Digital Technologies for Financial Inclusion: Three Papers on Innovative Mobile Money Regulation and Use in sub-Saharan Africa

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Abstract

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Globally, about 24% of adults lack access to a basic account that can safely store and transfer money. The majority of these adults live in low and middle income countries; many are poor and many are women. Financial exclusion is especially widespread in sub-Saharan Africa, where nearly half of all adults do not have a bank account (Demirguc-Kunt et al., 2018). Advances in digital financial technology, especially through the proliferation of mobile money, offer a new way to extend financial services to populations who do not have access to the formal financial sector. Mobile money technology provides users with a convenient way to send and receive payments, such as domestic remittances, as well as a mechanism to safely and privately store money. Mobile money is accessible for anyone with a mobile phone and SMS network connectivity (smartphone and internet access are not required). Existing research reveals promising improvements in financial inclusion outcomes and welfare benefits (Jack & Suri,

2014; Nanda & Kaur, 2016; Bahia et al., 2020), but mobile money innovations currently outpace the academic literature.

In Chapter 1, I examine one such innovation: a 2014 Bank of Tanzania policy mandating the distribution of interest to mobile wallet account balances. I exploit the differences in interest allocation methods of different mobile money providers in Tanzania to conduct a difference-in-differences analysis of the effect of a specific savings incentive on mobile savings behavior. I find a consistent and positive effect of the savings incentive; customers under this policy had an 11 percentage point increase in the probability of saving with their mobile wallet. I also show that the mobile savings incentive produced no negative repercussions for bank account ownership, directly addressing concerns from the banking sector that mobile interest is a threat to the formal financial sector. Such findings may be highly relevant to the current policy debates around leveraging mobile money interest provision to increase financial inclusion among the world's poorest.

In Chapter 2, I investigate another mobile money innovation: digital loan repayment for microfinance customers. Existing research is largely focused on the implications of digitization for loan repayment rates and operational efficiency, but this paper uniquely centers the overlooked perspectives of microfinance borrowers. I leverage a mixed-methods approach, including a quantitative discrete choice analysis and a qualitative content analysis of stated preferences, to explore the determinants of demand for a digital repayment option among a group of current microfinance clients in Uganda. I find that borrowers' comfortability with mobile money, education level, and perceptions of the cost and convenience of digital repayment are important determinants of demand. However, qualitative data reveal heterogeneity in borrowers' understanding of how digital repayment will impact the microfinance group structure and their

future access to credit, which has substantial implications for the uptake of digital repayment. These findings can inform the design of digital microfinance innovations and also contribute to the broader literature around technology adoption by highlighting the importance of qualitative data and user-centered research.

In Chapter 3, I focus on the diffusion of mobile money policies. Specifically, I examine the policy convergence around risk-based Know-Your-Customer (KYC) regulation over time in sub-Saharan Africa. Risk-based KYC policies lower barriers to both mobile money provision and access. I ask the research question: What are the internal determinants and external influences associated with the regulator's decision to adopt internationally recommended KYC policies for mobile money? Using an event history approach, I investigate the relative importance of domestic banking concentration, foreign aid dependence, and participation in the international financial inclusion community on the time-to-implementation of risk-based KYC policies. While domestic pressures from highly concentrated banking sectors may marginally deter risk-based KYC adoption, I find the primary accelerator of risk-based KYC policy adoption to be regional diffusion. Insight into the mechanisms underlying mobile money policy convergence lays the groundwork for future research to facilitate the regulatory components of financial inclusion promotion.

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A PhD takes a long time - and a lot of life happens in those years! In the last four years, I became an aunt (twice!), met the woman I'm going to marry, and watched Georgia win a national championship (go dawgs!). I also experienced the devastating loss of my dad. I honestly don't think I would have finished this degree without a community around me to support me through both the highs and the lows.

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Chapter 1
Mobile Money Interest Distributions and Savings Behavior in Tanzania

Introduction

Globally, about 24% of adults lack access to a basic account that can safely store and transfer money (Demirguc-Kunt et al., 2022). The majority of these adults live in low and middle income countries; many are poor and many are women. Financial exclusion is especially widespread in sub-Saharan Africa, where nearly half of all adults do not have a bank account (Demirguc-Kunt et al., 2022). Without access to a formal, secure method of saving, individuals may resort to informal methods - such as hiding cash in the house or burying it in a can outside (Batista & Vicente, 2013). These informal methods are less secure from theft and subject to social pressures to give money to family and friends, which can hinder a household's ability to store money for consumption smoothing during lean times and exacerbate the effects of poverty (Riley, 2020). Lack of access to savings accounts can also hinder the ability of small business owners to accumulate capital for entrepreneurial investments (Karlan et al., 2014).

Digital financial inclusion through mobile money extends financial services to populations around the world who do not have access to the formal financial sector (Jack & Suri, 2014; Nanda & Kaur, 2016). Mobile money can be defined broadly as any financial transaction that is carried out on a mobile device, but I prefer to use a narrower definition in the context of development to avoid conflating basic digital financial services with the complexities of internet banking (Suri, 2017). For the purposes of this paper, mobile money refers to digital financial transactions carried out through mobile network operators (MNOs), such as Vodacom or MTN. This distinction of provider is important; MNOs transmit information via SMS messaging and do not require an internet connection (or smartphone). Mobile money is therefore accessible to

anyone with a basic mobile device in a geographic area of limited connectivity. Mobile money technology has been described as enabling unbanked populations to "leapfrog" the institutional barriers to formal financial inclusion (Aron, 2018).

The introduction and expansion of mobile money services in sub-Saharan Africa has the potential to increase financial inclusion and incentivize savings behavior among the region's poorest citizens. Regions with large unbanked populations tend to have a high rate of mobile money use, and the World Bank's 2021 Global Findex Report identified sub-Saharan Africa as the only region in which as many as 33% of adults have a mobile money account (Demirguc-Kunt et al., 2022). The majority of mobile money activity is characterized by sending or receiving payments, such as domestic remittances, but an increasing percentage of users are taking advantage of the opportunity to save with mobile money (Cherwon & Schueth, 2018; Demirguc-Kunt et al., 2018; Waweru & Kamau, 2017). Prior research has shown that mitigating the supply-side barriers to saving is an effective way to increase savings rates among the poor (Banerjee et al., 2022; Demombynes & Thegeya, 2012; Ikhide, 1996; Kochar, 2018; Prina, 2015; Steinert et al., 2018), and access to savings is an important source of resilience during financial shocks - especially for the poorest of the poor (Bukari et al., 2021; Naito et al., 2021). Thus, access to mobile wallets as a safe storage device for those lacking formal savings alternatives may be an important technological development for poverty reduction.

When account holders store money in their mobile wallets (as "e-money"), the MNO is generally required to hold the equivalent value (the "float") in a trust account at a bank. This trust account is typically ring-fenced to safeguard customer assets from financial shocks to the provider, and the MNO is not permitted to intermediate the funds in the trust account. Specific regulation of these float accounts is determined by central banks and varies by country. As global

mobile money transactions reach $1 trillion in value, MNO float accounts have grown to hold hundreds of millions of dollars (Awanis et al., 2022). These large accounts have the potential to earn substantial interest, and the question of how to distribute this interest is a currently debated issue among regulators and policy advisors.

In terms of interest accrual and distribution, central banks take a variety of regulatory approaches: (i) prohibit the accrual of interest on float accounts altogether; (ii) permit interest accrual without stipulating how the interest should be distributed; and (iii) permit interest accrual with specific policies for interest distribution, often mandating that a significant proportion of the interest be returned to the customer (Dias & Kerse, 2021). Variations on the last approach are the most common in sub-Saharan Africa. For example, the Bank of Kenya requires that float interest be donated to charity and prohibits interest distribution to mobile money customers. Conversely, in 2014 Tanzania became the first country to require the distribution of float interest to mobile account holders, followed by Ethiopia, Ghana, Liberia, Malawi, and Rwanda.

Regulations that distribute some portion of the earned interest to mobile account holders could serve as an important lever for incentivizing savings behavior for those without access to formal savings accounts (Di Castri & Gidvani, 2014; Ehrbeck & Tarazi, 2011). However, some formal financial institutions are opposed to policies permitting MNOs to distribute interest to mobile accounts, citing worries that clients will move their money from the formal banking sector into the mobile provider network, which could impact loan interest rates throughout the country (McKay, 2016; Rupiny, 2016). Ghana in particular has had an especially contentious path to policy implementation, as the central bank, banking sector, and MNOs have been unable to compromise on an appropriate interest rate and distribution percentage (Buruku & Staschen, 2016; Sawyer & Welch, 2018). Despite banking sector misgivings, no studies have yet found

evidence to validate concerns that mobile interest payments will lead to financial system disruption.

In this paper, I focus on both banking sector concerns and financial inclusion outcomes by investigating the impact of a mobile interest distribution policy on savings behavior. I exploit the differences in interest distribution policies of different MNOs in Tanzania to conduct a difference-in-differences analysis of the effect of an MNO policy with a specific savings incentive on household bank account ownership and mobile savings behavior. I find that the mobile interest distribution policy has no effect on overall bank account ownership; if anything, the mobile savings incentive may actually increase bank account uptake. Additionally, the distribution of mobile interest increases the likelihood that a household will use mobile money to save money by 11 percentage points when compared to mobile money customers who did not receive interest amounts based on their mobile wallet balances. These findings directly contribute to ongoing policy discussions around the provision of mobile interest by refuting the banking sector's concerns of negative outcomes for financial institutions while demonstrating mobile interest to be a promising mechanism for increasing financial inclusion among the world's poorest.

Study Context

Mobile money launched in Tanzania in 2008. Within five years, over one-third of households used mobile money (Di Castri & Gidvani, 2014), and 55% had mobile money accounts by 2017 (FinScope, 2017). In contrast, the percentage of Tanzanian adults using formal banking services grew much more slowly, from 9% in 2009 to just under 17% in 2017 (Mushi et al., 2017). According to 2021 Findex data, about 18% of adults in Tanzania stored money using a

mobile money account, and fewer than half (49%) saved money through any mechanism - formal or informal (Demirguc-Kunt et al., 2022).

Table 1 describes the mobile money providers in Tanzania. The market share is competitively split among three major MNOs (Vodacom, Tigo Pesa, and Airtel), with a few minor players (EzypPesa, HaloPesa, TTCL).

Table 1: MNOs in Tanzania

MNO	Launch	2016 Mkt Share	2020 Mkt Share
Vodafone	2008	42%	39%
ezyPesa	2009	3%	1%
Tigo Pesa	2010	31%	30%
Airtel	2012	24%	20%
HaloPesa	2016	NA	7%
TTCL	2017	NA	3%

Like most countries, the Central Bank of Tanzania (BoT) mandates that each MNO store the equivalent balance of e-money in a trust account. These trust accounts accrue substantial interest. In 2014, the BoT issued a policy that interest earned on the MNO float accounts must be utilized in a way that shall "directly benefit the mobile money customer" (BoT, 2015). The BoT did not specify an allocation process to satisfy the term "directly benefit" but rather encouraged MNOs to submit their plans for trust interest distribution to the Bank for approval. The three main providers decided on two different quarterly interest allocation mechanisms: Tigo Pesa and Airtel distribute interest to customer wallets based on the average daily stored balance, while Vodacom distributes interest relative to customers' frequency of activity (GSMA, 2014; The

Citizen, 2017, 2020). Table 2 summarizes these policies. There is no indication that ezyPesa, TTCL, or HaloPesa have distributed interest to customers.

Table 2: Interest Distribution Policies

MNO	Begin	Frequency	Policy
Tigo Pesa	Sept 2014	Quarterly	Distributed to all users based on average daily balance
Airtel	July 2015	Quarterly	Distributed to active users[a] based on average daily balance
Vodafone	Dec 2015	Quarterly	Distributed based on level of activity since last disbursement (transfers, purchasing airtime, paying bills, etc)

[a] Active users are customers who have used their mobile wallet at least once during the previous quarter.

In order to distinguish mobile money services from formal financial services provided by prudentially regulated deposit-taking institutions (i.e., commercial banks), the BoT prohibited the advertisement of specific interest rates and descriptions of mobile wallets as savings accounts or investment vehicles (McKay, 2016). Thus, the interest distributions were communicated to customers as profit-sharing initiatives through social media announcements, press releases, and SMS messages.[1] Despite the limitations imposed on the way MNOs were allowed to communicate the policy, the banking sector remained opposed to mobile interest payments for two primary reasons. First, the MNOs were neither categorized nor regulated as deposit-taking institutions, and permitting them to provide bank-like services like interest distribution without also imposing prudential regulations (e.g., mandatory deposit insurance, increased capital requirements, etc) put customers at risk. Second, the banking sector - in Tanzania and other African countries - was and remains concerned that if mobile money customers earn interest on mobile wallets, then they will transfer their money from bank accounts to mobile accounts and

[1] Example of press release: https://allafrica.com/stories/201510010244.html

this large transfer of financial assets out of the formal financial sector could have de-stabilizing effects on interest rates (Buruku & Staschen, 2016; McKay, 2016). There is some cross-sectional evidence to support that a very small percentage of Tanzanians with access to both mobile money and bank accounts may prefer to store money in a mobile money account (Kibwe et al., 2017), but there has been no discernable exodus from the financial sector to mobile money since the interest distributions were implemented. Even if mobile wallet interest pays significantly more than bank account interest, the balance limit on mobile wallets (~$2,000) precludes a massive shift in wealth storage.

The quarterly interest distribution policy adopted by Tigo Pesa and Airtel mirrors the saving incentive of a traditional savings account in that higher mobile wallet balances accrue higher interest payments. In contrast, the Vodacom policy lacks a saving incentive and instead encourages customers to frequently transfer money in and out of their mobile wallets. The differences in interest distribution policies between Tigo Pesa/Airtel and Vodacom present a unique opportunity to study the effect of a mobile saving incentive on saving behavior. I do not expect the mobile saving incentive to disrupt bank account ownership, but I do hypothesize that customers of Tigo Pesa/Airtel will be more likely to save in their mobile wallets than customers of other MNOs as a result of the interest distribution policy.

Data and Research Design

Data come from the Waves 4 and 5 Extended Panels of the Tanzania National Panel Survey (NPS), obtained from the World Bank Living Standards Measurement Study microdata. The Wave 4 survey was conducted in 2014-15, while the Wave 5 survey was conducted in 2018-19. For Wave 4, 989 households were sampled. Of these 989, 131 were lost to follow-up and 326 new households were established as split-offs of Wave 4 households. Thus, Wave 5 contains

1184 households (858 of which comprise a balanced panel with Wave 4). The two waves contain 2173 total observations of 1315 households. For the main analysis, the data are subset to households with mobile money accounts in Wave 4 (1299 observations of 795 households). The NPS panel sample was refreshed for Wave 4, precluding a matched panel of more than two time periods. For clarity, Waves 4 and 5 are hereafter referred to as survey rounds 1 and 2.

Dependent Variable

To analyze the relationship between the mobile savings incentive and bank account ownership, the dependent variable is a binary indicator of whether or not the household had a bank account at the time of the survey.[2] To assess the policy effect on mobile savings behavior, the dependent variable is a binary indicator of whether or not a household used mobile money to save or store money in the past 12 months. The NPS asks this in three sub-questions: did a household use mobile money as a way to (i) save/store for emergencies; (ii) save/store for everyday expenses; and (iii) save/store for a large capital expenditure. I have combined these three questions into a single binary outcome for which mobile savings is indicated with a "yes" response on any of the three questions.

Assignment to Treatment and Control

A household is assigned to treatment if any household member was a customer of Tigo Pesa or Airtel during the first round of the survey. This assignment does not preclude the household from also being a customer of other MNOs. Control households consist of households with at least one member who is a customer of at least one MNO that is not Tigo Pesa or Airtel. New households in round two that came from treatment (control) parent households are also assigned to treatment (control). The decision was made to drop households without mobile

[2] The survey asked: *"Do you or anyone else in your household have a bank account, either with a commercial bank, a credit union, or other similar institution?"*

money in round one from the primary analysis, as the most accurate comparators to mobile money customers of a certain MNO are mobile money users of different MNOs. Including non-users in the control group artificially depresses the proportion of mobile savers in the control group in the first time period and muddies the interpretation of the policy effect if they become mobile money customers between the two time periods.

Summary Statistics

Approximately 60% of households in round one and 75% of households in round two used mobile money.[3] Many households had more than one mobile money account (18% in round one and 27% in round 2, see Figure 1), and the proportion of total accounts belonging to each MNO is roughly equivalent to each MNO's market share in the country (Figure 2).[4]

Figure 1: MM Accounts, per HH

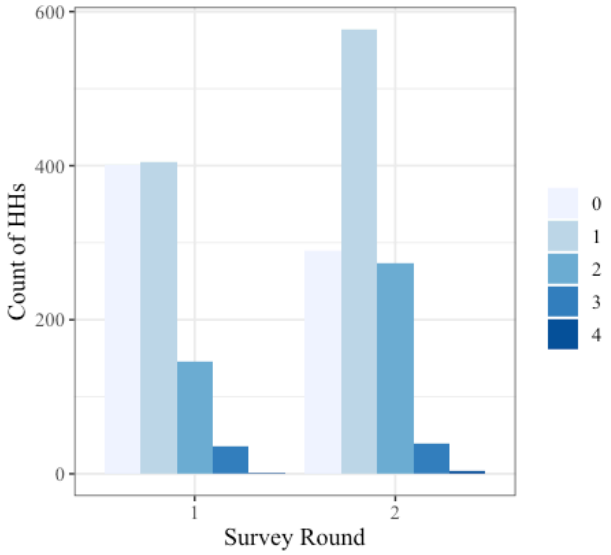
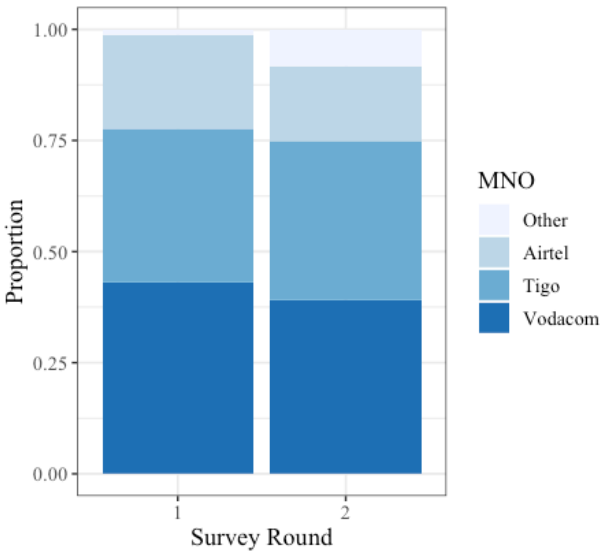


Figure 2: MNO Distribution



Savings behavior differed between the full sample and the sample used for the main analysis (households with mobile money in round 1), with a higher proportion of main analysis

[3] Only households with mobile money in round one were included in the primary analysis.
[4] I am unable to count multiple accounts with the same MNO in a single household; thus, these figures could undercount the total number of accounts.

households saving in both banks and mobile wallets (Table 3).[5] Correlates of saving within this sample accord with those found in the literature (see Appendix), as poorer households, households in rural areas, and households whose income is derived from agriculture tend to save less (Demombynes & Thegeya, 2012; Snyder, 1974). Rates of bank account ownership and mobile savings increased slightly over time for the full sample, but overall savings behavior decreased in the main analysis sample, from 56.6% to 50.7% of households owning a bank account and/or using a mobile wallet to save money.

Table 3: Savings Behavior

	Full sample		**MM in R1**	
	R1	**R2**	**R1**	**R2**
Bank	23.9%	25.1%	34.9%	34.5%
MM	21.6%	22.1%	36.5%	27.4%
Either	36.7%	39.6%	56.6%	50.7%
N	989	1184	587	712

With regard to treatment versus control households, there is a clear difference in the proportion of households who use mobile money to save or store money after the implementation of the interest distribution policy (Figure 3). During the first survey round, the mobile savings behavior was nearly identical for the two groups (~36%). After the implementation of the interest distribution policy, a much higher proportion of households in the treatment group used mobile money to save (31%) than households in the control group (20%). While the difference over time between the treatment and control groups is in the direction expected, the substantial decrease in mobile saving over time is puzzling. Insufficient sample sizes restrict informative

[5] In this paper, "owning a bank account" and "saving in a bank" are used interchangeably.

sub-group analysis, and the lack of additional time periods prevents the establishment of robust pre and post trends in saving behavior. Comparison with cross-sectional Finscope and Findex data mitigates some of these concerns, as there is a similar downward trend in both bank savings and mobile savings for a comparable time period (see Appendix).[6]

Figure 3: HH Saving Behavior, Treatment vs Control

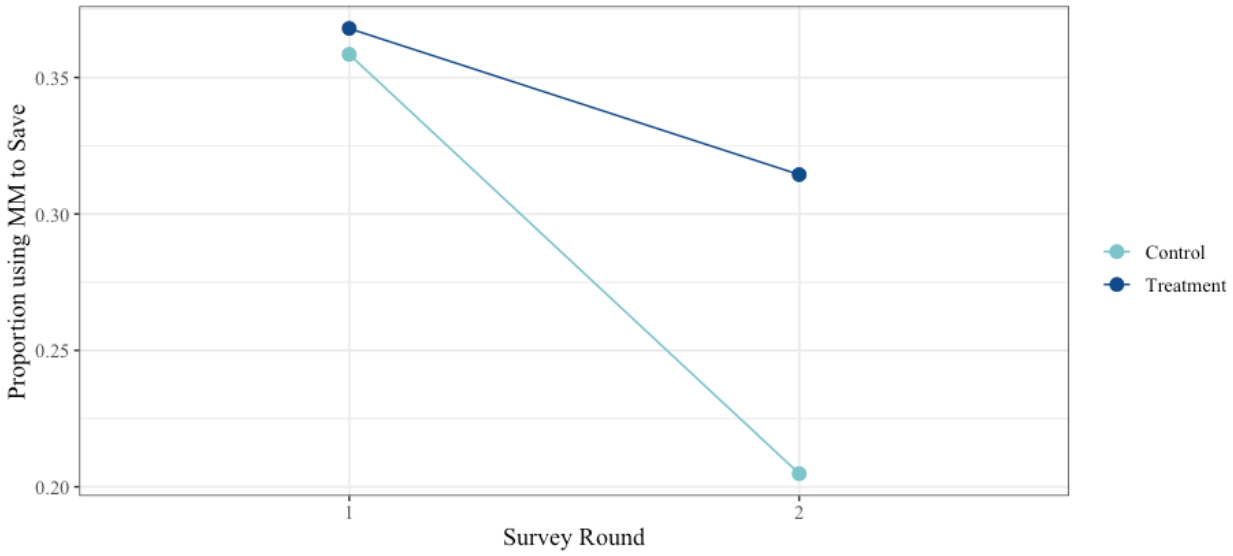


Table 4 lists additional summary statistics for the two groups, by survey round. Notably, bank account ownership is consistent over time for both groups. The groups are relatively similar with regard to the gender, age, and education level of the household head, the household size, and the proportion facing food insecurity in the past year. Treatment households tend to be more likely to have a bank account, less rural, and employed in sectors other than agriculture.

