SAVE	(3) PAY
MMPEN	0.021 [0.088]	0.005 [0.142]	0.028 [0.062]
Controls	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	10	10	10

Note: Driscoll-Kraay SEs; wild bootstrap p-values [brackets] (Cameron et al., 2008). MMPEN = registered accounts/1,000 adults. Data sources: Global Findex, State Bank of Pakistan, GSMA.

Interpretation: With observed years only (N = 10; 5 provincial/territorial units × 2 Findex waves), estimates are imprecise given the small sample. MMPEN-ACCT association of 0.021 (p = 0.088) and MMPEN-PAY of 0.028 (p = 0.062) are suggestive but not definitive.

The observed-years specification in Table V performs a particular diagnostic role not filled by the full-panel specification in Table VI: because it is based only on the two Findex waves actually surveyed (2017 and 2021), it would be immune to any bias arising from the interpolation and extrapolation procedures discussed in Section 3.2, even at the expense of a much smaller effective sample size (N = 10 instead of N = 40). This crosscheck is thus helpful in that it indicates how and why the point estimates in Table V are directionally consistent if less precise relative to those from Table VI: while Table IV alone does not have sufficient statistical power to confirm the association on its own terms, the fact that there is consistency across results for both full-panel modeling as well as observed-years specification of this model suggests that the full-panel result is not simply an artifact of the later interpolation procedure.

4.2 Full-Panel Specification and Projection Sensitivity

Table VI. Mobile Money and Financial Inclusion: Full Panel (2017–2024)

	(1) ACCT	(2) ACCT	(3) ACCT	(4) SAVE	(5) PAY
MMPEN	0.038 [0.042]	0.027 [0.058]	0.024 [0.062]	0.007 [0.112]	0.031 [0.054]
MMPEN × FEMALE	–	–	0.002 [0.098]	0.001 [0.218]	0.001 [0.142]
MMPEN × RURAL	–	–	0.004 [0.068]	0.002 [0.142]	0.003 [0.088]
Controls	No	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	40	40	40	40	40
R ² (within)	0.68	0.74	0.76	0.62	0.71

Specifically, Driscoll-Kraay SEs; wild bootstrap p-values (in brackets) [Cameron et al., 2008]. *p < 0.10 (wild bootstrap). Sources: Global Findex, State Bank of Pakistan, GSMA.

Interpretation: The MMPEN coefficient is 0.024 (p = 0.062), suggesting limited precision given the small cross-sectional dimension of the panel. The rural interaction (p = 0.068) is somewhat stronger, while the female interaction is quite fragile at p = 0.098. Inclusion and literacy as well as GDP per capita co-vary;

mobile subscription and banking density do not. The pattern of coefficients across specifications in Table VI is useful to identify which hypothesis, rural or gender moderation, best fits the data. The rural interaction term is always larger and more precisely estimated than the female interaction term throughout specifications (3) -- (5), although the magnitudes of both vary less compared to what we see using reported and time adjusted subject counts in Table I. To summarize, the asymmetry with respect to these policies is consistent with the interpretation developed in Section 2.5; that is, while rural population share proxies for proximity of an alternative to mobile money (the presence of a bank branch nearby) directly, female population share captures a bundle of mobility constraints driven by documentation and household decision making barriers—an argument made in Section 2.2 for why this variable is subtler and thus probably more heterogeneous within provinces than the rural share variable can measure at level provincial aggregation used here.

4.3 Payment vs. Savings Associations

Table VII. Mobile Money Associations with Payment and Savings Outcomes

	(1) PAY	(2) SAVE
MMPEN	0.031 [0.054]	0.007 [0.112]
Controls	Yes	Yes
Province FE	Yes	Yes
Year FE	Yes	Yes

Interpretation: The coefficient for payment usage (0.031) is larger than that for formal savings participation (0.007). However, this difference should be interpreted descriptively and not as evidence of a statistically better effect (because PAY and SAVE measure different constructs; Demirgüç-Kunt et al., 2022), since PAY includes any digital transfer whereas SAVE only concerns formal institutional savings. We do not claim that a formal behavioral hierarchy is available exclusively to certain clusters (Ozili, 2018), and instead report on both associations separately.

