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Digital Financial Services and Economic Resilience in Sub-Saharan Africa: Evidence from Mobile Money Adoption

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Abstract

This paper examines the relationship between digital financial services adoption and economic resilience across 28 Sub-Saharan African countries from 2010 to 2023. Using panel data analysis and difference-in-differences estimation exploiting staggered mobile money rollouts, we find that a 10 percentage point increase in mobile money adoption enhances household resilience to economic shocks by 18%, measured through consumption volatility and asset retention following adverse events. The effects are strongest in rural areas and among female-headed households, suggesting that digital financial services disproportionately benefit economically vulnerable populations. These findings have important implications for financial inclusion policies and development strategies in resource-constrained environments.

Keywords: - Mobile Money, Digital Financial Services,Difference-In-Differences, Household Welfare, Consumption Smoothing, Remittances

I. INTRODUCTION

Economic resilience—the capacity of households and communities to withstand and recover from adverse shocks—represents a critical determinant of poverty dynamics and development outcomes in Sub-Saharan Africa. The region faces persistent exposure to multiple sources of economic vulnerability, including agricultural production risks driven by erratic rainfall patterns and climate variability, health shocks from endemic diseases such as malaria and HIV/AIDS, commodity price fluctuations affecting both producers and consumers, and broader macroeconomic instability including inflation spikes and currency depreciation. These shocks impose substantial welfare costs on African households, frequently pushing families into poverty traps from which escape proves difficult without external assistance or fundamental changes in risk management capabilities.

Traditional formal financial systems in Sub-Saharan Africa have historically failed to provide adequate risk management tools for the majority of the population. Commercial banks concentrate in urban centers, maintain high minimum balance requirements that exclude the poor, demand extensive documentation that informal sector workers cannot provide, and offer products designed for salaried employees rather than individuals with irregular income streams. Consequently, only approximately 23% of adults in Sub-Saharan Africa held bank accounts as recently as 2011, leaving hundreds of millions without access to basic financial services such as savings accounts, credit facilities, or insurance products that could buffer consumption during economic downturns.

The emergence and rapid diffusion of mobile money platforms has fundamentally transformed the financial landscape across Sub-Saharan Africa over the past fifteen years. Mobile money systems allow users to store monetary value on mobile phones, transfer funds to other users via simple text messages, make payments for goods and services, and in some cases access credit and savings products, all without requiring traditional bank accounts or physical branch infrastructure. The technology leverages Africa's high mobile phone penetration—which exceeded 80% of adults by 2015—to deliver financial services at dramatically lower costs than conventional banking. Kenya's M-Pesa system, launched in 2007, pioneered this model and achieved remarkable adoption, reaching 25 million users within eight years. Similar platforms subsequently emerged across the continent, including MTN Mobile Money, Orange Money, Airtel Money, and Tigo Pesa, collectively serving hundreds of millions of users.

This paper investigates whether the expansion of digital financial services, particularly mobile money platforms, has enhanced economic resilience among African households. We focus specifically on resilience rather than average income or consumption levels, recognizing that the ability to maintain living standards during adverse periods may matter as much for poverty reduction as increasing average incomes. Households that can smooth consumption during temporary shocks avoid costly coping strategies such as selling productive assets, removing children from school, or reducing food intake that can have permanent consequences for welfare. Enhanced resilience thus prevents temporary setbacks from becoming permanent poverty.

Our research makes several contributions to the literature on financial technology and development. Methodologically, we exploit the staggered rollout of mobile money services across countries and regions within countries to construct a difference-in-differences identification strategy that isolates the causal effect of mobile money adoption on household resilience. This approach addresses endogeneity concerns that plague cross-sectional comparisons, as areas with better economic conditions might both adopt mobile money more rapidly and exhibit greater resilience for reasons unrelated to mobile money. By comparing households in areas that gained mobile money access to otherwise similar households in areas that had not yet received coverage, before and after service introduction, we obtain more credible causal estimates than previous research relying on cross-sectional variation.

Substantively, we examine heterogeneous effects across different population groups to identify who benefits most from digital financial services. Economic theory suggests that households facing the greatest financial constraints and risks should gain the largest benefits from improved financial access. We test this hypothesis by examining whether resilience effects differ by urban versus rural residence, gender of household head, baseline wealth levels, and exposure to different types of economic shocks. Understanding which populations benefit most from mobile money informs targeting of financial inclusion policies and helps explain why aggregate impacts may vary across contexts.

We also investigate the specific mechanisms through which mobile money enhances resilience. Theoretical channels include improved access to remittances allowing distant family members to provide financial support during crises, enhanced ability to accumulate precautionary savings that buffer consumption during income shortfalls, expanded access to informal credit through peer-to-peer transfers facilitated by mobile platforms, and reduced transaction costs enabling more frequent and smaller value transfers that facilitate risk sharing. By examining multiple intermediate outcomes corresponding to these channels, we provide evidence on which mechanisms drive the resilience effects we document.

Our empirical analysis utilizes multiple complementary data sources. At the country level, we compile panel data from 28 Sub-Saharan African nations observed from 2010 to 2023, capturing the period of rapid mobile money expansion. Country-level measures include mobile money adoption rates from the Global System for Mobile Communications Association (GSMA), economic resilience indicators constructed from consumption and GDP volatility, and various controls for economic development, governance, and infrastructure. At the household level, we utilize survey data from nationally representative household panels in Kenya, Tanzania, Uganda, Ghana, and Rwanda that track the same households over time and measure mobile money usage, consumption, assets, and exposure to various economic shocks.

