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RESEARCH ARTICLE

Farmers' awareness of digital credit: Does financial literacy matter?

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Abstract

This study investigates the relationship between financial literacy and farmers' awareness of digital credit in rural Madagascar. We apply questions that demonstrate individuals' understanding of the four fundamental concepts for financial decision making: numeracy, interest compounding, inflation and risk diversification to measure farmers' financial literacy. We find that financial literacy has a positive and statistically significant effect on farmers' awareness of digital credit. Our study highlights the importance of financial literacy for increasing farmers' awareness of digital credit in rural areas of Madagascar and supports the widely held view that financial literacy is crucial for individuals' awareness of financial products.

KEYWORDS

awareness of financial products, digital credit, financial literacy, Madagascar, smallholder farmers

JEL CLASSIFICATION

G23, G53, Q14

1 | INTRODUCTION

Previous studies have indicated the limited presence of formal financial institutions in rural areas of sub-Saharan Africa (SSA) compared to urban areas (Consumer Survey Highlights, 2016; Dupas et al., 2012; Mpuga, 2010). As a result, a large number of people in rural areas are excluded from formal credit markets. Over the past decade, digital finance (e.g. digital credit, mobile money services) has developed rapidly in SSA in order to expand access to financial

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services to people who are underserved by formal credit markets, including those in rural areas (e.g. Kaffenberger & Totolo, 2018; Suri et al., 2021).

A branch of digital finance that has the capability of expanding access to credit to farmers in rural areas of SSA is digital credit. Digital credit is a loan product that is 'instant, automated and remote' (Chen & Mazer, 2016): 'instant' because the process from credit application to credit decision occurs within seconds or takes at most 24 h, 'automated' because decisions such as credit eligibility, credit limit and customer management are automated based on preset parameters and 'remote' because digital credit transactions such as loan applications, disbursements and repayments can be managed remotely, removing infrastructural and geographical requirements for the provision/access to credit. Digital credit has the ability to reduce the transaction costs of providing formal financial services considerably by bridging the geographical distance between lenders and potential borrowers (Francis et al., 2017). This makes digital credit a plausible option for people in rural areas whose access to formal financial services (e.g. conventional credit) is normally constrained by geographical remoteness.

Previous studies on digital credit largely acknowledge the potential of this branch of digital finance to expand access to credit, even for those in remote rural areas (Munyegera & Matsumoto, 2018; Robinson et al., 2022). Despite the potential of digital credit to serve the credit needs of people in rural areas, it is suggested that digital credit is mostly out of reach or not used by the most vulnerable groups, such as those who receive their income primarily through farming or casual work (Kaffenberger & Totolo, 2018). On the one hand, it could be argued that the higher annualised interest rate and the shorter loan duration of digital credit products compared to conventional credit products (Francis et al., 2017) may render digital credit unattractive to farmers. For example, most digital credit products in SSA have a loan duration of 1 month (Hwang & Tellez, 2016), which may not be sufficient to accommodate farmers' production season. As a result, a loan product with a short duration—as is the case of most digital credit products—may not be suitable for such purpose(s). Nonetheless, digital credit can be beneficial to farmers, particularly those in remote rural areas with limited access to formal financial services, in order to address their short-term credit needs, for example, credit to purchase a few kilogrammes of fertiliser or hire labourers for farm operations.

On the other hand, a possible reason for the low uptake of digital credit among farmers, largely in rural areas, could perhaps be that they may not be aware or only possess limited knowledge about digital credit. One of the main reasons identified in literature for the poor awareness and adoption of new financial products among individuals in developing countries is low financial literacy (e.g. Cole et al., 2009). Beck et al. (2007) suggest that individuals with low financial literacy will not be aware of financial service products and will not have any demand for them.

Financial literacy may be more important for individuals' awareness and subsequently adoption of digital financial products compared to conventional financial products because they are offered through digital channels, often via mobile phones (Hwang & Tellez, 2016). For example, digital credit borrowers can make loan applications, disbursements and repayments remotely without making a trip to the bank (Chen & Mazer, 2016). As such, it is imperative for potential digital credit borrowers to have the needed financial knowledge so that they can ensure they understand the terms and conditions (e.g. interest rate per month, loan duration) to avoid excessive borrowing and over-indebtedness, as well as low acceptance of digital credit. Additionally, the importance of financial literacy in the awareness and use of digital credit is highlighted further considering the increasing call for the transparency of digital credit products in literature (e.g. Kaffenberger & Totolo, 2018; McKee et al., 2015). For example, Kaffenberger and Totolo (2018) observed from Tanzania that about 16% of digital credit borrowers were charged fees they did not expect, whereas 9% of digital credit borrowers did not fully understand the fees. The lack of transparency of the fees of digital credit products makes financial literacy particularly important for the use of digital credit.