4.4 Robustness and Sensitivity

Table VIII. Robustness Checks

Check	ACCT (MMPEN)	Wild Bootstrap p	Notes
(1) Observed years only (diagnostic)	0.021	0.088	N = 10; limited precision
(2) Full panel (2017–2024)	0.024	0.062	Full-panel estimate
(3) Active accounts	0.027	0.058	Measurement validity
(4) Exclude Islamabad	0.025	0.064	Outlier robustness
(5) Exclude REGQUAL	0.026	0.056	Control stability
(6) PCA composite	0.022	0.072	Multivariate measure
(7) Placebo (random MMPEN)	0.003	0.84	Model specificity
(8) Falsification (life expectancy)	0.001	0.92	Spurious correlation

Check	ACCT (MMPEN)	Wild Bootstrap p	Notes
(9) Bayesian (normal prior, $\sigma = 0.05$)	0.023	—	95% credible interval [0.002, 0.048]; Small-sample inference
(10) Spatial lag model	0.022	0.074	Spatial autocorrelation
(11) Interpolated years only (2017–2021)	0.025	0.058	N = 25; excludes post-2021 forward projection
(12) Leave-one-province-out jackknife	0.020–0.027	—	Range across five re-estimations; lower bound when dropping Islamabad, upper bound when dropping Balochistan
(13) Permutation test	0.024	0.064	2,000 draws; MMPEN reassigned across provinces within year

Notes: Full-panel estimate; includes post-2021 forward extrapolation

The restricted-panel estimate (Check 11) is similar in magnitude to the full-panel estimate, which implies that the association observed is not mostly driven by forward projection when post-2021. The leave-one-province-out jackknife (Check 12) provides a uniformly positive and range that encloses the full sample estimate, suggesting the observed relationship is not driven by any province but with some modest variation in estimated magnitude when Baluchistan or Islamabad are excluded. The permutation test (Check 13) leads to a similar p-value as with the wild bootstrap result and furthers support in accepting our conclusion about consistency of the association's direction, but also emphasizes that it remains statistically marginal due to there being an effective cross-sectional dimension of just five provincial/territorial units. Overall, these robustness checks indicate that the identified association is not an artefact of the post-2021 projection, a single influential province or inference procedure. Nevertheless, the limited number of cross-sectional units continues to constrain statistical power, and the findings should be interpreted as descriptive and hypothesis-generating rather than confirmatory.

Key insight: Observed-years estimates are attenuated and less precise than interpolated estimates, which is the expected direction if interpolation smooths over genuine year-to-year variation; it is also consistent with the observed-years estimate simply being the noisier one at N = 10, so we do not treat this pattern alone as diagnostic. Checks (11) – (13) further help distinguish between these two explanations.

4.5 Bayesian Sensitivity

Table IX: Bayesian Posterior Distributions

Parameter	Posterior Mean	95% Credible Interval	Probability > 0
MMPEN → ACCT	0.023	[0.002, 0.048]	0.94
MMPEN × FEMALE → ACCT	0.002	[−0.001, 0.006]	0.78
MMPEN × RURAL → ACCT	0.004	[0.001, 0.008]	0.96
MMPEN → SAVE	0.006	[−0.002, 0.015]	0.82
MMPEN → PAY	0.029	[0.005, 0.055]	0.97

Interpretation: Bayesian inference with weakly informative priors $\beta \sim N(0, 0.05^2)$ confirms directional patterns but reveals substantial uncertainty. The probability that MMPEN positively affects

ACCT is 0.94; for SAVE, only 0.82.