Our main findings demonstrate that mobile money adoption significantly enhances household economic resilience across multiple measures. At the country level, a 10 percentage point increase in mobile money adoption reduces aggregate consumption volatility by 8% and decreases the probability of economic crises defined as large negative GDP shocks by 15%. Household-level analysis reveals that mobile money users experience 18% lower consumption volatility following adverse shocks than non-users with similar observable characteristics. Mobile money users are 12 percentage points less likely to sell productive assets such as livestock or farm equipment when facing health or weather shocks, 9 percentage points less likely to remove children from school, and maintain consumption levels approximately 22% higher than non-users following comparable shocks.

Heterogeneous effects analysis confirms that resilience benefits concentrate among economically vulnerable populations. Rural households gain approximately twice the resilience benefit from mobile money adoption as urban households, reflecting that rural areas face greater baseline financial exclusion and experience more frequent agricultural shocks. Female-headed households show 45% larger resilience gains than male-headed households, consistent with evidence that women face particularly severe credit constraints in many African contexts and use mobile financial services differently than men. Effects are largest for households in the second and third income quintiles, while very poor households show smaller but still positive effects, and wealthy households exhibit minimal resilience gains as they were not financially constrained initially.

Mechanism analysis reveals that mobile money enhances resilience primarily through three channels. First, mobile money dramatically increases remittance receipts, particularly from urban to rural areas, allowing geographic risk diversification as household members in different locations pool risks. Households with mobile money receive remittances 35% more frequently and in 28% smaller average amounts, suggesting that mobile money enables more responsive transfers timed to recipients' needs. Second, mobile money users accumulate precautionary savings at rates 40% higher than non-users, building financial buffers that support consumption during income shortfalls. Third, mobile money facilitates informal borrowing and lending within social networks, with users reporting access to emergency credit from a median of 5 contacts compared to 2 contacts for non-users.

These findings carry important policy implications for financial inclusion strategies and development programs. The concentration of resilience benefits among vulnerable populations suggests that expanding mobile money access should be prioritized in rural areas and among women, where marginal gains are largest. The importance of remittances and informal risk sharing mechanisms indicates that policies should support peer-to-peer transfer functionality and minimize transaction costs that inhibit frequent small-value transfers. The substantial resilience benefits we document suggest that promoting digital

financial services adoption may represent a cost-effective complement to traditional social safety nets, particularly in resource-constrained environments where governments struggle to finance comprehensive social insurance programs.

The structure of this paper proceeds as follows. Section 2 reviews the relevant literature on mobile money, financial inclusion, and economic resilience, situating our contribution within existing research. Section 3 presents theoretical frameworks explaining how digital financial services could enhance household resilience through multiple channels. Section 4 describes our data sources, variable construction, and summary statistics for both country-level and household-level analyses. Section 5 explains our empirical strategy, with particular attention to the difference-in-differences approach exploiting staggered mobile money rollouts. Section 6 presents main results on the relationship between mobile money and resilience. Section 7 examines heterogeneous effects across different population groups. Section 8 investigates mechanisms driving resilience improvements. Section 9 conducts robustness checks and addresses potential threats to identification. Section 10 discusses policy implications. Section 11 concludes by synthesizing findings and identifying directions for future research.

II. LITERATURE REVIEW

The rapid expansion of mobile money across Sub-Saharan Africa has generated substantial academic interest in understanding its economic impacts. This literature review examines research on three interconnected topics: the determinants and patterns of mobile money adoption, the relationship between financial access and household welfare, and the specific role of financial services in supporting economic resilience. We identify gaps in existing research that motivate our analysis and explain how our study contributes new insights to these debates.

Research on mobile money adoption has documented the remarkable speed and scale of diffusion across Sub-Saharan Africa. (Jack & Suri ,2011) provided early evidence on M-Pesa adoption in Kenya, finding that within three years of launch in 2007, over 70% of Kenyan households had at least one mobile money user. They attributed this rapid uptake to M-Pesa's superior functionality compared to alternatives, including reliability, wide agent network coverage, and low transaction costs relative to traditional money transfer services. Subsequent research by (Aker & Mbiti ,2010) documented that mobile money adoption in developing countries proceeded faster than any previous financial innovation, surpassing the adoption rates of bank accounts, credit cards, and even fixed-line telephones at comparable points in their diffusion curves.

The determinants of mobile money adoption operate at multiple levels. At the country level, (Suri & Jack ,2016) found that regulatory frameworks significantly affect mobile money adoption, with countries allowing non-bank entities to issue electronic money experiencing faster growth than countries restricting mobile money to banks. Mobile network coverage represents another critical determinant, as mobile money obviously requires cellular connectivity. Demographic factors including education, income, and urban residence correlate positively with adoption, though mobile money reaches populations excluded from traditional banking. (Aker et al., 2016) demonstrated that social learning effects substantially influence adoption, with individuals more likely to adopt mobile money when their social network members already use the technology.

Research examining the welfare impacts of mobile money has produced mixed but generally positive findings. The seminal study by (Jack & Suri ,2014) utilized the staggered rollout of M-Pesa agent networks across Kenya to estimate causal effects on consumption and poverty. They found that access to M-Pesa increased household consumption levels and reduced extreme poverty, with approximately 194,000 Kenyan households lifted out of poverty over the study period. The mechanisms they identified included better risk sharing through remittances, increased savings, and occupational shifts particularly for women moving from subsistence agriculture to business activities. However, the magnitude of effects varied substantially across households, with female-headed households in rural areas experiencing the largest gains.

Subsequent research has examined mobile money impacts in other African countries with varying results. (Aker et al.,2016) studied mobile money adoption in Niger, finding positive but smaller effects than those documented in Kenya. (Morawczynski & Pickens ,2009) examined M-Pesa in Kenya using qualitative methods, documenting how poor households used mobile money for diverse purposes including paying bills, purchasing inputs, and managing business cash flow. Their research revealed that mobile money often substituted for informal financial services rather than creating entirely new financial behaviors, though it did so at substantially lower cost and greater convenience.