[6] I find decreases in both bank and mobile savings rates for Tanzania with Finscope between 2013-17 and for bank savings with Findex between 2014-17. However, these datasets are much more detailed in their measures of savings behavior and have narrower definitions of "save" than this analysis, making direct comparisons difficult.

Table 4: Summary statistics, by treatment group and round

	Round 1		Round 2	
Variable	**Treatment**	**Control**	**Treatment**	**Control**
MM Save	0.37	0.36	0.31	0.20
Bank Acct	0.38	0.29	0.38	0.28
Male	0.77	0.73	0.75	0.73
Age	41.44	44.29	43.11	43.85
Completed Primary Ed	0.78	0.72	0.8	0.76
HH size	4.53	5.09	4.17	4.88
Rural	0.34	0.57	0.38	0.58
Food Insecurity 12 months	0.29	0.28	0.2	0.16
HH Head Occupation				
Non-Ag Employment	0.66	0.47	0.62	0.54
Unemployed	0.05	0.04	0.09	0.05
Ag Employment	0.29	0.49	0.28	0.42
N	375	212	448	264

Identification Strategy

I use a difference-in-differences approach to estimate the impact of a mobile interest distribution policy with a savings incentive on i) bank account ownership and ii) on mobile savings behavior. Specifically, I estimate the following linear probability model for each research question, using the appropriate dependent variable:

$$Y_{ijt} = \beta_0 + \beta_1(Treatment)_{ijt} + \beta_2(Post)_{ijt} + \beta_3(Treatment * Post)_{ijt} + \alpha_j + \gamma X_{ijt}$$

The outcome of interest (Y_{ijt}) is a binary indicator for i) whether or not a household owned a bank account at the time of the survey or ii) whether or not a household used a mobile money account to save or store money. The coefficient of interest is β_3, which represents the difference in bank account ownership or savings behavior after policy implementation for customers of

Tigo Pesa/Airtel compared to the difference after policy implementation for the control group. Alpha (α_j) represents a geographic fixed effect at the survey cluster level[7], and X_{ijt} is a vector of household control variables including the age, gender, and occupation type of the household head, whether or not the household head has completed primary education, household size, whether or not the household experienced food insecurity (defined as not having enough food to feed the household) in the past year, whether or not the household is categorized as rural, and a dummy indicator for households that were newly split households in round two. Best difference-in-differences practices advocate choosing covariates that are time invariant and that could not also be categorized as outcomes of the treatment (Angrist & Pischke, 2008); thus, I do not include mobile phone ownership or mobile money uptake in my vector of controls.

Before conducting the main analysis, it is important to consider variables that may predict selection into particular MNOs. As a pre-analysis, I estimate a linear probability model with assignment to the treatment group as the dependent variable with four specifications of covariates (Table 5). This step is recommended by Besley and Case to mitigate the potential for endogeneity and to limit omitted variable bias due to time-varying attributes of households that may determine MNO selection (Besley & Case, 2000). The results show that households in the treatment group tend to have slightly younger household heads, and that these household heads are more likely to be unemployed than employed in non-agricultural enterprises. However, the small magnitude of the age estimate and the marginal significance of the occupation estimate alleviate major concerns of selection bias.

[7] Survey clusters refer to villages in rural environments and to census enumeration areas in urban zones.

Table 5: Regression Models to Predict Selection into Treatment

	(1)		(2)		(3)		(4)	
	Est	(SE)	Est	(SE)	Est	(SE)	Est	(SE)
Save	0.013	(-0.033)	-		-		0.004	(-0.033)
Bank	-		0.029	(-0.035)	-		0.027	(-0.038)
Male	-		-		0.013	(-0.037)	0.012	(-0.038)
Age	-		-		-0.003**	(-0.001)	-0.003**	(-0.001)
Primary	-		-		-0.055	(-0.043)	-0.061	(-0.044)
HH size	-		-		0.002	(-0.007)	0.002	(-0.007)
Rural	-		-		-0.039	(-0.045)	-0.041	(-0.045)
Food Security	-		-		0.014	(-0.035)	0.017	(-0.036)
HH Head Occupation								
Unemployed	-		-		0.133	(-0.084)	0.144*	(-0.085)
Agriculture	-		-		-0.042	(-0.044)	-0.035	(-0.045)

Notes: *p<0.1; **p<0.05; ***p<0.01. The comparison category for occupation is employment in non-Agriculture. All specifications include cluster-level fixed effects. Standard errors are clustered at the household.

Findings

Primary Analyses

The results of the main analyses are presented in Tables 6 and 7, as well as in Figure 5. All model specifications include cluster-level fixed effects with standard errors clustered at the household level. The first specification (M1) does not include any covariates, the second (M2) includes covariates that most significantly differ by group, as well as a dummy indicator for households that were newly split in round two, and the third specification (M3) fits all covariates.

Table 6: Bank Account Ownership

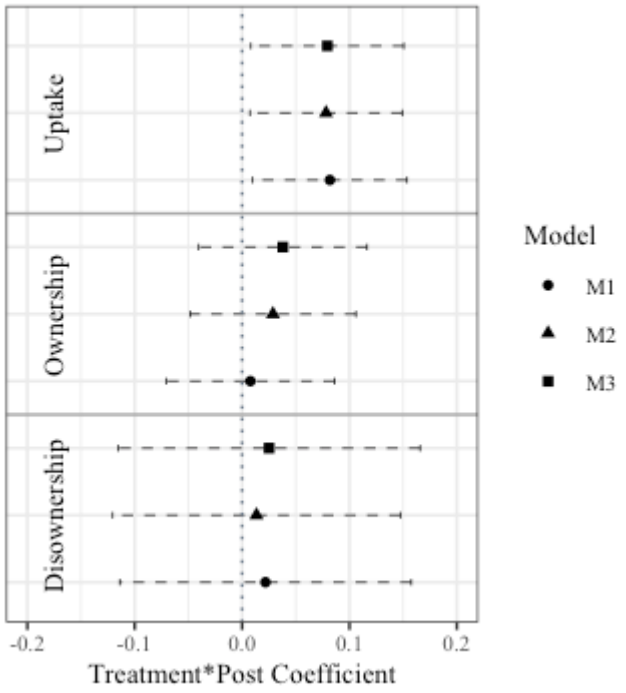
	(M1)		(M2)		(M3)	
	Est	(SE)	Est	(SE)	Est	(SE)
Treatment	0.094*	(-0.05)	0.086*	(-0.048)	0.081*	(-0.046)
Post	0.008	(-0.03)	-0.022	(-0.03)	-0.05*	(-0.03)
Treatment*Post	0.008	(-0.04)	0.029	(-0.039)	0.038	(-0.04)
Age	-		0.005***	(-0.001)	0.007***	(-0.001)
Rural	-		-0.064*	(-0.037)	-0.051	(-0.036)
Split HH	-		0.043	(-0.037)	0.06	(-0.037)
HH Head Occupation						
Unemployed	-		-0.268***	(-0.053)	-0.246***	(-0.049)
Agriculture	-		-0.222***	(-0.037)	-0.194***	(-0.036)
Male	-		-		0.049	(-0.032)
HH size	-		-		0.01*	(-0.005)
Primary Ed	-		-		0.214***	(-0.031)
Food Security	-		-		-0.147***	(-0.028)
Observations	1298		1296		1280	
Cluster FE/SE clustered	Y/Y		Y/Y		Y/Y	
Adj R-squared	0.163		0.208		0.257	
AIC	1597		1529		1420	

Notes: *p<0.1; **p<0.05; ***p<0.01. The comparison category for occupation is employment in non-Agriculture. All specifications include cluster-level fixed effects. Standard errors are clustered at the household.

As reported in Table 6, the effect of the mobile savings incentive on bank account ownership is consistently null across specifications. Age, occupation, education, and food insecurity are much stronger predictors of bank account ownership. Next, I investigate for potential heterogeneity masked by the null effect; that is, I examine whether the mobile savings

policy impacts bank account uptake (for those without a bank account in round 1) and/or effects bank account disownership (for those with a bank account in round 1). Figure 5 plots the difference-in-differences coefficients for these three sets of models, along with the associated 95% confidence intervals.

Figure 5: Bank Account Ownership



The estimates of the mobile savings incentive's impact on bank account ownership (results in Table 5) is plotted in the middle panel. The top panel plots estimates for any effect on bank account uptake, while the bottom panel plots estimates for any effect on bank account disownership. The heterogeneity revealed is in the positive direction for bank account uptake; that is, in an analysis of households who did not have a bank account in round 1, the mobile savings incentive produced a significant increase (~8pp) in bank account uptake for households in the treatment group compared to the control group. For the subset of households who had a bank account in round 1, the mobile savings incentive had no discernible effect on account

disownership. Taken together, these analyses rule out negative effects on bank account uptake along with substantial negative impacts on bank account ownership attributable to the implementation of the mobile savings incentive.

Table 7 contains estimates of the effect of the mobile savings incentive on mobile savings behavior. The coefficient of interest (Treatment*Post) is consistently positive and significant across all three model specifications, with an estimated savings incentive policy effect of an 11 percentage point increase in the probability that a household will use mobile money to save, compared to households in the control group. The relationship between household head occupation and mobile savings is similar to that of bank account ownership, with unemployed household heads and those employed in agricultural settings being significantly less likely to save in mobile wallets. There is no clear relationship between other household characteristics and mobile savings behavior.

Table 7: Mobile Savings Behavior

	(M1)		(M2)		(M3)	
	Est	(SE)	Est	(SE)	Est	(SE)
Treatment	-0.003	(-0.05)	-0.017	(-0.0511)	-0.021	(-0.051)
Post	-0.146***	(-0.04)	-0.168***	(-0.0419)	-0.168***	(-0.042)
Treatment*Post	0.087*	(-0.05)	0.109**	(-0.0519)	0.109**	(-0.052)
Age	-		-0.002*	(-0.0009)	-0.001	(-0.001)
Rural	-		0.009	(-0.0356)	-0.001	(-0.036)
Split HH	-		0.035	(-0.0411)	0.045	(-0.042)
HH Head Occupation						
Unemployed	-		-0.179***	(-0.0545)	-0.18***	(-0.055)
Agriculture	-		-0.101***	(-0.0351)	-0.094***	(-0.036)
Male	-		-		0.014	(-0.032)
HH size	-		-		0.002	(-0.005)
Primary Ed	-		-		0.044	(-0.036)

Food Security	-	-	-0.001 (-0.032)
Observations	1259	1257	1243
Cluster FE/SE clustered	Y/Y	Y/Y	Y/Y
Adj R-squared	0.046	0.065	0.062
AIC	1657	1635	1623

Notes: *p<0.1; **p<0.05; ***p<0.01. The comparison category for occupation is employment in non-Agriculture. All specifications include cluster-level fixed effects. Standard errors are clustered at the household.

Robustness Tests

The Appendix contains the results for multiple tests of the primary analyses' robustness. The results are robust to alternative model specifications, including a logit model and using region-level (instead of cluster-level) fixed effects. When restricting the sample to only the balanced panel (i.e., excluding the 326 split-off households and the 131 lost to follow-up), the magnitude of the mobile savings results remains consistent but the standard errors increase slightly so that the results are only marginally significant. This increase in standard errors suggests that significance of the 11pp increase in mobile savings may be in part an artifact of the interplay between treatment assignment and split-off households, warranting a cautious optimism for the policy treatment effect. The finding that the mobile savings policy had no negative impact on bank account ownership is robust to all tests.

Estimation Concerns

This empirical strategy has three primary estimation concerns. First, the composition of the treatment and control groups over time is messy: approximately one-third of the round 1 sample is in a different category during round 2. That is, seventy households assigned to the control group became customers of Tigo Pesa/Airtel in between survey rounds, and 50 households assigned to the treatment group were mobile money customers of other MNOs

during round 2. Further, 79 mobile money customers in round one were no longer mobile money customers in round 2. I explore these subgroups below in an effort to uncover any informative trends; however, sample sizes for subgroup analyses are too small for meaningful statistical inference.

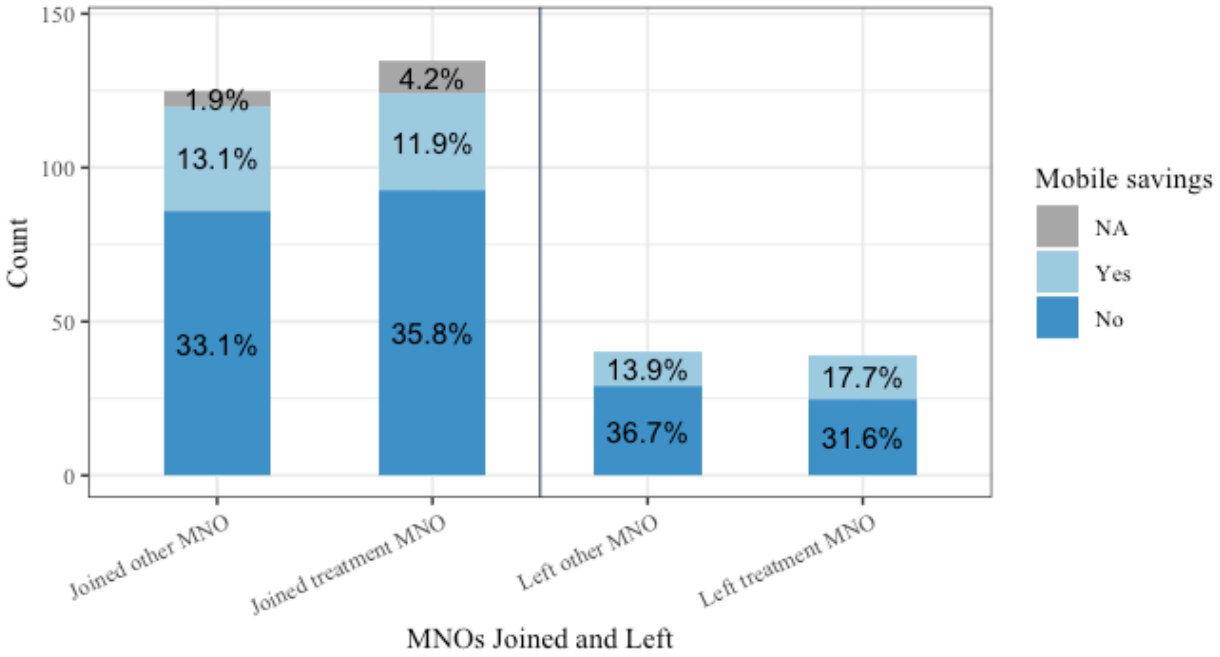
The second concern is with the timing of the policy implementation and round one of the survey. Approximately 55% of sample households were surveyed after an initial interest distribution, meaning that there is no true pre-treatment measure for these households. However, it is reasonable to assume that the savings incentive policy would not have an immediate effect on customer behavior for two reasons: (i) Fewer than half of Tanzanian adults had any savings (Demirgüç-Kunt et al., 2018), making it unlikely that they were able to quickly add to their mobile wallets; and (ii) the BoT did not permit the MNOs to advertise the interest distribution as savings account interest; that is, it is likely that it took some time for customers to become aware of the details of the policy. To investigate this concern, I looked for a relationship between mobile savings behavior and time in the round one data and found no correlation (see Appendix).

Finally, there are spatial concerns with the geographic distribution of MNOs and the potential confounding effect of covariate shocks. Covariate shocks, such as drought, floods, crop pests, and price shocks, tend to deal a financial shock to households in a specific geographic region. If the coverage area of treatment MNOs overlaps with regions that disproportionately experienced (or failed to experience) covariate shocks when compared to the geographic area occupied by control households, then the impact of the mobile savings incentive on mobile savings is confounded. I conduct a spatial analysis to investigate this concern, and I do not find any large geographic clusters containing households with disproportionate assignment to treatment and covariate shock experience (see Appendix).

Subgroup Analyses

I undertake several descriptive analyses of subgroups to investigate trends in mobile money uptake and MNO choice over time. Figure 6 depicts the 260 households who became new users of mobile money between rounds (left panel) and the 79 households who ceased mobile money use between rounds (right panel). Households are evenly split regarding whether or not they joined (left) a treatment MNO, and there is no discernible relationship between mobile savings behavior and MNO choice. This analysis suggests that the mobile interest distribution policy was not an important factor in mobile money uptake or the decision to leave mobile money.

Figure 6: Households joining and leaving mobile money



It is also unclear whether the savings incentive policy contributed to the decision to join a treatment MNO for households who were already using mobile money. Only 159 households switched MNOs between survey rounds, with 70 joining a treatment MNO and 89 exiting a

treatment MNO for a different mobile money provider. Bank account ownership is largely unchanged for the two groups between rounds,[8] while mobile savings decreases in both groups. The reduced mobile savings rate is more pronounced in the group of 89 households who exited a treatment MNO, but sample sizes are too small to attribute this difference in savings behavior to policy implementation.

In an attempt to explore any potential welfare implications of the mobile interest distribution, I examine the proportion of households experiencing food insecurity in the year prior to each survey round. I do not find the savings incentive to have any effect on household food insecurity; rather, food insecurity appears most closely related to the recent experience of a covariate shock (see Appendix).

Discussion

This study examines the impact of the world's first mobile money interest distribution policy. The results suggest that providing interest according to mobile wallet balances has a substantial and significant effect on whether or not customers choose to save money in their mobile wallet. Importantly, the findings reveal that this increase in mobile savings does not come at the expense of bank account ownership; the policy does not lead households to close their bank accounts in favor of mobile wallets and may actually facilitate bank account uptake among the unbanked. Prior mobile money research has shown that mobile money accounts can serve as a stepping stone into formal financial services (Di Castri & Gidvani, 2014; Suri & Jack, 2016), and this study finds that the provision of mobile interest does not interfere with the uptake of formal bank accounts. Instead, the mobile interest policy is both a benefit to mobile users by increasing savings and to banks by potentially facilitating the transition into formal financial services.

[8] Only 17 households lose bank account ownership between rounds; 10 of these gain mobile wallets.

To date, there are no peer-reviewed studies of the impact of interest-bearing mobile money accounts on customer savings behavior.[9] Perhaps the closest is a study with farmers in Mozambique that incentivized mobile savings by providing "interest" in the form of fertilizer, allocated according to the average daily balance of the mobile account over a specified time period (Batista & Vicente, 2020). The authors found that this incentive increased mobile savings by over 30%, but the savings behavior did not persist when the interest incentive was removed. These results suggest that the provision of an interest payment based on a customer's stored balance is a plausible mechanism for increasing mobile saving.

This study has several important limitations. First, the restriction to only two time periods blinds the analysis to any overarching differences in savings behavior over time between the treatment and control groups, as well as precludes any analysis of the sustainability of the treatment effect. Second, the outcome measures (bank account ownership and mobile savings) are binary indicators and do not capture any shift in asset proportion between banks and mobile wallets. It is possible that the mobile savings incentive led some customers to reallocate funds between their bank account and their mobile wallet, but this study lacks the data for such a detailed analysis of savings behavior. Third, there is a lack of detailed information concerning the initial communication of the interest distribution policies to mobile customers. Press releases for all MNOs can be found online, but it is difficult to determine if there were systematic differences in the effectiveness of policy communication across subgroups. Fourth, the sample size is not large enough to conduct meaningful subgroup analyses for the investigation of heterogeneity and welfare implications. Ultimately, policymakers would benefit from a better understanding of how the mobile interest policy could increase resilience to financial shocks in

[9] It is important to distinguish interest-bearing mobile money accounts, as described in this paper, from mobile savings accounts, which are formal savings accounts resulting from partnerships between MNOs and banks.

vulnerable subgroups, but this paper can only lay the groundwork for these deeper research questions.

Conclusions

The results of this study are directly relevant to current financial inclusion policy discussions around the provision of interest to mobile money customers, how to regulate these interest distributions, and how to address concerns from the banking sector. These findings reveal that mobile interest provision can incentivize mobile savings, even when regulations prohibit the marketing of mobile wallets as savings accounts. Further, there is no indication that users substitute mobile wallets for bank accounts, which should alleviate concerns that mobile customers will shift financial assets away from formal financial institutions. Mobile interest distribution is a promising mechanism for increasing financial inclusion among the world's poorest, and future research should explore the potential welfare benefits of enabling mobile interest regulations across countries.

Chapter 2
Determinants of Demand for Digital Loan Repayment among Microfinance Clients

Introduction

The rapid spread of mobile money throughout sub-Saharan Africa has paved the way for digital innovations in microfinance. Savings groups now have the option to store money digitally in a mobile wallet instead of placing large amounts of cash into a lock box or making regular journeys to a commercial bank for deposit. Lending organizations can disburse loans digitally to mobile money accounts rather than require borrowers to travel to a central location to receive lump sums in cash. Borrowers now have the convenience of sending digital repayments from any location at any time of day instead of taking time away from work and family to bring a cash repayment to a credit officer. These examples highlight the potential successes of digital financial innovations, but effective implementation and adequate user uptake are necessary to realize the full potential of this new technology.

As microfinance institutions experiment with the switch from cash to digital finance, researchers are seizing the opportunity to investigate questions around outcomes, such as 'how does digitizing repayment affect default rates?' and 'what are the effects of digital microcredit on household consumption?'. These are important outcome-oriented questions that will inform future innovations in anti-poverty interventions and financial inclusion initiatives, but in the nascent stages of innovation, questions of process are equally valuable. Process-oriented questions focus on the implementation of the innovation, the perceptions and preferences of users, and barriers and facilitators to uptake. Understanding the manner in which a microfinance institution rolls out digital innovations and how borrowers respond to new technology can

illuminate the causal pathways to successful outcomes, but ongoing research is largely centered around impacts for the microfinance organization (e.g., the implications of digital repayment for repayment rates and operational efficiency), and very little (if any) research has assessed the response to digital innovations among microfinance clients.