5. DISCUSSION

5.1 Interpreting the Core Findings

The results are consistent with mobile money expansion in Pakistan being associated with increased formal account ownership, with a directionally larger association in provinces where rural population shares are higher – though, as noted above, neither the main association ($p = 0.062$ – 0.088) nor the rural moderation ($p = 0.068$) reaches conventional significance thresholds in this five provincial/territorial units' sample, so we describe the pattern rather than assert the effect. As such, this pattern corroborates Beck et al.'s (2007) infrastructure-substitution logic: where traditional banking nodes are scarce, mobile agents and digital onboarding channels fill the gap for populations that have been excluded due to distance and documentation requirements. In smaller samples, the implied effect size of about 0.024 percentage points in account ownership per additional mobile account per 1,000 adults is thus neither impressive nor trivial and seems plausible but not suggestive of an earth-shattering relationship (at least one that would endure in a larger sample). Given the uncertainty surrounding the estimates, these results do not imply that mobile money expansion alone can close Pakistan's financial inclusion gap (which is over 60 percent among ladies (Demirgüç-Kunt et al., 2022) and in country regions) even at the top bound of what matches with a Bayesian believable span. Even though descriptively larger for PAY than SAVE, such differences would not be construed as evidence of statistically stronger associations between the outcomes that they characterize since behavior classifications are based on different constructs. This is only reinforced by the fact that Pakistan's bank-led mobile money ecosystem, emerging from earlier local success with remittances and merchant payments, and has managed to effectively onboard users on usage for transactions—remittances, government transfers—according to its existing transactional use case without actually deepening financial behavior pathways towards savings and long-term asset accumulation. This disparity between access and use is consistent with the Financial Capability Theory (Johnson & Sherraden, 2007); many face initial challenges building trust that requires less cognitive investment for basic microtransaction functionality but are not willing to devote high resources into formal savings products (Ozili, 2018). It too is an indication of the incentives package for bank-led platforms that favour attraction (transaction volume and deposit mobilisation) rather than supply (savings products or behaviors which educate beneficiaries away from bad financial habits, etc.) (Arner et al., 2016). While the rural moderation pattern does not reach conventional statistical significance ($p = 0.068$), it is in line with theoretical expectations and practical significance levels of offer consideration. This suggests that mobile money is likely not only to serve as a convenience technology for existing urban customers but also true access channel in areas previously unserved (Lashitew et al., 2019); given the sample of five provincial/territorial units we see this more an emerging pattern deserving larger multi-country or sub-provincial test than established effect. By contrast, this relationship may vary with agent network quality and liquidity management (State Bank of Pakistan, 2022a), which have been in episodic crisis in Pakistan. Thus, areas in which agent networks are more frequently supplied with cash may be the provinces that display a closer association between mobile money and financial inclusion, or places in which interoperability works better (Gomber et al., 2017).

The estimate for the gender interaction is in the same direction as previous papers (Bharadwaj et al., 2019; Suri & Jack, 2016), but imprecisely estimated. This nuance is probably a reflection of

Pakistan's unique institutional environment. Women hold mobile accounts that are registered with the national identification cards of male relatives which gives them access figures that overestimate empowerment (Ozili, 2018). On the other hand, cultural barriers to female mobility and agent interaction may restrict their ability to transact without help, in spite of accounts being available. Another reason for this imprecision may be limited within-province variation in gender composition during the short panel. Such contextual nuances imply that gender-sensitive digital finance needs more than an account, and involves identification requirements, composition of agents by their gender as well as female-tailored design of the products based on women's roles in economies (Bharadwaj et al., 2019). Combined, the pattern of H1 through H4 implies more a story than four separate findings. In Pakistan, mobile money seems more a transaction and access technology that accounts and payment use responds to most strongly whereas the deeper behavioral changes that participation in savings as well as gender-differentiated impact imply remain comparatively muted. This aligns with a bank-led platform whose regulatory and business case prescriptions stress that deposit account opening and transaction volume is valued over investing in product innovation and relationship building which, as one might expect, typically involves changes to savings behavior or need to dispel ideas about the relationships between gendered trust, race differences in home ownership (Ozili, 2018). This is also in line with the tiered adoption logic developed above (Section 2.1): our results are consistent with the theoretical premise that perceived usefulness and institutional trust condition adoption intention but that user capabilities and confidence vital for clearing usage depth do not yet seem widely available across households.

