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Financial and Digital Behavioral Engagement and Saving Behavior: Cross-Country Evidence from the Global Findex Database 2021

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Abstract

This paper examines the determinants of saving behavior, with a focus on the individual and joint effects of financial literacy and digital literacy, using individual-level microdata from the Global Financial Inclusion Database (Global Findex) 2021, a nationally representative dataset covering 143,887 adults across 139 economies. Since the Global Findex 2021 does not include direct knowledge assessments, both constructs are operationalized through composite behavioral engagement indices constructed from indicators of active financial and digital system participation, following the proxy-based approach validated by Grohmann et al. (2018) and Morgan and Trinh (2019). These indices capture the observable, behavioral expression of financial and digital literacy as theorized in the literature. Using survey-weighted binary logistic regression models that incorporate probability weights to ensure national representativeness, the results show that both financial literacy, as proxied by financial behavioral engagement ($\beta = 0.762$, $p < 0.001$), and digital literacy, as proxied by digital behavioral engagement ($\beta = 0.870$, $p < 0.001$), significantly increase the probability of saving, with effects robust across four distinct saving outcomes, namely general, formal, retirement, and informal saving. Notably, financial behavioral engagement exerts its strongest effect on formal institutional saving ($\beta = 2.383$, $p < 0.001$), while digital behavioral engagement emerges as the dominant predictor in Sub-Saharan Africa ($\beta = 1.107$), the only region where it surpasses financial behavioral engagement. An interaction analysis reveals a partial substitution effect between the two constructs ($\beta = -0.345$, $p < 0.001$), suggesting diminishing marginal returns when both competencies are present simultaneously. Regional heterogeneity analysis across seven World Bank geographic regions further reveals substantial variation in the relative importance of financial versus digital literacy. These findings contribute novel cross-country evidence to the financial literacy-saving nexus and carry important implications for the design of financial inclusion and digital education policies.

Keywords: Financial Literacy, Saving Behavior, Digital Literacy, Financial Inclusion, Global Findex

Introduction

Saving behavior constitutes one of the most fundamental dimensions of household financial decision-making, with well-documented implications for individual financial resilience, intergenerational wealth accumulation, and macroeconomic stability. Two structural transformations make its determinants a matter of particular urgency at the present juncture. The first is the persistent and geographically uneven deficit in household saving: despite a decade of financial inclusion efforts, the Global Findex 2021 documents that only 54 percent of adults in low- and middle-income economies reported saving any money in the prior twelve months, and more than one billion adults worldwide remain financially excluded (World Bank, 2022). The macroeconomic consequences are well-established: deficient household saving depresses capital formation, constrains investment, and perpetuates intergenerational financial vulnerability in precisely the economies where domestic resource mobilization is most critical (Lusardi and Mitchell, 2014; World Bank, 2022). The second transformation is the accelerating digitalization of financial services: between 2014 and 2021, the share of adults in developing economies making or receiving digital payments rose from 35 to 57 percent (Demirguc-Kunt et al., 2022), fundamentally altering the infrastructure through which saving participation occurs. These two transformations intersect at a critical juncture: as digital channels progressively displace traditional financial intermediaries, the competency profile required to participate meaningfully in saving behavior has itself changed, raising the question of whether financial literacy and digital literacy now constitute parallel, complementary, or partially substitutable drivers of saving propensity. Understanding which competencies drive saving, and how they interact, is therefore of direct relevance for financial inclusion policy, digital infrastructure investment, and financial education program design across a broad range of economies.

The social consequences of this saving deficit extend beyond macroeconomic aggregates. At the household level, inadequate saving constrains individuals' capacity to absorb adverse income shocks, finance human capital investments, and provision retirement consumption, thereby perpetuating intergenerational cycles of financial vulnerability (Lusardi and Mitchell, 2014). The fragility of household financial buffers is strikingly documented by the Global Findex 2021: even among the formally banked population, half of adults in emerging market and developing economies report an inability to mobilize emergency funds within 30 days (World Bank, 2022). Notwithstanding the expansion of global account ownership from 51 percent in 2011 to 76 percent in 2021, 65 percent of adults in low-income economies still lack access to a basic transaction account, revealing a persistent disjuncture between formal financial access and meaningful financial participation that income constraints alone are insufficient to explain. Behavioral and competency-related determinants, encompassing financial literacy and, more recently, digital literacy, have accordingly emerged as theoretically grounded and empirically tractable candidates for explaining residual variation in saving propensity net of structural access conditions.

Three canonical theoretical frameworks establish the mechanisms through which financial literacy is expected to influence saving behavior. The life-cycle hypothesis, first formalized by Modigliani and Brumberg (1954), conceptualizes saving as a deliberate

intertemporal optimization problem, the effective execution of which presupposes a level of financial competency sufficient to translate the normative imperative of consumption smoothing into concrete financial planning. The human capital model of financial literacy, developed by Jappelli and Padula (2013), endogenizes financial knowledge acquisition, predicting that individuals invest in financial literacy because it raises the effective return on their savings portfolio through superior product selection, fee minimization, and risk diversification. The behavioral economics framework of Thaler and Sunstein (2008) and Kahneman (2011) further specifies that financial literacy attenuates present bias and bounded rationality, thereby reducing systematic tendencies to defer saving in favor of immediate consumption. Alongside these established mechanisms, the progressive digitalization of financial services has introduced a fourth theoretical channel: transaction cost theory (Coase, 1937; Williamson, 1985) predicts that digital financial tools reduce the logistical and informational barriers to formal savings participation, independently of knowledge-based competencies. The theoretical convergence of these four frameworks implies that financial literacy and digital literacy may exert partially overlapping yet conceptually distinct effects on saving behavior, a joint relationship that has not been subjected to systematic cross-country econometric examination in the prior literature.

A substantial body of empirical work has established financial literacy as a significant predictor of saving behavior, demonstrating that individuals with greater financial knowledge are more likely to plan for retirement, maintain formal savings accounts, and build financial buffers against adverse shocks. More recently, the rapid expansion of digital financial services has prompted growing interest in digital literacy as an additional determinant of financial behavior. However, despite the parallel growth of these two literatures, relatively little research has examined financial literacy and digital literacy within a unified empirical framework, and no study has systematically tested whether the two constructs operate as substitutes or complements in driving saving outcomes across a globally representative sample.

The empirical case for examining these two constructs within a unified framework is reinforced by several convergent strands of recent research that collectively delineate the boundaries of the existing knowledge base. Xu et al. (2024) demonstrate, using household-level data, that digital financial literacy exerts an independent and economically significant effect on rural income inequality through its role in expanding access to formal savings channels, a finding that establishes digital competency as a substantive determinant of financial behavior beyond the financial literacy channel traditionally examined in the literature. Dluhopolskyi et al. (2024), employing a two-step system Generalized Method of Moments estimator on panel data from 56 emerging economies, confirm the joint effect of digital literacy and technology adoption on financial inclusion, while documenting pronounced regional heterogeneity in its magnitude. At the aggregate level, Kaiser et al. (2022), in a meta-analysis synthesizing 76 randomized controlled trials, affirm that financial education interventions produce statistically significant but context-contingent improvements in saving behavior, a finding that underscores the importance of population-specific competency profiles in determining intervention effectiveness. Crucially, the interaction between financial and digital literacy in determining saving outcomes remains, to date, empirically unresolved: Struckell et al. (2022), in a bibliometric meta-analysis of the financial literacy scholarship, document that cross-construct interaction effects between

behavioral, attitudinal, and inclusion dimensions of financial competency constitute one of the most conspicuously underrepresented configurations in the extant literature. This gap acquires particular salience in light of the OECD/INFE (2023) finding that 40 percent of digitally active adults across 39 economies fail to attain minimum digital financial literacy thresholds, raising the empirically consequential question of whether financial literacy can substitute for digital competency deficits in determining saving outcomes, or whether the two must be cultivated concurrently to produce behavioral change. The present study is situated at precisely this intersection.

This study addresses this gap by investigating the independent and joint effects of financial literacy and digital literacy on saving behavior, operationalized through behavioral engagement indices given the absence of direct knowledge assessments in the Global Findex 2021. Specifically, it examines two central research questions: to what extent do financial literacy and digital literacy, as captured by their behavioral proxies, each contribute to saving propensity, and does the simultaneous presence of both competencies amplify or attenuate their individual effects? A secondary objective concerns the degree of cross-regional heterogeneity in these relationships, namely whether the relative importance of financial versus digital literacy varies systematically across geographic and institutional contexts.

To address these questions, this study draws on individual-level microdata from the Global Financial Inclusion Database (Global Findex) 2021, a nationally representative survey covering 143,887 adults across 139 economies. Since the dataset does not contain direct measures of financial or digital knowledge, composite behavioral engagement indices are constructed as proxy measures for financial literacy and digital literacy, drawing on indicators of active financial and digital system participation available in the Findex 2021. This operationalization follows the approach validated by Grohmann et al. (2018) and Morgan and Trinh (2019), who demonstrate that behavioral engagement indicators capture the practical, applied dimension of financial literacy most directly relevant to saving decisions. Survey-weighted binary logistic regression models are then estimated to assess the effects of these proxies on four distinct saving outcomes: general saving, formal institutional saving, retirement saving, and informal saving. The results confirm that both financial literacy and digital literacy, as operationalized through behavioral engagement, are positive and statistically significant predictors of saving behavior across all specifications. A negative and significant interaction term reveals a partial substitution effect between the two constructs, indicating diminishing marginal returns when both competencies are present simultaneously. Regional sub-sample analyses further document substantial heterogeneity: digital literacy emerges as the dominant predictor in Sub-Saharan Africa, while financial literacy proves the stronger driver in Europe and Central Asia.

This study makes three contributions to the existing literature. **First**, it provides cross-country empirical evidence on the simultaneous effects of financial literacy and digital literacy on saving behavior, operationalized through behavioral engagement proxies and explicitly modeling their interaction within a single framework and testing for substitution versus complementarity. **Second**, by drawing on the Global Findex 2021 across 139 economies, it extends the geographic scope of individual-level evidence beyond the small multi-country samples of prior studies (Grohmann et al., 2018, cover 14 economies; Morgan and Trinh, 2019, cover five), enabling a fully powered test of regional heterogeneity across all seven

World Bank geographic regions simultaneously. **Third**, the disaggregated analysis of four saving outcomes reveals how the channel through which saving occurs varies systematically with individual financial and digital competency, a dimension that aggregate saving measures obscure.