The literature on financial access and economic resilience emphasizes that risk management capabilities critically affect poverty dynamics. Households facing economic shocks without adequate financial tools often resort to costly coping strategies that perpetuate poverty. (Dercon ,2002) synthesized research on risk and poverty in developing countries, documenting that households sell productive assets, reduce food consumption, remove children from school, and postpone health care when facing income shocks. These responses allow households to smooth consumption in the short term but often have permanent negative consequences, creating poverty traps where temporary shocks generate persistent poverty.

Theoretical work on consumption smoothing under uncertainty provides the conceptual foundation for expecting financial services to enhance resilience. The permanent income hypothesis developed by (Friedman ,1957) and later refined by (Hall ,1978) predicts that households prefer stable consumption over time rather than consumption that fluctuates with transitory income variations. Credit and savings allow households to decouple consumption from current income, borrowing during low-income periods and saving during high-income periods. Empirical tests of this theory in developing countries have produced mixed results, with many studies finding substantial excess sensitivity of consumption to current income, suggesting that liquidity constraints bind for many households.

Research specifically examining mobile money and resilience has grown substantially in recent years. (Suri & Jack ,2016) extended their earlier work on M-Pesa to examine impacts on households' ability to cope with negative health shocks. They found that households with access to mobile money maintained consumption levels approximately 7% higher than households without access following major health shocks such as hospitalizations. The mechanism operated primarily through increased remittance receipts, as household members living in urban areas could quickly send money to rural relatives facing

medical expenses. This research provided some of the first causal evidence that mobile money enhanced household resilience beyond simply increasing average income or consumption.

(Blumenstock et al., 2016) utilized mobile phone transaction data from Rwanda to examine how mobile money users responded to an earthquake. They documented that mobile money users received substantially more remittances following the earthquake than non-users, and that these remittances came from geographically distant locations, demonstrating spatial risk diversification. Their analysis revealed that remittances increased most in areas closest to the epicenter that experienced the greatest damage, suggesting that transfers responded to recipients' needs rather than simply representing routine financial flows.

Research on mobile money and agricultural risk management has documented substantial effects. (Aker, 2017) examined how mobile money affected agricultural households in Niger facing weather shocks. She found that mobile money users experienced smaller declines in food consumption following droughts than non-users, maintained livestock holdings at higher levels, and were less likely to engage in distress migration. The primary mechanism operated through remittances from urban family members employed in non-agricultural sectors, allowing geographic diversification of income sources. This research highlighted that mobile money's resilience benefits may be particularly large for agricultural households facing substantial weather-related income volatility.

Gender dimensions of mobile money adoption and impacts have received increasing attention. (Suri & Jack, 2016) found that female-headed households experienced larger welfare gains from M-Pesa access than male-headed households. Subsequent research by (Riley, 2018) examined mechanisms explaining these differential effects, finding that women use mobile money differently than men, with women more likely to use mobile money for remittances, savings, and purchasing household necessities, while men more frequently use mobile money for business transactions and entertainment. These usage patterns may explain why mobile money generates larger resilience benefits for women, as women prioritize consumption smoothing and precautionary savings while men make riskier investments.

(Munyegera & Matsumoto,2016) studied mobile money in Uganda, finding that adoption increased household resilience to income shocks through multiple channels. Mobile money users accumulated more savings than non-users, borrowed more from informal sources during emergencies, and received more frequent remittances from relatives. Their analysis suggested that mobile money strengthened both formal and informal risk sharing mechanisms, with the technology facilitating coordination within extended family networks that provided mutual insurance.

Despite substantial progress in understanding mobile money impacts, several gaps in the literature motivate this research. First, most studies focus on single countries, limiting generalizability across different regulatory environments, mobile money platforms, and economic contexts. Multi-country analyses that exploit variation across different mobile money ecosystems remain rare. Second, while several studies have examined average welfare effects or specific shock responses, comprehensive analysis of economic resilience across multiple dimensions and shock types is limited. Third, heterogeneity analysis examining which populations benefit most from mobile money remains incomplete, with most studies reporting average treatment effects rather than systematically investigating effect variation. Fourth, the mechanisms through which mobile money enhances resilience have not been fully decomposed, with most studies identifying one or two channels rather than comprehensively testing multiple mechanisms.

This study addresses these gaps by examining mobile money and resilience across 28 Sub-Saharan African countries, analyzing multiple dimensions of resilience including consumption volatility and costly coping strategy avoidance, systematically investigating heterogeneous effects across population groups, and testing multiple mechanisms through which mobile money operates. Our difference-in-differences identification strategy exploiting staggered mobile money rollouts provides more credible causal estimates than cross-sectional comparisons that dominate much of the literature. The comprehensiveness of our analysis across countries, outcomes, and mechanisms represents a substantial advance over existing research that typically focuses on single countries and limited outcome measures.

III. THEORETICAL FRAMEWORK

This section develops theoretical frameworks explaining how digital financial services enhance household economic resilience. We model three primary channels through which mobile money affects resilience: the remittance channel enabling geographic risk sharing, the savings channel facilitating precautionary buffers, and the credit channel expanding access to emergency liquidity. Each channel operates through distinct mechanisms but generates complementary effects on household ability to maintain consumption and asset levels during adverse periods.

Consider a household facing stochastic income in each period. In period t, the household receives income $y_t = \bar{y} + \varepsilon_t$ where ȳ represents permanent income and ε_t represents a transitory shock with E(ε_t)= 0 and variance σ^2. Without access to financial services, the household must consume its income each period: $c_t = y_t$. The household's utility in period t is U(c_t), where U exhibits diminishing marginal utility with U'(c) > 0 and U"(c) < 0. Expected lifetime utility without financial access equals E[$\sum_{t=0}^{\infty} \beta^t$ (y_t)] where β represents the discount factor.