A growing body of research on digital credit has largely focused on the ability of digital credit to expand credit access to individuals in developing countries (e.g. Benami & Carter, 2021; Johnen et al., 2021; Sarfo et al., 2021), household welfare (e.g. Björkegren et al., 2022; Brailovskaya et al., 2021; Robinson et al., 2022; Suri et al., 2021) and borrowers' data privacy and protection (e.g. Blechman, 2016). Up until now, little is known about the financial literacy of potential borrowers and their awareness of digital credit in general and for farmers in particular. The only study that investigated the relationship between financial literacy and individuals' awareness of financial technology products

(financial products offered through mobile phone and internet platforms) is Morgan and Trinh (2019). They examined the effect of financial literacy on individuals' awareness of financial technology products. However, they did not specifically consider digital credit, neither did they consider farmers.

We add to this literature and investigate whether farmers' financial literacy influences their awareness of digital credit. Specifically, we are particularly interested to know whether farmers with higher financial literacy are more likely to be aware of digital credit. For this purpose, we use primary data collected from smallholder farmers in rural Madagascar. We measure financial literacy using questions that relate to individuals' understanding of the four fundamental concepts for financial decision making: numeracy (interest rate), interest compounding, inflation and risk diversification (Klapper et al., 2015). Accordingly, an individual is said to be financially literate if they are able to correctly answer at least three out of the four questions regarding the four fundamental concepts for financial decision making. Furthermore, 'awareness' is the knowledge that something is happening or exists. In this regard, Hidayat et al. (2020) define awareness as 'the level of being aware of something or knowing something'. FinScope (2020) suggests that awareness is crucial for the uptake of financial service products (e.g. mobile money) especially in rural areas where uptake is generally low. In this study, we define awareness of digital credit as a situation in which an individual has heard of or has knowledge of digital credit.

We focus our study on Madagascar because digital credit has been introduced to the country in recent years (Donkin, 2017). Formal financial institutions (banks and microfinance institutions) in the country are largely concentrated in urban areas with very little presence in rural areas where the majority of the population lives (Consumer Survey Highlights, 2016). Furthermore, farmers in the country are of special interest because about 63% of the population are subsistence farmers who live in remote rural areas with very limited access to formal financial services (Demirguc-Kunt et al., 2018; World Food Program, 2019). This makes farmers' awareness of innovative financial products such as digital credit particularly important in the study setting given the potential of digital credit to address the credit needs of people in rural areas.

To the best of our knowledge, this study is novel and contributes to literature from two perspectives. Firstly, it is the first study to focus on financial literacy and awareness of digital credit for rural farmers in general and those in Madagascar in particular. Secondly, we are the first to provide empirical evidence on the relationship between financial literacy and individuals' awareness of digital credit in Madagascar—a country that has rarely been analysed when it comes to financial literacy and financial inclusion. The findings of the study will help digital credit providers and policymakers in Madagascar to design appropriate strategies to create awareness about digital credit among smallholder farmers. The rest of the paper is organised as follows: In Section 2, we review the literature on financial literacy and derive the hypothesis for the study. We then describe the data and methods used for the study in Section 3. This is followed by the results and discussion in Section 4, and finally, we conclude the paper in Section 5.

2 | LITERATURE REVIEW AND HYPOTHESIS

Globally, financial literacy is progressively recognised as a top policy agenda for international organisations, national regulators and financial institutions (e.g. Grohmann et al., 2018; Hütten et al., 2018; Miller et al., 2014). Financial literacy is the application of knowledge of the basic financial concepts to manage financial resources (Lusardi et al., 2017; Pandey et al., 2022). One of the key reasons for the heightened interest in financial literacy is the global financial crisis (2008/09), which suggested that consumers had taken financial products that they did not fully understand (Miller et al., 2014).