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature on financial literacy, digital literacy, and saving behavior. Section 3 describes the data, variable construction, and empirical strategy. Section 4 presents the empirical results. Section 5 discusses the findings and their policy implications, and concludes with a summary of limitations and directions for future research.

Literature Review

Financial Literacy and Saving Behavior

The central proposition of this subsection is that financial literacy, understood as an individual-level competency encompassing financial knowledge, attitudes, and behavior, constitutes a significant and theoretically grounded determinant of saving. The mechanisms through which this relationship operates are multiple and have been formalized in the economic literature.

Three theoretical frameworks underpin the relationship between financial literacy and saving behavior, each identifying a distinct mechanism of influence.

The **life-cycle hypothesis**, first formalized by Modigliani and Brumberg (1954) and extended by Ando and Modigliani (1963), provides the foundational framework for understanding saving as a deliberate intertemporal choice. Under this model, rational individuals' smooth consumption across the life cycle by accumulating savings during peak earning years and drawing them down in retirement. Financial literacy enters this framework as a competency that enables individuals to operationalize life-cycle planning: without an understanding of compounding, inflation, and retirement product design, individuals cannot effectively translate the theoretical imperative to save into actionable financial behavior. The life-cycle hypothesis generates a clear prediction: financial literacy should be positively associated with saving in general and especially strongly with retirement saving, as the latter requires the longest planning horizon and the most complex product navigation.

The **human capital model of financial literacy**, advanced by Jappelli and Padula (2013), treats financial literacy as an endogenous investment: individuals optimally allocate resources to acquiring financial knowledge because doing so raises the return on their savings portfolio. Within this framework, financial literacy and saving are jointly determined, with higher literacy enabling better product selection, lower fees, and more efficient risk diversification, all of which increase the net return to saving and thereby raise the equilibrium saving rate. This model generates the prediction that financially literate individuals should not only save more but should preferentially channel saving toward formal financial products where their knowledge advantages are most applicable.

The **behavioral economics framework**, drawing on the concepts of present bias and bounded rationality developed by Thaler and Sunstein (2008) and Kahneman (2011), argues that saving deficits arise not merely from income constraints or lack of knowledge but from systematic cognitive biases that cause individuals to discount future consumption excessively

relative to present consumption. Financial literacy partially counteracts present bias by enhancing awareness of the long-term costs of inaction, the so-called 'cost of financial ignorance' documented by Lusardi and Tufano (2009). Under this framework, financial literacy should have a positive effect on saving across all time horizons, with the effect on long-term saving (retirement) being particularly pronounced.

Empirically, the relationship between financial literacy and saving is well established, though the magnitude and channels of influence vary across contexts. Three broad patterns emerge from the literature. First, financial literacy is consistently associated with higher rates of retirement saving and long-term financial planning. Lusardi and Mitchell (2007) documented that financially illiterate individuals approaching retirement had accumulated significantly less wealth and engaged in substantially less retirement planning, a finding subsequently replicated across multiple country contexts. Second, financial literacy predicts a preference for formal over informal saving channels: cross-country evidence from Grohmann et al. (2018) demonstrates that higher financial literacy is associated not merely with saving in general, but specifically with saving through regulated financial institutions, suggesting that knowledge of financial products shifts channel preferences. Third, at the aggregate level, Kaiser et al. (2022), synthesizing 76 randomized experiments, confirm that financial education interventions produce measurable improvements in saving behaviors, though effect sizes are modest and contingent on program design and targeting.

A critical measurement challenge runs throughout this literature. Most large-scale cross-country datasets, including the Global Findex employed in this study, do not include direct assessments of financial knowledge such as the three-question Big Three instrument developed by Lusardi and Mitchell (2008). As a consequence, researchers have relied on behavioral proxies, namely indicators of active financial engagement such as account ownership, card use, and deposit behavior, as indirect measures of financial competency. While this approach has limitations, it has been validated in the literature as capturing the practical, applied dimension of financial literacy that most directly shapes saving decisions (Grohmann et al., 2018; Morgan and Trinh, 2019). This study adopts and extends this approach, constructing a composite behavioral index from five indicators available in the Global Findex 2021.

A gap that persists in this literature concerns the extent to which financial literacy interacts with emerging digital financial competencies in shaping saving outcomes. The existing evidence establishes the independent effect of financial literacy but does not systematically account for the growing role of digital channels, an omission that this study addresses.

This lacuna is corroborated by the bibliometric evidence on the field’s structural composition. Struckell et al. (2022), in a systematic review and meta-analysis encompassing several decades of financial literacy scholarship, document that the integrated examination of financial behavior, financial attitudes, and financial inclusion constitutes one of the most conspicuously underrepresented research configurations in the extant literature. Their network analysis of co-citation clusters reveals a persistent tendency for empirical studies to examine individual constructs in isolation, with cross-construct interaction effects remaining largely absent from formal econometric testing. This structural characteristic of the literature

provides bibliometric corroboration for the analytical choice, adopted in the present study, of treating financial and digital literacy as potentially interacting rather than strictly parallel determinants of saving behavior, and of subjecting their joint dynamics to direct empirical scrutiny.

Digital Literacy and Financial Behavior

Digital literacy, broadly defined as the capacity to access, evaluate, and effectively use digital technologies (Gilster, 1997), has emerged as a distinct determinant of financial behavior as the financial services landscape has undergone rapid digitalization. The central argument of this subsection is that digital literacy operates through mechanisms that partially overlap with, but are not reducible to, those of financial literacy, and that its effects on saving behavior are theoretically grounded and empirically substantiated.

The theoretical basis for digital literacy effects on saving rests on three complementary mechanisms. First, **transaction cost theory** (Coase, 1937; Williamson, 1985) predicts that digital financial services lower the costs of accessing and using formal savings instruments by reducing travel, time, documentation, and minimum balance requirements, thereby expanding saving participation among previously excluded populations. This mechanism operates independently of financial knowledge: even financially illiterate individuals benefit from lower transaction costs if digital tools simplify the saving process sufficiently. Second, the **technology adoption and diffusion framework** (Rogers, 2003) predicts that individuals who are more digitally proficient are more likely to adopt new financial technologies early, gaining experience with a broader range of savings products and developing the habits associated with regular digital financial interaction. Third, consistent with the behavioral economics framework discussed above, digital financial tools enhance the **behavioral salience of saving** through real-time balance monitoring, automatic transfer features, and push notifications that counteract present bias through architecture rather than knowledge, a mechanism described by Thaler and Sunstein (2008) as choice architecture.

The empirical evidence on digital literacy and saving converges on several consistent findings. Digital financial inclusion is associated with higher saving rates particularly among previously unbanked populations in developing economies, where mobile money serves as a primary savings vehicle (Suri and Jack, 2016; Sabbaghi, 2024). The COVID-19 pandemic accelerated this dynamic: Demirguc-Kunt et al. (2022) document that digital payment adoption in developing economies rose from 35% to 57% of adults between 2014 and 2021, with persistent behavioral effects on saving and payment practices. Crucially, these effects are documented net of income and education controls, suggesting that digital competency per se, rather than socioeconomic status, drives at least part of the observed relationship. Extending this cross-regional evidence base, Dluhopolskyi et al. (2024) employ a two-step system Generalized Method of Moments estimator applied to panel data from 56 emerging economies across Africa, Asia, and Latin America over the period 2011 to 2021, and find that the joint effect of digital literacy and technology adoption on financial inclusion is both positive and statistically significant, while exhibiting pronounced regional heterogeneity: the magnitude of the digital literacy premium is greatest in contexts characterized by underdeveloped formal banking infrastructure, where digital tools function as the primary conduit for financial participation rather than as a complement to pre-existing formal channels. This finding provides direct empirical grounding for the regional sub-sample

analysis undertaken in the present study and motivates the expectation, formalized in Hypothesis 3, that the relative salience of digital behavioral engagement will vary systematically across geographic regions differentiated by institutional development.

A significant measurement gap exists here as well. Digital literacy in large-scale surveys is typically proxied through behavioral indicators of digital technology adoption, including mobile phone ownership, internet access, and digital payment use, rather than through direct competency assessments. This approach conflates access with ability and may understate the role of digital skills in contexts where infrastructure is available but underutilized. The present study acknowledges this limitation while employing the best proxies available in the Global Findex 2021 and distinguishes the digital literacy construct from the financial literacy index to avoid conflation of the two dimensions.

The Interaction Between Financial and Digital Literacy

The central question motivating this subsection is whether financial literacy and digital literacy operate independently on saving behavior, or whether their joint presence generates interaction effects that are theoretically meaningful and empirically testable. The existing literature has largely treated the two constructs as parallel but separate channels, without directly addressing their interaction.

Two competing theoretical predictions can be derived from the literature. The complementarity hypothesis holds that financial and digital literacy reinforce one another: a financially literate individual who also possesses digital skills can more effectively identify and utilize digital savings products, generating supra-additive returns from possessing both competencies. This view rests on the premise that navigating complex fintech products requires a convergence of traditional financial knowledge and digital competency, such that each competency amplifies the returns to the other (Morgan and Trinh, 2019; Dluhopolskyi et al., 2024).

The substitution hypothesis, by contrast, proposes that financial and digital literacy share overlapping mechanisms of influence; both reduce barriers to saving, enhance access to financial products, and strengthen financial self-efficacy, such that the marginal return to acquiring one competency is diminished for individuals who already possess the other. Under this view, the two forms of literacy are partially fungible instruments for achieving the same behavioral outcome, and their joint effect is positive but less than additive.

The empirical evidence on this question is sparse. The few studies that incorporate both constructs do so using aggregate country-level panels or single-country household surveys: Dluhopolskyi et al. (2024) employ panel data from 56 emerging economies at the country level, while Xu et al. (2024) use household data from rural China. Neither permits the estimation of an individual-level interaction term across a globally representative sample. No prior study has therefore directly tested the substitution versus complementarity hypothesis at the individual level in a large-scale cross-country context. This study addresses this gap by introducing an explicit interaction term between the two behavioral engagement indices and interpreting its sign and significance as evidence for one hypothesis over the other.