This study uniquely centers the overlooked perspectives of microfinance borrowers to explore the determinants of demand for a digital repayment option. That is, I endeavor to understand how and why borrowers develop preferences for digital versus cash repayment. I leverage a mixed-methods approach for the purpose of "expansion" - using qualitative data to gain a richer understanding of the processes underlying quantitative outcomes (Greene et al., 1989). With this approach, I uncover parallel insights around borrower preferences for digital repayment and technology adoption. I find that borrowers' familiarity with mobile money, education level, and perceptions of the cost and convenience of digital repayment are important determinants of demand. However, qualitative data reveal heterogeneity in borrowers' understanding of how digital repayment will impact the group structure, as well as key insights into the perceived liability structure - both of which have substantial implications for the uptake of digital repayment.

These findings make two primary contributions. First, the results can inform the design and implementation of digital microfinance innovations. Borrower concerns around fees, group attendance policies, and repercussions for future access to credit should be addressed during program rollout in order to facilitate uptake. Second, these findings contribute to the broader literature around technology adoption by highlighting the importance of qualitative data and user-centered research. When modeling adoption of new technologies, researchers make important assumptions about the information received, the learning process, individual payoffs,

and potential externalities (Besley & Case, 1993; Foster & Rosenzweig, 2010). In this study, qualitative data reveals constraints on adoption rooted in underexplored assumptions around the implications of digital repayment for group attendance and future access to credit. Thus, the use of qualitative data to interrogate assumptions around program implementation and user perceptions can contribute to more accurate models of technology adoption.

This paper begins with a historical overview of microfinance that purposes to pay homage to the pre-existing peer-to-peer financial networks upon which the modern microfinance apparatus is built. I then outline my theoretical frame, detailing the borrowers' perceived repayment options and associated tradeoffs. I use survey data to conduct a quantitative discrete choice analysis, comparing user preferences before and after a detailed information session. Motivated by the puzzling results of the quantitative component, I implement a qualitative content analysis to explore patterns in open-ended survey questions that reveal unanticipated externalities and underlying heterogeneity in borrowers' payoffs of adoption. I conclude with a discussion of policy recommendations for increasing access to and adoption of digital credit among historically financially excluded populations.

Background

The practice of microfinance has been ongoing for decades (if not centuries), but the awarding of the 2006 Nobel Peace Prize to Muhammad Yunus and the Grameen Bank vaulted microfinance into public and academic popularity. Through microfinance institutions, people who were previously excluded from access to credit due to an inability to signal credit-worthiness to the lender (through lack of collateral and/or lack of credit history) were able to obtain loans through a joint liability group structure. That is, the borrowers self-selected into groups and received individual loans under the agreement that if any group member defaulted,

then all group members were categorized as defaulters and cut off from subsequent loans. The self-selection component serves as a screening mechanism to exclude non-credit worthy individuals from the groups, as borrowers have better information about the credit-worthiness of their peers than the lending organization and would not elect to enter joint liability arrangements with those who would jeopardize their own access to credit. This joint liability thus mitigated the risk to the lender and transferred much of the screening, monitoring, and enforcement costs to the group members (Besley & Coate, 1995; Morduch, 1999).

Group-based financial services were not a unique innovation of microfinance institutions; rather the ability of these organizations to capitalize on existing structures of peer-to-peer lending and saving helps explain the sustained proliferation of microfinance throughout the developing world. Previously, an entrepreneurial woman might have joined a rotating savings and credit association (ROSCA) to achieve savings goals and/or to access start-up capital.[10] In these neighborhood groups, members each make regular contributions to the group fund, which is then paid out to individual members on a rotating basis (functioning like a savings account) and/or made available to members as a loan (functioning as a credit association). The commitment and enforcement mechanisms are based on social capital - members who default or miss contributions risk being shamed within their social network and excluded from communal financial assistance in the case of an idiosyncratic economic shock, such as the death of the primary income earner (Allen & Panetta, 2010; Besley et al., 1993; Gugerty, 2007). With the entrance of formal microfinance institutions, the credit-seeking woman now has the option to join a microfinance group; instead of making contributions to and/or borrowing out of a group fund, she receives a loan from the institution and then brings her cash repayment to the group

[10] Village savings and loan associations (VSLAs) are a similar, more recent type of peer-to-peer financial network implemented by NGOs.

meetings, which is collected by a credit officer from the institution (or occasionally transported by group members to the creditor). Connection to a formal financial institution offers a greatly expanded pool of resources to microfinance group members compared to members of independent neighborhood groups, as microfinance members can obtain simultaneous loans without depleting the pool, and the group's access to resources is much less vulnerable to covariate shocks, such as droughts or floods (Demont, 2022; Walcott et al., 2021). Thus, the displacement of standalone peer-to-peer lending groups by microfinance groups appears to be a win-win; the group members have access to a larger and more sustainable pool of credit, and the microfinance institutions can lend at profitable interest rates with low risk of default due to the joint-liability structure of the groups.

Increased competition for borrowers among microfinance providers has incentivized some microfinance organizations to transition away from joint liability loans and instead disburse more individual liability loans to microfinance group members (De Quidt et al., 2018). A growing body of research is examining the transition from joint liability to individual liability loans, and a general consensus appears to be that repayment rates are largely unchanged as long as the group structure is maintained (Attanasio et al., 2014; Banerjee, 2013; De Quidt et al., 2016; Giné & Karlan, 2014). That is, even with individual liability loans, the borrowers still bring their repayment amount to the regular group meeting to give to the credit officer. Giné and Karlan (2014) hypothesize that defaulting on an individual liability loan in a group setting risks "public loss of face" that serves as a comparable enforcement mechanism to the joint liability structure. De Quidt, et al. (2016) go so far as to call these loans "implicit joint liability" loans instead of individual liability loans, describing how the social capital accumulated through group

meetings preserves the monitoring function and fosters an environment of informal mutual insurance.

The adoption of mobile money by microfinance organizations adds another twist to the relationship between loan liability and group structures, as digital microcredit is typically offered to individuals instead of through groups.[11] Often these individual loans require external guarantors, but advances are being made in the use of big data to determine individual credit risk in the absence of traditional credit scores (Benami & Carter, 2021). Microfinance institutions are experimenting with digital loan disbursement and/or repayment, but it is unclear how the traditional group structure fits into this new world of digital finance. Will borrowers still attend group meetings to publicly share their digital repayment receipts and thus maintain the monitoring and enforcement mechanisms? Will digital repayment render the group meetings unnecessary to borrowers? Existing research is largely focused on the implications of digitization for loan repayment rates and operational efficiency; that is, current research questions center the priorities of the microfinance organization. Very little (if any) research has assessed the demand for digital loan services for existing microfinance clients.

Theoretical Framing

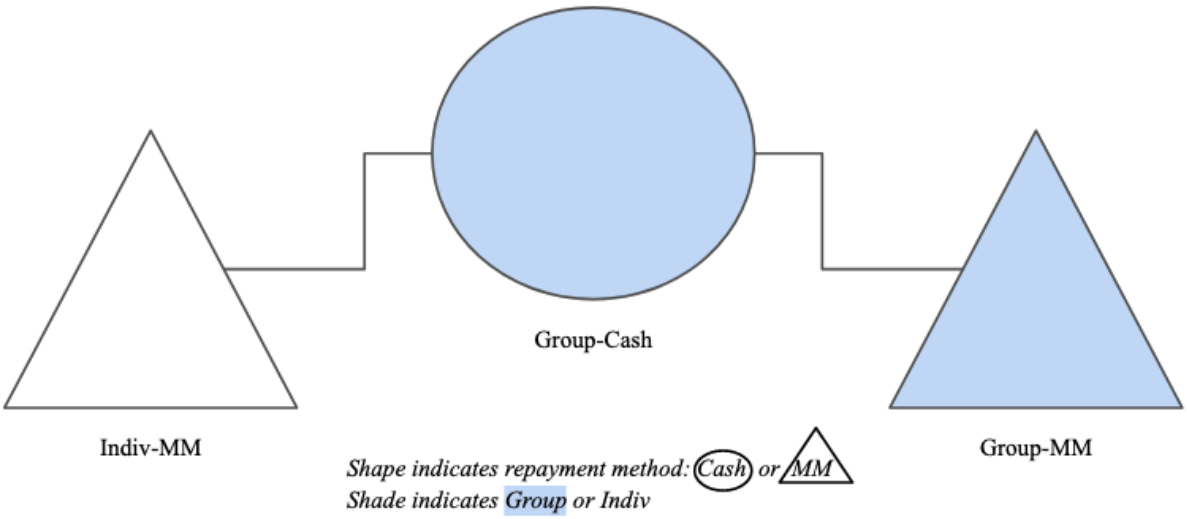
To frame my analysis, I adopt the guidelines developed for discrete choice experiments by articulating the different scenarios faced by borrowers when given the option to move from cash to digital repayment (Coast et al., 2012; Lancsar & Louviere, 2008). Within each scenario, I describe the attributes likely to play a meaningful role in an individual's decision-making process and provide a theoretical underpinning to each tradeoff.

[11] Digital microcredit was pioneered in sub-Saharan Africa by M-Shwari in Kenya, which offered microloans to mobile money customers. Other mobile money providers in the region followed this model.

When a current cash-based microfinance client is offered the choice of digital repayment, there is some uncertainty surrounding the continuity of the microfinance group structure in the digital alternative. In Figure 1, I posit three unique lending scenarios. The shape represents the repayment mechanism (circle for cash; triangle for mobile money), while the shading indicates the continuation of the group structure (shaded for group-based repayment; unshaded for individual repayment). For all scenarios, I assume that the microfinance organization is offering individual liability loans conditional on guarantors who may or may not also be in the group. In the status-quo scenario, which I refer to as *Group-Cash*, borrowers repay their loans in cash during regular group meetings, and the group structure imposes De Quidt, et al.'s "implicit joint liability" to the loans. When choosing the digital repayment option, borrowers repay through mobile money but may or may not still participate in the group meetings. If the group structure persists (scenario *Group-MM*), then implicit joint liability is maintained because repayment is still a public activity; however if switching to digital repayment leads borrowers to discard the group structure (scenario *Indiv-MM*), then the implicit joint liability mechanism is greatly reduced if not eliminated because there is no public peer monitoring of repayment.[12] With these three scenarios in mind (*Group-Cash*, *Group-MM*, *Indiv-MM*), I attempt to disentangle the costs and benefits from the borrower perspective of moving from cash to digital repayment both with and without the group structure.

[12] The two scenarios are a simplified conceptualization of the possibilities under digital repayment. It is possible that individuals perceive a flexible in-between scenario, in which they attend group meetings only when convenient.

Figure 1: Three repayment scenarios



Much of the literature on group-based lending versus individual lending is focused on the importance of groups for repayment rates (Attanasio et al., 2014; Banerjee, 2013; Giné & Karlan, 2014), but several authors explore additional implications from the borrower perspective. Costs of group-centered lending may include travel costs and materials costs, as well as the opportunity costs of time spent traveling to and participating in groups (Dehem & Hudon, 2013). Benefits of group-centered lending include the accumulation of social capital, deterrence from overly risky investments through risk-sharing, and learning from the experiences of other group members (Attanasio et al., 2014; De Quidt et al., 2016; Godquin, 2004; Kodongo & Kendi, 2013). There is also a rich literature on the potential benefits of women's groups with an economic focus (which also describes many microfinance groups), including access to information networks (Demont, 2022; Karlan et al., 2017), increased empowerment (Brody et al., 2016; Deininger & Liu, 2013; Swain & Wallentin, 2009), increased community engagement (Desai & Joshi, 2014), the provision of a social commitment mechanism to overcome self control deficiencies and pressure from spouses (Gugerty, 2007), and the ability of these groups to serve as human infrastructure

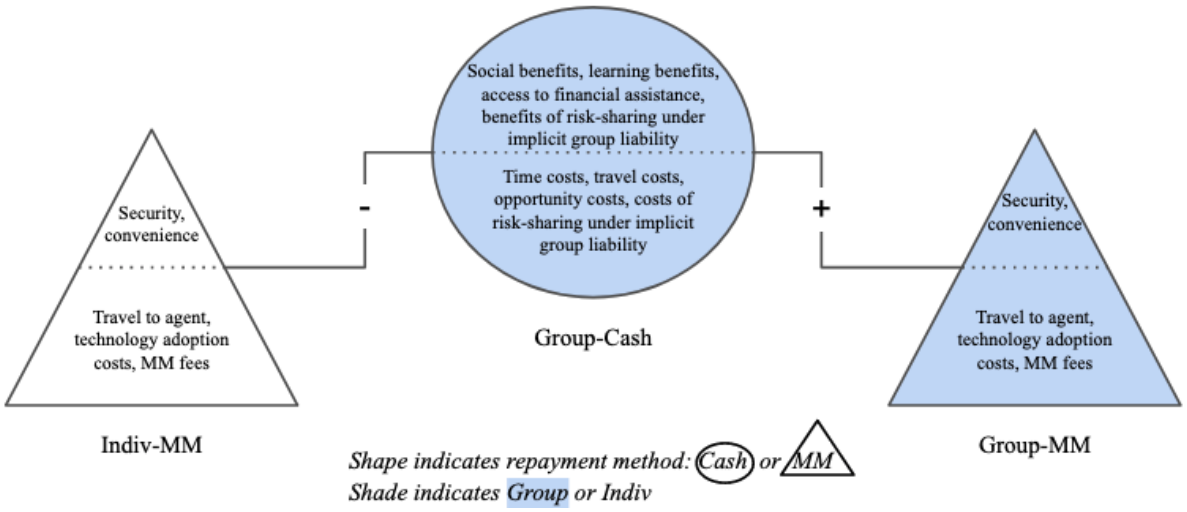
for the delivery of community-level interventions during crises (WHO, 2018). Borrowers who choose to eschew group meetings no longer have to pay the costs of group attendance, but they also forego the benefits of group membership.

Research examining the transition from cash to mobile money repayment from the borrower perspective is still at a nascent stage, but research in similar contexts can provide some insights. Individual barriers to mobile money uptake often include lack of access to and/or familiarity with mobile technology, distrust of mobile money, transfer and withdrawal fees, perceived difficulty of use, and distance from an agent (Naghavi, 2019). Thus, costs for digital repayment consist of direct financial costs in the form of fees as well as the learning costs of technology adoption and travel costs to a mobile money agent to deposit cash in the mobile wallet. The benefits of digital repayment take the form of increased convenience with the ability to repay at any time from any location, increased security from not having to physically transport cash and risk being robbed (Economides & Jeziorski, 2017), and increased privacy that is gained from the ability to hide digital assets from spouses and/or social pressures to share (Riley, 2020).

I summarize the costs and benefits of group-based cash repayment versus the two scenarios for digital repayment in Figure 2. To clarify, the borrowers are not explicitly given either *Group-MM* or *Indiv-MM* as discrete options; rather, uncertainty around whether or not the group structure will be maintained produces two potential scenarios for digital repayment. Each borrower is choosing between *Group-Cash* and whichever scenario she perceives to be the alternative under digital repayment. All individuals begin in the status-quo *Group-Cash* scenario, represented by a shaded circle. Associated benefits appear in the upper half of the circle, while associated costs appear in the lower half. An unshaded triangle represents the alternative *Indiv-MM* scenario, and a shaded triangle represents the alternative *Group-MM* scenario. The costs and

benefits of mobile repayment are listed in each triangle, but the total costs and benefits for borrowers in each scenario is derived differently. For those in *Indiv-MM*, the costs and benefits of *Group-Cash* (i.e., the costs and benefits of group-based borrowing - such as travel costs and social benefits) are not included with the costs and benefits of digital repayment. Conversely, borrowers in *Group-MM* realize the sum of all the costs and benefits of both group-based borrowing and digital repayment.

Figure 2: Costs and Benefits, by Scenario



Consideration of each alternative scenario leads to several hypotheses about the determinants of demand for digital repayment.

For individuals choosing between *Group-Cash* and *Indiv-MM*, the individual calculation is one of *trading off* costs and benefits. These individuals are assessing the time costs, financial costs, and opportunity costs of carrying cash to the group each week and comparing them to the costs of transacting with a mobile money agent and sending their repayment digitally. Within this alternative scenario, individuals for whom group attendance is costly (compared to the costs of mobile money) are likely to prefer digital repayment as an opportunity to maintain their

borrower status without the burden of the group structure. Conversely, individuals for whom group attendance is not costly (or for whom mobile money is very costly) are likely to prefer cash repayment.

Hypothesis 1: Individuals who perceive Indiv-MM to be the alternative to Group-Cash are more likely to prefer digital repayment:

a) *When the time required for group attendance is greater than the time required to access a mobile money agent*
b) *When the financial cost of group attendance is greater than the financial cost of mobile money transactions*
c) *When there is a noted opportunity cost to attend the group meetings*

For individuals choosing between *Group-Cash* and *Group-MM*, the costs of group attendance remain constant in both scenarios and thus should not feature as a determinant of repayment preference. Instead, the individual's calculation is focused on the *added* costs and benefits of digital repayment.

Hypothesis 2: Individuals who perceive Group-MM to be the alternative to Group-Cash are more likely to prefer digital repayment:

a) *When the time required to access a mobile money agent is low*
b) *When the financial costs of mobile money transactions are minimal*
c) *When travel time to the group is long, and carrying large quantities of cash presents a security threat*

For all individuals, regardless of their perceived alternative scenario, it is important to consider the learning costs of technology adoption. The perceived alternative scenario may be moot if a borrower is unable or unwilling to use mobile money.

Hypothesis 3: Preference for digital repayment will be more likely when the learning costs of mobile money adoption are low, independent of the borrower's scenario.

Study Setting, Data, Methods

Microfinance organizations have been active in Uganda since the 1990s, and one development agency named Uganda "the country with the most vibrant and successful microfinance industry in Africa" (Carlton et al., 2001). According to the 2021 Findex, 53.8% of adults in Uganda have a mobile money account, and nearly 16% have borrowed money using mobile money (Demirguc-Kunt et al., 2022). This study was conducted against this backdrop of an established microfinance industry and rapid digital financial innovations.

The study sample includes 2151 female microfinance clients from geographically diverse regions of Uganda, representing respondents from nine different branches of the microfinance organization. Table 1 reveals select characteristics of the sample, by branch. About 5% of the overall sample does not own a personal mobile phone, but nearly all of these women have at least one mobile phone in their household. On average, the more urban branches tend to have shorter travel times to both group meetings and to mobile money agents, and travel time to mobile money agents tends to be substantially shorter regardless of location.

Table 1: Sample Characteristics, by Branch

	Married	**Completed primary ed**	**Own mobile**	**Min to group**	**Min to agent**	**N**
Urban						
Kabuusu	69.8%	75.2%	98.1%	25.4	5.2	262
Kalerwe	52.0%	74.9%	97.4%	15.8	3.9	227
Peri-urban						
Masaka	63.7%	72.6%	97.8%	29.7	10.4	179

Mbarara	66.3%	65.0%	95.3%	22.1	6.4	300
Mityana	63.7%	62.8%	94.5%	27.6	13.4	328
Rural						
Iganga Nkono	79.8%	62.0%	90.5%	27.1	16.8	263
Kyenjojo	63.9%	43.8%	86.8%	34.8	19.3	219
Mukono Central	67.7%	79.0%	96.8%	24.4	6.4	186
Semuto	64.2%	55.6%	94.1%	26.1	9.8	187

Note: Urbanicity categorization provided by microfinance organization.

All women in the sample currently participate in microfinance groups with individual liability loans backed by guarantors. Occasionally, group members serve as mutual guarantors for one another.[13] The loans are disbursed individually as cash, and the group meets weekly to repay cash installments to a credit officer. Although there is no formal group liability, it is not uncommon for the women to help group members pay if a member is short one week.

An initial survey was conducted in September and October 2021 that assessed the sample's experience in the group, experiences with mobile money, and preference for cash versus mobile money repayment. The survey was administered in a one-on-one setting, and the women were not provided specific details about the alternative of mobile money repayment. Importantly, the women were not explicitly informed that they would be responsible for paying the mobile money transaction fees if they enrolled in digital repayment, and the women were also not informed that group attendance would be mandatory regardless of repayment modality. In summary, at the time of the baseline survey, the women were not given enough information to

[13] Unfortunately, I do not have data about guarantors or which clients serve as mutual guarantors versus have external guarantors. Neither do I know the overall prevalence of mutual guarantors, but qualitative data suggests that internal guarantors are not uncommon.

understand that the true alternative scenario under digital repayment would be *Group-MM* instead of *Indiv-MM*.

In November 2021, all microfinance groups (not just women in the study) were given a presentation from their credit officers about the mobile money repayment system that would be used by the microfinance organization. Credit officers met with each group and informed borrowers that they would be responsible for all mobile money transaction fees and provided information on fee amounts. The presentation was also intended to clarify that borrowers who chose digital repayment would still be expected to attend all group meetings. After the presentation, the respondents were again asked their individual preference for cash versus mobile money repayment. Notably, this individual vote occurred in the group setting, with each borrower submitting a paper ballot to the credit officer. In December 2021, women who had changed their preference were contacted for a phone survey to ascertain their reason for switching (466 of 579 recorded preference switchers were contacted).

Data

The initial survey contained a number of indicators relevant to a respondent's initial choice of cash versus digital repayment, which are detailed in Table 2. These indicators include time costs for both alternatives, measures of travel cost and opportunity costs for group participation, current frequency of mobile money use, and a revealed preference for mobile money versus cash when offered 1000 UGX. The second column lists the actual survey question, and the third column indicates the type of variable. I recode the ordinal scale on frequency of mobile money use to a binary indicator for at least weekly use because digital repayment would occur weekly for most borrowers.