Previous studies on financial literacy have largely focused on individuals in developed countries (e.g. Clark et al., 2017; Lusardi & Tufano, 2015; Yeh, 2022) even though a number of studies also exist about the financial literacy of individuals in developing countries in general (e.g. Adetunji & David-West, 2019; Kass-Hanna et al., 2021; Pandey et al., 2022) and for farmers in particular (e.g. Liu et al., 2023; Maji & Laha, 2022; Sayinzoga et al., 2016). These studies, both in developed and developing countries, generally concentrated on the effect of individuals'

financial literacy on debt behaviour (Lusardi & Tufano, 2015), retirement planning (Clark et al., 2017; Sun et al., 2021), household savings (Adetunji & David-West, 2019; Beckmann, 2013), poverty reduction (Wang et al., 2022) and financial inclusion (Hasan et al., 2021; Koomson et al., 2020; Ozili, 2021). The striking evidence from these studies generally suggests that most individuals lack an understanding of basic financial concepts needed to make prudent financial decisions.

Consequently, it is established that individuals with low financial literacy are more likely to be in bigger debts, borrow more, incur higher transaction fees and pay higher interest rates on loans (e.g. Disney & Gathergood, 2013; Lusardi & de Bassa Scheresberg, 2013; Lusardi & Tufano, 2015; Stango & Zinman, 2009). Conversely, it is suggested that individuals with high financial literacy are more able to save and plan for their retirement (Sun et al., 2021; Yeh, 2022), are more likely to use financial services (Disney & Gathergood, 2013; Grohmann et al., 2018; Hasan et al., 2021) and are less likely to invest in highly risky financial products (Gui et al., 2021).

In a randomised experiment in India, Carpena et al. (2011) investigated the impact of financial literacy on individuals' numeracy skills, basic financial awareness and attitudes towards financial decisions. The authors find that financial literacy statistically significantly improves individuals' awareness of financial products and services available to them and attitudes towards financial decisions. In a similar study, Gupta and Kaur (2014) investigated the financial literacy of micro entrepreneurs in the Kangra district of India and concluded that low financial literacy of micro entrepreneurs results in less awareness of different financial products. Further, Dalkilic and Kirkbesoglu (2015) investigated the relationship between financial literacy and insurance awareness among university students in Turkey. They find that students who took finance courses were more likely to be aware of insurance products compared to their counterparts who did not take finance courses. Even though the studies of Carpena et al. (2011), Gupta and Kaur (2014) and Dalkilic and Kirkbesoglu (2015) provide insights into the relationship between financial literacy and individuals' awareness of financial products, they are largely based on conventional financial products, not digital financial products, and they are not focused on farmers.

Even though not focused on farmers, the closest to the current study is the paper by Morgan and Trinh (2019). They investigated the relationship between financial literacy and individuals' awareness of financial technology products like mobile banking in Laos. The authors measured financial literacy by using individuals' financial knowledge (e.g. individuals' knowledge on interest paid on a loan, compound interest, time value of money), financial behaviour (e.g. individuals' behaviour towards household budgeting, savings, purchases, payment of bills) and their attitude towards longer-term financial planning. The authors find evidence that a higher level of financial literacy has a positive and statistically significant effect on individuals' awareness of financial technology products.

However, our study deviates from that of Morgan and Trinh (2019) from three perspectives.

First, our sample consists of smallholder farmers and we focus on Madagascar, a context that has rarely been analysed. Second, our study specifically focuses on decision makers' awareness of digital credit, whereas that of Morgan and Trinh (2019) considered individuals' awareness of financial technology products in general. Third, our study differs on the approach to measuring financial literacy. Compared to Morgan and Trinh (2019) who measured financial literacy by focusing on individuals' financial knowledge, financial behaviour and financial attitude, we measure financial literacy based on individuals' understanding of the four fundamental concepts of financial decision making—numeracy (interest rate), interest compounding, inflation and risk diversification (Klapper et al., 2015). This approach or similar—based on the four fundamental concepts of financial decision making—has been used broadly in literature to investigate individuals' financial literacy in different contexts (e.g. Abubakar, 2015; Beckmann, 2013; Boisclair et al., 2017). Nonetheless, considering the effect of financial literacy on individuals' awareness of conventional financial products (e.g. Carpena et al., 2011; Dalkilic & Kirkbesoglu, 2015; Gupta & Kaur, 2014) and following the findings of Morgan and Trinh (2019), although none of these studies specifically considered digital credit, our hypothesis is the following:

Financial literacy has a positive and statistically significant effect on farmers' awareness of digital credit.