Cross-Country Heterogeneity and the Gender Dimension

A well-established finding in the financial literacy literature is that the strength of the literacy-saving relationship is not uniform but varies systematically with the institutional and economic context in which individuals operate. Grohmann et al. (2018) demonstrate that the effect of financial literacy on financial inclusion is stronger in countries with less developed financial systems, where the gap in behavior between financially literate and illiterate individuals is larger in absolute terms. This contextual dependency suggests that financial literacy operates partly by enabling individuals to navigate complex financial environments: where these environments are simpler or more accessible, the incremental effect of literacy may be smaller.

Digital financial adoption introduces an additional source of heterogeneity. In Sub-Saharan Africa, where mobile money has achieved widespread adoption and often substitutes for formal banking, digital competency may matter more for saving behavior than traditional financial literacy, a prediction consistent with the evidence that 39% of mobile money account holders in the region use their accounts to save (Demirguc-Kunt et al., 2022). In contrast, in high-income and digitally saturated economies, the marginal return to additional digital competency may be low, while financial literacy retains a premium due to the complexity of available financial products. These hypotheses motivate the regional sub-sample analysis conducted in Section 4.

The gender dimension adds a further layer of heterogeneity with direct implications for the disaggregated saving analysis. Women consistently exhibit lower financial literacy scores globally (Lusardi and Mitchell, 2014; Klapper et al., 2015), a gap linked to lower formal saving rates and retirement wealth accumulation (Bucher-Koenen et al., 2021). However, in developing economies, informal savings mechanisms such as rotating savings and credit associations serve as primary financial instruments for women who lack access to formal institutions (Anderson and Baland, 2002). This dual pattern of lower formal but higher informal saving among women implies that aggregate saving measures obscure important gender-differentiated effects, motivating the disaggregation of saving outcomes in this study.

Research Gaps and Positioning of the Present Study

The confluence of two structural transformations in global finance renders the question addressed by this study both timely and policy-consequential. The first is the persistent deficit in household saving, which represents one of the most consequential and least-resolved challenges in development economics. Despite a decade of concerted financial inclusion efforts, the Global Findex 2021 documents that only 54 percent of adults in low- and middle-income economies reported saving any money in the prior twelve months, while half of adults in emerging market and developing economies remain unable to mobilize emergency funds within 30 days (World Bank, 2022). The macroeconomic costs of this deficit are well established: deficient domestic saving rates suppress capital formation, constrain investment, and perpetuate intergenerational cycles of financial vulnerability in precisely the economies where domestic resource mobilization is most critical (Lusardi and Mitchell, 2014; World Bank, 2022). The second transformation is the accelerating digitalization of financial services, which has fundamentally altered the architecture of saving participation. Between 2014 and 2021, the share of adults in developing economies making or receiving digital payments rose from 35 to 57 percent (Demirguc-Kunt et al., 2022), with mobile money

platforms now serving as the primary savings vehicle for previously unbanked populations across Sub-Saharan Africa and South Asia. These two transformations intersect at a critical analytical juncture: as digital channels progressively displace traditional financial intermediaries, the competency profile required to participate meaningfully in saving behavior has itself changed, raising the question of whether financial literacy and digital literacy now constitute parallel, complementary, or partially substitutable drivers of saving propensity.

The preceding literature review establishes that each construct has been studied extensively in isolation. A substantial body of evidence confirms that financial literacy raises saving propensity through the mechanisms of life-cycle planning, portfolio optimization, and present-bias attenuation (Lusardi and Mitchell, 2014; Kaiser et al., 2022; Grohmann et al., 2018). A more recent and rapidly expanding literature establishes that digital literacy independently expands access to formal and informal saving channels by reducing transaction costs and enabling mobile-based financial participation (Suri and Jack, 2016; Xu et al., 2024; Dluhopolskyi et al., 2024). However, a careful reading of this evidence base reveals three structurally distinct gaps that this study is positioned to address.

The first and most consequential gap concerns the absence of any cross-country microeconometric test of the interaction between financial and digital literacy in determining saving behavior. The two constructs have been shown separately to matter; what remains unknown is whether they reinforce each other, partially substitute for each other, or operate through mechanisms sufficiently distinct that their joint effect is approximately additive. This is not a minor technical omission. The theoretical frameworks reviewed in Section 2.3 generate competing and irreconcilable predictions: the complementarity view (Morgan and Trinh, 2019; Dluhopolskyi et al., 2024) holds that both competencies are jointly necessary to navigate increasingly complex digital financial products, while the substitution view holds that both operate partly through the common mechanism of reducing barriers to formal financial participation, making them partially fungible. The distinction carries direct and asymmetric policy implications. Under complementarity, the welfare-maximizing response is integrated program design: combining financial education and digital skills training within a single intervention generates supra-additive returns to saving propensity. Under substitution, the optimal policy is targeted sequencing: identifying whichever competency constitutes the binding constraint for a given population segment yields greater cost-effectiveness than undifferentiated dual-literacy programming, because resources directed toward the second competency face diminishing marginal returns. The choice between these policy designs is not trivial in contexts of constrained public budgets and imperfect program targeting. Yet the OECD/INFE (2023) survey of 39 economies documents that 40 percent of digitally active adults fail to attain minimum financial literacy thresholds, a finding that underlines how common the coexistence of uneven competency profiles is among the very populations targeted by financial inclusion interventions, and how urgent it is to know empirically whether one competency can compensate for deficits in the other. To date, no study has subjected this question to direct econometric testing using cross-country individual-level data. The few studies that incorporate both constructs, including Dluhopolskyi et al. (2024) and Xu et al. (2024), do so using aggregate country-level panels or single-country household surveys, neither of which permits the estimation of an individual-level interaction term across a globally representative sample. Struckell et al. (2022), in a systematic bibliometric review

spanning several decades of the financial literacy scholarship, document that cross-construct interaction effects between behavioral, attitudinal, and inclusion dimensions of financial competency constitute one of the most persistently underrepresented research configurations in the extant literature, providing bibliometric corroboration for the gap this study addresses.

The second gap concerns the geographic scope and data structure of existing evidence. Cross-country studies on financial literacy and saving rely predominantly on aggregate country-level indicators drawn from World Development Indicators or similar macro-level databases, which conflate within-country heterogeneity and preclude individual-level behavioral analysis. Among studies using individual-level data, the multi-country sample is typically small: Grohmann et al. (2018), one of the most cited studies in this tradition, cover 14 developing economies; Morgan and Trinh (2019) examine five ASEAN countries. No prior study has exploited the Global Findex 2021, the most recent and comprehensive demand-side financial inclusion dataset available, to jointly examine financial and digital literacy effects across the full cross-country individual-level sample of 143,887 adults in 139 economies. This matters not only for statistical precision but because it enables, for the first time, a systematic and fully powered test of regional heterogeneity across all seven World Bank geographic regions simultaneously. The theoretical prior reviewed in Section 2.4 namely, that digital literacy carries a premium in contexts where mobile money substitutes for absent formal banking infrastructure, while financial literacy proves relatively more important in digitally saturated economies, has not been tested with a sufficiently large and geographically diverse sample to yield regionally differentiated estimates that are simultaneously comparable and internally valid.

The third gap concerns the treatment of saving behavior as an undifferentiated aggregate outcome. The existing cross-country literature predominantly employs binary indicators of whether an individual saved at all, without distinguishing between formal institutional saving, retirement saving, and informal saving through groups or rotating credit associations. This aggregation is theoretically consequential: as established in Section 2.1, the life-cycle hypothesis and the human capital model of financial literacy generate the prediction that financial competency preferentially channels saving toward long-term, formal products requiring the navigation of complex financial instruments, while digital literacy, operating through transaction cost reduction, may be comparatively more effective at expanding participation in informal and mobile-based saving, which impose lower knowledge barriers but higher digital access requirements. Aggregate saving specifications therefore impose a theoretically unwarranted homogeneity constraint across saving channels that may mask heterogeneous effects with distinct policy implications. Anderson and Baland (2002) and Bucher-Koenen et al. (2021) have examined formal and informal saving separately, but neither study incorporates digital literacy as a predictor, nor is either designed for cross-country comparison at the scale undertaken here. The disaggregation of saving outcomes across four channels (general, formal, retirement, and informal) is therefore a necessary extension of the existing evidence base rather than a purely descriptive addition.

This study addresses all three gaps through survey-weighted logistic regression on Global Findex 2021 microdata, estimated separately for four saving outcomes and across seven

geographic regions. Three testable hypotheses are derived directly from the theoretical frameworks reviewed above and the gaps identified here:

H1: Financial behavioral engagement and digital behavioral engagement each exert a positive and statistically significant effect on saving behavior, grounded in the human capital model (Jappelli and Padula, 2013), the life-cycle hypothesis (Modigliani and Brumberg, 1954), and transaction cost theory (Coase, 1937).

H2: The interaction between financial and digital behavioral engagement is negative, consistent with a partial substitution effect, derived from the theoretical framework developed in Section 2.3: if both forms of engagement operate partly through the shared mechanism of reducing barriers to formal financial system access, the marginal return to one competency is diminished for individuals who already possess the other.

H3: The relative magnitude of financial versus digital behavioral engagement effects varies systematically across geographic regions, grounded in the institutional context-dependence documented in the heterogeneity literature (Grohmann et al., 2018): digital behavioral engagement is expected to carry a premium in Sub-Saharan Africa, where mobile money substitutes for absent formal banking infrastructure, while financial behavioral engagement is expected to prove relatively stronger in digitally saturated economies.

Data and Methodology

Data Source

This study draws on the **Global Financial Inclusion Database (Global Findex) 2021**, compiled by the World Bank in collaboration with the Gallup World Poll. The Global Findex 2021 constitutes the most comprehensive demand-side dataset on financial inclusion available globally, covering **143,887 individual-level observations** across **139 economies**, representing over 5.5 billion adults worldwide. Data were collected through nationally representative surveys conducted during 2021, encompassing face-to-face and telephone interviews depending on country context.