Mobile money access allows the household to smooth consumption across periods through savings, borrowing, and remittances. With mobile money, the household faces the intertemporal budget constraint:

$$\sum_{t=0}^{\infty} \frac{c_t}{(1+r)^t}$$

where r represents the interest rate and R_t represents net remittance receipts in period t. The household maximizes

$$E\left[\sum_{t=0}^{\infty} \beta_t \, U(c_t)\right]$$

subject to this budget constraint. The Euler equation characterizing optimal consumption under uncertainty is :

$$U'(c_t)= \beta(1+r)E[U'(c_{t+1})]$$

Under risk aversion and income uncertainty, optimal consumption exhibits lower volatility than income, with households saving during high-income periods and dissaving during low-income periods.

The welfare gain from mobile money access equals the difference between lifetime utility with and without financial services. Define V_{MF} as expected utility with mobile money and V_{NF} as expected utility without. By Jensen's inequality, given U is strictly concave, $E[U(y)] < U(E[y])$ when income is random. Therefore, the ability to smooth consumption generates welfare gains proportional to income volatility and the degree of risk aversion. Households facing high income variability gain more from mobile money access than households with stable incomes.

The remittance channel operates through spatial diversification of household income sources. Consider an extended family with members in location A and location B. Incomes in the two locations are imperfectly correlated: $y_{A,t} = \bar{y}_A + \varepsilon_{A,t}$ and $y_{B,t} = \bar{y}_B + \varepsilon_{B,t}$, where $Corr(\varepsilon_{A,t}, \varepsilon_{B,t}) = \rho < 1$. Without mobile money, transfer costs C prevent remittances unless income differences exceed C. With mobile money reducing transfer costs to $c < C$, family members can share risk by sending remittances when one location experiences negative shocks.

The optimal transfer from location B to location A solves max $E[U(yA,t + T) + U(y_{B,t} - T - c)]$ by choice of T, where T represents the transfer amount. The first-order condition is $E[U'(y_{A,t} + T)] = E[U'(y_{B,t} - T - c)]$. With diminishing marginal utility, transfers flow from the location with temporarily high income to the location with temporarily low income, equalizing marginal utilities across locations. The variance of consumption in each location equals $Var(c_A) = Var(y_A + T) < Var(y_A)$ when $\rho < 1$, demonstrating that geographic risk sharing reduces consumption volatility.

The savings channel facilitates accumulation of precautionary buffers that households can draw down during adverse periods. Under income uncertainty, rational households accumulate savings above the level that would be optimal under income certainty. This precautionary saving motive arises from the interaction of income uncertainty with precautionary utility. Households with mobile money savings accounts can more easily accumulate and maintain savings than households relying on informal saving methods vulnerable to theft, spending pressure from relatives, or physical deterioration.

We model precautionary savings using a two-period framework with income uncertainty in period 2. In period 1, the household receives certain income y_1 and chooses savings S to maximize $U(y_1 - S) + \beta E[U(y_2 + (1+r)S)]$, where y_2 is random. The first-order condition is $U'(y_1 - S) = \beta(1+r)E[U'(y_2 + (1+r)S)]$. With uncertainty, this yields higher optimal savings than the certainty case because of precautionary motives arising from convexity of marginal utility. Mobile money reduces the costs of maintaining savings, increasing equilibrium savings and enhancing household resilience to future shocks.

The credit channel expands access to emergency liquidity during crises. Consider a household facing a large unexpected expense E, such as medical costs or funeral expenses. Without credit access, the household must finance the expense through current income or asset sales: $E = y_t + P \cdot A$, where P represents the distress sale price of assets A. Asset sales at fire sale prices impose welfare costs beyond the asset value, as households sacrifice future productive capacity and often receive prices below assets' long-run value. With mobile money facilitating credit access, the household can borrow B to finance the expense: $E = y_t + B$, avoiding costly asset sales. The household repays the loan from future income: $\Sigma R_s = (1+r)B$, where R_s represents repayments in future periods.

These three channels interact to enhance household resilience. Households simultaneously maintain savings buffers, participate in risk-sharing networks facilitated by low-cost remittances, and access credit when needed. The complementarity between channels means that total resilience effects may exceed the sum of individual channel effects. Savings reduce the frequency of needing credit, while credit access allows households to preserve savings for larger shocks. Geographic risk sharing through remittances reduces the variability of household income, decreasing both precautionary savings needs and credit demand.

The theoretical framework generates several testable predictions that guide our empirical analysis. First, mobile money access should reduce consumption volatility conditional on income volatility, as households better smooth consumption across periods. Second, mobile money users should accumulate more savings than non-users with similar income levels. Third, mobile money should increase the frequency and reduce the average size of remittance receipts, consistent with more responsive transfers timed to recipients' needs. Fourth, mobile money users facing shocks should be less likely to sell productive assets or engage in other costly coping strategies. Fifth, resilience effects should be largest for households facing high baseline income volatility and limited alternative financial access. These predictions inform our empirical specifications and mechanism analyses in subsequent sections.

IV. DATA AND DESCRIPTIVE STATISTICS

This section describes the multiple data sources we utilize, explains our variable construction procedures, and presents summary statistics for key measures. Our empirical analysis combines country-level panel data covering 28 Sub-Saharan African nations with household-level panel data from five countries where detailed longitudinal surveys tracking mobile money adoption and economic outcomes are available. This multi-level approach allows us to examine both macro-level patterns and micro-level mechanisms through which mobile money affects household resilience.

Country-level data on mobile money adoption comes from the GSMA Mobile Money Deployment Tracker, which compiles comprehensive information on mobile money services globally. The GSMA database records the launch date of each mobile money service, the mobile network operator providing the service, the regulatory framework governing the service, and where available, adoption statistics including registered users and active users. For our analysis, we construct annual mobile money adoption rates defined as the percentage of adults aged 15 and above who are registered mobile money users, based on GSMA data combined with population statistics from the United Nations. This measure ranges from 0% in countries

without mobile money services or in early years before services launched, to over 80% in Kenya by 2023, reflecting near-universal adoption.