3 | MATERIALS AND METHODS

3.1 | Sampling and data collection

The data used for this study was collected from smallholder farmers in the districts of Ambatolampy, Ambohidratrimo, Arivoimamo, Betafo and Miarinarivo in Madagascar during November 2019 and February 2020. The majority of the people in these districts are subsistence farmers who live in rural areas with very little access to formal financial services (Consumer Survey Highlights, 2016; World Food Program, 2019). Our sample comprises of clients and non-clients from a commercial microfinance bank in the country, Access Bank Madagascar (ABM). ABM was founded in 2007, in Antananarivo, the capital of Madagascar, with the aim of providing banking services to small and medium-sized enterprises in the country.

We applied a multi-stage sampling procedure to randomly select 300 smallholder farmers for the study. At the first stage, we purposively selected five ABM branches for the study, one branch from each district. These branches were selected because they are largely located in rural areas, but also because they offer agricultural loans. With regard to the selection of non-ABM clients, we randomly selected two villages from each district. For the second stage, from each of the five selected ABM branches, we randomly selected 30 smallholder farmers for interviews. These smallholder farmers were randomly drawn from a complete list of clients on the agricultural loan portfolio of each branch. For non-ABM clients, 15 households were then randomly selected from each village for interviews based on complete household lists. Accordingly, 300 smallholder farmers were randomly selected for the study. However, given that five respondents did not complete the questionnaire, our sample was reduced to 295 following data cleaning.

Our sample is made of smallholders who are mainly rice and vegetable producers. The majority of farmers in the study districts produce rice because rice is the main staple food in Madagascar. The sample for the study is generally representative of the farmers in the study districts because the farmers in the study area are mainly rural smallholder farmers with similar socio-economic characteristics to the parent population and they produce similar crops (e.g. rice, carrot) in predominantly agricultural communities with very limited access to formal financial services.

Using locally trained enumerators, we carried out face-to-face interviews with each of the farmers who participated in the survey. Before each interview, the enumerator explained the purpose of the study to the respondent. Additionally, the enumerator clarified that the data collected during the interview would be confidential and would only be used for scientific purposes. Participation of farmers in the survey was voluntary. The questionnaire for the study comprised of questions relating to farmers' household, farm operations, access to financial services and finally, questions relating to farmers' financial literacy.

3.2 | Measuring awareness of digital credit and financial literacy

In light of the rapid development of new financial products by formal financial institutions in developed and developing countries and the frequent changes in the broader economy (Lusardi, 2019), it is increasingly important for people to have the necessary financial knowledge to make prudent financial decisions. In this study, we follow Klapper et al. (2015) to apply a set of questions to measure the financial literacy of smallholder farmers in rural Madagascar. The multiple-choice questions used in this study relate to farmers' understanding of interest rate, interest compounding, inflation and risk diversification. The questions were adapted to the local situation in Madagascar to facilitate comprehension by the farmers. For example, the use of local currency (Malagasy Ariary) instead of US dollars for questions on interest rate and interest compounding as applied in Klapper et al. (2015). This set of questions or similar questions have been used extensively in literature to investigate individuals' financial literacy in different contexts (e.g. Abubakar, 2015; Beckmann, 2013; Boisclair et al., 2017; Lusardi & Mitchell, 2011). It is important to mention that this study uses the four main concepts of financial decision making to measure financial literacy (Klapper et al., 2015)

TABLE 1 Financial literacy questions as presented to the farmers during the survey.

<p><i>1. Interest rate</i></p> <p>Suppose that you have to borrow MGA 1000 from a microfinance bank. Which is the lower amount to pay back (i) MGA 1100 or (ii) MGA 1000 plus 5%?</p> <p>MGA 1100</p> <p>MGA 1000 plus 5%^a</p> <p>Both alternatives are equal</p> <p>Do not know</p> <p>Refuse to answer</p>
<p><i>2. Compound interest</i></p> <p>Suppose that you have MGA 1000 in your savings account with a microfinance bank for 2 years. If the interest rate is 10% per year. How much money would you have in your savings account after 2 years if you decide not to remove any money from your account?</p> <p>More than MGA 1200^a</p> <p>Exactly MGA 1200</p> <p>Less than MGA 1200</p> <p>Do not know</p> <p>Refuse to answer</p>
<p><i>3. Inflation</i></p> <p>Suppose that the interest rate on your savings account was 5% per year and the rate of price increase was 10% per year. After 1 year, how much would you be able to buy with the money in your savings account?</p> <p>Exactly the same</p> <p>More than today</p> <p>Less than today^a</p> <p>Do not know</p> <p>Refuse to answer</p>
<p><i>4. Risk diversification</i></p> <p>Suppose that you have some money for investment or business. Is it safer to put all your money into one investment or business, or to put your money into multiple investments or businesses?</p> <p>One investment or business</p> <p>Multiple investments or businesses^a</p> <p>The risk for both alternatives is equal</p> <p>Do not know</p> <p>Refuse to answer</p>