A key methodological feature of the Global Findex 2021 is the inclusion of sampling weights (wgt), assigned by the World Bank to correct for differential probabilities of selection across and within countries, ensuring that estimates are nationally representative at the economy level. These weights are not pre-applied to the raw microdata and must be explicitly incorporated into the estimation procedure. Failure to apply them would result in parameter estimates that are driven by the sheer population size of large economies such as China and India rather than by the underlying behavioral relationships of interest. Following established practice for multi-country surveys of this type (Grohmann et al., 2018; Morgan and Trinh, 2019), all models incorporate these probability weights within a survey-weighted regression framework, with economies treated as strata.

Variable Construction

Dependent Variable: Saving Behavior

Saving behavior is operationalized through four distinct binary indicators, each capturing a different dimension of how individuals save. This disaggregated approach reflects the theoretical prediction that financial and digital competency may differentially affect not only

the propensity to save, but also the channel, whether formal, informal, or long-term, through which saving occurs. Each variable is coded 1 if the respondent engaged in the respective saving behavior in the past 12 months, and 0 otherwise.

The four saving outcome variables are defined as follows:

(1) saving (primary dependent variable), derived from the survey item saved: whether the respondent personally saved or set aside any money in the past 12 months, regardless of the method or channel used. This is the broadest measure of saving behavior and is available for all 143,887 respondents with no missing values.

(2) saving_form (fin17a), whether the respondent saved at a bank or another type of formal financial institution in the past 12 months, including through another person's account. This indicator captures formal institutional saving and is used to test whether financial competency predicts a preference for regulated savings channels.

(3) saving_old (fin16), whether the respondent saved specifically for old age or retirement in the past 12 months. This indicator captures long-term financial planning behavior and is theoretically most sensitive to financial literacy effects, given that retirement planning requires an understanding of compounding, time discounting, and financial product choices.

(4) saving_inf (fin17b), whether the respondent saved through an informal savings group or club outside the family, such as a rotating savings and credit association (ROSCA). This indicator captures informal saving mechanisms prevalent in developing economies and is expected to be comparatively less sensitive to financial literacy but potentially more responsive to digital literacy through mobile-based informal saving platforms. Note that 20.6% of observations have missing values on this variable because the question was posed only to respondents who had previously indicated engagement in saving activities; these missing values reflect the conditional survey design and are treated as zero, consistent with the interpretation that respondents who did not progress to this question did not use informal saving channels.

Variables saving_form, saving_old, and saving_inf are used as dependent variables in robustness specifications alongside the primary outcome saving, forming a comprehensive picture of saving behavior across both formal and informal channels.

Independent Variable: Financial Behavior Index

A central methodological challenge in this study concerns the operationalization of financial competency. The Global Findex 2021 does not include direct assessments of financial knowledge, such as the three-question instrument measuring understanding of interest compounding, inflation, and risk diversification developed by Lusardi and Mitchell (2008). What the dataset does contain is a rich set of indicators measuring whether individuals actively engage with formal financial services, namely whether they hold accounts, use payment instruments, make deposits, and monitor their balances. These are behavioral outcomes, not knowledge measures.

Following the established literature on behavioral proxies for financial competency (Grohmann et al., 2018; Morgan and Trinh, 2019; Demirguc-Kunt et al., 2022), this study constructs a **Financial Behavior Index** as a composite of five binary indicators of active financial engagement. The theoretical justification for this approach rests on the premise that financially competent individuals, specifically those who possess the knowledge, attitudes,

and skills necessary to make effective financial decisions, are more likely to manifest that competency through observable engagement with formal financial services. Account ownership, card use, and deposit behavior thus serve as behavioral traces of underlying financial competency, capturing its practical dimension more directly than self-reported knowledge assessments in a cross-cultural context. It is explicitly acknowledged, however, that this index measures the behavioral expression of financial competency rather than knowledge per se, and findings should be interpreted accordingly.

The Financial Behavior Index is an additive composite of five binary indicators, each recoded to 1 (yes) or 0 (no/don't know/refused):
(1) fl_account, ownership of an account at a formal financial institution or mobile money provider. Account ownership is the most fundamental behavioral marker of financial system engagement and a prerequisite for most formal saving behaviors. Individuals without accounts are effectively excluded from formal financial channels regardless of their knowledge level, making this a necessary baseline component of the index.
(2) fl_fin2, possession of an ATM/debit card. Card ownership reflects a level of financial engagement beyond passive account holding, indicating active integration into the formal payment system and familiarity with card-based financial instruments.
(3) fl_fin5, use of a mobile phone or internet to make payments, buy things, or send/receive money through a financial institution account in the past 12 months. This indicator captures active digital-financial behavior and the application of technological tools to financial management, which requires both financial and digital competency.
(4) fl_fin9, having made at least one deposit into a personal financial account in the past 12 months. Active depositing behavior indicates deliberate use of the formal financial system for fund accumulation, beyond merely receiving payments passively.
(5) fl_fin10b, typically keeping money stored in a personal financial account. This indicator captures a deliberate preference for bank-mediated liquidity management over cash holding, reflecting a positive disposition toward formal financial instruments.

An important coding decision concerns the three conditional variables (fl_fin5, fl_fin9, fl_fin10b), which in the FINDEX survey were posed only to account holders, resulting in missing values for the 38.1% of respondents without accounts. These missing values do not indicate refusal to answer or inability to respond; rather, they reflect the survey's skip logic, whereby non-account holders were not asked questions about account usage. Treating these as missing and excluding them from the analysis would reduce the sample by over a third and systematically exclude the financially excluded population, biasing the results. Instead, following the methodological approach of Grohmann et al. (2018), these variables are coded as 0 for non-account holders, on the grounds that individuals without accounts have, by definition, a score of zero on behaviors that require account ownership. This coding decision is explicitly acknowledged as a methodological choice rather than an empirical fact.

The resulting index ranges from 0 to 5. A binary dummy variable (fin_behavior) is derived by coding respondents scoring 3 or above as exhibiting high financial engagement (= 1), using the sample median as the threshold (mean index = 2.51). In the full sample, 52.7% of respondents are classified as exhibiting high financial engagement.

Moderating Variable: Digital Behavior Index

Analogous considerations apply to the operationalization of digital literacy. The Global Findex 2021 does not contain direct assessments of digital knowledge or skills. What it does contain are indicators of whether individuals own digital devices, have internet access, and actively use digital channels for financial transactions. As with the financial behavior index, these indicators are best understood as behavioral manifestations of digital competency: individuals who own mobile phones, access the internet, check account balances online, and make digital payments demonstrate, through observable behavior, the practical application of digital skills in a financial context.

The construct measured here is therefore more precisely described as **digital financial behavior**, reflecting active engagement with digital financial tools rather than digital knowledge per se. The theoretical link to saving behavior operates through two mechanisms: first, digital tools reduce the transaction costs and logistical barriers associated with accessing formal savings channels; second, digital financial engagement cultivates the habits and self-efficacy associated with regular financial monitoring and management. Both mechanisms are expected to generate a positive relationship between digital behavioral engagement and saving propensity.

The Digital Behavior Index comprises five binary indicators:
(1) dl_internet, access to the internet (internetaccess). Internet access constitutes the foundational infrastructure enabling digital financial participation. Its inclusion captures the enabling condition for all subsequent digital financial behaviors.
(2) dl_mobile, ownership of a mobile phone (mobileowner). Mobile phone ownership is the primary enabling technology for digital financial services in developing economies, where smartphone-based banking and mobile money platforms have achieved widespread adoption.
(3) dl_fin6, use of a mobile phone or internet to check account balances in the past 12 months (fin6). This indicator captures active digital financial monitoring behavior, which has been linked to improved financial self-awareness and more deliberate saving decisions.
(4) dl_merchant, use of a card, mobile phone, or internet to make a purchase at a point-of-sale or online (merchantpay_dig). Active digital payment behavior in commercial contexts indicates habituation to digital financial tools and comfort with cashless transactions.
(5) dl_anydig, having made or received any digital payment in the past 12 months (anydigpayment). This is the most comprehensive indicator of digital financial participation in the FINDEX 2021, capturing the broadest dimension of digital financial engagement.

The index ranges from 0 to 5 (mean = 2.89), and a binary dummy dig_behavior is derived using the same threshold of 3 or above. In the full sample, 57.6% of respondents exhibit high digital behavioral engagement, marginally exceeding the share exhibiting high financial behavioral engagement.

Control Variables

Five individual-level control variables are included, each justified by theoretical and empirical evidence linking them to saving behavior. **Female** (binary, 1 = female) is included because the financial literacy and saving literatures consistently document gender differences in financial behavior, with women exhibiting lower formal saving rates but higher

informal saving propensity, partly due to differential access to formal financial services and social norms governing financial decision-making (Lusardi and Mitchell, 2014). **Age** (continuous, 15 to 99 years) is included based on life-cycle theory, which predicts that saving propensity varies with stage of life, with middle-aged individuals saving more in anticipation of retirement and younger and older individuals saving less. **Education** (ordinal: 1 = primary or less, 2 = secondary, 3 = tertiary or more) is included as a proxy for general human capital, which enhances the ability to process financial information, engage with formal institutions, and plan over longer time horizons; responses coded as don't know or refused (values 4 and 5 in the raw data) are recoded as missing. **Income Quintile** (within-economy quintile 1 to 5) is included because income is a fundamental determinant of saving capacity, as budget constraints limit the ability to set aside funds regardless of financial competency. **Urban** (binary, based on the OECD-EU population grid classification) is included because urban residence is associated with greater proximity to formal financial institutions, higher exposure to digital infrastructure, and different consumption patterns, all of which may independently affect saving behavior.

The urban variable has 47.4% missing values, as it is available only for economies where face-to-face surveys were conducted. When included, the effective sample is reduced to 75,134 observations. A robustness specification excluding this variable retains 142,684 observations. Both specifications are reported to allow assessment of whether the restriction in sample size induced by the inclusion of urban influences the estimated coefficients on the key variables of interest.

Variable Summary Table

Table 1 presents a summary of all variables included in the analysis, including notation, definition, coding, and source.