Table 2: Survey questions used to examine demand for digital versus cash repayment

Attribute	Survey Q	Type of Variable	Mean (sd)
Group			
Travel time	How much time does it take you to go to the group meeting, round-trip?	Continuous (minutes); combined with meeting time for an estimate of total group time	26 (27)
Meeting time	On average, how long does a meeting take?	Continuous (minutes); combined with travel time for an estimate of total group time	60 (27)
Travel cost[a]	How much money does it cost for you to attend each meeting, round-trip?	Continuous (UGX)	576 (1475)
Opportunity cost[b]	Would you rather attend the meeting or use that time on [alternate activity]?	Binary	0.37
Digital Repayment			
Travel time	How long would it take you to find a [mobile money] shop/agent?	Continuous (minutes)	10 (16)
MM frequency	How often do you use mobile money?	Binary (at least weekly vs less)	0.79
Pref for 1000 UGX[c]	Which do you prefer receiving: 1000 UGX cash or 1000 UGX in mobile money?	Binary	0.41

[a] The majority of borrowers (~80%) do not incur a travel cost.
[b] Potential alternate activities include: work on business, childcare, leisure, housework, social activities, and other.
[c] The survey included games of chance that resulted in respondents "winning" actual money. Respondents had to indicate a preference in order to receive the 1000 UGX (~$0.26). Thus, there were no indifferent responses.

The survey also captures demographic data that may be associated with choosing digital repayment, such as the completion of primary education, business revenue, marital status, and the branch geographic indicator. Finally, there is a broad, open-ended question at the end of the

survey that adds qualitative depth to prior survey responses and indicates some respondents' perceived costs and benefits of switching from cash to digital repayment. Perhaps surprisingly, concerns around COVID-19 did not appear to factor into this decision.

Quantitative Analysis

I conducted a quantitative analysis to identify the determinants of demand for digital repayment in each survey iteration and to detect any shift in perceived costs and benefits between surveys. To address my research questions, I applied methods from the field of discrete choice analysis. Discrete choice analysis models an individual's choice among two or more options by framing preferences as a utility function - the option providing the most utility has the higher likelihood of being chosen (Hensher et al., 2005; Train, 2009). By estimating a random utility model, I can learn which attributes have the greatest influence on utility.

For each preference solicitation, I fit a random utility model to assess the demand for digital repayment in the sample:

$$U_{ij} = V(x_{ij}, s_i) + \varepsilon_{ij}, \forall\, j\ in\ J$$

Each individual, *i*, chooses between two alternatives: *J = {C, M}*. Each alternative produces a certain amount of utility for the individual, such that U_{ij}represents the utility for individual *i* choosing alternative *j*. *V* represents a set of parameters estimated for perceived attributes of each option for the individual (x_{ij}) and attributes of each individual (s_i). Specifically, x_{iM} includes the perceived financial cost of mobile money (fees) and time to the nearest agent. Similarly, x_{iC} includes travel costs and travel time to group meetings, as well as time in group meetings. Individual attributes (s_i) include group attendance, perceived opportunity cost of group attendance, frequency of mobile money use, preference for receiving 1000 UGX in cash versus

mobile money, and demographic characteristics of the respondent. Unobserved components of the utility function are given in ε_{ij}. The individual will choose the option with the greatest utility, thus the probability that an individual will choose mobile repayment is estimated by:

$$P_{iM} = \Pr\left(U_{iM} \geq U_{iC}\right)$$

Substituting in the components of each utility function and rearranging the terms produces:

$$P_{iM} = \Pr\left[(V_{iM} - V_{iC}) > (\varepsilon_{iC} - \varepsilon_{iM})\right]$$

Assuming that enC - enM follows a standard logistic distribution allows me to estimate the logistic regression:

$$\ln\left(\frac{P_{iM}}{P_{iC}}\right) = V_{iM} - V_{iC}$$

where the log odds of choosing mobile money is equal to the difference in the representative utility functions. The alternative-specific attributes (time and cost) are measured as $V(x_{iM} - x_{iC})$, and $V_M(s_i)$ is set to zero so that individual-level characteristics do not difference out (Train, 2009).

To conduct this analysis, it was necessary to make a couple of important assumptions about the respondents perceived costs and benefits of switching to digital repayment. I used the qualitative data from the surveys to verify these assumptions. First, I assume that the perceived financial cost of digital repayment is 0 during the baseline survey. The qualitative data reveal that many respondents were not aware that they would be responsible for the fees until after the digital repayment presentation in November 2021.[14] Second, I assume that baseline respondents perceive their alternative to the status-quo scenario of *Group-Cash* to be *Indiv-MM*. A common

[14] Questions about who would pay the mobile transaction fees were common on the baseline survey, and learning that borrowers would be responsible for all fees was the most predominant rationale given for switching from digital to cash repayment after the second preference solicitation.

explanation in the qualitative data for the choice of digital repayment focuses on no longer having to attend group meetings.

For the November survey data, I adjusted these assumptions to reflect the respondents' updated perceptions according to the information that was meant to be communicated in the presentation: the financial costs of digital repayment now include mobile money fees, and borrowers now understand that they are required to attend the weekly group meetings - even if they choose digital repayment. Mobile money fees were estimated for each borrower, based on their weekly loan repayment amount and the fee schedule of their preferred mobile provider.[15] These weekly fees ranged from 700 - 4100 UGX, with an average of 1655 UGX (~ $0.43). Using the updated alternative scenario *Group-MM*, I estimated new cost and time tradeoffs for each respondent.

Qualitative Content Analysis

The adoption of new technology is not always a "homogenous process", and there are often sociocultural factors that differently shape users' objectives (Place et al., 2007). Qualitative data can provide insights into borrowers' preferences for repayment modality and allow for the exploration of unexpected quantitative outcomes. To add a richer qualitative component to the determinants of demand for digital repayment, I "follow up surprises" in the second preference solicitation - a qualitative method that purposes to interrogate previously held assumptions by examining surprising patterns in the outcome data (Miles et al., 2018). For this analysis, I used data from a phone survey conducted with respondents who changed their preference after the presentation in November 2021. Borrowers who changed their payment preference were

[15] Loan repayment amounts were estimated as total loan * 1.25 divided by 40 weeks (this was the most common loan structure). Preferred provider was solicited in the baseline survey; respondents without a preference (~2%) were assigned to the majority preference.

contacted in December 2021 and asked to give an open-ended response to the question of why they switched from cash to digital or from digital to cash.

I incorporated these qualitative responses into a content analysis to identify the prevalence of multiple themes underlying borrower preferences. Specifically, I coded for themes around the perceived alternative scenario, the costs of group attendance, the perceived loan liability structure, the social cohesion of the group, mobile money affordability, and the costs of mobile money adoption. After an initial coding round, additional themes around the voting process and specific barriers to mobile money uptake emerged; thus, the content analysis was carried out both deductively and inductively (see Appendix for coding procedure). I then analyzed the relationship between themes and repayment preference, noting any geographic clustering, in order to gain a thicker understanding of the conditions under which borrowers prefer digital versus cash repayment.

Results

Quantitative Findings

Of the 2151 women in the sample, 1192 (55.4%) indicated a preference for mobile repayment on the baseline survey. Due to data missingness, 105 respondents were dropped from the sample for model estimation.[16] The omitted observations were not significantly correlated with repayment preference. Of the included 2046 women, 55.8% preferred digital repayment.

Table 4 presents the random utility model results for the analysis of baseline responses; Model 1 is a base model including only the attribute differences of cost and time, while Model 2 includes relevant covariates.[17] The sign on the coefficients for time and cost are negative,

[16] Most of these missing responses (n=86) are the result of the respondent's refusal to complete the cash games section of the survey, and thus their preference for receiving 1000 UGX in cash or mobile money was not asked. Regression imputation was explored but unsuccessful (details in Appendix).
[17] Table 4 does not include the branch fixed effects estimates; see Appendix for complete model results.

indicating that preference for digital repayment is associated with the perception that paying individually with mobile money will save time and money when compared to paying cash in the group setting. However, the magnitude of these coefficients is very close to zero, and the significance is marginal in the full model. Preferring an alternative activity to the group meeting, using mobile money on a weekly basis, completion of primary education, and preferring to receive 1000 UGX digitally are strongly associated with increased odds of choosing digital repayment. Thus, the analysis of the first preference solicitation provides weak support for hypotheses centering the time and financial costs of group attendance (hypotheses 1a and 1b), and robust support for the influence of opportunity costs (hypotheses 1c) and learning costs (hypothesis 3).

Table 4: Results from Baseline Survey

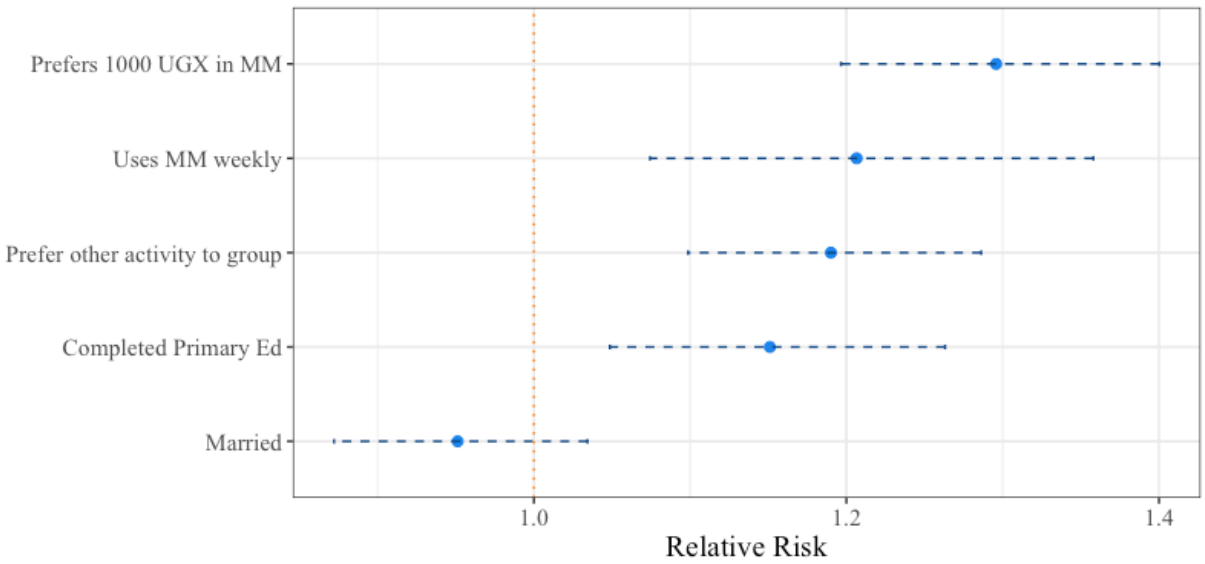
	Model 1	**Model 2**
Variable	***β*** **(se)**	***β*** **(se)**
(Intercept)	0.002 (0.096)	-0.390 (0.272)
Time Diff	-0.002** (0.001)	-0.002 (0.001)
Cost Diff	< -0.001** (0.000)	< -0.001** (0.000)
Alt Activity		0.410*** (0.100)
Weekly MM		0.399*** (0.120)
Pref MM		0.611*** (0.097)
Married		-0.118 (0.101)

Primary Ed		0.310*** (0.103)
Revenue		-0.003 (0.013)
N	2046	2046
AIC	2802	2651

Notes: *p < 0.1; **p < 0.05; ***p < 0.01. Revenue is the log of the last six months of revenue from the respondent's business.

The model results were transformed into relative risks and associated 95% confidence intervals using simulation techniques and illustrated in Figure 3 (estimated scenarios and counterfactuals hold all additional model variables constant at their means). Using mobile money weekly and preferring alternative activities to group meetings each increase the likelihood of preferring digital repayment by about 20%. Completing primary education and preferring 1000 UGX in mobile money increase the likelihood of preferring digital repayment by about 15% and 30%, respectively. Being married does not appear to influence repayment preference.

Figure 3: Relative Risks



After a digital repayment presentation in November (approximately two months after the baseline survey), 1455 of the original 2151 responded to a second solicitation of preferences (both the presentation and solicitation of preferences were conducted in the microfinance group setting).[18] Of these 1455, 579 changed their preference (876 did not change). 481 of those who indicated a preference for digital repayment in the first survey changed to a cash preference, and 98 switched from cash to mobile money.[19] Thus, the percentage of women preferring mobile money to cash repayment dropped from 55% of the original sample (46% of the follow-up sample) to 26% of the follow-up sample.[20]

Table 5 presents the RUM analysis for the second preference solicitation. Models 3 and 4 are constructed with the assumption of perfectly updated information; that is, the cost and time attributes are estimated with the assumptions that respondents understand that they are responsible for all mobile money transaction fees and that they are still expected to attend all group meetings. Surprisingly, there is no longer a relationship between repayment preference and preference for receiving 1000 UGX in mobile money.[21] Weekly mobile money use and completion of primary education remain strong predictors of the preference for digital repayment, but I find no evidence to support any components of hypothesis 2, which predicts preferences based on the added time and financial costs of accessing a mobile money agent and the risk of traveling long distances with cash. The additional time and costs of digital repayment are not significantly associated with repayment preference, and borrowers traveling longer

[18] An additional 24 responses were recorded, but qualitative data indicated that these borrowers were not present and did not cast a vote during the second round of voting. Thus, these 24 were dropped from the analysis (more details in Appendix).
[19] A total of 42 respondents insisted in the qualitative data that their second round votes had been mis-recorded. I recoded their preferences accordingly for the analysis (more details in Appendix).
[20] The conclusions of the first analysis are unchanged if models 1 and 2 are re-estimated using the follow-up sample of 1455 (see Appendix).
[21] Unfortunately, the qualitative data do not contain many insights into this finding. It is possible that the quantity of mobile money questions in the survey primed preferences for digital options.

distances to group meetings do not appear to significantly prefer the security of mobile money. Further, the coefficient on opportunity cost remains large in magnitude and significance - a finding that should not occur if respondents understood that digital repayment was not a substitute for group attendance.

I construct additional Models 5 and 6 to estimate November repayment preferences with baseline assumptions about group attendance; that is, I use the *Indiv-MM* scenario to calculate the time and cost differences for digital repayment.[22] The time difference is not significant in the full model, suggesting that time costs are not an important determinant of demand for digital repayment under either scenario.[23] The significance of the cost difference indicates that respondents are valuing the *tradeoff* in costs between digital and cash repayment (i.e., substituting mobile money fees for group attendance costs) instead of evaluating the addition of mobile money fees to the given group attendance costs. Thus, the predominant perceived alternative scenario in the second round of preference solicitation appears to be *Indiv-MM* instead of the more accurate *Group-MM*.[24] I now turn to the qualitative analysis for further insights into these findings.

[22] I keep the updated preferences about fee responsibility; it is clear from the qualitative data that this information was effectively communicated in the November presentations.

[23] One could speculate that the respondents are completing multiple errands as they travel to and from group meetings, thus only the opportunity cost variable matters for preferences. This speculation is somewhat supported by the lack of a correlation between preference for an alternative activity and group time costs ($p > 0.8$).

[24] It is possible that borrowers understand the correct alternative scenario (*Group-MM*) but do not perceive any negative repercussions from missing group meetings. I do not have data on whether or not attendance enforcement was communicated in the presentation, and the qualitative data do not indicate any explicitly expressed intentions to subvert the attendance policy. Nevertheless, these results could be obtained in a scenario of high group costs and low perceived enforcement rather than a mis-perception due to lack of communication.

Table 5: Results for Second Survey

Variable	Model 3 β (se)	Model 4 β (se)	Model 5 β (se)	Model 6 β (se)
(Intercept)	-0.843*** (0.230)	-2.309*** (0.472)	-1.182*** (0.146)	-2.076*** (0.434)
Time Diff	-0.007* (0.004)	-0.004 (0.005)	-0.004*** (0.002)	0.000 (0.002)
Cost Diff	< -0.001 (0.000)	< -0.001 (0.000)	< -0.001*** (0.000)	< -0.001*** (0.000)
Alt Activity		0.360*** (0.138)		0.350** (0.139)
Grp Dist		0.004 (0.003)		0.002 (0.003)
Weekly MM		0.497*** (0.186)		0.507*** (0.187)
Pref MM		0.183 (0.134)		0.172 (0.134)
Married		-0.135 (0.140)		-0.135 (0.141)
Primary Ed		0.525*** (0.147)		0.519*** (0.147)
Revenue		0.015 (0.022)		0.017 (0.022)
N	1380	1380	1380	1380
AIC	1595	1456	1579	1448

Notes: *p < 0.1; **p < 0.05; ***p < 0.01. Revenue is the log of the last six months of revenue from the respondent's business.

Qualitative Findings

The preponderance of borrowers who changed their repayment preference came as a surprise to the researchers, and 466 respondents were contacted for a phone survey that asked

them to give an open-ended response to the question of why they switched from cash to digital or from digital to cash.[25]

I first sorted respondents according to whether they appeared to understand the correct alternative scenario (Group-MM).[26] Of the 466, only 68 borrowers provided qualitative evidence that they understood that group meetings would continue under digital repayment. All but two of these borrowers switched their preferences from mobile money to cash. Common themes include the opportunity cost of group attendance (n = 31) and the cost of mobile transaction fees (n = 33):

> *"I changed my vote because when I asked the credit officer she told me that even if we change to mobile money we shall be meeting in the group so I said now mobile money is useless because I thought it would help us who do want to attend the group meetings."*
>
> *"During the survey I thought that when I start using mobile money to repay my loan I will save my time because they will be no need of attending group meetings but during voting they told us even if you use mobile money you have to continue attending group meetings so I didn't see any change yet I have to incur extra costs of sending the money to the bank."*
>
> *"During voting exercise was told I have to pay mobile money charges and continue going to the group meetings didn't make sense to me I saw it as an extra cost I voted cash."*

Thus, the qualitative evidence of mobile fees deterring digital repayment provides some support for hypothesis 2b, but there is no indication that mobile money offers any benefit of convenience or security for the borrowers perceiving this scenario.

For the remaining 374 phone survey respondents who voted in the second round, it does not appear that they understood the updated alternative scenario and instead perceived their option for digital repayment to be a replacement for group attendance. Table 6 summarizes the

[25] As mentioned in the footnote accompanying the quantitative results, these 466 included 24 who did not actually vote in the second round and 42 who did not actually change their vote (see Appendix for details).
[26] I included respondents who directly indicated that they understood they would still have to attend group meetings (n=49), as well as respondents who did not indicate any particular scenario but who were in the same group as these respondents.

prevalence of themes among these borrowers, by repayment preference. Borrowers tend to prefer cash when the group location is convenient, when they value the social and learning aspects of the group, and when mobile money is costly and potentially risky. Conversely, borrowers choosing digital repayment tend to value the group less than other activities, see mobile money as a convenient alternative to cash repayment, and are less deterred by the risks and/or difficulty of the technology. Borrowers with cash preferences were much more likely to perceive a joint liability loan structure and cite group influence as part of their rationale; these themes are explored further in the following anecdotes.

Table 6: Reasons for Repayment Preference

	Theme	**MM (n = 87)**	**Cash (n=287)**
Group Costs and Benefits	The group location is…		
	convenient	0	17
	inconvenient	10	3
	The social and learning aspects of the group are valuable	2	38
	Other activities are preferred to group attendance	21	2
Mobile Money Costs and Benefits	Digital repayment is…		
	expensive	2	129
	risky and vulnerable to fraud	1	34
	convenient	53	6
	inconvenient	1	12
	too difficult to learn	3	51

Loan Structure	Loan structure is implicit joint liability	1	36
Group Influence	Group members influenced repayment preference	2	38

It is clear from respondents' answers that their alternative scenario perception mediates the relationship between the costs of group attendance and their repayment preference. For borrowers who see digital repayment as a substitute for group attendance, higher group costs predict digital preference, while higher group benefits are associated with cash preference:

> *"I changed to mobile money because I have less time to go to group meetings."*
>
> *"Group meeting helps us to know each other's problems and we advise each other that's why I changed to cash because mobile money you just have to send without meeting your group members."*

The qualitative analysis uncovers four important barriers to digital repayment uptake. First, the borrowers are deterred by the transaction fees; over one-third of respondents voiced concern about the fees. There is no association between a borrower's estimated fee amount and whether or not she mentioned it in the phone survey; rather, borrowers appear generally opposed to any additional repayment fees.[27]

> *"I changed because mobile money has charges and since I am the one to pay those charges I decided to change to cash because I can't afford them."*

Second, over 10% of those who switched from digital to cash repayment view mobile money as too risky. These borrowers are worried about losing money due to user error or to fraudsters. Several cite specific anecdotes of previous mobile money mishaps:

> *"Fear of sending money to the wrong account because it happened and I lost my money."*
>
> *"[Con] men now days use mobile money to steal our money and tracking them is also very expensive so you end up losing every thing."*

[27] Borrowers indicating concerns with mobile fees tend to earn less business revenue on average, but this relationship is not significant ($p>0.3$).

Third, the learning costs of technology adoption are too high for many respondents. More than 15% who switched their preference to cash indicated that the presentation revealed the process of digital repayment would be too difficult for them to learn. Several cannot use mobile money without the assistance of a family member or agent, some do not have consistent access to a mobile phone, and a handful lack the literacy to read the SMS transaction messages:

> *"In baseline I didn't understand well all about mobile money but after explaining to me the whole process in group voting exercise it become complicated for me to use… [I] voted cash."*

Fourth, the perception of implicit joint liability makes the group meeting necessary for continued access to credit, and digital repayment poses a threat to the group structure - which consequently threatens the financial welfare of the members. In order to receive a loan, each borrower must have a guarantor (or multiple guarantors), and these guarantors are often other group members. Thus, the group meetings serve two vital purposes for the many members who are simultaneously acting as borrowers and guarantors: the meetings provide a mechanism through which the guarantors can monitor their borrowers, and the meetings allow the borrowers to demonstrate that they are low-risk to potential guarantors. In the phone survey, respondents worried that allowing digital repayment would dissolve the group structure, leaving them unable to monitor others and unable to attract guarantors for their next loan:

> *"Again if I use mobile money who will sign for me to get my next loan?"*

> *"[I] changed because [I want] to monitor payment behavior for the members [I] guaranteed."*

> *"I followed [the group] because we need each other especially when it comes to signing on loan application forms."*

This fear was strong enough to inspire collusion in many groups, with members encouraging all other members to vote for cash repayment in the second round:

"I changed my vote because all the group members said that we should vote cash and the fear we had that people may fail to pay back the loans."

"Voted mobile money in baseline because that's what I wanted but voting in group majority of the members decided we vote cash so I went with majority."

Lastly, I examined the prevalence of themes by branch, but no consistent patterns emerged aside from a strong preference for mobile money among Semuto borrowers that is potentially attributable to the perceived convenience of digital repayment over group attendance (see Appendix).