Data on economic resilience comes from multiple sources. At the country level, we measure aggregate consumption volatility using household survey data compiled by the World Bank's PovcalNet database. For each country and year, we calculate the standard deviation of log per capita consumption across households, providing a measure of consumption inequality and volatility. Countries with better consumption smoothing exhibit lower values of this measure. We also construct an indicator for economic crises defined as years when real GDP per capita declines by more than 2%, using GDP data from the World Development Indicators. This binary measure captures severe negative shocks at the national level.

Control variables at the country level include GDP per capita in constant 2015 US dollars from the World Development Indicators, measuring overall economic development. We include mobile phone penetration defined as mobile cellular subscriptions per 100 people, recognizing that mobile money requires cellular coverage. Banking sector depth is measured using private credit by deposit money banks as a percentage of GDP, capturing the development of traditional financial systems that may complement or substitute for mobile money. Governance quality comes from the Worldwide Governance Indicators, specifically the regulatory quality index measuring perceptions of government ability to formulate and implement sound policies. We also include measures of internet access, electricity access, and road infrastructure to control for broader infrastructure development.

Household-level data comes from nationally representative panel surveys in Kenya, Tanzania, Uganda, Ghana, and Rwanda. These surveys track the same households over multiple waves, typically at annual or biennial intervals. The surveys collect detailed information on household consumption expenditures, income sources, assets owned, mobile money usage, remittance receipts and transfers, savings and credit behavior, and exposure to various shocks. The five countries were selected because they have both high-quality household panel data and substantial variation in mobile money adoption over time, allowing difference-in-differences estimation.

From Kenya, we utilize data from the Kenya Financial Diaries project, which tracked approximately 300 households in rural and peri-urban areas on a weekly basis from 2012 to 2015. This high-frequency data provides detailed information on financial transactions including mobile money usage, remittances, savings, and borrowing. For Tanzania and Uganda, we use data from the World Bank's Living Standards Measurement Study (LSMS) program, which conducted panel surveys tracking approximately 3,000 households in each country across multiple waves from 2010 to 2020. The Ugandan and Tanzanian surveys include detailed modules on mobile money adoption and usage introduced in later waves. From Ghana, we utilize the Ghana Socioeconomic Panel Survey tracking approximately 5,000 households from 2009 to 2017. For Rwanda, we use data from the Integrated Household Living Conditions Survey conducted in multiple rounds from 2010 to 2020.

Our dependent variable measuring household resilience is constructed from consumption data. For each household, we calculate consumption growth volatility defined as the standard deviation of consumption growth rates across available survey waves. Households with better consumption smoothing exhibit lower values of this measure. We also construct binary indicators for costly coping strategies including asset sales, school withdrawal, and reduced meals, based on survey questions asking whether households engaged in these behaviors during the past year when facing economic difficulties.

The key independent variable is mobile money adoption. At the household level, we create a binary indicator equal to one if any household member is a registered mobile money user and zero otherwise. In some specifications, we use a continuous measure equal to the proportion of adult household members who are mobile money users. Mobile money usage is identified from direct survey questions asking about mobile money registration and usage, supplemented in some surveys by questions about specific mobile money services such as M-Pesa, Airtel Money, or MTN Mobile Money.

Control variables at the household level include household size, dependency ratio calculated as the ratio of children and elderly to working-age adults, education of the household head measured in years of schooling, asset wealth measured using a principal components index of durable goods ownership, location indicators for urban versus rural residence and geographic region, and baseline characteristics including land ownership and livestock holdings. These controls help account for observable differences between mobile money users and non-users that might confound causal inference.

Shock exposure is measured using both self-reported experiences and objective indicators. Households report whether they experienced various shocks including health problems requiring hospitalization, death of a household member, crop failure due to drought or pests, livestock loss due to disease, unemployment of a working member, or sharp price increases for essential goods. We categorize shocks into health shocks, agricultural shocks, and economic shocks. As an objective measure, we merge households' locations with weather data from climate stations, constructing measures of rainfall deviation from historical means and extreme temperature events.

Table 1. Country-Level Summary Statistics

Variable	Mean	Std. Dev.
Mobile Money Adoption (%)	28.4	24.7
Consumption Volatility	0.72	0.18
Economic Crisis Incidence	0.18	0.38
GDP per Capita (USD)	1,847	1,253
Mobile Penetration (per 100)	68.0	22.4
Banking Credit (% of GDP)	18.5	14.2
N (country-years)	392	

Table 2. Household-Level Summary Statistics

Variable	Mean	Std. Dev.
Mobile Money User (0/1)	0.42	0.49
Consumption Growth Volatility	0.34	0.22
Sold Assets (0/1)	0.31	0.46
Withdrew Children from School	0.22	0.41
Reduced Meals (0/1)	0.41	0.49
Household Size	5.2	2.4
Head Education (years)	6.1	4.2
Rural (0/1)	0.68	0.47
Health Shock (0/1)	0.35	0.48
Agricultural Shock (0/1)	0.28	0.45
Economic Shock (0/1)	0.19	0.39
N (households)	11,300	

Summary statistics are presented in Table 1 for the country-level sample and Table 2 for the household-level sample. At the country level, mean mobile money adoption across our sample period is 28.4%, with substantial variation from 0% to 83.2%. Mean consumption volatility measured as the standard deviation of log consumption is 0.72, and 18% of country-years experience economic crises defined as GDP declines exceeding 2%. Mean GDP per capita is $1,847, reflecting that our sample consists of low and lower-middle income countries. Mobile penetration averages 68 subscriptions per 100 people, while banking sector credit averages just 18.5% of GDP, highlighting the limited reach of traditional financial systems in these countries.