Note: MGA indicates Malagasy Ariary. 1 € = MGA 4150.

^aCorrect answers.

Source: Adapted from Klapper et al. (2015) following the conditions in Madagascar.

and does not focus on other dimensions of financial literacy such as individuals' financial behaviour, attitude or experience, for example, in debt management or retirement planning (e.g. Clark et al., 2017; Lusardi & Tufano, 2015). In this study, an individual is said to be financially literate if they are able to correctly answer at least three out of the four questions regarding the four fundamental concepts for financial decision making (Klapper et al., 2015). The exact wording of the questions as presented to the farmers during the survey is shown in Table 1.

In relation to measuring farmers' awareness of digital credit in the study districts, we asked the sampled farmers the following question: Have you heard of digital credit (borrowing money over the mobile phone, e.g. from Orange

or Telma¹)? This approach 'Have you heard of ...' or similar has been broadly used in literature to investigate individuals' awareness of financial service products and concepts such as loans, insurance, savings account and interest on savings (e.g. Abubakar, 2015; FinScope Survey, 2020; Kuruvilla & Harikumar, 2018; Morgan & Trinh, 2019). For example, Morgan and Trinh (2019) used a similar question to investigate individuals' awareness of financial technology products in Laos. Similarly, FinScope Survey (2020), which focuses on financial inclusion in developing countries, uses a similar approach or question—'Has never heard of ...'—to measure individuals' awareness of financial service products and concepts such as insurance, mobile money services or savings accounts, among others. Thus, in this study, we use a similar approach to measure farmers' awareness of digital credit in the study districts. Accordingly, we define awareness of digital credit as a situation in which an individual has heard of or has knowledge of digital credit.

It is important to mention that, in this study, before the respondent is allowed to answer the question, the enumerator explains the characteristics of digital credit to them ('instant', 'automated' and 'remote') in comparison to conventional credit. This made it possible for the respondents to be sure that they have a basic definition/understanding of digital credit before answering the question. Furthermore, the enumerator clarifies the potential credit amount (e.g. up to a MGA equivalent of local money units or €50) and the credit conditions (e.g. interest rate per month, loan duration) of digital credit compared to that of conventional credit to the respondent. Farmers had the choice to choose either 'Yes' or 'No' to answer the question, 'Yes' indicating that the farmer is aware or has knowledge of digital credit and 'No' if otherwise. This offers a straightforward approach to measuring farmers' awareness of financial service products (digital credit) in the study districts based on their knowledge and/or experience, in particular, considering the limited availability of formal financial institutions in rural areas of the country.

3.3 | Econometric approach

We investigate the effect of financial literacy on smallholder farmers' awareness of digital credit in rural Madagascar. Given that our outcome variable of interest is binary (i.e. probability of awareness of digital credit), we estimate a probit model of the following form:

$$y_i = \alpha + \beta(FL)_i + \lambda X'_i + \varepsilon_i \quad (1)$$

where y_i is a dummy variable, which takes a value of 1 if a smallholder farmer i is aware of digital credit and 0 otherwise. The variable $(FL)_i$ is the main independent variable of interest in this study, and it takes the value of 1 if a smallholder farmer i is financially literate and 0 otherwise. X'_i is a vector of control variables (e.g. farmers' age, years of education) that may influence farmers' awareness of digital credit; α, β and λ are parameters to be estimated and ε_i is the random error term.