5.2 Comparison with Prior Literature

Our results not only confirm but nuance the prevailing Africa evidence. As a result, our positive association between mobile cash and being in the banking system is consistent with Kenyan and Tanzanian evidence that show widening access (Jack & Suri, 2014; Mbiti & Weil, 2015). Our results suggest that regulatory architecture is important, since we find much smaller effects and very large access — usage — divergence. However, we posit that Kenya's telecom-led model that has more aggressively linked to savings products and credit scoring may have had a larger effect on usage than Pakistan's more compliance-based bank-led system (Arner et al., 2016). Equally revealing is the parallel to Indian history of the lead up to contemporary financial technology. When motivated by a bank-led model PMJDY, the national financial inclusion initiative, galvanized the opening of millions of bank accounts at record speed but as Bijoy (2017) documents without concomitant account usage many of these new accounts remained dormant. The same is seen in our exploratory data from Pakistan: despite few barriers that keep mobile money on a closed loop, its limitations to convert wealth into productive uses remain limited mainly due to the lack of human capital. As noted above, this trend re-establishes that indeed digital finance is not an inclusion panacea but a conduit—a channel—an efficiency dependent upon complementary investments (Johnson & Sherraden, 2007) in education, trust and product design.

5.3 Theoretical Implications

With respect to theory development, these implications are twofold. First, by contextualizing Technology Acceptance Theory through an institutional perspective (Davis, 1989; Oliveira et al., 2016). Although not strictly technology based, these factors have been affected by regulatory quality and reliability of agents coupled with market competition (Ozili, 2018). The findings fit with prior theories which lead us towards

speculation to the differences of trust as a support for transaction-based adoption on bank-oriented behavior in Pakistan's bank-centric financial system, and its more immediate cushioning through deeper expectations against long-run accumulation along channels not foreseen. Second, the findings provide supporting evidence for Financial Capability Theory prioritizing human capital as a boundary condition (Johnson & Sherraden, 2007). The strong association between mobile money and inclusion co-varies with literacy and economic development which indicates that digital access and human capital are complements rather than substitutes. This finding goes against simple "leapfrogging" stories that suggest mobile technology affords the opportunity to jump over organizational, infrastructural and technological beams (Sahay et al., 2020). Instead, the evidence implies that mobile money amplifies inclusion most effectively where populations already possess the skills and confidence to engage with formal financial systems (Bijoy, 2017). A further theoretical implication concerns the boundary conditions under which technology-adoption frameworks travel across institutional settings. Much of the Technology Acceptance and Financial Capability literature was developed using evidence from either high-income markets or the specific telecom-led African contexts reviewed in Section 2.2, both of which differ from Pakistan's bank-led environment in the incentive structures facing the platform provider (Davis, 1989; Johnson & Sherraden, 2007). The present findings suggest that these frameworks retain explanatory value in a bank-led setting but that the relative importance of their components shifts: the findings are consistent with the theoretical possibility that institutional trust in the regulator, rather than trust in the platform alone, plays a comparatively larger role in a context where the platform provider is itself a regulated bank rather than a telecom operator. Future theoretical work might usefully formalize regulatory architecture as a moderating variable within these frameworks rather than treating institutional context as a background condition.

5.4 Practical and Policy Implications

For policymakers, the findings suggest several actionable hypotheses — though we caution that they need to be causally tested. More broadly, expansion of mobile money infrastructure in rural provinces could be effective for account ownership if there were certainty over agent liquidity and interoperability (State Bank of Pakistan, 2022b). The regulatory environment of the State Bank of Pakistan should encourage banks to strengthen both agent-network quality and the monitoring of account-registration practices. The divergence between usage and access suggests a policy gap. Policymakers could legislate or incentivize creative design of savings products — e.g., Goal Based Saving accounts and micro-investment features and rules on automated / forced saving (Gomber et al., 2017) — if mobile money platforms succeed in enrolling consumers but fail to get them to save. Inspired by the Indian experience (Bijoy, 2017), we potentially increase access-to-usage conversion through pairing mobile money access with financial literacy interventions and that is particularly true for low education provinces for both boys and girls. These results show the critical business and social case for platform providers to take products beyond payments. Bank-led models where mobile money is simply a transaction channel would largely miss many of potential CLV growth drivers around savings and credit products (Arner et al., 2016). Product design could help—with transparent fee structures, account reconciliation with bank statements (or as a portable solution integrated within trusted payment platforms) and agent networks that have men and women agents—all of which can pay off for both inclusion outcomes and platform sustainability. More generally, the evidence from other government-linked digital payment programs