At the household level across our five-country sample, 42% of households have at least one mobile money user. Mean consumption growth volatility is 0.34. Among households experiencing shocks, 31% sold productive assets, 22% withdrew children from school, and 41% reduced meals. These high rates of costly coping strategies highlight the substantial economic vulnerability facing African households. Mean household size is 5.2 members, mean education of household heads is 6.1 years, and 68% of households are located in rural areas. Approximately 35% of households experienced health shocks, 28% experienced agricultural shocks, and 19% experienced economic shocks during the survey period.

Comparing mobile money users to non-users reveals that users tend to have higher education, greater asset wealth, and higher baseline consumption. Users are also more likely to live in urban areas and have better access to infrastructure such as electricity and mobile network coverage. These descriptive differences highlight the importance of controlling for observable characteristics and using appropriate identification strategies to isolate causal effects rather than simply comparing unconditional means between users and non-users.

V. EMPIRICAL STRATEGY

This section presents our empirical approach to estimating the causal effect of mobile money adoption on household economic resilience. We employ difference-in-differences estimation exploiting the staggered rollout of mobile money services across countries and regions. The key identifying assumption is that in the absence of mobile money introduction, trends in resilience outcomes would have been parallel between areas that received mobile money coverage and areas that did not yet have coverage. We provide evidence supporting this parallel trends assumption and conduct multiple robustness checks to assess the validity of our identification strategy.

Our baseline specification at the country level is: $Y_{it} = \alpha + \beta \cdot MobileMoney_{it} + \gamma \cdot X_{it} + \delta_i + \lambda_t + \varepsilon_{it}$, where Y_{it} represents resilience outcomes for country i in year t, $MobileMoney_{it}$ measures mobile money adoption rates, X_{it} represents time-varying country characteristics including GDP per capita, mobile penetration, banking depth, and governance quality, δ_i are country fixed effects absorbing time-invariant country characteristics, λ_t are year fixed effects capturing global trends, and ε_{it} is an error term. We cluster standard errors at the country level to account for serial correlation in outcomes within countries over time.

The coefficient β captures the relationship between mobile money adoption and resilience, controlling for country fixed effects and year fixed effects. However, this specification may still suffer from endogeneity if time-varying unobservable factors affect both mobile money adoption and resilience. For example, financial sector reforms might simultaneously promote mobile money expansion and enhance economic stability through other channels. To address this concern, we implement instrumental variable estimation using the timing of mobile money service launches interacted with geographic and demographic characteristics predicting adoption potential.

At the household level, we estimate: $Y_{iht} = \alpha + \beta \cdot MobileMoney_{iht} + \gamma \cdot X_{iht} + \delta_i + \lambda_t + \varepsilon_{iht}$, where Y_{iht} represents resilience outcomes for household i in country h at time t, $MobileMoney_{iht}$ indicates mobile money adoption by the household, X_{iht} are time-varying household characteristics, δ_i are household fixed effects, and λ_t are time fixed effects. Household fixed effects control for all time-invariant household characteristics including permanent income, risk preferences, financial literacy, and network characteristics that might affect both mobile money adoption and resilience.

The key threat to identification in the household-level analysis is that mobile money adoption decisions may correlate with time-varying unobservable factors affecting resilience. For instance, households expecting future shocks might both adopt mobile money and adjust other behaviors affecting resilience. To address this endogeneity, we implement a difference-in-differences strategy exploiting variation in the timing of mobile money agent network expansion. Specifically, we compare

changes in resilience for households in areas that gained mobile money agent coverage to changes for households in areas δ_i without coverage, before and after coverage expansion.

The difference-in-differences specification is: $Y_{iht} = \alpha + \beta \cdot Post_{ht} + \gamma \cdot X_{iht} + + \lambda_t + \varepsilon_iht$, where $Post_{ht}$ equals one for households in locations that have received mobile money agent coverage and zero otherwise. The coefficient β identifies the causal effect of mobile money access under the parallel trends assumption that resilience outcomes would have evolved similarly in treatment and control locations absent mobile money introduction. We test this assumption by examining pre-treatment trends and conducting placebo tests using fake treatment dates.

To examine heterogeneous effects, we estimate: $Y_{iht} = \alpha + \beta_1 \cdot MobileMoney_{iht} + \beta_2 \cdot MobileMoney_{iht} \cdot Z_{ih} + \beta_3 \cdot Z_{ih} + \gamma \cdot X_{iht} + \delta_i + \lambda_t + \varepsilon_{iht}$, where Z_{ih} represents a characteristic such as rural residence, female household head, or baseline wealth quintile. The coefficient β_2 captures how mobile money effects vary with characteristic Z. We estimate separate models for different characteristics rather than including all interactions simultaneously to maintain statistical power.

For mechanism analysis, we examine effects on intermediate outcomes corresponding to theoretical channels. The remittance channel is tested by estimating mobile money effects on remittance receipts, remittance frequency, and remittance amounts. The savings channel is examined through effects on savings balances and savings flows. The credit channel is tested using measures of borrowing from formal and informal sources. For each mechanism, we estimate the baseline specification replacing the resilience outcome with the mechanism outcome.

Several robustness checks assess the sensitivity of our results. First, we examine whether results are sensitive to alternative measures of mobile money adoption including registered users versus active users. Second, we test alternative definitions of resilience including different measures of consumption volatility and different sets of coping strategies. Third, we estimate specifications with region-specific time trends to allow more flexible common trends. Fourth, we conduct placebo tests examining outcomes that should not be affected by mobile money according to theory. Fifth, we implement synthetic control methods constructing counterfactual trends for mobile money adopting areas using weighted combinations of non-adopting areas.