Table 1
Variable Definitions and Sources

Variable	Label	Definition / Coding	Role	Source
saving	General Saving	1 = saved in past 12 months; 0 = otherwise	Dependent (Y1)	Findex 2021
saving_form	Formal Saving	1 = saved at financial institution; 0 = otherwise	Dependent (Y2)	Findex 2021
saving_old	Retirement Saving	1 = saved for old age; 0 = otherwise	Dependent (Y3)	Findex 2021
saving_inf	Informal Saving	1 = saved via informal group; 0 = otherwise	Dependent (Y4)	Findex 2021
fin_behavior	Financial Behavior Index	Additive index 0-5; dummy = 1 if score >= 3	Independent (X1)	Findex 2021
dig_behavior	Digital Behavior Index	Additive index 0-5; dummy = 1 if score >= 3	Independent (X2)	Findex 2021
female	Gender	1 = female; 0 = male	Control	Findex 2021
age	Age	Continuous, years (15-99)	Control	Findex 2021
educ	Education	Ordinal: 1=primary, 2=secondary, 3=tertiary	Control	Findex 2021

inc_q	Income Quintile	Within-economy quintile 1-5	Control	Findex 2021
urban	Urban Residence	1 = urban; 0 = rural (47.4% missing)	Control	Findex 2021
wgt	Survey Weight	Probability weight; ensures representativeness	Weight	World Bank

Empirical Strategy

The empirical strategy is organized around four complementary objectives: establishing baseline relationships between behavioral competency indices and saving outcomes, assessing the robustness of these relationships to sample composition, testing for interaction effects between financial and digital behavioral engagement, and documenting cross-regional heterogeneity. Each objective corresponds to a distinct model specification, and together they form a coherent analytical framework designed to address the three research hypotheses formulated in Section 2.5.

All models employ a **survey-weighted binary logistic regression (logit) framework**, estimated using the svyglm function in R with probability weights (wgt) and economy-level strata. The logit specification is chosen over the probit alternative on both practical and theoretical grounds. From a practical standpoint, the logit model yields coefficients that can be interpreted as log-odds ratios, a scale that facilitates direct comparison across specifications and population subgroups. From a theoretical standpoint, the logistic distribution places heavier probability mass in the tails compared to the normal distribution underlying probit, making it marginally more appropriate for outcomes where extreme probabilities, such as very high or very low saving rates, as are observed, as is the case in several regional subsamples. In practice, logit and probit yield virtually identical marginal effects for most empirical applications, and the choice between them does not materially affect the substantive conclusions.

The use of probability weights (wgt) serves two purposes. First, it corrects for differential sampling probabilities within countries, ensuring that observations are weighted in proportion to the population they represent. Second, when combined with economy-level strata, it accounts for the clustered and stratified nature of the survey design, producing standard errors that are robust to within-stratum correlation and appropriately conservative. Without this correction, standard errors would be understated, leading to inflated test statistics and an elevated risk of Type I error in significance assessments.

Coefficient interpretation in logit models requires care. A positive coefficient β indicates that an increase in the corresponding predictor raises the log-odds of saving, or equivalently, the odds of saving by a multiplicative factor of exp(β). A coefficient of β = 0.762 on financial behavioral engagement, for example, implies that financially behaviorally engaged respondents have odds of saving that are exp(0.762) = 2.14 times higher than non-engaged respondents, holding all other variables constant. The magnitude of the coefficient thus reflects both statistical significance and economic meaningfulness, with larger absolute values indicating stronger associations between the predictor and the probability of saving.

Model 1: Baseline Specification

The baseline model examines the direct effects of financial and digital behavioral engagement on general saving, controlling for individual characteristics:

$$P(saving_i = 1) = \Lambda(\beta_0 + \beta_1 FinBehav_i + \beta_2 DigBehav_i + \beta_3 Female_i + \beta_4 Age_i + \beta_5 Educ_i + \beta_6 IncQ_i + \beta_7 Urban_i + \varepsilon_i)$$

where Λ(.) denotes the logistic cumulative distribution function and ε_i is the error term. This model is estimated on the subsample with non-missing urban information (N = 75,134) and addresses Hypothesis 1: that financial and digital behavioral engagement each exert positive and significant effects on saving propensity.

Model 2: Robustness Specification Without Urban

The urban variable has 47.4% missing values due to its availability only in face-to-face survey economies, reducing the baseline sample to 75,134 observations. To assess whether this restriction biases the results through sample selection, a robustness specification excludes urban and is estimated on the full available sample (N = 142,684). Consistency of the key coefficients across Models 1 and 2 provides evidence that the baseline findings are not an artifact of the restricted sample.

Model 3: Disaggregated Saving Outcomes

To assess channel heterogeneity in saving behavior and address the theoretical prediction that financial and digital behavioral engagement differentially predict formal versus informal saving, Model 2 is re-estimated using three alternative dependent variables: saving_form, saving_old, and saving_inf. Systematic variation in coefficient magnitudes across these specifications provides evidence on which saving channels are most sensitive to each form of behavioral competency.

Model 4: Interaction Specification

To test Hypothesis 2, namely that the joint presence of financial and digital behavioral engagement generates a substitution effect, an interaction term is introduced:

$$P(saving_i = 1) = \Lambda(\beta_0 + \beta_1 FinBehav_i + \beta_2 DigBehav_i + \beta_{12}(FinBehav_i \times DigBehav_i) + \beta_3 Female_i + \beta_4 Age_i + \beta_5 Educ_i + \beta_6 IncQ_i + \varepsilon_i)$$

The coefficient β_{12} captures the moderating effect of digital behavioral engagement on the financial engagement-saving relationship. A negative and significant β_{12} is consistent with the substitution hypothesis: the combined log-odds effect of possessing both competencies is $\beta_1 + \beta_2 + \beta_{12}$, which is positive but less than the sum of the individual effects, indicating diminishing marginal returns. A positive β_{12} would support the complementarity hypothesis.

Model 5: Regional Sub-sample Specifications

To test Hypothesis 3, namely that the relative importance of financial versus digital behavioral engagement varies systematically across geographic contexts, Model 2 is re-estimated separately for each of the seven World Bank geographic regions. Systematic variation in the ratio of β_1 to β_2 across regions provides evidence of context-dependent heterogeneity in the literacy-saving relationship, with the prediction that digital behavioral engagement will prove relatively more important in Sub-Saharan Africa and relatively less important in more digitally saturated regions such as Europe and Central Asia.

A note on methodological limitations: the cross-sectional design of the Global Findex 2021 precludes causal identification, as reverse causality, whereby individuals who save may accumulate financial and digital competencies through the experience of managing savings; cannot be ruled out. The behavioral proxy approach introduces measurement error relative to direct knowledge assessments. The urban variable restriction introduces potential sample selection. These limitations are discussed further in Section 5.1.

Results

Descriptive Statistics

Table 2 presents the descriptive statistics for all variables. The sample of 143,887 respondents across 139 economies provides broad global coverage. Approximately **54.1% of respondents saved money** in the past 12 months, while **52.7% exhibit high financial behavioral engagement** and **57.6% exhibit high digital behavioral engagement** based on their respective composite indices. The mean Financial Behavior Index score is 2.51 (SD = 2.03) out of 5, while the Digital Behavior Index averages 2.89 (SD = 1.57). The sample is approximately gender-balanced (53.2% female), with a mean age of 41.1 years (SD = 17.3) and average education falling between primary and secondary schooling (mean = 1.96).

Table 2
Descriptive Statistics

Variable	N	Mean	St. Dev.	Min	Max
Saving Behavior	143,887	0.541	0.498	0	1
Financial Literacy (dummy)	143,887	0.527	0.499	0	1
Digital Literacy (dummy)	143,887	0.576	0.494	0	1
FL Index (0-5)	143,887	2.510	2.029	0	5
DL Index (0-5)	143,887	2.888	1.573	0	5
Female	143,887	0.532	0.499	0	1
Age	143,420	41.057	17.343	15	99
Education	143,132	1.955	0.702	1	3
Income Quintile	143,887	3.234	1.420	1	5

Source: Global Findex Database 2021, World Bank. N = 143,887 observations across 139 economies. Note: "Financial Literacy" and "Digital Literacy" refer to the Financial Behavioral Engagement Index and Digital Behavioral Engagement Index, respectively. These labels reflect the theoretical constructs they operationalize (financial literacy and digital literacy as defined in the literature) and are retained for brevity throughout all tables. Both indices are constructed from behavioral proxy indicators of active financial and digital engagement, following the operationalization approach of Grohmann et al. (2018) and Morgan and Trinh (2019), as detailed in Section 3.2. They capture the observable, behavioral expression of the underlying competencies rather than cognitive knowledge assessments directly.

Baseline Regression Results

Table 3 presents the survey-weighted logit results for four saving outcomes. The log-odds coefficients reported in Table 3 indicate the direction and statistical significance of each predictor. To facilitate economic interpretation, average marginal effects (AME), expressing

the change in the **probability** of saving associated with a unit change in each predictor, holding all other variables at their means, are reported in Tables 2b through 2e immediately following each model discussion. AMEs are computed using the *avg_slopes()* function in R (marginaleffects package) and are expressed in percentage points.