Discussion

This study examined the determinants of demand for digital repayment among current microfinance group clients. In a baseline preference solicitation, borrowers were more likely to prefer digital repayment when they were already frequent mobile money users, had completed primary education, and noted an opportunity cost to attend the microfinance group meetings. A presentation was given to each group to clarify that borrowers would be responsible for all mobile transaction fees and that group attendance was still required regardless of repayment modality, but most borrowers either did not receive or failed to understand the information about group attendance expectations. This incomplete information transfer had differential effects on the individual cost-benefit calculation for digital versus cash repayment in the second preference solicitation. Borrowers who misunderstood the conditions of digital repayment viewed mobile money as an alternative to group attendance, preferring digital repayment when the mobile transaction fees were less than the cost of transportation to group meetings and when other activities were preferred to time spent in group meetings. Weekly mobile money use and completion of primary education remained strongly associated with digital repayment preference in all models.

A content analysis of the qualitative data reinforced the speculation that borrowers did not have complete information about the group structure under digital repayment and also provided key insights around barriers to uptake. Namely, many borrowers were strongly opposed to transaction fees, a substantial number had issues of distrust and/or unfamiliarity with mobile money, and the necessity of the group structure for monitoring and enforcement produced a large peer pressure effect in the groups toward cash repayment.

These findings are largely in alignment with other studies examining the uptake of digital finance - mobile money users tend to be more educated, own mobile phones, and have access to mobile agents (Munyegera & Matsumoto, 2016), while persistent barriers to mobile money uptake include lack of trust, connectivity issues, taxes and fees, and poor financial literacy (GSMA, 2021). Perhaps the most comparable study is an examination of willingness to pay in Ethiopia for digital utility payments (Awel & Yitbarek, 2022). Similar to the results of this study, the authors find that demand for mobile payments is strongly associated with price, trust in mobile money, education level, and onerousness of paying in cash.

The big-picture qualitative finding of this study is that the researcher's assumptions about the borrowers' knowledge and needs were mistaken; the information about the group structure was not effectively communicated to all borrowers, and many borrowers thus failed to update their cost-benefit calculations to account for the appropriate digital repayment scenario. Further, the tendency of groups to vote collectively against the perceived threat that digital repayment posed to the group structure and access to credit was unanticipated. This discovery of incorrect assumptions underscores the importance of a mixed methods approach for studies of technology adoption. For example, the global health literature is saturated with failed cookstove interventions, and the qualitative components of these studies (when they exist) repeatedly

emphasize the need for a deep understanding of the cultural context and the specific population's barriers and facilitators to adoption (Khandelwal et al., 2017; Thomas et al., 2015). Likewise, uptake of agricultural technologies is often low and/or unsustainable, and a thicker understanding of local contexts is necessary to overcome these barriers (Place et al., 2007; Ruzzante et al., 2021). A sole focus on the quantitative evidence generated through experimental designs categorizes technology adoption as a technical problem to be solved when in fact there may be deeply embedded cultural contexts and undiscovered needs that shape user behavior.

Limitations

The non-random distribution and receipt of information, combined with an inability to determine exactly what borrowers understood about the digital repayment scenario, comprise the primary limitations of this study. I have used available qualitative data to gain key insights about the demand for digital repayment, but I was unable to ascertain the determinants of demand for users who (correctly) understood that the group structure will be maintained because too few of these borrowers were identifiable in the data. The fact that the phone survey was conducted with a small, non-random subset of respondents is an additional limitation, as it is likely that there are characteristics of these "switchers" that are systematically correlated with repayment preference.[28]

Also, it is possible that my conceptualization of the alternative scenarios (*Indiv-MM* versus *Group-MM*) is too rigidly binary, and borrowers may base preferences on a more flexible intermediate scenario in which they prefer digital repayment because they are occasionally unable or unwilling to attend the group meetings and they do not perceive any negative repercussions for their absence. There is some support for this perception in the qualitative data,

[28] For example, I do not know the pervasiveness or the persuasiveness of the social pressure to vote for cash repayment because only those who were successfully swayed into changing their votes were surveyed.

with respondents who travel frequently or who take care of sick family members. If data were available on each borrower's alternative scenario, it would be possible to quantitatively examine if this desire for flexibility could offset the additional costs of mobile money fees. However, it is important to note that the microfinance institution's design for digital repayment does not include this flexibility and instead maintains that group meeting attendance is required regardless of payment modality - thus, such findings may end up moot if the institution is able to enforce the attendance policy.

The large change in preferences over a short time period points to another potential limitation of the study. The baseline survey contained many questions about mobile money, and it is possible that this priming falsely inflated initial digital repayment preference. Priming might also explain why digital repayment is so strongly associated with preference for receiving 1000 UGX in mobile money in the baseline survey but not significant in the second round; maybe respondents were just excited about mobile money after talking about it with the interviewer. The qualitative data mitigate much of this concern, as the majority of digital-to-cash switchers cite reasons based on updated information or group influence, but many borrowers who chose mobile repayment were not contacted for the phone survey. Of course, it is also possible that borrower preferences are non-static and changed as a function of other unobservable factors over time, but the short time period in between surveys (~2 months) assuages these concerns.

Policy Implications

These findings should be valuable to microfinance organizations who are considering offering digital repayment services. Ascertaining the needs of the borrowers and the implications for the group is paramount; for groups of clients entangled in simultaneous borrower-guarantor liability relationships, the potential for digital repayment to weaken the overall group structure is

a threat to vital group monitoring and enforcement mechanisms. For clients who value digital repayment as a substitute for burdensome group meetings, mandatory attendance policies are likely to hinder uptake. Mobile transaction fees present a substantial barrier to uptake, and microfinance organizations should consider the likelihood that digital repayment, uncoupled from the potential added benefits of digital disbursement, may not offer clients enough added convenience to offset the cost of adoption. Further, there is a large subset of borrowers for whom digital repayment feels too risky and/or for whom the technology is too complicated. Educational outreach may overcome some of these barriers, but equity concerns arise if access to credit becomes contingent on technological prowess. In order to facilitate adoption, microfinance organizations must be able to effectively communicate the value of digital repayment to the borrower.

Conclusion

To my knowledge, this is the first study to assess demand for digital repayment from the often overlooked borrower perspective. I uncover several insights useful for the design of digital microfinance innovations; namely, that borrowers have varying needs and expectations that produce heterogeneous payoff calculations, and a universal approach to the implementation of digital repayment is unlikely to succeed. Further, I contribute to the literature on technology adoption by highlighting the importance of using qualitative data to interrogate model assumptions and reveal unanticipated constraints on adoption. With these findings, microfinance organizations are better equipped to facilitate access to credit among historically financially excluded populations.

Chapter 3
The Internal and External Determinants of Mobile Money Policy Convergence

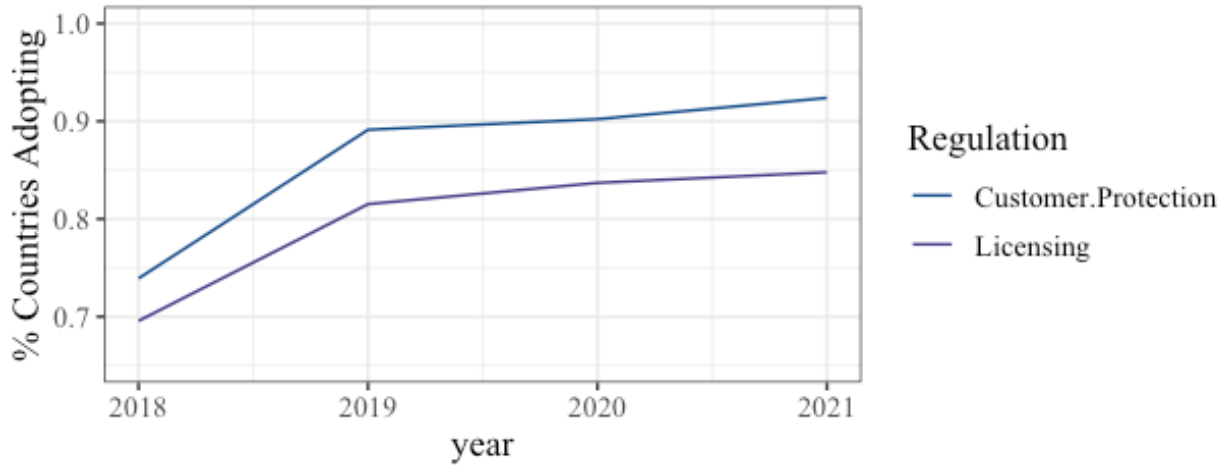
Introduction

In sub-Saharan Africa, the percentage of adults with a financial account has increased from 23% in 2011 to over 55% in 2021, and the majority of this increase is due to the rapid expansion of mobile money (Demirguc-Kunt et al., 2022). There is a growing literature on the welfare benefits of mobile money for users, but the realization of these benefits depends in large part on the public policy decisions of a country's mobile money regulator (Di Castri, 2013; Gutierrez & Singh, 2013; Staschen & Meagher, 2018). Most often, this regulator is the central bank – but other public managers such as finance ministers and telecommunications officials may shape regulations as well. Leading international financial inclusion strategists have noted that a primary determinant of mobile money expansion and sustainability in a country is an "enabling" regulatory environment that consists of inclusive licensing terms, limits on first-mover advantage, and risk-based customer due diligence (Di Castri, 2013; Gutierrez & Singh, 2013; Staschen & Meagher, 2018). These regulatory components are widely agreed upon by the international community to facilitate mobile money uptake and expansion, and multiple sources present evidence that less supportive regulatory environments are harmful for financial inclusion goals (Evans & Pirchio, 2015; Gutierrez & Singh, 2013; Jenik & Lauer, 2017; Porteous, 2006; Villasenor et al., 2015).

The regulatory environments surrounding mobile money tended to vary widely during the initial period of mobile money launch in a country (Bahia & Muthiora, 2019; Villasenor et al., 2015), but regulatory convergence is becoming more common across jurisdictions over time

(GSMA, 2022; Raithatha, 2021). Consider inclusive licensing terms as an example; in the early years of mobile money launch (~2012), countries employed a variety of licensing models with perhaps a slight majority qualifying as fully inclusive (Di Castri, 2013; Osafo-Kwaako et al., 2018; Penicaud & Katakam, 2013). Over time, the percentage of countries enacting fully inclusive licensing terms increased from 69.6% in 2018 to 84.8% in 2021 (GSMA, 2022). Figure 1 illustrates the policy convergence since 2018 in 92 countries for two "enabling" mobile money policies: inclusive licensing terms and customer protection rules.

Figure 1: Policy Convergence of "Enabling" Regulations



Source: GSMA Regulatory Index, 2022

Existing literature focuses on the relationship between these enabling regulations and financial inclusion outcomes in a country, but very few studies center the decision-making environment of the regulator to explain policy adoption (Johnson & Williams, 2016; Settle, 2020). Traditionally, the role of a central bank is to maintain stability in the financial system, and it is worth pondering why the central bank of a low- or middle-income country (LMIC) would take on a "transformative role" to foster financial inclusion, especially in cases when financially inclusive policies conflict with stabilizing regulation (Dafe, 2012). For example, the international financial inclusion community recommends that non-bank entities, such as mobile network

operators (MNOs), should be eligible to offer mobile money services in order to best achieve financial inclusion (Di Castri, 2013; Gutierrez & Singh, 2013; Malady et al., 2015). From the regulator perspective, allowing a non-bank to operate as a deposit taking institution and payment service provider without subjecting it to strict banking regulations could be risky and potentially destabilizing. The regulator must be convinced that the prospective benefits of financial inclusion under the transformative policy outweigh the status quo of traditional, stabilizing policy. The adjacent banking literature has examined why LMICs often converge around international banking standards - even when these standards are not appropriate for their domestic banking infrastructure - finding that countries often want to increase their international reputation, attract investment, and participate in global policy venues (Bach & Newman, 2010; Gandrud, 2014; Jones, 2020). However, I have seen no papers that tie the banking policy convergence literature to the recent diffusion of enabling mobile money regulations for financial inclusion.

To address this gap, I combine the theoretical frame of Putnam's "Two-Level Game", which acknowledges the interplay of domestic politics and international influences (Putnam, 1988), with Berry and Berry's unified model of government innovation (Berry & Berry, 2018). I ask the research question: What are the internal determinants and external influences associated with the regulator's decision to adopt internationally recommended mobile money policies? Specifically, I examine the adoption of risk-based Know Your Customer (KYC) regulations over time across sub-Saharan Africa. Risk-based KYC regulations set identity verification requirements for account ownership proportional to risk, which can increase access to mobile money in resource-constrained settings. I employ an event history approach to investigate how the hazard of adoption changes in relation to internal country characteristics and exposure to

external influences. While domestic pressures from highly concentrated banking sectors may marginally deter risk-based KYC adoption, I find the primary accelerator of risk-based KYC policy adoption to be regional diffusion. For each percentage point increase in the number of regional neighbors adopting risk-based KYC requirements, I estimate that a country's risk of adoption increases by more than 6%. Further, I find that this relationship wanes over time, suggesting a diffusion mechanism of mimicry rather than learning (Shipan & Volden, 2008).

The Enabling Regulatory Environment

The idea of the "enabling regulatory environment" for financial inclusion is promoted by an international community of financial inclusion experts, including intergovernmental organizations, international development agencies, non-governmental organizations, and philanthropic foundations. Recommendations and funding tend to flow unidirectionally from centers of wealth to LMICs; however there are organizations such as the Alliance for Financial Inclusion that promote a cooperative model of peer learning within its network.[29]

The first global recommendations for mobile money governance were produced by the UK's Department for International Development (DFID) in 2006 (Porteous, 2006). The DFID report draws on the results of a comparative case study of Kenya and South Africa to present "enabling principles" that include prioritization of an open market (inclusive licensing terms and limitations on first-mover advantage) as well as customer protection from fraud. The World Bank followed up on the DFID report in 2013 by conducting the first multi-country cross-sectional analysis of the relationship between the regulatory environment and mobile money outcomes (Gutierrez & Singh, 2013). The World Bank study included 35 countries, assigning each one a score based on the supportiveness of the mobile money environment and comparing this index score to person-level mobile money data from the Global Financial Index (Findex).

[29] https://www.afi-global.org/about/

The results reveal a strong association between enabling regulation, mobile money uptake, and financial inclusion indicators.

Several more recent sources of regulatory recommendations build on those of DFID and the World Bank. The Consultative Group to Assist the Poor (CGAP) examined mobile money regulations and financial inclusion outcomes in 10 countries to produce a detailed description of regulatory enablers that echo much of the content of prior publications (Staschen & Meagher, 2018). The Groupe Spécial Mobile Association (GSMA) has produced many case studies of mobile money implementation, and the organization has consolidated regulatory best practices into several reports (Di Castri, 2013; Maina, 2018). Additionally, both GSMA and the Brookings Institution have constructed a regulatory index ("Regdex") similar to the World Bank's 2013 index that grades countries on the supportiveness of their regulatory environment for mobile money expansion and links Regdex scores to mobile money outcomes using case study reports and Findex data (Bahia et al., 2020; Bahia & Muthiora, 2019; GSMA, 2022; Villasenor et al., 2015).

The international financial inclusion community tends to categorize enabling mobile money regulations into four key areas: licensing terms, first-mover advantage, consumer protection, and KYC requirements (Di Castri, 2013; Jenik & Lauer, 2017; Villasenor et al., 2015). I will briefly introduce the first three categories before focusing on KYC requirements for the remainder of the study.

Licensing terms

Licensing terms define the entities eligible to operate as mobile money providers and the types of services these providers are permitted to offer. There are two primary models of mobile money provision that stem from licensing terms: the bank-led model, under which mobile money

license eligibility requires a bank to be the service provider, and the mobile network operator (MNO) -led model, under which non-bank entities (most commonly MNOs) are eligible to apply for mobile money licenses. The international financial inclusion community recommends that non-bank entities be eligible for mobile money licenses in order to best achieve financial inclusion (Di Castri, 2013; Gutierrez & Singh, 2013; Malady et al., 2015). The MNO-led model permits the mobile money provider to take advantage of their extensive agent network and customer relationships to reach end users. Bank-led models, on the other hand, impose strict regulation about who can be an agent and how far from a brick and mortar bank agents can operate. Thus, MNO-led models are able to reach a much higher proportion of the financially excluded population.

First-mover advantage

The preservation of first-mover advantage is important for continued technological innovation, but adequate competition among providers is important for customer value (Mas, 2014). The central bank uses multiple levers to regulate competition in the mobile money provider market, such as prohibiting agent exclusivity (i.e., mobile money agents can simultaneously work for multiple MNOs), interoperability requirements, and fee caps. Recommendations on competition management from the international financial inclusion community are less specific than those of licensing terms, but they tend to prioritize expected user outcomes (Di Castri, 2013; Gutierrez & Singh, 2013; Staschen & Meagher, 2018). For example, there is general support among the international financial inclusion community to promote a norm of shared agent networks and interoperable platforms in order to foster competition, drive down transaction fees, and increase financial access for unbanked populations (Staschen & Meagher, 2018; Villasenor et al., 2015).

Consumer protection

The popularity of consumer protection initiatives has increased over time, with distrust of mobile money persisting as a barrier to uptake and among increasing reports of fraud (Akomea-Frimpong et al., 2019). Financial inclusion experts agree that e-money should be 100% backed in a trust account at a bank (or other ring-fenced type of account), and that MNOs should be prohibited from intermediating this money. There is growing consensus around price transparency protocols and customer access to recourse in the case of fraud (Di Castri, 2013; Staschen & Meagher, 2018). The topic of deposit insurance finds mixed support, as the costs of provision exceed the capacity of many MNOs (Raithatha, 2021).

KYC requirements

The purpose of KYC requirements is to reduce the risk of money laundering and terrorism financing. At a minimum, KYC compliance requires a mobile money operator to obtain some form of identification from customers during account registration. Strict KYC compliance may require multiple forms of government-approved identification documents and biometric identification (e.g., fingerprint scans). Accounts with a relatively low value in transfers and stored balances pose minimal risks to financial security and thus warrant more flexible KYC requirements. When KYC requirements are standardized across all financial services, mobile money providers are held to the same strict level of identity verification as banks, producing barriers to both supply and access. Mobile money providers often lack the resources to carry out extensive identification verification, and clients (especially financially excluded clients) may not have the appropriate identification documents. For example, strict KYC regulations may require that the mobile money agent photograph the customer and customer's ID and then send the photos to a bank for identity verification. In this scenario, agents must possess a smartphone with

a camera and internet access to send the photo, which produces a supply-side constraint on mobile money provision (Di Castri et al., 2015). Risk-based KYC requirements tailor the amount of identity verification to the amount of money being stored or transferred so that clients sending/receiving small amounts of e-money face minimal identification requirements and are able to access services.

The Financial Action Task Force (FATF) is the intergovernmental body that generates policy recommendations for financial regulators with the aim to prevent money laundering and terrorism financing. In 2012, the FATF revised their recommendations to encourage risk-based KYC requirements in order to increase financial inclusion, with the rationale that moving more transactions from cash into mobile money would increase monitoring and decrease the risk of terrorism financing (Di Castri et al., 2015; FATF, 2012). The international financial inclusion community followed suit and converged around the recommendation for risk-based KYC compliance; that is, the identification requirements should be tailored to the risk posed by the account (Di Castri, 2013; Gutierrez & Singh, 2013; Staschen & Meagher, 2018; Villasenor et al., 2015). Compared to relatively expensive FATF policy recommendations, such as enhanced anti-money laundering regulations, risk-based KYC is likely less costly to implement and enforce. There is a substantial upfront cost associated with the design of risk tiers that are appropriate for a specific country context, but the reduced enforcement costs of the lower tiers should have a long run public sector cost advantage to the status quo of strict KYC (Jusic, 2017).

The Democratic Republic of the Congo (DRC) was the first country in sub-Saharan Africa to implement risk-based KYC. The DRC was an early and active member in the Alliance for Financial Inclusion, and a GSMA case study notes how the Banque Centrale du Congo collaborated with international partners in the development of mobile money regulations (Di

Castri, 2014). In 2012, the DRC implemented minimal KYC requirements for mobile money customers transacting less than $100 per day; identity verification consisted of the agent collecting the customer's name, address, and date of birth and checking the information against the customer's SIM registration. The customer was not even required to provide an ID, a policy decision consistent with the lack of a national ID program in the DRC. With the help of these low barriers to identity verification, the DRC went from less than 4% of the population having any sort of financial account in 2011 to over 17% in 2014 (Demirguc-Kunt et al., 2018).

Even though these regulations are often separated into the categories of licensing requirements, first-mover advantage, customer protection, and KYC, it is important to note that the effectiveness of each regulation for promoting financial inclusion is interdependent with the full landscape of mobile money regulations. For example, interoperability requirements in India were implemented with the goal of increased financial access, but interoperability initiatives were paired with standardized KYC requirements. The KYC requirements burdened smaller mobile money providers and decreased access for unbanked populations who did not have the necessary government identification documents. Thus, the combined result of the regulations was to produce barriers to both competition and financial inclusion (Kulkarni, 2018). It is also important to note that implementation of a regulation does not always equal enforcement, and unenforced regulations may not produce expected outcomes. For example, agent exclusivity was prohibited in Kenya in 2010, but the policy was not enforced until a series of anti-competitive complaints were addressed by the court in 2014 (Robb & Vilakazi, 2016). A comprehensively enabling regulatory environment involves considerations of tradeoffs across all categories of regulation and vigilance to counteract providers who may attempt to subvert regulatory constraints.

Policy Convergence as a Two-Level Game

I borrow the metaphor of Putnam's "two-level game" to frame the decision-making process of the mobile money regulator (Putnam, 1988). Level I takes place in the international context, where the regulator is exposed to the financial inclusion community and encouraged to implement the best practices. Level II refers to the domestic context, in which the regulator is constrained by existing institutions and "constituents"[30]. The two-level game is most often invoked to frame game theoretic approaches to explaining domestic foreign policy decisions, but the metaphor is also useful in this study of policy diffusion because it acknowledges the political struggle among competing domestic interests (i.e., the state is not a unitary actor) while accounting for the influence of international pressures. The regulator is a key player in both "games" and must simultaneously navigate the two levels to produce a policy outcome.