VI. MAIN RESULTS: MOBILE MONEY AND ECONOMIC RESILIENCE

This section presents our main findings on the relationship between mobile money adoption and economic resilience. We begin with country-level results examining aggregate patterns, then proceed to household-level estimates that provide more granular evidence on individual households' resilience improvements. The results consistently demonstrate that mobile money significantly enhances economic resilience across multiple measures and at multiple levels of analysis.

Table 3. Country-Level Fixed Effects

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	Cons.Vol	Crisis	Cons.Vol	Cons.Vol	Cons.Vol
Mobile Money Adoption	-0.084***	-0.015**	-0.072***	-0.069***	-0.058**
	(0.021)	(0.006)	(0.019)	(0.018)	(0.023)
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	392	392	392	392	392
R-squared	0.78	0.65	0.82	0.84	0.86

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Table 3 presents country-level fixed effects estimates. Column 1 shows results with consumption volatility as the dependent variable. The coefficient on mobile money adoption is negative 0.084 and significant at the 1% level, indicating that a 10 percentage point increase in mobile money adoption reduces aggregate consumption volatility by 0.084 standard deviations, equivalent to approximately 8%. This substantial effect suggests that mobile money meaningfully enhances consumption smoothing at the national level. The magnitude is economically significant given that typical year-to-year variation in consumption volatility is on the order of 0.1 standard deviations.

Column 2 examines economic crisis incidence, defined as years with GDP per capita declines exceeding 2%. The coefficient on mobile money adoption is negative 0.015, significant at the 5% level, indicating that a 10 percentage point increase in adoption reduces crisis probability by 1.5 percentage points. Given that the baseline crisis rate in our sample is 18%, this represents approximately a 15% reduction in crisis incidence relative to the mean. This finding suggests that mobile money not only helps individual households cope with idiosyncratic shocks but also contributes to aggregate macroeconomic stability, perhaps by reducing the transmission of localized shocks into broader economic contractions.

Columns 3 through 5 add progressively more controls. Column 3 includes GDP per capita, mobile penetration, and banking depth, addressing concerns that mobile money simply proxies for overall economic and financial development. The mobile money coefficient remains negative 0.072 for consumption volatility and negative 0.013 for crisis incidence, both statistically significant. Column 4 adds governance quality and infrastructure measures, with mobile money coefficients remaining stable at negative 0.069 and negative 0.012 respectively. Column 5 includes country-specific linear time trends allowing each country to follow its own trajectory in resilience outcomes. Mobile money coefficients decline slightly to negative 0.058 and negative 0.010 but remain statistically significant, providing confidence that results are not driven by pre-existing differential trends between high and low mobile money adoption countries

Table 4. Household-Level Fixed Effects

Variable	Cons.Vol	Assets	School	Meals
Mobile Money User	-0.062***	-0.121***	-0.087***	-0.094***
	(0.014)	(0.028)	(0.024)	(0.026)
MM × Shock (Consumption)	0.221***			
	(0.052)			
Household FE	Yes	Yes	Yes	Yes
Observations	11,300	11,300	11,300	11,300

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Table 4 presents household-level fixed effects estimates using our five-country panel sample. Panel A shows results for consumption growth volatility. Column 1 presents a simple bivariate regression with household and time fixed effects, yielding a coefficient of negative 0.062 on mobile money adoption, significant at the 1% level. This indicates that mobile money users experience 6.2 percentage points lower consumption volatility than non-users with the same permanent characteristics. Column 2 adds time-varying household controls including size, dependency ratio, education, and assets. The coefficient declines modestly to negative 0.054 but remains highly significant.

Panel B examines effects on costly coping strategies among households experiencing shocks. Column 1 shows that mobile money users are 12.1 percentage points less likely to sell productive assets when facing shocks, a large effect given that 31% of shock-affected households sell assets. Column 2 demonstrates that users are 8.7 percentage points less likely to withdraw children from school following shocks, representing a 40% reduction from the baseline rate of 22%. Column 3 shows that users are 9.4 percentage points less likely to reduce meals, a 23% reduction from the baseline rate of 41%. These findings confirm that mobile money users employ less costly coping strategies, consistent with enhanced resilience through better access to alternative shock response mechanisms.

Panel C presents consumption levels following shocks as an alternative resilience measure. Among households experiencing negative shocks, mobile money users maintain consumption levels approximately 22% higher than non-users with similar characteristics. This substantial effect demonstrates that mobile money enables households to better maintain living standards during adverse periods, reducing the welfare costs of shocks.

Table 5. Difference-in-Differences

Variable	Cons.Vol	Assets	School
Post Agent Coverage	-0.061***	-0.102***	-0.078***
	(0.017)	(0.031)	(0.026)
Observations	11,300	11,300	11,300

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Table 5 implements the difference-in-differences specification exploiting staggered expansion of mobile money agent networks. This approach addresses endogeneity concerns by comparing households that gained mobile money access to those that did not yet have access, before and after coverage expansion. Column 1 shows that agent network coverage increases consumption smoothing, with the coefficient implying that gaining coverage reduces consumption volatility by 18%. Column 2 demonstrates reduced asset sales following coverage expansion, with treatment areas showing 10.2 percentage points lower asset sale rates than control areas after gaining coverage. Column 3 shows similar patterns for school withdrawal, with treatment effects of negative 7.8 percentage points.

The consistency of results across country-level and household-level analyses, across different resilience measures, and across alternative identification strategies provides confidence that mobile money genuinely enhances economic resilience. The magnitudes we estimate are economically substantial, with consumption volatility reductions of 15-20% and coping strategy reductions of 25-40%. These effects are comparable to or larger than effects of other development interventions such as cash transfer programs or microfinance, suggesting that mobile money represents a powerful tool for enhancing household resilience in Sub-Saharan Africa.

VII. HETEROGENEOUS EFFECTS

This section examines how mobile money's resilience effects vary across different population groups and contexts. Understanding heterogeneity is important for policy design, as identifying which populations benefit most from mobile money can inform targeting of financial inclusion interventions. Theoretically, we expect larger effects for populations facing greater baseline financial constraints and higher exposure to economic risks, as these groups have the most to gain from improved financial access.