Table 3
Baseline Regression Results: Log-Odds Coefficients

	General (1)	**Formal** (2)	**Retirement** (3)	**Informal** (4)
Panel A: Log-Odds Coefficients (β)				
Financial Behavior	0.938***	2.383***	1.110***	0.094**
	(0.022)	(0.046)	(0.037)	(0.039)
Digital Behavior	0.684***	0.652***	0.489***	0.591***
	(0.021)	(0.046)	(0.039)	(0.037)
Female	-0.035**	-0.106***	-0.125***	0.305***
	(0.015)	(0.030)	(0.027)	(0.026)
Age	-0.007***	0.003***	0.014***	-0.007***
	(0.0004)	(0.001)	(0.001)	(0.001)
Education	0.150***	0.115***	0.142***	-0.318***
	(0.013)	(0.025)	(0.023)	(0.024)
Income Quintile	0.186***	0.160***	0.129***	0.155***
	(0.005)	(0.011)	(0.010)	(0.010)
Urban	n/a	-0.105***	0.011	-0.252***
		(0.021)	(0.029)	(0.028)
Constant	-1.299***	-4.159***	-3.568***	-1.812***
	(0.032)	(0.072)	(0.065)	(0.057)
Panel B: Odds Ratios (exp(β))				
Financial Behavior	2.554	10.840	3.035	1.099
	[2.449, 2.664]	—	—	—
Digital Behavior	1.982	1.919	1.631	1.806
Female	0.966	0.899	0.882	1.357
Age	0.993	1.003	1.014	0.993
Education	1.162	1.122	1.153	0.728
Income Quintile	1.205	1.174	1.138	1.167
Panel C: Model Fit Statistics				
Observations	142,684	75,134	75,134	75,134
McFadden R^2	0.133	0.744	0.664	0.331

Log-Likelihood	-86,418	-20,842	-27,177	-29,898
AIC	172,857	41,704	54,374	59,817

*Note: Standard errors in parentheses. 95% confidence intervals for OR in brackets (Model 1 only). Survey-weighted logistic regression with probability weights (wgt) and economy-level strata. Model 1 excludes urban (N=142,684); Models 2-4 include urban (N=75,134). McFadden R^2 = 1 - (LogL_full / LogL_null). The notably high McFadden R^2 for Model 2 (formal saving, R^2 = 0.744) reflects the strong conceptual alignment between the Financial Behavior Index components, particularly active account usage (fin9) and account-based liquidity management (fin10b), and the formal saving outcome variable. VIF diagnostics confirm the absence of multicollinearity (all VIF < 2.0). "Financial Behavior" and "Digital Behavior" denote the behavioral engagement indices operationalizing financial literacy and digital literacy respectively; see Table 2 note and Section 3.2. *p<0.1; **p<0.05; ***p<0.01*

Model 1: General Saving

In Model 1, both financial and digital behavioral engagement exert positive and highly significant effects on general saving (p < 0.001), supporting Hypothesis 1. The AME on financial behavioral engagement is **+0.2147**, meaning that individuals with high financial behavioral engagement have, on average, a **21.5 percentage point higher probability of saving** than those with low engagement, all else equal. The AME on digital behavioral engagement is **+0.1542**, a **15.4 percentage point increase** in saving probability. For context, a one-quintile increase in income raises saving probability by only 3.9 pp (AME = +0.0385), confirming that behavioral competency is a substantially stronger predictor of saving than income alone. Age reduces saving probability by 0.15 pp per year, while education and income have positive effects of 3.1 and 3.9 pp per unit respectively.

Table 4

Average Marginal Effects - Dependent Variable: General Saving P(saving=1)

AME = change in probability of general saving (pp) per unit change in predictor, ceteris paribus. N = 142,684.

Variable	**AME**	**Std. Err.**	**z**	**p-value**	**Sig.**
Financial Behavior (0 to 1)	**+0.2147**	0.0051	42.05	<0.001	***
Digital Behavior (0 to 1)	**+0.1542**	0.0051	30.30	<0.001	***
Female (0 to 1)	-0.0072	0.0031	-2.31	0.021	**
Age (per year)	-0.0015	0.0001	-16.15	<0.001	***
Education (per level)	+0.0311	0.0026	11.95	<0.001	***
Income Quintile (per unit)	+0.0385	0.0011	35.22	<0.001	***

*AME computed via avg_slopes() in R (marginaleffects). Financial/Digital Behavior: binary dummies operationalizing financial literacy and digital literacy respectively (see Table 2 note and Section 3.2). *** p<0.01; ** p<0.05.*

Model 2: Formal Institutional Saving

Financial behavioral engagement exerts its largest AME on formal saving (**+0.2744**), a **27.4 pp increase** in probability of saving at a formal institution, the largest marginal effect in the entire analysis. This confirms that financial competency preferentially channels saving toward regulated financial products. Digital behavioral engagement also increases formal saving (AME = +0.0610, +6.1 pp), though substantially smaller. Notably, urban residence is statistically insignificant (AME = +0.0002, p = 0.954): conditional on competency, geographic proximity to banks does not independently predict formal saving. Women have a 0.97 pp lower probability of saving formally (AME = -0.0097, p < 0.001).

Table 5
Average Marginal Effects - Dependent Variable: Formal Saving P(saving_form=1)
AME = change in probability of saving at a formal institution (pp) per unit change in predictor. N = 75,134.

Variable	**AME**	**Std. Err.**	**z**	**p-value**	**Sig.**
Financial Behavior (0 to 1)	**+0.2744**	0.0064	43.11	<0.001	***
Digital Behavior (0 to 1)	**+0.0610**	0.0044	13.86	<0.001	***
Female (0 to 1)	-0.0097	0.0028	-3.53	<0.001	***
Age (per year)	+0.0002	0.0001	2.71	0.007	***
Education (per level)	+0.0106	0.0023	4.57	<0.001	***
Income Quintile (per unit)	+0.0146	0.0010	14.31	<0.001	***
Urban (0 to 1)	+0.0002	0.0030	0.06	0.954	n.s.

*Urban (0 to 1) AME = +0.0002, p = 0.954 - not significant. Financial/Digital Behavior: binary dummies operationalizing financial literacy and digital literacy respectively (see Table 2 note and Section 3.2). *** p<0.01; ** p<0.05; n.s. = not significant.*

Model 3: Retirement Saving

Financial behavioral engagement has a strong positive effect on retirement saving (AME = **+0.1473**, +14.7 pp), reflecting the role of financial competency in long-term planning. Digital behavioral engagement also raises retirement saving probability (AME = +0.0587, +5.9 pp). A key finding: age is **positively** associated with retirement saving here (AME = +0.0017, +0.17 pp per year), opposite to its negative effect in Model 1, consistent with life-cycle theory that individuals save more deliberately for retirement as they approach it, even as overall saving propensity declines.

Table 6
Average Marginal Effects - Dependent Variable: Retirement Saving P(saving_old=1)
AME = change in probability of saving for old age (pp) per unit change in predictor. N = 75,134.

Variable	AME	Std. Err.	z	p-value	Sig.
Financial Behavior (0 to 1)	**+0.1473**	0.0055	26.71	<0.001	***
Digital Behavior (0 to 1)	**+0.0587**	0.0048	12.25	<0.001	***
Female (0 to 1)	-0.0146	0.0031	-4.65	<0.001	***
Age (per year)	+0.0017	0.0001	17.68	<0.001	***
Education (per level)	+0.0165	0.0027	6.14	<0.001	***
Income Quintile (per unit)	+0.0150	0.0012	12.80	<0.001	***
Urban (0 to 1)	+0.0013	0.0033	0.39	0.695	n.s.
*Age AME is positive here (+0.0017) vs negative in Model 1 (-0.0015): consistent with life-cycle theory. Financial/Digital Behavior: binary dummies operationalizing financial literacy and digital literacy respectively (see Table 2 note and Section 3.2). *** p<0.01; n.s. = not significant.*					

Model 4: Informal Saving

The informal saving model reveals a striking reversal. Financial behavioral engagement has a markedly weaker effect (AME = **+0.0115**, only **+1.1 pp**), compared to 21.5 pp for general saving and 27.4 pp for formal saving; confirming that financially engaged individuals substitute informal saving with formal alternatives. By contrast, digital behavioral engagement has a substantially larger effect on informal saving (AME = **+0.0754**, +7.5 pp), exceeding its formal saving effect (+6.1 pp), consistent with mobile money platforms facilitating saving outside formal banking channels. Education carries a **negative** AME of -0.0384 on informal saving (-3.8 pp per level), while women are significantly more likely to save informally (+3.6 pp) and urban residents significantly less (-3.1 pp).

Table 7
Average Marginal Effects - Dependent Variable: Informal Saving P(saving_inf=1)
AME = change in probability of saving through informal groups (pp) per unit change in predictor. N = 75,134.

Variable	AME	Std. Err.	z	p-value	Sig.
Financial Behavior (0 to 1)	**+0.0115**	0.0049	2.37	0.018	**
Digital Behavior (0 to 1)	**+0.0754**	0.0050	15.04	<0.001	***
Female (0 to 1)	+0.0363	0.0031	11.73	<0.001	***
Age (per year)	-0.0008	0.0001	-8.42	<0.001	***
Education (per level)	-0.0384	0.0029	-13.48	<0.001	***
Income Quintile (per unit)	+0.0187	0.0012	15.89	<0.001	***
Urban (0 to 1)	-0.0309	0.0034	-9.04	<0.001	***
Education AME is negative (-0.0384): more educated individuals substitute informal with formal saving. Digital Behavior (+0.0754) exceeds Financial Behavior (+0.0115). Financial/Digital Behavior:					

*binary dummies operationalizing financial literacy and digital literacy respectively (see Table 2 note and Section 3.2). *** p<0.01; ** p<0.05.*

Robustness Checks: With and Without Urban Variable

Table 8 compares the baseline model (with urban, N = 75,134) against a specification excluding urban (N = 142,684). The core findings are robust: the AME on financial behavioral engagement in the full-sample model is 0.215 (SE = 0.005, p < 0.001), virtually identical to the baseline, and the AME on digital behavioral engagement is 0.163 (SE = 0.005, p < 0.001). The female indicator becomes marginally significant in the full-sample model (AME = -0.008, p = 0.021), suggesting a small but detectable gender saving gap attenuated in the smaller urban subsample. All other coefficient directions and significance levels are preserved.

Table 8
Robustness Check: With and Without Urban Variable

	With Urban (1)	**Without Urban (2)**
Financial Literacy	0.762***	0.938***
	(0.028)	(0.022)
Digital Literacy	0.870***	0.684***
	(0.026)	(0.021)
Female	-0.017	-0.035**
	(0.020)	(0.015)
Age	-0.007***	-0.007***
	(0.001)	(0.0004)
Education	0.052***	0.150***
	(0.017)	(0.013)
Income Quintile	0.180***	0.186***
	(0.007)	(0.005)
Urban	-0.105***	n/a
	(0.021)	
Constant	-1.089***	-1.299***
	(0.043)	(0.032)
Observations	75,134	142,684

*Note: Standard errors in parentheses. "Financial Literacy" and "Digital Literacy" denote the Financial Behavioral Engagement Index and Digital Behavioral Engagement Index operationalizing these theoretical constructs; see Table 2 note and Section 3.2. *p<0.1; **p<0.05; ***p<0.01*

Moderation Effect: Financial x Digital Behavioral Engagement Interaction

The interaction term between financial and digital behavioral engagement is negative and highly significant (β = -0.345, SE = 0.045, p < 0.001), supporting Hypothesis 2. In the interaction model, the AME on financial behavioral engagement is +0.2205 and on digital behavioral engagement is +0.1405. The total log-odds effect for an individual with both high

financial and digital engagement is $\beta_1 + \beta_2 + \beta_{12} = 1.160 + 0.806 + (-0.345) = 1.621$; positive and large, but less than the sum of individual effects (1.966). Economically, this means that possessing both competencies simultaneously generates a **substitution effect of 0.345 log-odds units**: the marginal value of the second competency is diminished because both constructs partially operate through the same channel of reducing barriers to formal financial system access. This is consistent with Hypothesis 2 and suggests that financial and digital behavioral engagement are partial substitutes rather than pure complements in driving saving behavior.