Level I

Of particular importance to the international socialization of regulatory behavior is the existence of "epistemic communities" - international networks of experts in a particular policy domain (Haas, 1992). Slaughter identifies central banks as especially susceptible to socialization through interaction with epistemic communities and describes regulator decision-making as, in part, a function of reputation management within these communities (Slaughter, 2004). Research in LMIC countries reveals that regulators in these settings may be particularly likely to adopt policies in order to avoid "the stigma of backwardness" or out of fear of losing social acceptance rather than adopting policies for more instrumental reasons (Sharman, 2008; Weyland, 2005). In a study of anti-money laundering policy convergence, Sharman (2008) finds the regulator's need for social acceptance and legitimacy in international networks to be a key driver of policy diffusion from epistemic centers to developing countries.

[30] I use quotation marks because the regulator is not elected - but they are still enmeshed in political processes.

The LMIC country context is not only uniquely susceptible to perceptions of backwardness but also to a more consequentialist logic through what Weyland describes as the external pressure framework (Weyland, 2005). Due to their structural position in the international community, public managers in LMIC countries are often subject to constraints imposed by donor organizations. These constraints range widely in their level of coerciveness, but it is important to note that regulators in recipient countries may face a skewed estimation of the tradeoffs of various regulatory options due to their obligations to more financially powerful members of the international community (Stallings, 1992). For example, recent research has found that the alignment of donor preferences around shared conceptions of "good governance" produces aid that is tailored toward political reforms that enable economic development (Molenaers et al., 2015). In the case of risk-based KYC regulations, foreign aid may include technical assistance to overcome the capacity constraints associated with the construction of risk tiers, which could greatly lower the cost of risk-based KYC adoption. Further, UN agencies and the World Bank explicitly link financial inclusion to the achievement of multiple sustainable development goals (SDGs), and aid that is tied to performance on SDG targets may entice a regulator to adopt "enabling" regulations without a full assessment of the domestic implications.[31,32]

Additionally, heavy reliance on foreign aid for public finance has the potential to erode government accountability to citizens because the funding of public programs through foreign aid bypasses the social contract between domestic sources of revenue (i.e., taxpayers) and policymakers (Bauer, 1973; Dafe, 2012; Eubank, 2012). Thus, regulators may become more accountable to donor institutions than to their own public. This phenomenon of donor influence

[31] https://www.worldbank.org/en/topic/financialinclusion/overview
[32] https://www.uncdf.org/financial-inclusion-and-the-sdgs

is widely documented in the field of global health; public health initiatives in donor-reliant health systems tend to reflect the priorities of global philanthropic organizations and intergovernmental organizations rather than being matched to local needs (Baccini et al., 2022; Esser & Keating Bench, 2011; Shiffman & Smith, 2007). With regard to central bank reforms, a recent case study of African countries found that dependence on foreign aid was associated with the adoption of central bank reforms that reflected the policy preferences of international donors, compared to the central bank policy stances of countries with more domestic sources of revenue (Dafe, 2019). Thus, the ability of the donor community to incentivize certain reforms or policies through the provision of grants or technical assistance is an additional consideration in the regulator's decision-making calculus.

Finally, it is important to mention the more traditional mechanisms of policy diffusion and isomorphism, such as mimicry, learning, and the centralization of resources. Central banks may mimic other countries when regulating technological innovations due to a lack of information, or they may learn from their peers' application of successful regulations (Dobbin et al., 2007)**.** Mimicry may also result from the aforementioned need for social acceptance in the international community - a need that likely grows with increased participation in transnational policy networks (Sharman, 2008; Slaughter, 2004). The centralization of information, policy resources, and technical assistance in the epistemic financial inclusion community may induce regulatory isomorphism in the participating peripheral countries (DiMaggio & Powell, 1983). For example, if the World Bank offers financial inclusion grants that contain specific technical assistance for developing inclusive mobile money licensing regulations, then all countries receiving the grants are likely to develop very similar licensing regulations. Identifying each unique mechanism at play is beyond the scope of this paper, but I will seek to measure the extent

of participation in the international financial inclusion community and dependence on external sources of financing and capacity building in order to examine the Level I contribution to policy adoption.

Hypotheses

- H1a: I hypothesize that a country is more likely to implement risk-based KYC regulations if the regulator is an active participant in the international financial inclusion community.
- H1b: I hypothesize that a country is more likely to implement risk-based KYC regulations if the regulator is largely dependent on foreign aid.[33]
- H1c: I hypothesize that a country is more likely to implement risk-based KYC regulations when a higher proportion of regional peers also adopt the policy.

Level II

On the domestic level, the regulator must negotiate a political process involving the public interest, elite interests, the banking sector interests, and his or her own interests. One of the most common frameworks for this political context is capture theory. Capture theory (also known as special interest theory, interest group theory, or the economic theory of regulatory behavior) maintains that the regulator is self-interested and that powerful special interest groups are able to exploit this self-interest in exchange for regulatory rents. That is, the regulator's ability and desire to pursue their own self-interest makes them vulnerable to 'capture' by powerful interest groups who supply the regulator with resources or power in exchange for favorable regulation (Peltzman, 1976; Posner, 1974; Stigler, 1971). In its simplest specification, capture theory places the regulator between concentrated special interests and diffuse public

[33] I focus on development aid specifically and distinguish between ODA and Chinese assistance. More details are provided in the Methods section.

interests, and the regulator must estimate the tradeoffs in policy concessions to one or the other (Frieden & Martin, 2001).

The primary opponents of enabling mobile money regulations tend to be commercial banks, as they must now compete with MNOs in the provision of payment services and the safe storage of money. With regard to other international financial regulations, such as anti-money laundering laws, large banks tend to advocate for higher compliance demands as a way to pursue a competitive advantage over smaller banks that lack the resources to comply with burdensome regulations (Behrens, 2021). Similarly, I expect the banking sector in a country to share a competitively motivated anti-MNO policy preference for strict KYC compliance and organize as the predominant special interest group vying for regulator concessions in the domestic level of the two-level game.

One of the few empirical pieces exploring capture theory in the mobile money sphere is a qualitative comparison study of Kenya and Mexico (Suárez, 2016). The author seeks to answer the question of why regulators choose a bank-led model over the more "enabling" MNO-led model, and she finds that "the level of regulatory capture by banks explains the mobile payments model". Using process tracing methodology, she describes how the close relationship between the regulator and the banking industry in Mexico prevented non-bank stakeholders from participating in the decision-making process, resulting in capture. She describes the regulator-bank relationship in Kenya as "not a close one", and attributes Kenya's ability to evade capture to this fractured relationship and the inability of the banking industry to quickly organize against the rapid expansion of mobile money. An additional study of the relationship between susceptibility to capture and mobile money uptake corroborates Suárez's results, finding that banking concentration is significantly associated with reductions in mobile money accounts

(Dietman, 2019). The mechanism between banking concentration and regulatory outcomes follows the capture theory outlined by Laffont & Tirole (1991); namely, that concentrated special interests face lower organizing costs and can exploit information asymmetries when information costs are high for the regulator (highly relevant for the regulation of new technologies). That is, a highly concentrated banking sector can more easily organize and petition the regulator as a unified body.

Hypothesis

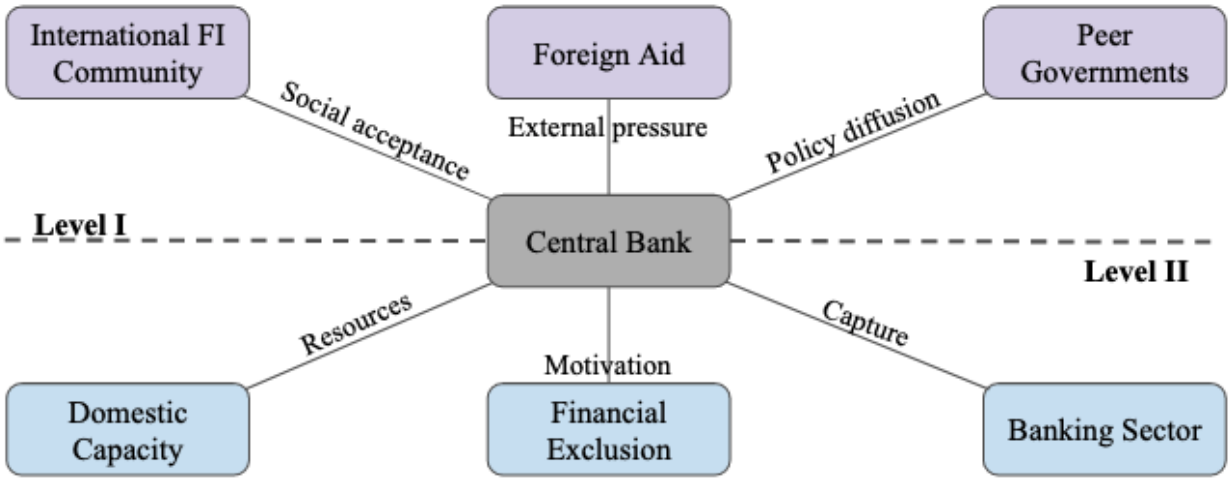
- H2: I hypothesize that a country is less likely to implement risk-based KYC regulations if the concentration of the banking sector poses a high risk of capture.

Other internal factors are likely to influence whether or not a country adopts enabling mobile money regulations; in their unified model of government innovation, Berry & Berry (2018) list the contributing factors of "Motivation" and "Resources" (Berry & Berry, 2018). Motivation refers to the severity of the problem, which for this exercise could be captured with the level of financial exclusion in a country. Central banks tend to be motivated to decrease financial exclusion because increasing the proportion of financial transactions that take place in environments that can be monitored (such as within commercial banks or through mobile money) provides more information for the development of monetary policy (Settle, 2020). Resources for policy adoption may include financial indicators, such as GDP, or an indicator of regulator capacity, such as government effectiveness. Both financial resources and technical capacity are necessary for the development, dissemination, and enforcement of risk-based KYC.

The theoretical frame is summarized in Figure 2. The central bank is simultaneously engaged in political processes on both the international and domestic levels. International forces for policy convergence around risk-based KYC include socialization through participation in the

transnational financial inclusion community, external pressure from the preferences of foreign donors, and policy diffusion from regional peers. On the domestic level, the regulator must possess the financial resources and technical capacity to design, implement, and enforce risk-based KYC. Motivations for adoption are strengthened through consideration of the diffuse public interest for achieving higher degrees of financial inclusion, but concentrated special interests from the banking sector present an obstacle to adoption.

Figure 2: Policy Convergence as a Two-Level Game



Methods

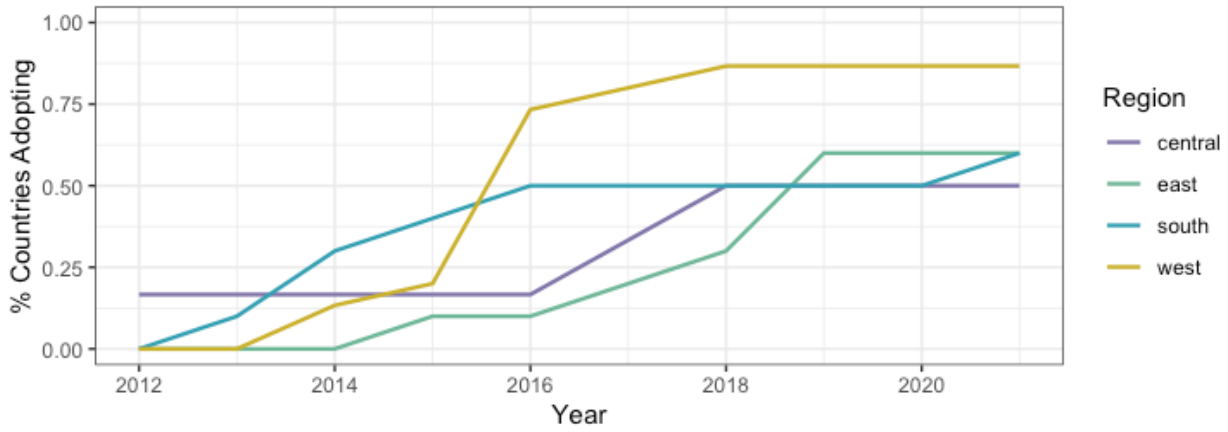
I propose an event history analysis to estimate the determinants of policy convergence over time. Event history analysis is a methodology that is used to examine the probability that an event that has not yet occurred will occur in a particular observational unit in a unit of time; it is an analysis of duration. Also called survival analysis, event history analysis was developed in the biological sciences to study the duration from an initial 'exposure' to the occurrence of a final 'event' (i.e., death) among cohorts. The results are generally presented as hazard ratios and/or survival curves, which can demonstrate the increased risk of event posed by individual

covariates. This approach is common in policy diffusion studies, in which the "event" is policy adoption, and it is especially applicable to the unified model of policy adoption.

Sample

I focus my analysis on 41 countries in sub-Saharan Africa that are included in the GSMA Regulatory Index Database, for the years 2012-2021.[34] Figure 2 illustrates the adoption of risk-based KYC requirements over time for the sample of 41 countries, by region.[35]

Figure 2: Adoption of risk-based KYC over time, by region



In policy diffusion event history analysis, countries enter the analysis when they become 'at risk' of adoption - usually after the first jurisdiction has adopted the focal policy. Thus, I begin with 2012 because it marked the first instance of risk-based KYC adoption, kicking off the 'at risk' period for other countries. Additionally, mobile money must exist in a country for it to be at risk of adopting risk-based KYC.[36] After enacting the focal policy, countries exit the analysis. The dataset is therefore structured with each row representing a country-time, beginning from the

[34] The RegDex includes 44 countries, but I drop Equatorial Guinea, Central African Republic, and Somalia due to data constraints.
[35] There are eight countries in western Africa that share a central bank; the central bank implemented risk-based KYC in 2015, which counted as the year of adoption for seven of these countries. More information on the implications for analysis are in the Estimation Concerns section and Appendix C.
[36] For example, if Country A doesn't have mobile money until 2014, then it doesn't make sense for it to be 'at risk' of enacting mobile money regulations prior to 2014. In this case, Time0 for Country A would be 2014.

first time 'at risk' and ending with either the time of policy adoption or the end of the observation period (2021) if adoption did not occur.

Measures

My event of interest is whether or not a country adopted risk-based KYC requirements in a given year. Data sources for this variable include the GSMA Regulatory Index Database, country central bank publications, and case studies and reports published by financial inclusion organizations (such as CGAP, GSMA, and UNCDF). Covariates and their data sources, as well as strategies for missing data, are detailed below.

International participation. I include two measures of participation in the international financial community - one measures membership in an epistemic community and one measures the adoption of a policy document shaped by international norms (True & Mintrom, 2001). I include the years of membership in the Alliance for Financial Inclusion (AFI), as well as the cumulative number of years that a country has a National Financial Inclusion Strategy (NFIS) in place. The AFI is a peer learning network in which central banks are the primary members. The organization highlights country-led approaches and lateral learning, and members participate in working groups to facilitate knowledge sharing and technical assistance across financial inclusion goals.[37] The NFIS, on the other hand, is an initiative advanced by the World Bank Group that provides consultation and assistance in assessing a country's financial inclusion needs and mapping out a strategy for the future.[38] I measure both variables in cumulative time in order to capture the additive influence of continuous participation.

Foreign aid. I include two measures for dependence on foreign development aid. I use official development aid (ODA) as a percentage of GNI (Dafe, 2019), and I use the annual count

[37] https://www.afi-global.org/about/
[38] https://www.worldbank.org/en/topic/financialinclusion/brief/national-financial-inclusion-strategies

of projects aided through Chinese development assistance. I separate these measures, as there is evidence that the source of aid may produce different regulatory outcomes; that is, Chinese development assistance tends to lack the embedded incentives for policy reform common in ODA (Watkins, 2021). ODA, on the other hand, is more likely to contain technical assistance directly applicable to reducing the costs of developing risk tiers for risk-based KYC regulations. ODA data are available from the International Development Statistics database through the year 2020, and I impute the 2020 value to year 2021 to avoid missing data for the year. Data for Chinese aid are available from AidData's Global Chinese Development Finance Dataset through 2017. I follow AidData's recommended methodology for aggregating the number of funded projects for comparative longitudinal analysis (Custer et al., 2021; Dreher et al., 2022). To impute years 2018-2021, I use the 5-year average of the number of projects.

Regional diffusion. I account for regional diffusion with the proportion of regional neighbors that have implemented risk-based KYC requirements through the previous time period (i.e., lagged by one year). The influence of geographic proximity on diffusion, particularly on mimicry mechanisms, is well documented, thus regional diffusion is preferred to total sample diffusion (Bach & Newman, 2010; Berry & Berry, 1990; Shipan & Volden, 2008).[39] I categorize countries according to the African Union regions, with the inclusion of Mauritania in West Africa (instead of North). Innovative policies tend to diffuse slowly at first and then more rapidly over time, and this indicator captures the potential increase in the probability that a regulator adopts risk-based KYC as the policy becomes more widespread.

Banking concentration. My primary internal variable of interest is the risk for regulatory capture, indicated by domestic banking concentration. The World Bank tracks the percentage of

[39] I also examine this variable as a count of regional neighbors, and as a total count and proportion. Model fit was maximized with the proportion of regional neighbors.

total banking assets held by the three largest banks in each country each year. I use linear interpolation to impute missing data, and extend 2020 values to 2021 in the cases for which 2021 data are missing.

Policy need. Following Berry & Berry (2018), I measure the severity of the problem motivating the policy with the population's access to commercial bank branches.[40] When there are few bank branches, then the need for mobile money and accompanying enabling regulations is heightened. I also include the percentage of adults with a financial account as an additional variable. These data are measured by the Findex for years 2011, 2014, 2017, and 2021. I use linear interpolation and extrapolation to impute the missing years, as well as additional sources for these measures (Finscope surveys, GSMA reports, CGAP reports, and central bank data).

Resources and capacity. To measure a country's resources, I include the log of GDP. These data are obtained from the World Bank, as well as the African Development Bank. To account for regulator capacity, I use the measure of government effectiveness from the World Bank's Worldwide Governance Indicators. This indicator measures the quality of policy implementation, as well as other perceptions of governance quality, on a scale of -2.5 to 2.5.

Table 1 presents the summary statistics for the sample of 41 countries.[41] I show the mean and standard deviation for the first year of observation (2012) and the last (2021). The differences across years reveal that countries are increasing their engagement with the international financial inclusion community over time, and risk-based KYC policy convergence is evident over the nine-year span (~5% to over 70% adopting). Further, comparing the accounts metric to the number of commercial bank branches indicates that mobile accounts are

[40] Bank branches per 100,000 population, from the World Bank Development Indicators.
[41] A detailed list of included countries is available in Appendix A.

dominating the growth in access to financial services. Measures of foreign aid, banking concentration, and internal resources/capacity are stable or slightly increasing over time.

Table 1: Summary Statistics for 41 Countries

	2012		2021	
Variable	**Mean**	**SD**	**Mean**	**SD**
Risk-based KYC adoption (%)	4.89%	–	70.7%	–
Level I (External)				
AFI member (%)	59%	–	71%	–
NFIS (%)	7%	–	61%	–
ODA (%GNI)	6.88	5.56	7.86	6.30
China aid	7.22	4.55	9.70	6.86
Neighbors adopt	0.02	0.06	0.68	0.15
Level II (Internal)				
Banking conc.	75.02	19.59	78.11	17.08
Financial accounts	26.25	20.10	50.72	21.31
Bank branches	6.07	7.90	6.29	7.34
GDP (log)	24.07	1.32	24.52	1.36
Gov effectiveness	-0.72	0.62	-0.73	0.67

Model

There are several different adaptations of event history analysis for social scientists; I follow the Box-Steffensmeier and Jones guide (2004), which highlights the flexibility of the semi-parametric Cox model as the most appropriate for studies with time-varying covariates in

the field of political science (Box-Steffensmeier & Jones, 2004).[42] I fit the following extension of the Cox proportional hazards model to allow for time-varying covariates (Therneau et al., 2022):

$$h(t) = h_0(t)\, e^{\beta X(t)}$$

The instantaneous hazard of adopting risk-based KYC requirements at time *t* (given that adoption has not yet happened) is captured with *h(t)*. The baseline hazard $h_0(t)$ reflects the risk of adoption when all covariates are 0. In a Cox model, the baseline hazard is not constrained to any specific distribution, which is especially suitable for research questions more focused on the relationship between covariates and events than on understanding the role of time dependency (Box-Steffensmeier & Zorn, 2001). The term $\beta X(t)$ represents a matrix of parameters for time-varying covariates. The exponentiated coefficients produce a hazard ratio for each covariate that can be interpreted similarly to an odds ratio: values greater than one indicate an increased hazard of adoption, while values less than one indicate a reduced hazard.

Results

The first step after fitting the Cox proportional hazards model is to assess the proportional hazards assumption. I do this with the cox.zph test in R, which evaluates the Schoenfeld residuals to reveal any time dependence among the coefficients (Therneau & Grambsch, 2000). Table 2 presents the result of this diagnostic test.

[42] There are examples of policy diffusion studies that fit a Weibull AFT model, assuming the baseline hazard to be monotonically increasing. To me, the specification of the baseline hazard is an unrealistic assumption about the independent force of 'time' on policy adoption. I prefer the Cox NPH approach, which relaxes assumptions about the baseline hazard and accounts for non-proportional hazards with time interactions.

Table 2: Diagnostic Test for PH Assumption

Variable	**Chi-Square**	**p-value**
AFI member (yrs)	0.028	0.868
NFIS (yrs)	0.468	0.494
ODA (%GNI)	0.726	0.394
China aid	2.811	0.094
Neighbors adopt	4.712	0.030
Banking conc.	1.012	0.314
Financial accounts	2.021	0.155
Bank branches	2.949	0.086
GDP (log)	1.487	0.223
Gov effectiveness	0.014	0.907
Global test	17.123	0.072

It is clear that the proportional hazards assumption is violated for the measure of regional neighbors adopting, and it is likely violated for Chinese aid and bank branches.[43] This violation of the proportional hazards assumption is not surprising; it is reasonable to think that the influence of these covariates may wax or wane over time. For example, Shipan and Voldan examine mechanisms of policy diffusion and find that when policy diffuses through imitation, the influence of neighbor adoption wanes over time. That is, either the neighbor's adoption has an immediate effect on a jurisdiction's decision to adopt, or there is no effect (Shipan & Volden, 2008).

[43] Box-Steffensmeier, et al. (2003) recommend a cutoff of $p < 0.15$.