Given that $(FL)_i$ —financial literacy—could be endogenous (Boisclair et al., 2017), and may potentially bias the estimates due to reverse causality or unobservable factors that may possibly influence both awareness of digital credit and financial literacy, we use an instrumental variable (IV) approach. We address the possible endogeneity issue in our estimation by using the 'household head' status of the respondent as an instrument for financial literacy. Household head is a binary indicator that takes a value of 1 if the respondent is the head of the household and 0 otherwise. We argue that in this context, 'household head' does not directly influence farmers' awareness of digital credit, but it does so only indirectly through financial literacy. This is possible because in the study setting, the household head is largely responsible for the day-to-day financial responsibilities or obligations of the household. In this respect, they are largely in charge of budgeting and purchasing decisions of the household. Also, in rural areas (mainly inhabited by farmers), household resources such as land for agricultural production and capital are generally controlled by the head of the household, which makes it possible for them to determine in most cases, if not all, the production

¹Orange and Telma in addition to Airtel are the main mobile network operators in Madagascar.

and consumption decisions of the household. These roles and responsibilities, among others, make it likely for the household head to be financially literate in the study setting. This makes the variable 'household head' an appropriate instrument for financial literacy in the study context.

Considering that our dependent variable is binary, we rely on the IV probit approach in addressing the endogeneity concerns. We implement this in a two-step procedure as follows:

$$(FL)_i = \delta + \gamma(HH)_i + \theta X'_i + \varepsilon_i \quad (2)$$

$$y_i = \phi + \tau(\hat{FL})_i + \Pi X'_i + u_i \quad (3)$$

where $(FL)_i$ has the same definition as used in Equation (1). The variable $(HH)_i$ 'household head' is our binary instrument, which takes the value of 1 if the smallholder farmer i is the head of the household and 0 otherwise. X'_i is a vector of independent variables that may influence farmers' financial literacy; $(\hat{FL})_i$ is the predicted farmer i 's financial literacy; $\delta, \gamma, \theta, \phi, \tau$ and Π are parameters to be estimated, and ε_i and u_i are random error terms associated with models (2) and (3), respectively. Our main parameter of interest is τ . Equations (2) and (3) are estimated simultaneously using maximum likelihood estimation.

3.4 | Control variables

To investigate farmers' awareness of digital credit in the study districts, we control for their age, years of formal education, gender, use of a mobile money account, monthly income and their access to remittance during the past 12 months. These variables were selected based on literature regarding their importance for individuals' awareness of financial service products. Regarding the selection of the farmers' age (in years), it is argued that digital credit users are more likely to be young (Cook & McKay, 2015). This is supported by Morgan and Trinh (2019) who show a negative relationship between individuals' age and their awareness of financial technology products. Thus, we expect the farmers' age to have a negative effect on their awareness of digital credit.

When considering farmers' years of education—which refers to the number of years of formal education attained by a farmer—as a control variable, it is established that individuals with higher years of education are more likely to use digital credit (e.g. Kaffenberger & Totolo, 2018; Sarfo et al., 2021). Hence, it is appropriate variable to investigate farmers' awareness of digital credit. Thus, we expect that farmers' years of education has a positive effect on their awareness of digital credit. Furthermore, regarding the use of the gender of the respondent as an independent variable, which simply indicates whether the respondent is a male or female, previous studies suggest that the use of formal financial services among females is lower compared to their male counterparts, particularly in developing countries (e.g. Adegbite & Machethe, 2020; Demircuc-Kunt et al., 2018; Kulkarni & Ghosh, 2021). Also, it is suggested that the users of digital credit are more likely to be men (Kaffenberger & Totolo, 2018). Accordingly, it is expected that male farmers in our sample are more likely to be aware of digital credit compared to their female counterparts.

In relation to the use of a mobile money account as a control variable in this study, mobile money—as it is generally called—makes it possible for the electronic transfer of money from one individual to the other through a mobile phone (Sekabira & Qaim, 2017). The use of a mobile money account is of a particular importance in this context because it is a prerequisite for the delivery of digital credit (Suri et al., 2021). Thus, it is expected that individuals who use mobile money accounts are more likely to be aware of digital credit.