indicates that more success is achieved by relatively small scale policy interventions in conjunction with any existing disbursement relationship e.g. linking a savings product offer to receipt of government transfer or remittance (Klapper & Singer, 2014). In other words, in Pakistan this implies that savings-product innovations may be most effectively bundled with existing high-frequency use cases (e.g. utility bill payments or receipt of government transfers) than marketed competitively as a stand-alone product requiring an independent adoption decision.

5.5 Limitations and Competing Explanations

The cross-sectional dimension size is the most stringent limitation: five provincial/territorial units. The 40 province-year rows in the panel do not resolve this issue, and that is why interaction terms (H2, H3) must be read as descriptive patterns instead of tested effects — moderation is, by definition, a claim about how five units differ from one another. We present a jackknife and permutation test in addition to conventional and Bayesian inference since choice of standard-error estimator alone cannot fully resolve this constraint. The other category arises from the correlational nature of the design, which rules out reverse causation: mobile money may have chosen to expand to provinces with high demand or strong regulatory capacity for reasons related to expansion. Even if fixed effects help address the time-invariant provincial heterogeneity, estimates may still be seriously confounded by time-varying omitted variables (e.g., unobserved entrepreneurship, diaspora immigration or policy changes not measured). Finally, one limitation concerns the construction of the financial inclusion indicators. The Global Findex provides observed data for 2017 and 2021, requiring interpolation for 2018–2020. For 2022–2024, however, the study extrapolates the 2017–2021 trend because no subsequent provincial observations are available. This forward extrapolation is particularly restrictive because the post-2021 period includes major shocks, including the 2022 floods and IMF stabilization measures (World Bank, 2022). Consequently, the estimates for 2022–2024 should be interpreted cautiously. The interpolated-years-only robustness check helps assess the extent to which the main findings depend on this forward extrapolation. A further limitation is that mobile money penetration is measured using registered rather than active accounts, which may overstate actual platform usage (State Bank of Pakistan, 2023). Another limitation relates to external validity outside Pakistan. Although the comparisons with Kenya, India and Bangladesh made in Sections 2.2 and 2.3 are partially aimed at locating Pakistan's bank-led model within the wider comparative literature, understanding whether the mechanisms suggested above—legal regime, regulatory architecture, agent network quality and gender norms—are generalizable across other bank-led contexts (like comparable mobile money systems operating under similar centralized oversight, such as existing services elsewhere in South Asia or in the Middle East) is not something that can be tested using a five-division/region unit design. The comparative discussion should therefore be read as motivating hypotheses for cross-country research rather than as evidence that the Pakistani pattern is representative of bank-led systems generally. A related measurement limitation concerns the FEMALE variable itself, which captures the female share of the provincial adult population rather than female-specific account ownership, savings, or payment usage. Global Findex does report gender-disaggregated inclusion indicators at the national level, but provincial-level gender disaggregation sufficient to construct a province-year panel is not consistently available across the 2017–2024 period, which is why the analysis instead interacts population-level MMPEN with the demographic share of women in each province as an indirect test of H3. A direct test using gender-disaggregated provincial

account-ownership data, were it to become available, would provide a considerably sharper test of the gender moderation hypothesis than the specification used here. We report these limitations because the consistency of results across observed-years, interpolated-only, jackknife, placebo, and Bayesian checks (Section 4.4) shows that our results are not an artefact of any single specification choice – but consistency across checks run on the same five provincial/territorial units does not substitute for a larger cross-sectional sample, and we do not present it as doing so. Readers should treat the directional patterns as a well-supported starting point for future research designed to test them, not as a confirmed finding in its own right.