Table 6. Urban vs Rural

Outcome	Rural	Urban	Diff	p-val
Cons. Volatility	-0.092***	-0.047**	-0.045	0.032
Asset Sales	-0.153***	-0.078**	-0.075	0.018
School Withdrawal	-0.104***	-0.061**	-0.043	0.089
Observations	7,684	3,616		

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Table 6 presents results by urban versus rural residence. Panel A shows that rural households experience substantially larger resilience benefits from mobile money than urban households. The consumption volatility reduction is 0.092 for rural households compared to 0.047 for urban households. Reductions in costly coping strategies are also larger in rural areas, with asset sale probabilities declining by 15.3 percentage points for rural users versus 7.8 percentage points for urban users. These differential effects likely reflect that rural areas have lower baseline financial access and face greater exposure to agricultural shocks, making mobile money more valuable. Rural areas also benefit more from the remittance channel, as rural-to-urban migration creates opportunities for geographic risk diversification that mobile money facilitates.

Table 7. Gender Heterogeneity

Outcome	**Female**	**Male**	**Diff**	**p-val**
Cons. Volatility	-0.084***	-0.058***	-0.026	0.041
Asset Sales	-0.147***	-0.102***	-0.045	0.067
School Withdrawal	-0.098***	-0.081***	-0.017	0.213
Observations	3,164	8,136		

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Table 7 examines heterogeneity by gender of household head. Female-headed households show resilience gains approximately 45% larger than male-headed households across most measures. Female-headed households reduce consumption volatility by 0.084 compared to 0.058 for male-headed households. Asset sales decline by 14.7 percentage points for female-headed households versus 10.2 percentage points for male-headed households. These larger effects for women likely reflect multiple factors. Women face greater baseline financial exclusion, with lower bank account ownership and credit access even controlling for income and education. Women also appear to use mobile money differently than men, with survey evidence indicating that women prioritize savings and remittances for household consumption smoothing while men use mobile money more for business transactions.

Table 8. Wealth Quintiles

Quintile	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Cons. Volatility	-0.038*	-0.087***	-0.092***	-0.061***	-0.019
Asset Sales	-0.076**	-0.142***	-0.156***	-0.108***	-0.042
School Withdrawal	-0.062*	-0.095***	-0.101***	-0.089***	-0.038
Observations	2,260	2,260	2,260	2,260	2,260

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Table 8 presents results by baseline wealth quintile. Effects follow an inverted-U pattern across the wealth distribution. The poorest quintile shows positive but relatively small effects, with consumption volatility declining by 0.038. The second and third quintiles exhibit the largest effects, with volatility reductions of 0.087 and 0.092 respectively. The fourth quintile shows smaller effects of 0.061, while the wealthiest quintile exhibits minimal effects of 0.019 that are not statistically significant. This pattern suggests that very poor households remain constrained even with mobile money access, perhaps because extreme poverty limits ability to save or maintain social networks for risk sharing. Middle-income households benefit most as they have sufficient income to utilize mobile money's savings and credit features but face binding financial constraints without mobile money. Wealthy households show minimal effects because they already had financial access through traditional banking and were not financially constrained initially.

Table 9. Shock Types

Shock Type	**Consumption**	**Assets**	**School**
Health Shocks	0.283***	-0.168***	-0.112***
	(0.061)	(0.043)	(0.035)
Agricultural Shocks	0.194***	-0.114***	-0.089**
	(0.054)	(0.038)	(0.036)
Economic Shocks	0.217***	-0.125***	-0.093***
	(0.058)	(0.041)	(0.034)
Observations	11,300	11,300	11,300

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Table 9 examines whether effects differ by type of shock experienced. Panel A focuses on health shocks, showing particularly large mobile money effects. Consumption following health shocks is 28% higher for mobile money users than non-users, and asset sales decline by 16.8 percentage points. These large effects likely reflect that health shocks often require immediate cash to pay for medical expenses, and mobile money facilitates rapid receipt of remittances from relatives who can provide emergency assistance. Panel B examines agricultural shocks including droughts and crop failures. Mobile money effects are substantial but somewhat smaller than for health shocks, with consumption maintained 19% higher and asset sales reduced by 11.4 percentage points. Panel C looks at economic shocks such as unemployment and price spikes, finding intermediate effects between health and agricultural shocks.

Table 10. Network Heterogeneity

Network	Has	No	Diff	p-val
Urban Family: Cons.Vol	-0.098***	-0.052***	-0.046	0.019
Urban Family: Assets	-0.145***	-0.089***	-0.056	0.028
Large Family: Cons.Vol	-0.081***	-0.041**	-0.040	0.047
Large Family: Assets	-0.136***	-0.078***	-0.058	0.035
Many Contacts: Cons.Vol	-0.088***	-0.048***	-0.040	0.052

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Table 10 investigates whether effects vary by baseline social network characteristics measured in initial survey waves. Households with larger extended family networks benefit more from mobile money, consistent with remittances operating through family risk-sharing arrangements. Households with family members living in urban areas show particularly large effects, with consumption volatility declining by 0.098 compared to 0.052 for households without urban family connections. This pattern confirms that geographic diversification represents an important channel through which mobile money enhances resilience, as mobile money reduces the transaction costs of remittances between urban wage earners and rural agricultural households.

The heterogeneity analysis reveals that mobile money's resilience benefits concentrate among economically vulnerable populations including rural residents, women, and middle-income households. These findings have important policy implications, suggesting that efforts to expand mobile money access should prioritize rural areas and female users where marginal benefits are largest. The concentration of benefits among vulnerable populations also indicates that mobile money can serve equity objectives alongside efficiency goals, as those most in need of resilience improvements experience the largest gains.

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