I specify a Cox non-proportional hazards model by interacting each of the offending covariates with the natural log of time (Box-Steffensmeier et al., 2003; Fox & Weisberg, 2018).[44] Table 3 contains the main results of the analysis. The sign of the coefficient represents whether or not a covariate increases or decreases the hazard of adopting risk-based KYC requirements, and the exponentiated coefficient in the third column is the relative hazard ratio. For robustness, I also fit a binary time-series-cross-section model (Beck et al., 1998) and find comparable results (see Appendix B).

Level I (External) Covariates

The coefficients for variables representing participation in the international financial inclusion community (AFI and NFIS) suggest a positive relationship between engagement and the time to adoption of risk-based KYC requirements, but the estimates are not significant. Interestingly, there is no significant association between ODA and the risk of adoption, but the association with Chinese aid is positive and marginally significant. The model suggests that a one unit increase in the number of Chinese-aided projects increases a country's hazard of adoption by about 18%, but that this relationship wanes over time.[45] I find support for my hypothesis of regional diffusion, as each percentage point increase in the number of regional neighbors adopting increases a country's risk of adoption by more than 6%, and this relationship also significantly wanes over time.

[44] I also examine models with a single interaction (neighbor) and two interactions (neighbor and bank branches). Likelihood ratio tests of nested models indicate the best fit is the model with three interactions (neighbor, bank branches, and Chinese aid).

[45] I am stumped by this finding. Further research could examine the types of projects funded with Chinese aid to see if there is a pattern that would facilitate risk-based KYC adoption.

Table 3: Results of Cox NPH Model

Variable	β	(SE)	exp(β)	p-value
Level I (External)				
AFI member (yrs)	0.0160	(0.0832)	1.0161	0.8475
NFIS (yrs)	0.1813	(0.1681)	1.1988	0.2807
ODA (%GNI)	0.0382	(0.0463)	1.0389	0.4096
China aid	0.1663*	(0.0958)	1.1810	0.0826
Neighbors adopt	0.0623***	(0.0197)	1.0642	0.0016
Level II (Internal)				
Banking conc.	-0.0257	(0.0166)	0.9746	0.1213
Financial accounts	-0.0044	(0.0177)	0.9956	0.8020
Bank branches	0.0838	(0.0748)	1.0874	0.2628
GDP (log)	0.3460	(0.3367)	1.4135	0.3040
Gov effectiveness	-0.2470	(0.5790)	0.7811	0.6697
China aid x ln(Time)	-0.1694**	(0.0757)	0.8442	0.0252
Neighbors x ln(Time)	-0.0377**	(0.0164)	0.9630	0.0220
Bank branches x ln(Time)	-0.1428	(0.0884)	0.8669	0.1062

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

Level II (Internal) Covariates

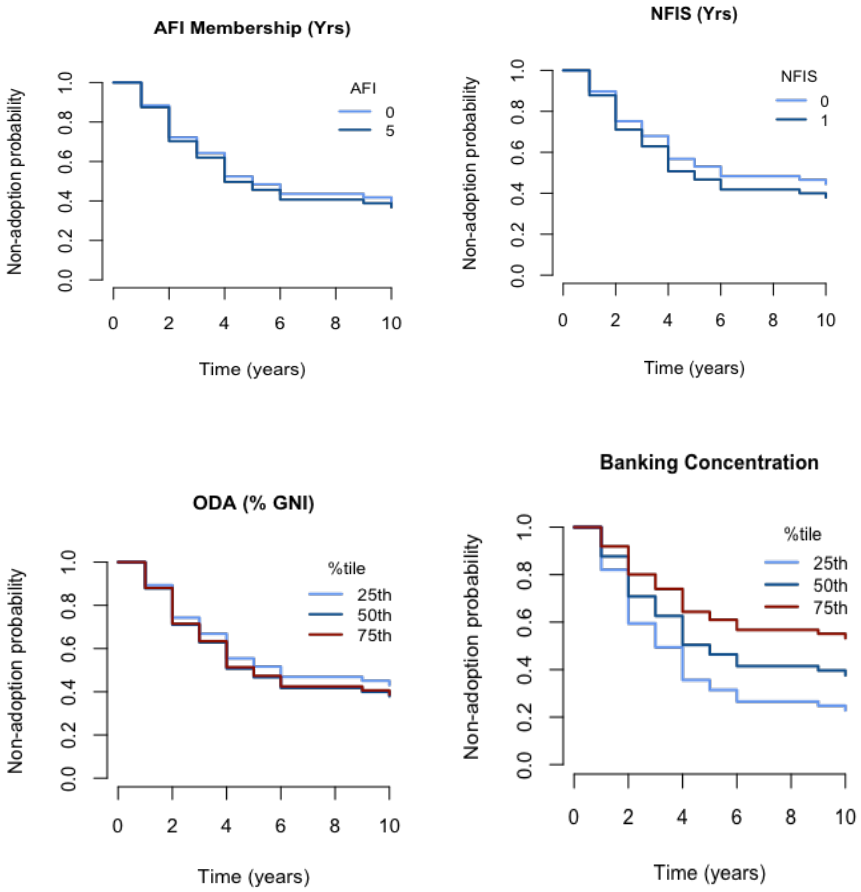
I find weak support for my hypothesis that higher banking concentrations inhibit the risk of adopting risk-based KYC requirements. The coefficient is in the direction hypothesized (the hazard ratio indicates about a 2.5% decrease in the hazard per percentage point increase in concentration), but the significance is marginal at best. The coefficient for bank branches is positive, suggesting a positive relationship between KYC adoption and access to commercial banks. This relationship makes sense, as countries with high levels of commercial bank access have less need for risk-based KYC policies. The coefficients on financial accounts and the

indicator for government effectiveness are surprisingly negative, but these relationships are not significant.

Investigation of Heterogeneity

I divide my sample into subgroups and construct survival curves to investigate any heterogeneity (Figure 3). For participation in the international community, I use the model to estimate and compare the non-adoption probability (i.e., the survival probability) over time for countries with 0 years of AFI membership and countries with 5 years of AFI membership. The risk of non-adoption over time is nearly identical for the two groups. The estimated curves are similar when comparing countries without a NFIS to countries establishing a NFIS in the past year, and across percentiles of ODA dependence. For banking concentration, probabilities of non-adoption over time tend to be higher for countries in the 75th percentile of banking concentration (~93% of total banking assets concentrated in the top three banks) when compared with countries in the 25th percentile (~60% concentrated).

Figure 3: Survival Curves



Estimation concerns

First, there are endogeneity concerns with the relationship between participation in the international financial inclusion community and the adoption of risk-based KYC. That is, an underlying mechanism may lead to simultaneous decisions about regulations and international participation, or the adoption of risk-based KYC may prompt more international participation. These concerns are partially mitigated with an investigation of the timing between the two actions. The average length of AFI membership prior to risk-based KYC adoption is 4.5 years, and there is only one country, as of 2021, that adopted risk-based KYC before joining AFI (there are no instances of simultaneous membership and adoption).

Second, there are eight countries in western Africa that share a central bank (BCEAO).[46] The shared central bank adopted risk-based KYC measures in 2015, resulting in adoption for the seven states who had not independently adopted risk-based KYC. The main analysis treats each country as an individual unit, but I conduct a supplementary analysis in which I combine them into one unit of analysis (see Appendix C). The finding that the proportion of neighbors adopting exerts a significant influence on the hazard of adoption is consistent in both analyses, with a slightly larger hazard ratio in the supplementary analysis (1.09 compared to 1.06). However, the coefficient on banking concentration produces a hazard ratio of 1 with a large p-value, indicating that the tenuous support for this hypothesis in the main analysis is not robust to sample configuration. Estimates for the remaining covariates are roughly consistent between the two models, with the exception of GDP being positive and significant in the reduced sample supplementary analysis.

Finally, missing data was a limitation for a subset of indicators, but I collected complete data for the event variable (risk-based KYC adoption) and for the AFI/NFIS variables. Most of the missing data can be categorized as a single time period missing for a variable that tends to behave predictably over time (e.g., banking concentration does not vary much year to year; financial account ownership tends to rise year to year). Thus, I was comfortable with simple linear interpolation rather than complex multiple imputation. When possible, I corroborated my imputation estimates with reports from central banks or third party sources.

Discussion

This study is one of the first to take a political economy approach to examine the policy convergence of enabling mobile money regulation in sub-Saharan Africa. Using frameworks

[46] There are six central African countries that also share a central bank; however, adoption decisions around risk-based KYC in these countries appear to be independent.

from the international relations and policy diffusion literatures, I investigated the influence of external pressures from donor communities, participation in international policy networks, and neighbor behavior on the adoption of risk-based KYC requirements. I did not find evidence of international influence from donors or financial inclusion organizations, but I did find consistent support for the hypothesis that neighbor adoption increases the risk of local adoption. In his examination of different theories of policy diffusion, Weyland (2005) attributes this phenomena to psychology's "availability heuristic", stating "[b]old changes that happen next door are immediately available and thus grab the attention of decision-makers". This conception of regional diffusion as a product of decision heuristics is also consistent with the temporal pattern of diffusion for mimicry described by Shipan and Volden (2008), in which the influence of neighbor adoption is strong but short-lived. In this study, I find that neighbor adoption has a waning influence, matching the authors' estimated trajectory for diffusion through imitation.

Despite theoretical rationale, I do not find strong support for the hypothesis that a concentrated banking sector inhibits the adoption of risk-based KYC requirements. In fact, I am unable to identify any influential internal determinants of adoption. It is possible that the only important driver of the adoption of enabling regulations is regional diffusion over time, but it is more likely that my model is overly limited in its scope of domestic indicators. I do not include domestic covariates for a country's level of democracy, characteristics of the central bank or its director, or other country-specific circumstances that may influence policy decisions. For example, the experience of a domestic financial shock is likely to disrupt a regulator's calculus regarding the adoption of monetary policies (Stallings, 1992). This study's reliance on estimates of GDP and government effectiveness is likely an inadequate operationalization of the domestic

game, and further research on this topic should incorporate a more comprehensive exploration of the domestic tradeoffs of policy adoption.

Although the insights derived from this study are limited, the findings can serve as a jumping off point for future research. In addition to incorporating a more sophisticated model that accounts for internal determinants such as level of democracy and financial shocks, future research could more deeply explore the relationship between enabling financial inclusion policies and the banking sector. Risk-based KYC requirements are an enabling policy that the banking sector is largely incentivized to oppose (because the policy lowers barriers to competition for non-bank providers), but customer protection requirements for mobile money providers present an enabling policy that the banking sector should largely support (because the policy increases barriers to competition). An analysis that can disentangle the relationship between enabling policies and potential domestic obstacles could provide valuable insights for financial inclusion initiatives.

Conclusion

The vast majority of the literature on mobile money regulation is focused on its relationship with financial inclusion, but very few articles investigate the factors that lead to the adoption of internationally recommended enabling regulations. This study finds that neighbor behavior is a key driver of local policy adoption and reveals the need for further studies to produce more insights into the domestic context of central bank decision-making. A more comprehensive understanding of the mechanisms driving policy convergence can facilitate the adoption of enabling regulations to achieve financial inclusion goals.

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Appendices to Accompany Chapter 1

Contents:

Chapter 1 Appendix A: Correlates of savings behavior

Table A.1 displays correlation coefficients for three different categories of household savings behavior: bank savings, mobile savings, and either bank or mobile savings.

Table A.1: Correlations of savings behavior

	Bank Savings		Mobile Savings		Bank and/or Mobile Savings	
	R1	**R2**	**R1**	**R2**	**R1**	**R2**
Bank Savings	1***	1***				
Mobile Savings	0.207***	0.158***	1***	1***		
Bank/Mobile Savings	0.735***	0.734***	0.690***	0.667***	1***	1***
MM	0.314***	0.244***	0.435***	0.313***	0.498***	0.395***
Age	0.002	-0.005	-0.115***	-0.121***	-0.060**	-0.089***
Rural	-0.253***	-0.244***	-0.244***	-0.146***	-0.326***	-0.269***
Male	0.022	0.065**	0.010	0.050*	0.004	0.065**
Split HH	–	0.023	–	0.090***	–	0.075**
HH size	0.013	-0.008	-0.056**	-0.066**	-0.024	-0.052**
Primary Ed	0.268***	0.267***	0.173***	0.186***	0.288***	0.305***
Food insecurity	-0.170***	-0.188***	-0.076**	-0.037	-0.144***	-0.152***
Ag Employed	-0.334***	-0.293***	-0.261***	-0.223***	-0.382***	-0.349***
Covariate shock	-0.125***	-0.127***	-0.002	-0.018	-0.101***	-0.096***

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

Chapter 1 Appendix B: Comparison with Finscope/Findex data

I explore Tanzania Finscope data and Tanzania Findex data for comparable trends in savings behavior. These datasets contain cross-sectional representative samples. Both the Finscope and Findex surveys have narrow definitions of the word "save", thus the savings estimates presented here are likely lower than the savings estimates in the paper, which also include storage of money.

Table B.1: Tanzania Finscope data[47]

Year	Bank Savings	Mobile Savings	Bank/Mobile Savings
2013	10.9%	17.8%	24.3%
2017	7.52%	14.5%	18.5%

Table B.2: Tanzania Findex data[48]

Year	Bank Savings	Mobile Savings	Bank/Mobile Savings	Saved any method
2014	9.0%	NA	NA	59.2%
2017	6.1%	NA	NA	48.4%
2021	6.3%	19.2%	22.1%	49.5%

[47] Available from FinMark Trust
[48] Available from the World Bank DataBank

Chapter 1 Appendix C: Robustness checks

Table C.1 presents the results of the logistic regression:

$$\log\left(\frac{\pi_{ijt}}{1-\pi_{ijt}}\right) = \beta_0 + \beta_1(Treatment)_{ijt} + \beta_2(Post)_{ijt} + \beta_3(Treatment * Post)_{ijt} + \alpha_j + \gamma X_{ijt}$$

In which π_{ijt} is the probability that household *i* in survey cluster *j* at time *t* i) owned a bank account at the time of the survey (M1); or ii) used a mobile money account to save or store money (M2).

Table C.1: Logit model estimates

	(M1)		(M2)	
	Est	(SE)	Est	(SE)
Intercept	-4.82***	(-1.031)	-0.862	(-0.915)
Treatment	0.48*	(-0.282)	-0.112	(-0.246)
Post	-0.36	(-0.26)	-0.948***	(-0.24)
Treatment*Post	0.26	(-0.309)	0.646**	(-0.281)
Age	0.05***	(-0.007)	-0.007	(-0.006)
Rural	-0.24	(-0.191)	-0.015	(-0.179)
Split HH	0.41*	(-0.23)	0.284	(-0.211)
Male	0.31*	(-0.183)	0.077	(-0.167)
HH size	0.06*	(-0.034)	0.012	(-0.029)
Primary Ed	1.64***	(-0.257)	0.25	(-0.202)
Food Security	-1.05***	(-0.198)	0.018	(-0.167)
HH Head Occupation				
Unemployed	-1.7***	(-0.388)	-0.995***	(-0.359)
Agriculture	-1.23***	(-0.224)	-0.472**	(-0.201)
Observations	1280		1243	

Notes: *p<0.1; **p<0.05; ***p<0.01. The comparison category for occupation is employment in non-Agriculture. All specifications include cluster-level fixed effects.

Table C.2 repeats the primary analyses with region level fixed effects (instead of survey cluster fixed effects). The outcome variable for M1 is whether or not the household owned a bank account, and the outcome variable for M2 is whether or not the household used a mobile money account to save or store money.

Table C.2: Region-level fixed effects

	(M1)		(M2)	
	Est	(SE)	Est	(SE)
Treatment	0.022	(-0.047)	0.0112	(-0.051)
Post	-0.063**	(-0.031)	-0.1683***	(-0.042)
Treatment*Post	0.048	(-0.04)	0.1159**	(-0.052)
Age	0.007***	(-0.001)	-0.0009	(-0.001)
Rural	-0.07**	(-0.033)	-0.0365	(-0.033)
Split HH	0.038	(-0.038)	0.0299	(-0.042)
Male	0.031	(-0.033)	0.0005	(-0.031)
HH size	0.011**	(-0.005)	0.0008	(-0.005)
Primary Ed	0.252***	(-0.031)	0.0469	(-0.035)
Food Security	-0.17***	(-0.028)	-0.0069	(-0.031)
HH Head Occupation				
Unemployed	-0.263***	(-0.054)	-0.1966***	(-0.055)
Agriculture	-0.234***	(-0.036)	-0.1192***	(-0.036)
Observations	1280		1243	

Notes: *p<0.1; **p<0.05; ***p<0.01. The comparison category for occupation is employment in non-Agriculture. All specifications include region-level fixed effects. Standard errors are clustered at the household.

Table C.3 repeated the primary analyses with a balanced panel of 858 households (excludes the 326 split-off households and the 131 lost to follow-up). The outcome variable for M1 is whether or not the household owned a bank account, and the outcome variable for M2 is whether or not the household used a mobile money account to save or store money.

Table C.3: Main results using balanced panel

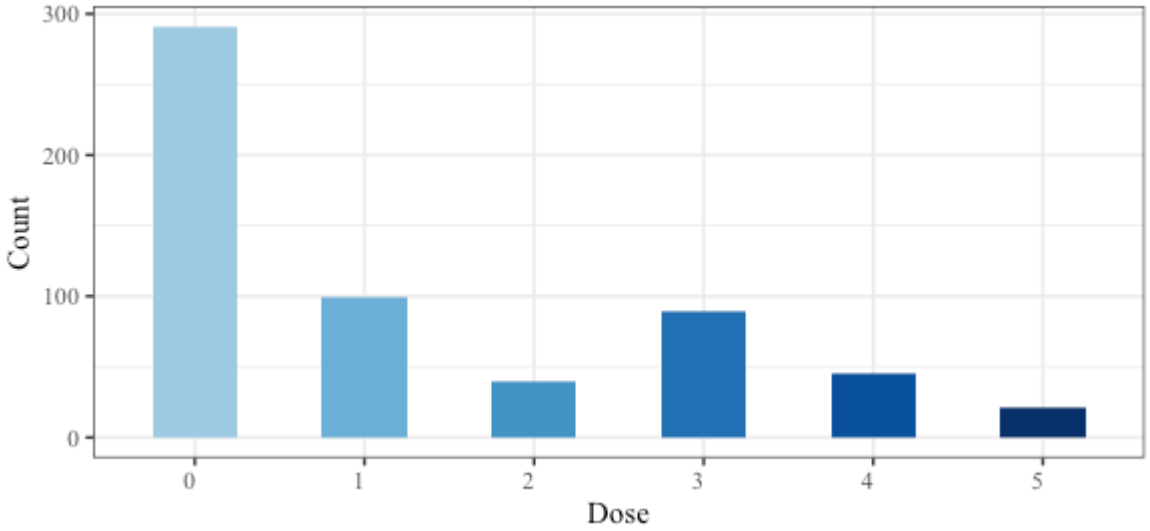
	(M1)		(M2)	
	Est	(SE)	Est	(SE)
Treatment	0.034	(-0.054)	0.0124	(-0.058)
Post	-0.045	(-0.031)	-0.1636***	(-0.045)
Treatment*Post	0.017	(-0.042)	0.0966*	(-0.057)
Age	0.008***	(-0.001)	-0.0009	(-0.001)
Rural	-0.057	(-0.038)	-0.0278	(-0.037)
Male	0.063	(-0.039)	-0.0199	(-0.036)
HH size	0.005	(-0.006)	0.0013	(-0.006)
Primary Ed	0.242***	(-0.037)	0.0779**	(-0.039)
Food Security	-0.159***	(-0.033)	-0.0005	(-0.035)
HH Head Occupation				
Unemployed	-0.248***	(-0.062)	-0.1758***	(-0.062)
Agriculture	-0.236***	(-0.042)	-0.1122***	(-0.04)
Observations	994		970	

Notes: *p<0.1; **p<0.05; ***p<0.01. The comparison category for occupation is employment in non-Agriculture. All specifications include cluster-level fixed effects. Standard errors are clustered at the household.

Chapter 1 Appendix D: Interest distribution and timing

To examine potential confounding effects from not having pure "pre" estimates for much of the sample, I analyze the relationship between mobile savings and "dosage" of interest distribution. The interest distributions were made quarterly, and I categorized the sample by the number of doses received at the time the household was surveyed.

Figure D.1: Round 1 sample, by interest distribution received at time of survey



I then estimate a linear regression for the round 1 data, with mobile savings as the outcome variable (Table D.1).

Table D.1: Relationship between dose and mobile savings

	Est	(SE)
Dose	0.0213	(-0.019)
Age	-0.0009	(-0.002)
Rural	0.0013	(-0.061)
Male	0.0511	(-0.05)
HH size	0.0003	(-0.009)
Primary Ed	0.0038	(-0.058)
Food Security	-0.0115	(-0.048)

HH Head Occupation		
Unemployed	-0.2119*	(-0.113)
Agriculture	-0.0794	(-0.06)
Observations	576	

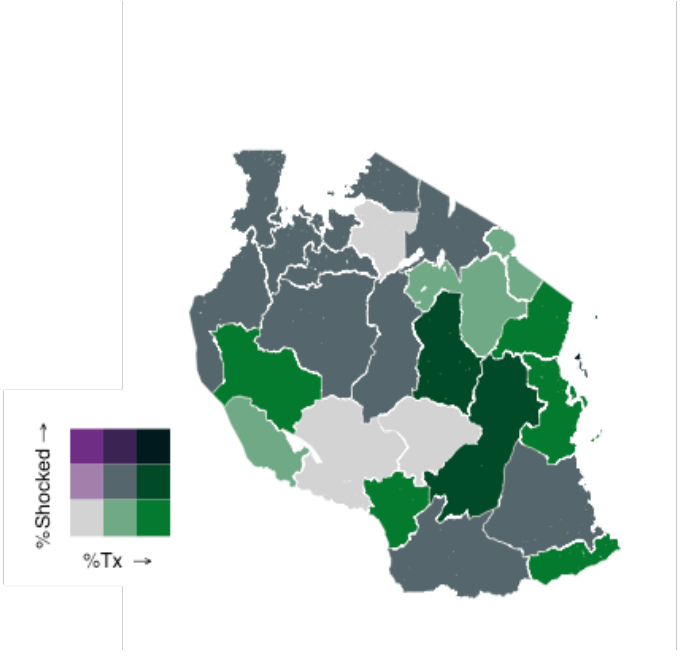
Notes: *p<0.1; **p<0.05; ***p<0.01. The comparison category for occupation is employment in non-Agriculture. All specifications include cluster-level fixed effects.