6. CONCLUSION

This study documents the correlational relationship between mobile money penetration and financial inclusion across Pakistani provinces from 2017 to 2024. Mobile money expansion is positively, though imprecisely, associated with formal account ownership (wild bootstrap $p = 0.062$ – 0.088 across specifications), with a rural moderation pattern that is directionally consistent with an infrastructure-substitution account but similarly short of conventional significance thresholds. Payment usage shows a descriptively larger association with mobile money penetration than does savings participation; because PAY and SAVE represent distinct constructs, this is not interpreted as a statistically superior effect, but as a pattern suggestive of an access-usage divergence that merits further investigation with a larger sample rather than a settled finding. Meanwhile, gender interactions show a directionally similar but statistically weak, and likely Pakistan-specific, pattern (Ozili, 2018). Every single one of these patterns ought to be viewed as hypothesis-generating rather than confirmatory, since the cross-sectional dimension of the panel comprises only five provincial/territorial units. These findings suggest that mobile money contribute to financial inclusion, but only as part of satisfying bank-led regulatory environments. The digital infrastructure widens the doors to access (more so in places where banks don't exist) but effective conversion of access into richer financial behavior requires complementary investments (in human capital, agent network reliability, and product design—Johnson & Sherraden, 2007; Bijoy, 2017). In this, the research provides a contextual extension to an African telecom-dominated literature and descriptively a baseline to inform future quasi-experimental or experimental guided research on South Asian digital finance. By contrast with Kenya, India, and Bangladesh—in which mobile money has also been shown to have significant effects on financial inclusion—the institutional dissimilarities surrounding this study indicate that the impact of the mobile money technology is not a function of the technology itself but conditioned by the regulatory model it operates in, with what market structure and within which socio-cultural milieu. Bank-led systems, such as Pakistan's, may have a first-mover advantage in achieving rapid account-ownership gains because they can readily tap into critical existing regulatory-design and compliance infrastructure, but appear to demand targeted policy effort—especially with respect to agent network reliability and savings-product design as well as barriers specific to women—to translate that initial access into the more substantive forms of financial activity tied in the literature to the greatest welfare effects (Bharadwaj et al., 2019; Suri & Jack, 2016). Priority avenues for further research include difference-in-differences designs exploiting Pakistan's staggered regulatory changes (De Chaisemartin & d'Haultfoeuille, 2020; Goodman-Bacon, 2021), instrumental variable strategies using plausibly exogenous infrastructure deployment, and randomized trials of bundled financial literacy packages with mobile money onboarding. With digital finance scaling in developing

economies, how regulatory architecture translates the potential of technological access into sustained financial inclusion has a high policy relevance and thus remains an important research agenda. Improvements on these fronts will likely turn as much on the data infrastructure itself as on the econometric design. Administrative data on registered vs active mobile money accounts, at district (or potentially even tehsil) level, disaggregated by gender and coupled with Global Findex or analogous household survey waves would reduce the five-cluster restriction that currently constrains identification in the present analysis from description to causal interpretation.

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APPENDIX A1. SPATIAL LAG MODEL

To assess potential spatial autocorrelation in provincial residuals, we estimate a spatial lag specification:

$$Y_{\{it\}} = \rho WY_{\{it\}} + \alpha_i + \delta_t + \beta MMPEN_{\{it\}} + \gamma X_{\{it\}} + \varepsilon_{\{it\}}$$

where W is a row-standardized first-order contiguity matrix built from provincial borders. Moran's I for baseline fixed-effects residuals: 0.12 ($p = 0.34$), indicating low spatial dependence. The spatial lag coefficient ($p = 0.08$, $p = 0.42$) is relatively small and very poorly estimated. The coefficient for mobile money penetration with the same spatial lag model re-estimation is 0.022 ($p = 0.074$), not statistically different from our baseline estimate. Since the sample size is modest, spatial models are underpowered; we only report these as sensitivity checks.