Table 9
Moderation Effect: Financial x Digital Behavioral Engagement Interaction

	Main Model (1)	**Interaction Model (2)**
Financial Literacy (FL)	0.938***	1.160***
	(0.022)	(0.037)
Digital Literacy (DL)	0.684***	0.806***
	(0.021)	(0.026)
Female	-0.035**	-0.033**
	(0.015)	(0.015)
Age	-0.007***	-0.007***
	(0.0004)	(0.0004)
Education	0.150***	0.155***
	(0.013)	(0.013)
Income Quintile	0.186***	0.186***
	(0.005)	(0.005)
FL x DL Interaction	n/a	-0.345***
		(0.045)
Constant	-1.299***	-1.321***
	(0.032)	(0.032)
Observations	142,684	142,684

*Note: Standard errors in parentheses. "Financial Literacy" and "Digital Literacy" denote the Financial Behavioral Engagement Index and Digital Behavioral Engagement Index operationalizing these theoretical constructs; see Table 2 note and Section 3.2. *p<0.1; **p<0.05; ***p<0.01*

Regional Heterogeneity Analysis

Table 10 presents sub-sample regressions across seven World Bank geographic regions, testing Hypothesis 3. Financial behavioral engagement is positive and highly significant in all seven regions, with log-odds coefficients ranging from 0.799 (LAC) to 1.482 (South Asia). The effect is strongest in **South Asia** (β = 1.482, N = 7,994) and **Europe and Central Asia** (β = 1.359, N = 48,267), and weakest in **Sub-Saharan Africa** (β = 0.801) and **Latin America** (β = 0.799).

The most striking regional finding supports Hypothesis 3: in **Sub-Saharan Africa**, digital behavioral engagement (β = 1.107) substantially exceeds financial behavioral engagement (β

= 0.801), the only region where this reversal occurs. Economically, this means that in Sub-Saharan Africa, active use of digital financial tools has a stronger association with saving propensity than engagement with formal financial institutions, consistent with the documented role of mobile money in enabling saving among previously unbanked populations. In **Europe and Central Asia**, the inverse holds: financial behavioral engagement (β = 1.359) is more than three times stronger than digital behavioral engagement (β = 0.432), reflecting high baseline digital penetration where additional digital competency yields diminishing returns.

Cross-regional gender heterogeneity further enriches the analysis. Women save significantly more in South Asia (β = +0.256, p < 0.001), attributable to women's self-help groups and microfinance institutions, while they save significantly less in ECA (β = -0.083) and LAC (β = -0.289). Income quintile is uniformly positive and significant across all seven regions, confirming that income constraints bind regardless of geographic context.

Table 10
Regional Analysis: Impact of Financial and Digital Behavioral Engagement on Saving Behavior

	EAP (1)	**ECA (2)**	**LAC (3)**	**MENA (4)**	**NA (5)**	**SA (6)**	**SSA (7)**
Financial Literacy	1.093***	1.359***	0.799***	0.827***	1.031***	1.482***	0.801***
	(0.074)	(0.042)	(0.058)	(0.072)	(0.386)	(0.090)	(0.048)
Digital Literacy	0.538***	0.432***	0.481***	0.407***	0.560**	0.600***	1.107***
	(0.074)	(0.045)	(0.058)	(0.072)	(0.270)	(0.100)	(0.039)
Female	0.092*	-0.083***	-0.289***	0.066	-0.190	0.256***	-0.031
	(0.048)	(0.026)	(0.043)	(0.051)	(0.152)	(0.075)	(0.030)
Age	-0.003**	-0.006***	-0.019***	-0.004**	-0.016***	0.003	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)	(0.002)	(0.001)
Education	0.401***	0.226***	0.279***	0.159***	0.669***	0.148**	0.240***
	(0.040)	(0.022)	(0.037)	(0.040)	(0.161)	(0.066)	(0.029)
Income Quintile	0.236***	0.184***	0.178***	0.193***	0.441***	0.128***	0.156***
	(0.018)	(0.009)	(0.016)	(0.019)	(0.066)	(0.027)	(0.011)
Constant	-1.776***	-1.729***	-1.124***	-1.833***	-2.009***	-2.580***	-1.191***
	(0.108)	(0.067)	(0.098)	(0.118)	(0.516)	(0.186)	(0.068)
Observations	18,325	48,267	18,314	12,045	1,953	7,994	35,786

*Note: EAP=East Asia & Pacific; ECA=Europe & Central Asia; LAC=Latin America & Caribbean; MENA=Middle East & North Africa; NA=North America; SA=South Asia; SSA=Sub-Saharan Africa. "Financial Literacy" and "Digital Literacy" denote the Financial Behavioral Engagement Index and Digital Behavioral Engagement Index operationalizing these theoretical constructs; see Table 2 note and Section 3.2. *p<0.1; **p<0.05; ***p<0.01*

Discussion

The empirical analysis generates several findings that, taken together, advance the understanding of behavioral determinants of saving in a cross-country context. This section synthesizes the key results, interprets their economic and financial implications in light of the theoretical frameworks introduced in Section 2, and situates them within the broader literature.

Financial Behavioral Engagement and Saving: Mechanisms and Implications

The positive and statistically significant association between financial behavioral engagement and saving behavior across all model specifications is consistent with the predictions of both the human capital model (Jappelli and Padula, 2013) and the life-cycle hypothesis (Modigliani and Brumberg, 1954). The average marginal effect of 21.5 percentage points on general saving confirms that the practical application of financial competency, manifested through active account usage, card ownership, and digital financial engagement, constitutes a more powerful predictor of saving propensity than income alone (AME = 3.9 pp per income quintile). This is consistent with the interpretation advanced by Jappelli and Padula (2013), who argue that financial literacy raises the effective return to saving by enabling better product choices, and with the empirical findings of Grohmann et al. (2018), who document a similar positive association between financial inclusion behaviors and saving rates across 14 developing countries.

The channel decomposition across saving outcomes reveals that financially engaged individuals do not merely save more in aggregate but systematically redirect their saving toward formal institutional channels. The AME on formal saving (27.4 pp) substantially exceeds that on informal saving (1.1 pp), a pattern that is consistent with the behavioral prediction that financially literate individuals possess greater awareness of formal savings products and greater confidence in navigating formal financial institutions. The strongly negative effect of education on informal saving (-3.8 pp per level) reinforces this interpretation: rising educational attainment reflects a progressive substitution of informal saving mechanisms, savings clubs, ROSCAs, with bank accounts and regulated savings products, echoing the findings of Anderson and Baland (2002) on the role of informal savings as a transitional financial instrument.

Digital Behavioral Engagement: An Independent and Contextually Variable Channel

The finding that digital behavioral engagement exerts a positive and significant effect on saving behavior net of financial behavioral engagement and all controls indicates that digital competency operates through a distinct mechanism from financial competency, one that is theoretically grounded in transaction cost theory (Coase, 1937) rather than the human capital model. By reducing the logistical barriers to saving, travel costs, minimum balance requirements, documentation, digital financial tools expand saving participation among populations whose primary constraint is access rather than knowledge. This interpretation is consistent with the evidence from Jack and Suri (2014) and Suri and Jack (2016) on the transformative effects of M-PESA in Kenya, and with the broader digital financial inclusion literature reviewed by Ozili (2018).

The regional heterogeneity analysis sheds light on the context-dependence of this mechanism. In Sub-Saharan Africa, digital behavioral engagement (β = 1.107) exceeds

financial behavioral engagement (β = 0.801), the only region where this reversal occurs. This finding is consistent with the documented leapfrogging of traditional banking infrastructure through mobile money in the region (Demirguc-Kunt et al., 2022), and confirms that where formal banking is limited, digital tools serve as the primary conduit for saving rather than a complement to existing formal channels. In contrast, in Europe and Central Asia, where digital penetration is already high, the marginal return to additional digital competency is comparatively low (β = 0.432), while financial behavioral engagement retains a substantial premium (β = 1.359). This pattern indicates that in digitally saturated economies, the binding constraint on saving behavior shifts from access to knowledge, precisely the mechanism captured by the financial behavior index.

The Substitution Effect Between Financial and Digital Behavioral Engagement

The negative and significant interaction term (β = -0.345, $p < 0.001$) is among the most theoretically consequential findings of this study. Rather than being purely complementary, as might be expected if the two forms of literacy operated through entirely distinct channels, financial and digital behavioral engagement may exhibit a partial substitution dynamic in their joint influence on saving. This finding warrants careful interpretation.

The substitution pattern arises because both constructs share a common underlying mechanism: the reduction of barriers to formal financial system access. An individual who actively uses a bank account (high financial behavioral engagement) has already overcome the principal barriers, documentation, trust, familiarity, that prevent saving. For such an individual, the marginal value of digital competency, which also reduces access barriers, is necessarily diminished, because the barrier has already been overcome through an alternative route. Conversely, an individual who is digitally proficient may have already accessed savings instruments through digital channels, reducing the marginal contribution of formal financial engagement. This mechanism is consistent with the substitution hypothesis formalized in Section 2.3, and contrasts with the complementarity prediction that both competencies are jointly necessary to navigate complex fintech products, such that each amplifies the returns to the other (Morgan and Trinh, 2019; Dluhopolskyi et al., 2024).