Chapter 1 Appendix E: Spatial analysis of assignment to treatment and covariate shocks

This spatial analysis investigates the geographic distribution of MNOs and the potential confounding effect of covariate shocks. Covariate shocks, such as drought, floods, crop pests, and price shocks, tend to deal a financial shock to households in a specific geographic region. If the coverage area of treatment MNOs overlaps with regions that disproportionately experienced (or failed to experience) covariate shocks when compared to the geographic area occupied by control households, then the impact of the mobile savings incentive on mobile savings is confounded. Households experiencing shocks (especially poor households without access to credit) tend to deplete savings in order to smooth consumption and thus may not have savings remaining to report in round 2 of the survey. If assignment to treatment is positively (negatively) correlated with experiencing a covariate shock in the year prior to round 2, then the policy effect is likely to be underestimated (overestimated). Approximately 23% of households reported experiencing a covariate shock in the 12 months before round 2.

Figure E.1 depicts the distribution of assignment to treatment and covariate shock experience, with percentage cutoffs at 25% and 75%. The center gray color indicates a roughly even allocation of treatment assignment and shock experience, while the colors in the corners of the legend indicate disproportionate assignment (Fewer than 25% treatment/shock and greater than 75% shock/treatment). There do not appear to be large geographic clusters containing households with disproportionate assignment to treatment and covariate shock experience.

Figure E.1: Distribution of treatment assignment and shock experience



Chapter 1 Appendix F: Food insecurity

I explore any potential welfare implications of the mobile interest distribution. Savings provide a mechanism for smoothing consumption during hard times, so I examine the proportion of households experiencing food insecurity in the year prior to each survey round. First, I re-run my main analysis using food insecurity as the outcome variable. The mobile savings incentive has a null effect on whether or not a household experiences food insecurity (Table F.1).

Table F.1: Treatment effect on food insecurity

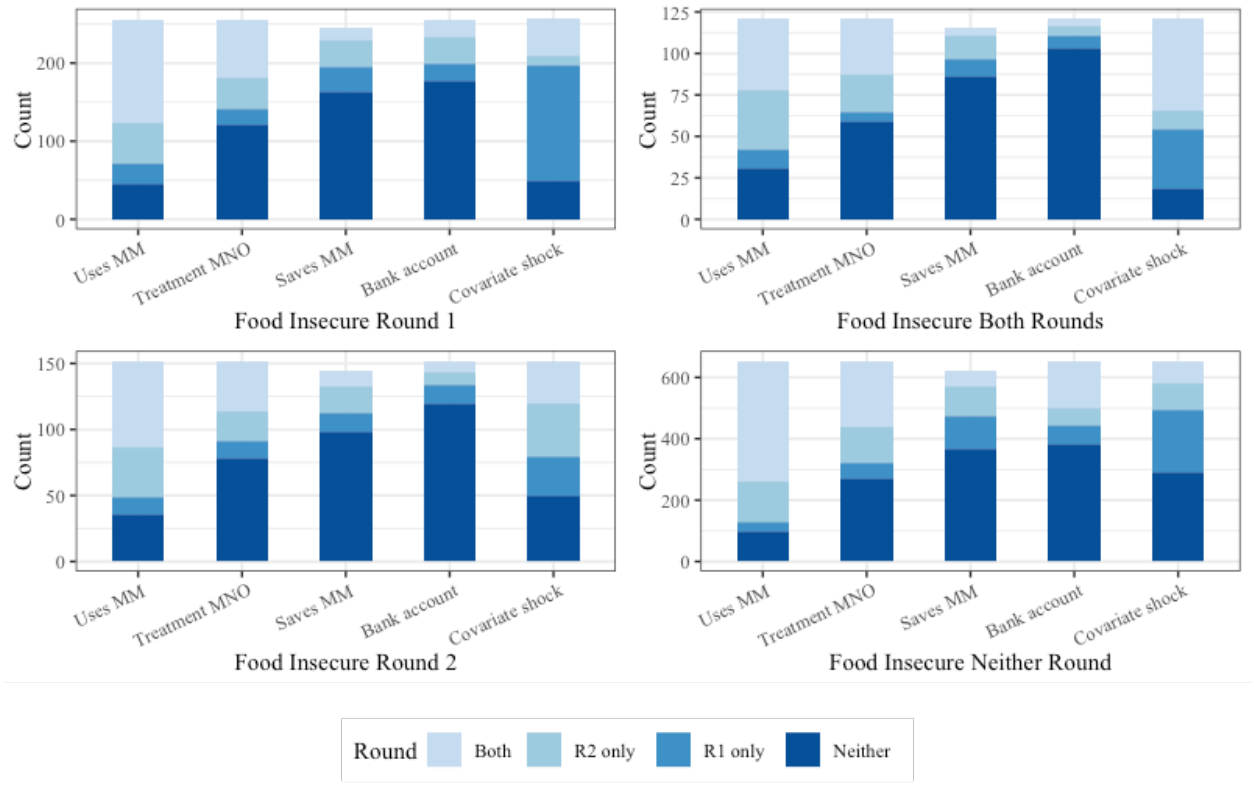
	Est	(SE)
Treatment	0.0202	(-0.045)
Post	-0.1286***	(-0.039)
Treatment*Post	0.0363	(-0.048)
Age	-0.0008	(-0.001)
Rural	0.0486	(-0.032)
Male	0.0311	(-0.034)
HH size	-0.0158**	(-0.03)
Primary Ed	0.0114**	(-0.005)
HH Head Occupation		
Unemployed	0.0823	(-0.058)
Agriculture	0.0052	(-0.035)
Observations	1280	

Notes: *p<0.1; **p<0.05; ***p<0.01. The comparison category for occupation is employment in non-Agriculture. All specifications include cluster-level fixed effects. Standard errors are clustered at the household.

To further investigate any descriptive relationship between household resilience to food insecurity and savings behavior, I divide the full sample into four categories based on when the household experienced food insecurity (prior to round 1 only, prior to round 2 only, prior to both rounds, or prior to neither round). Figure F.1 compares the timing of food insecurity with the timing of different mobile and savings behaviors across rounds, as well as reported incidence of a covariate shock. It is possible that there is a relationship between mobile money use and food insecurity, as well over half of households who did not experience food insecurity were mobile

money users in both survey rounds, but being a customer of a treatment MNO does not appear to have any mitigating effect on food insecurity. The most obvious difference across households in the four categories is the experience of a covariate shock, as the timing of the shock tends to correspond to the timing of reported food insecurity.

Figure F.1: Food insecurity and savings



Appendix to Accompany Chapter 2

Qualitative Content Analysis

Table A1: Coding Procedure for Content Analysis

Theme	Code	Definition
Perceived alternative scenario		
	Group-MM (1)	Respondent expresses that she has learned that group meeting attendance is still expected, regardless of payment choice.
	Indiv-MM (0)	Respondent indicates that digital repayment is a substitute for group attendance.
	Not Applicable (NA)	No mention of attendance expectations.
	GROUPS	
Travel time/cost to attend group meetings		
	Burdensome (1)	Respondent indicates that group meetings take place in a distant or inconvenient location; or that there is a financial cost to travel to the group meeting.
	Not Burdensome (0)	Respondent indicates that group meetings take place in a proximal or convenient location.
	Not Applicable (NA)	No mention of travel time/ costs to attend group meetings.
Opportunity cost of time spent in group meeting		

	Burdensome (1)	Respondent indicates that group meetings are too long; or that she would prefer to be doing other things during the group meetings.
	Not Burdensome (0)	Respondent indicates satisfaction with group meeting length and/or with group meetings in general; and does not mention a preference for alternative activities.
	Not Applicable (NA)	No stated opinions on the group meeting.
Social cohesion of group		
	Strong (1)	Respondent expresses fondness for the social and/or learning aspects of the group.
	Weak (0)	Respondent expresses negative sentiment toward the social/learning aspects of the group and/or dislike/distrust of group members.
	Not Applicable (NA)	No reference to the social/learning aspects of the group.
Perceived loan liability		
	Implicit joint (1)	Respondent expresses the importance of being able to monitor one another's repayment behavior.
	Individual (0)	Respondent expresses understanding that loans are structured as individual liability.
	Not Applicable (NA)	No explicit or implicit description of perceived loan structure.

Peer influence on vote preference		
	Effective (1)	Respondent explicitly attributes her stated preference between cash and MM to group pressure.
	Ineffective (0)	Respondent chooses contrary to explicit group pressure.
	Not Applicable (NA)	No reference persuasive pressure of the group.
	MOBILE MONEY	
Affordability		
	Costly (1)	Respondent indicates that mobile money fees are costly.
	Affordable (0)	Respondent indicates that mobile money fees are reasonable.
	Not Applicable (NA)	No mention of mobile money costs.
Convenience		
	Convenient (1)	Respondent indicates that mobile money is convenient; or that it saves time.
	Not convenient (0)	Respondent indicates that mobile money is less convenient than cash or not convenient (poor network or inaccessible agents).
	Not Applicable (NA)	No mention of mobile money convenience.
Trust/Risk		
	Distrust (1)	Respondent indicates distrust of mobile money or fear of losing money digitally.
	Trust (0)	Respondent indicates trust in

		or reliability of mobile money.
	Not Applicable (NA)	No mention of mobile money trust.
Perceived difficulty		
	Difficult (1)	Respondent indicates that mobile money is difficult or too complex.
	Not difficult (0)	Respondent indicates that mobile money is not difficult.
	Not Applicable (NA)	No mention of mobile money difficulty.

Details of Data and Model Decisions

Imputation for missing data

In an initial attempt at the analysis, respondents were dropped due to data missingness for the following variables: group meeting time, distance to a mobile money agent, weekly mobile money use, preferring an alternative activity to group attendance, and preference for receiving 1000 UGX in mobile money versus cash.

- I was able to impute group meeting time (n = 18) and distance to a mobile money agent (n = 50). The microfinance groups are generally scheduled for 60 minutes (and the majority report a meeting time of one hour); thus, I imputed 60 minutes for respondents missing this variable as long as other group members also reported 60 minutes or reported a range of times including 60 minutes. If other group members reported different times, I imputed the mode time reported. For distance to an agent, I imputed the average time reported by other group members (or other branch members if there were no other group members).
- I attempted to use regression imputation for those who were not asked their preference for receiving 1000 UGX. I used the highly correlated variables of digital repayment preference and weekly mobile money use in a logistic regression and then estimated prediction probabilities and associated 95% confidence intervals. For those who preferred digital repayment and used mobile money weekly, the 95% prediction interval crossed 50%, and I was not able to impute their preference for 1000 UGX. All other combinations of digital repayment preference and weekly mobile money use predicted a preference for 1000 UGX in cash, but imputing these respondents without the others

would introduce selection bias. Thus, these 86 were dropped from the analysis (along with 19 additional respondents missing data for weekly mobile money use).

There is no significant association between the 104 respondents dropped and repayment preference (phi = -0.031; p-value = 0.148).

Using phone survey data to recode round two preferences

Of the 466 phone survey respondents, 24 indicated that they were absent on the day of voting and never placed a second vote. Nearly all of these respondents (n = 17) were concentrated in one branch, making it unlikely that they just forgot that they voted. Further, 42 respondents insisted that their vote was recorded wrong (with unequal distribution across branches). Both the "ghost" votes and the incorrectly recorded votes are heavily biased toward cash repayment. With the additional insight of peer influence in the voting process, I chose to drop the ghost votes and recode the incorrect votes in order to more accurately reflect borrower preferences.

Complete Results Tables (include estimates for branch fixed effects)

Table A2: RUM Results from Baseline Survey (Companion to Table 4)

	Model 1	**Model 2**
Variable	$\boldsymbol{\beta}$ **(se)**	$\boldsymbol{\beta}$ **(se)**
(Intercept)	0.002 (0.096)	-0.390 (0.272)
Time Diff	-0.002** (0.001)	-0.002 (0.001)
Cost Diff	< -0.001** (0.000)	< -0.001** (0.000)
Alt Activity		0.410*** (0.100)
Weekly MM		0.399*** (0.120)
Pref MM		0.611*** (0.097)
Married		-0.118 (0.101)
Primary Ed		0.310*** (0.103)

Revenue		-0.003 (0.013)
Branch[a]		
Iganga Nkono (R)		-0.550*** (0.197)
Kabuusu (U)		-0.298 (0.201)
Kalerwe (U)		-0.200 (0.203)
Masaka (P)		0.174 (0.230)
Mbarara (P)		0.290 (0.200)
Mityana (P)		-0.977*** (0.189)
Mukono Central (R)		-0.797*** (0.215)
Semuto (R)		-0.508** (0.208)
N	2046	2046
AIC	2802	2651

Notes: *p < 0.1; **p < 0.05; ***p < 0.01. [a] Kyenjojo (R) is reference branch. U = Urban; P = Peri-urban; R = Rural. Revenue is the log of the last six months of revenue from the respondent's business.

Table A3: RUM Results for Round 2 (Companion to Table 5)

	Model 3	**Model 4**	**Model 5**	**Model 6**
Variable	***β*** **(se)**	***β*** **(se)**	***β*** **(se)**	***β*** **(se)**
(Intercept)	-0.843*** (0.230)	-2.309*** (0.472)	-1.182*** (0.146)	-2.076*** (0.434)
Time Diff	-0.007* (0.004)	-0.004 (0.005)	-0.004*** (0.002)	0.000 (0.002)

Cost Diff	< -0.001 (0.000)	< -0.001 (0.000)	< -0.001*** (0.000)	< -0.001*** (0.000)
Alt Activity		0.360*** (0.138)		0.350** (0.139)
Grp Dist		0.004 (0.003)		0.002 (0.003)
Weekly MM		0.497*** (0.186)		0.507*** (0.187)
Pref MM		0.183 (0.134)		0.172 (0.134)
Married		-0.135 (0.140)		-0.135 (0.141)
Primary Ed		0.525*** (0.147)		0.519*** (0.147)
Revenue		0.015 (0.022)		0.017 (0.022)
Branch[a]				
Iganga Nkono (R)		-0.830*** (0.307)		-0.792** (0.307)
Kabuusu (U)		0.231 (0.285)		0.250 (0.283)
Kalerwe (U)		-0.715** (0.300)		-0.726** (0.297)
Masaka (P)		0.573** (0.291)		0.584** (0.290)
Mbarara (P)		0.459* (0.270)		0.490* (0.273)
Mityana (P)		-0.439 (0.303)		-0.414 (0.302)
Mukono Central (R)		-0.856*** (0.317)		-0.879*** (0.316)
Semuto (R)		1.412*** (0.263)		1.408*** (0.266)

N	1380	1380	1380	1380
AIC	1595	1456	1579	1448

Notes: *p < 0.1; **p < 0.05; ***p < 0.01. [a] Kyenjojo (R) is reference branch. U = Urban; P = Peri-urban; R = Rural. Revenue is the log of the last six months of revenue from the respondent's business.

Robustness check

Table A4 re-estimates the round 1 analysis (Model 2 from Table 4) using the round 2 sample of 1455 respondents.

Table A4: Round 1 Analysis with Balanced Sample

Var	β	(se)	p-value
(Intercept)	-0.746**	(0.354)	0.035
Time Diff	-0.001	(0.001)	0.411
Cost Diff	0.000**	(0.000)	0.019
Alt Activity	0.346***	(0.123)	0.005
Weekly MM	0.428***	(0.145)	0.003
Pref MM	0.614***	(0.116)	0.000
Married	-0.049	(0.123)	0.688
Primary Ed	0.297**	(0.123)	0.016
Revenue	0.013	(0.019)	0.498
Branch			
Kabuusu (U)	-0.291	(0.256)	0.254
Kalerwe (U)	-0.120	(0.231)	0.604
Iganga Nkono (R)	-0.393*	(0.233)	0.091
Masaka (P)	-0.071	(0.269)	0.792
Mbarara (P)	0.399	(0.252)	0.114
Mityana (P)	-0.975***	(0.247)	0.000
Mukono Central (R)	-0.848***	(0.248)	0.001

Semuto (R)	-0.502**	(0.239)	0.036

Notes: Final model estimated with 1455 observations. AIC = 1817. *p < 0.1; **p < 0.05; ***p < 0.01. [a] Kyenjojo (R) is reference branch. U = Urban; P = Peri-urban; R = Rural. Revenue is the log of the last six months of revenue from the respondent's business.

Examination of Preferences and Themes by Branch

There is a very strong association between digital repayment preferences and being a borrower from the rural Semuto branch (exponentiating the coefficient in Table A4 reveals ~310% increase in the odds of voting digital repayment). I look to the qualitative analysis for insights into these curious findings. There were only 25 Semuto respondents in the phone survey, and there is no evidence that any of them received the information that group meetings would continue regardless of repayment preference. Compared to other branches, Semuto borrowers voiced the highest prevalence of themes around mobile money convenience and the lowest number of complaints about mobile transaction fees (Table A5). Semuto borrowers also tended to have lower than average perceptions of joint liability and incidences of peer influence over repayment preference. No consistent patterns emerged within the other branches, but these pieces of qualitative data do offer a reasonable explanation for the outlier Semuto branch.

Table A5: Proportion of Respondents Mentioning Themes, by Branch

Branch	Prefer MM	Group-MM	Joint Liability	Peer Influence	MM Conv.	MM Exp.	MM Difficult	N
Iganga Nkono (R)	0.15	0.15	0.02	0.06	0.02	0.34	0.13	53
Kabuusu (U)	0.21	0.19	0.09	0.02	0.21	0.34	0.08	53
Kalerwe (U)	0.22	0.12	0.14	0.14	0.15	0.32	0.11	65
Kyenjojo (R)	0.10	0.24	0.07	0.09	0.07	0.43	0.26	58
Masaka (P)	0.24	0.06	0.26	0.32	0.15	0.32	0.12	34
Mbarara (P)	0.12	0.26	0.14	0.20	0.09	0.40	0.11	65
Mityana (P)	0.19	0.17	0.10	0.02	0.15	0.46	0.13	48
Mukono	0.20	0.02	0.05	0.00	0.20	0.46	0.10	41

Central (R)								
Semuto (R)	0.64	0.00	0.04	0.04	0.28	0.16	0.12	25
Average	0.23	0.14	0.10	0.10	0.15	0.36	0.13	

Notes: The column headings refer to the following themes: voting for digital repayment; perceiving the Group-MM scenario; perceiving a joint liability loan structure; voting based on peer influence; mobile money is convenient; mobile money is expensive; mobile money is difficult.

Appendix to Accompany Chapter 3

Sample of Countries

Table A1: Included Countries

Country	Region	Year adopted KYC
Burundi	central	2017
Cameroon	central	2016
Chad	central	NA
Congo	central	NA
Dem. Rep. Congo	central	2012
Gabon	central	NA
Ethiopia	east	2018
Kenya	east	NA
Madagascar	east	NA
Mauritius	east	2019
Rwanda	east	2016
Seychelles	east	NA
South Sudan	east	2019
Sudan	east	2017
Tanzania	east	2014
Uganda	east	2021
Angola	south	2014
Botswana	south	NA
Eswatini	south	2020
Lesotho	south	2013
Malawi	south	2015
Mozambique	south	NA

Namibia	south	NA
South Africa	south	2013
Zambia	south	2014
Zimbabwe	south	NA
Gambia	west	NA
Ghana	west	2015
Guinea	west	2017
Liberia	west	2014
Mauritania	west	NA
Nigeria	west	2013
Sierra Leone	west	2016
Benin*	west	2015
Burkina Faso*	west	2015
Cote d'Ivoire*	west	2013
Guinea-Bissau*	west	2015
Mali*	west	2015
Niger*	west	2015
Senegal*	west	2015
Togo*	west	2015

Notes: * indicates one of eight WAEMU countries

BTSCS Results

Table A2: Results of BTSCS Model

Variable	$\boldsymbol{\beta}$	**(SE)**	**exp($\boldsymbol{\beta}$)**	**p-value**
Intercept	-5.9947	10.7464	0.0025	0.5770
Level I (External)				
AFI member (yrs)	-0.2164	0.6734	0.8054	0.7479
NFIS (yrs)	0.6225	0.6089	1.8635	0.3067
ODA (%GNI)	0.0654	0.0542	1.0676	0.2273
China aid	0.2087*	0.1119	1.2321	0.0621
Neighbors adopt	0.0766***	0.0263	1.0797	0.0036
Level II (Internal)				
Banking conc.	-0.0301	0.0191	0.9704	0.1145
Financial accounts	-0.0019	0.0205	0.9981	0.9278
Bank branches	0.0976	0.0924	1.1026	0.2907
GDP (log)	0.4211	0.3810	1.5236	0.2691
Gov effectiveness	-0.3957	0.6961	0.6732	0.5698
China aid x ln(Time)	-0.2034**	0.0888	0.8160	0.0220
Neighbors x ln(Time)	-0.0468**	0.0215	0.9543	0.0297
Bank branches x ln(Time)	-0.1678	0.1019	0.8455	0.0996

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

Cox NPH model for WAEMU Countries

For the estimation of all WAEMU countries as a single observation, I used the first year that any country joined AFI and adopted a NFIS. I took the mean of other covariates.

Table A3: Results of Cox NPH Model, WAEMU countries as one observation

Variable	β	**(SE)**	**exp(β)**	**p-value**
Level I (External)				
AFI member (yrs)	0.1320	0.0965	1.1411	0.1711
NFIS (yrs)	0.0641	0.1857	1.0662	0.7299
ODA (%GNI)	0.0617	0.0526	1.0636	0.2409
China aid	0.1682	0.1063	1.1831	0.1137
Neighbors adopt	0.0874***	0.0276	1.0913	0.0015
Level II (Internal)				
Banking conc.	0.0027	0.0186	1.0027	0.8827
Financial accounts	-0.0093	0.0242	0.9907	0.7006
Bank branches	0.0531	0.1185	1.0545	0.6543
GDP (log)	0.8041**	0.3670	2.2348	0.0284
Gov effectiveness	0.4724	0.7930	1.6039	0.5513
China aid x ln(Time)	-0.1276	0.0825	0.8802	0.1221
Neighbors x ln(Time)	-0.0463**	0.0221	0.9547	0.0358
Bank branches x ln(Time)	-0.1063	0.1028	0.8991	0.3011

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