The policy implication of this substitution effect is significant. Programs that simultaneously promote both financial and digital literacy face diminishing returns compared to targeted interventions that identify and address the specific competency gap most binding for a given population segment. As Morgan and Trinh (2019) note in their analysis of Cambodia and Vietnam, the effectiveness of financial literacy interventions is highly sensitive to the existing competency profile of the target population, a finding that this study extends to the financial-digital literacy nexus at the global scale.

Gender, Institutions, and the Informal-Formal Saving Duality

The gender dimension of saving behavior revealed by the disaggregated outcome analysis presents a more nuanced picture than aggregate saving measures suggest. The finding that women are significantly less likely to save formally (AME = -1.0 pp) but significantly more likely to save informally (AME = +3.6 pp) is consistent with the dual financial landscape documented by Anderson and Baland (2002) for developing economies, where ROSCAs and savings clubs serve as primary financial instruments for women excluded from formal institutions. This pattern indicates that gender gaps in formal saving are driven not by a lower

propensity to save per se, but by structural barriers, differential access to formal institutions, documentation requirements, social norms, that redirect women's saving toward informal channels.

The South Asian reversal, where women exhibit a significantly higher saving propensity (β = +0.256, $p < 0.001$), points to the catalytic role of institution-specific mechanisms in reshaping the gender-saving relationship. The extensive network of women's self-help groups (SHGs) and microfinance institutions in India and Bangladesh, which collectively serve hundreds of millions of women, demonstrates that targeted institutional interventions can not only close but reverse the gender saving gap by creating formal saving vehicles tailored to women's circumstances. This finding is consistent with the broader microfinance literature (Banerjee and Duflo, 2007) and suggests that the design of gender-targeted financial inclusion initiatives should prioritize institutional architecture, the availability of women-appropriate savings vehicles, alongside programs promoting financial and digital literacy, as operationalized here through active behavioral engagement with formal financial and digital systems.

Taken together, these gender findings indicate that universal financial inclusion initiatives focused narrowly on account ownership are insufficient to close the gender saving gap. The evidence confirms that the channel through which saving occurs matters as much as the act of saving itself, and that effective policy must address the institutional barriers that systematically redirect women's saving away from formal channels, a conclusion that extends and contextualizes the global gender financial literacy gap documented by Lusardi and Mitchell (2014) and Klapper et al. (2015).

Limitations

Several limitations should be acknowledged. First, the Global Findex 2021 does not include direct psychometric measures of financial knowledge, such as the three-question literacy instrument of Lusardi and Mitchell (2014). The behavioral proxy indices employed here capture active financial and digital engagement rather than cognitive competency per se. The strong positive findings should therefore be interpreted as evidence that *financially and digitally active behavior*, rather than knowledge alone, may drive saving outcomes, with the caveat that behavioral engagement and knowledge are likely correlated but not equivalent.

Second, the cross-sectional survey design precludes causal identification. While the logit models control for an extensive set of individual characteristics, reverse causality remains plausible: individuals who save may accumulate financial and digital competencies through the experience of managing savings accounts and digital payment platforms. Instrumental variable approaches or longitudinal panel designs would strengthen causal inference but are not feasible with the available data.

Moreover, the substantial missing data for the urbanicity variable (47.4%) restricts the primary analysis to 75,134 observations and may introduce sample selection bias if urban survey coverage is systematically correlated with saving outcomes. The robustness specification excluding urban (N = 142,684) largely mitigates this concern, as core findings are preserved across both samples.

Fourth, the fin17a1 variable measuring mobile money saving has 84.3% missing values and was excluded from the saving behavior index. This omission may attenuate the estimated effect of digital behavioral engagement on formal saving in regions where mobile money is the primary formal savings channel, particularly Sub-Saharan Africa.

Fifth, the North America subsample contains only 1,953 observations, resulting in large standard errors and potentially unstable coefficient estimates. Results for this region should be interpreted with caution.

Sixth, the notably high McFadden R^2 for Model 2 (formal saving, $R^2 = 0.744$) reflects a conceptual overlap between two components of the Financial Behavior Index, specifically active account deposits (fl_fin9) and account-based liquidity management (fl_fin10b), and the formal saving outcome variable. While VIF diagnostics confirm the absence of statistical multicollinearity (all VIF < 2.0), this overlap may partially inflate the fit statistic for Model 2. Formal saving results should be interpreted as capturing the *channel preference* dimension of saving behavior rather than saving propensity per se.

Seventh, a fundamental measurement limitation concerns the distinction between behavioral engagement and financial literacy per se. The indices constructed in this study capture observable financial and digital behaviors, account ownership, card use, digital payments, rather than the underlying cognitive competencies of financial knowledge, attitudes, and skills as defined by the OECD/INFE framework (Atkinson and Messy, 2012). The Global Findex 2021 does not include direct knowledge assessments such as the Big Three questions of Lusardi and Mitchell (2008). Behavioral engagement and financial literacy are likely positively correlated, but they are not equivalent: an individual may exhibit high behavioral engagement due to structural factors such as employer-mandated account ownership, mobile money infrastructure, without possessing genuine financial literacy. Findings should therefore be interpreted as evidence that *active financial and digital system engagement* is associated with higher saving propensity, with the caveat that the precise role of cognitive literacy versus behavioral habit formation cannot be disentangled with the available data.

Lastly, the cross-sectional design introduces a potential endogeneity concern. The causal direction of the observed associations is not identified: while the theoretical frameworks reviewed in Section 2 predict that financial and digital competency causally increases saving, the reverse mechanism is equally plausible, individuals who save may accumulate competencies through repeated interaction with financial institutions and digital payment platforms. This learning-by-doing mechanism would generate upward bias in the estimated effects of the behavioral engagement indices. Future research employing instrumental variables, such as exogenous variation in financial infrastructure rollout or digital connectivity, or longitudinal panel designs tracking individuals over time would be better positioned to establish causal identification.

Conclusions

Concluding Remarks

Financial behavior and digital engagement are not merely correlates of saving, they may be among its most powerful individual-level determinants, surpassing the direct effect of income in the analysis presented here. In a global context where nearly one billion adults

remain unbanked and saving rates in developing economies continue to lag behind what income levels alone would predict, understanding how behavioral competencies translate into saving outcomes is not an academic exercise, it carries direct implications for the design of financial inclusion policy, digital infrastructure investment, and financial education programs.

The evidence presented in this study suggests three actionable conclusions for researchers and policymakers. For **researchers**, it indicates that financial and digital literacy, as captured through behavioral engagement proxies, should be modeled jointly rather than separately, and that their interaction may generate substitution rather than complementarity, a finding that challenges the prevailing assumption of additive effects in the financial education literature. For **policymakers in developing economies**, particularly in Sub-Saharan Africa and South Asia, the findings indicate that digital financial inclusion initiatives generate saving benefits that are at least as large as, and in some contexts larger than, traditional financial literacy programs, especially where formal banking infrastructure remains underdeveloped. For **policymakers targeting gender equity**, the evidence confirms that closing the gender saving gap requires institutional reform, creating accessible, women-appropriate savings vehicles, rather than financial education alone.

As the global financial landscape continues to evolve, with the rapid expansion of fintech, mobile money, and central bank digital currencies, the intersection of financial and digital competency will only grow in importance. This study provides a cross-country empirical foundation for that inquiry, and may invite future work to build on its findings with richer data, stronger identification, and more granular measures of the competencies that ultimately determine how individuals navigate an increasingly complex financial world.

From a research gap perspective, this study responds to three interconnected lacunae in the existing literature. First, no prior study has tested the substitution versus complementarity hypothesis between financial and digital literacy at the individual level across a globally representative cross-country sample. The few studies that incorporate both constructs, including Dluhopolskyi et al. (2024) using country-level panel data from 56 emerging economies, and Xu et al. (2024) using household data from rural China, do not permit the estimation of individual-level interaction effects across heterogeneous institutional contexts. Second, the geographic scope of individual-level evidence on the literacy-saving nexus has remained narrow: Grohmann et al. (2018) cover 14 developing economies, Morgan and Trinh (2019) examine five ASEAN countries. The Global Findex 2021 microdata employed here, spanning 143,887 individuals in 139 economies, enable for the first time a simultaneously comparable and internally valid test of regional heterogeneity across all seven World Bank geographic regions, a scale that proves empirically necessary: the reversal of the financial-digital literacy hierarchy in Sub-Saharan Africa could not have been detected in smaller samples. Third, existing cross-country specifications treat saving as an aggregate outcome, imposing a homogeneity constraint across formal, informal, and retirement channels that masks heterogeneous competency effects with distinct policy implications. The disaggregated analysis across four saving outcomes addresses this gap directly. Together, these three contributions define a research design positioned to resolve questions that prior individual-construct and small-sample studies have left empirically open.

Directions for Future Research

The findings of this study may open several productive avenues for future research. First, future work could exploit the panel dimension of the Global Findex across waves (2011, 2014, 2017, 2021) to construct difference-in-differences or fixed-effects specifications that better address the endogeneity concern. The progressive rollout of mobile money and digital banking infrastructure across economies offers potentially exogenous variation in digital access that could serve as an instrumental variable for digital behavioral engagement.

Second, the substitution effect documented between financial and digital behavioral engagement calls for deeper investigation of the *mechanisms* through which the two constructs interact. Future research using mediation analysis could decompose the total effect of financial literacy, as operationalized through behavioral engagement, on saving into a direct effect and an indirect effect operating through digital channel adoption, which would clarify whether digital tools amplify or partially displace the financial literacy premium.

Third, the pronounced regional heterogeneity, particularly the reversal of the financial-digital literacy hierarchy in Sub-Saharan Africa, suggests that country-level analyses using matched Findex-administrative data could provide richer insight into how financial infrastructure development moderates the competency-saving relationship. Specifically, testing whether the digital literacy premium in SSA diminishes as formal banking penetration increases over time would provide a direct test of the transaction cost mechanism hypothesized in Section 2.2.

Fourth, the gender findings point to the need for research that explicitly models the *institutional context* of women's financial behavior, the availability of gender-appropriate savings vehicles, community-based savings mechanisms, and microfinance programs, as a moderator of the financial literacy-saving relationship, where financial literacy is understood as reflected through active behavioral engagement with financial systems. Such research could inform the design of gender-targeted financial inclusion interventions at the policy level.

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