Also, in respect to the use of respondents' monthly income as a control variable in this study, monthly income is the amount of money—in this context in Malagasy Ariary—that a farmer is able to generate from their farm activities and off-farm economic activities in a month. It has been suggested that individuals with higher monthly income are more likely to be aware of financial technology products compared to their counterparts with lower monthly income (Morgan & Trinh, 2019). Thus, we expect a positive relationship between individuals' monthly income and

their awareness of digital credit. Additionally, we also considered farmers' access to remittance during the past 12 months as a control variable in this study. Remittances are the amount of money that individuals receive from their family members and friends who generally live in bigger cities or abroad. Remittance received can increase household income and could also act as an insurance for households (Munyegera & Matsumoto, 2016; Sekabira & Qaim, 2017). For farmers in remote rural areas, remittances are more likely to be delivered through mobile phones and can be disbursed through a mobile money agent. Mobile money agents provide cash-in-cash-out services for the deployment of mobile money services and digital credit. Thus, we expect a positive relationship between farmers who received remittance during the past 12 months in the study area and awareness of digital credit.

4 | RESULTS AND DISCUSSION

4.1 | Results

4.1.1 | Descriptive statistics

Table 2 shows the summary statistics of the sampled farmers. It is observed from Table 2 that less than half of the sampled farmers (about 41%) are aware of digital credit. Farmers in rural areas of the study districts can only adopt/use digital credit if they are aware of the product. However, our study shows that a greater proportion of our respondents are not aware of digital credit, a condition that highlights the lower usage or adoption of digital credit among individuals with irregular cash flows such as farmers/casual workers, as suggested by Kaffenberger and Totolo (2018). Table 2 further shows that the mean age of the respondents is about 41 years of age. Furthermore, we notice from Table 2 that the sampled farmers have an average monthly income of MGA 478 888 (approximately €110). Additionally, Table 2 shows that about 60% of the sample are household heads.

Furthermore, Table 3 shows the distribution of answers by the sampled farmers to each of the financial literacy questions (Table 1). From Table 3, it emerged that about 43% of the respondents correctly answered the interest

TABLE 2 Summary statistics of respondents.

Variables	Unit	Mean	SD
Dependent variable			
Awareness of digital credit (Yes = 1)	1/0	0.407	-
Main independent variable			
Financial literacy (Yes = 1)	1/0	0.349	-
Instrumental variable			
Household head (Yes = 1)	1/0	0.603	-
Control variables			
Age	Years	40.925	12.013
Education	Years	10.976	4.410
Gender (Male = 1)	1/0	0.502	-
Mobile money account (Yes = 1)	1/0	0.675	-
Monthly income	MGA	478 888	216 271
Remittance (Yes = 1)	1/0	0.295	-
Number of participants		295	

Notes: 1 € = MGA 4,150. Mean values for dummy variables (1/0) indicate ratios.
Abbreviation: MGA, Malagasy Ariary.

TABLE 3 Summary statistics on the financial literacy questions (number of respondents = 295).

	Full sample (%)
Interest rate	
MGA 1100	32.20
MGA 1000 plus 5% ^a	43.05
Both alternatives are equal	12.20
DK	10.51
RF	2.03
Compound interest	
More than MGA 1200 ^a	42.03
Exactly MGA 1200	29.83
Less than MGA 1200	12.88
DK	12.20
RF	3.05
Inflation	
Exactly the same	4.41
More than today	21.69
Less than today ^a	66.10
DK	5.42
RF	2.37
Risk diversification	
One investment or business	38.64
Multiple investments or businesses ^a	56.61
The risk for both alternatives is equal	4.41
DK	0.00
RF	0.34
Cross question consistency	
All correct	6.44
At least 3 correct	34.92
At least 2 correct	72.20
At least 1 correct	94.24
None correct	5.76
At least 1 DK	14.92
All DK	1.02
At least 1 RF	7.46
All RF	0.00

Notes: Distribution of farmers' responses to the financial literacy questions (cf. Table 1). DK indicates that the respondent does not know the answer to the question. RF indicates that the respondent refused to answer the question.

^aThe correct answer to each question.

rate question whereas 2% of the respondents refused to answer the same question. In relation to farmers' response to the interest compounding question, it is observed from Table 3 that about 42% of the respondents correctly answered the question. However, about 12% of the sampled farmers indicated that they do not know the answer to the question. Furthermore, it is noticeable from Table 3 that about 66% of the respondents were able to answer the

inflation question correctly. Given that Madagascar experienced an inflation rate of about 18% in 2005 and taking into account that the inflation rate was much lower at the time of this survey (about 6%) (International Monetary Fund, 2021), it is not surprising that about two-thirds of the sampled farmers were able to answer this question correctly.

Similarly, Table 3 shows that more than half of the respondents (about 57%) were able to answer the risk diversification question correctly. This is expected in the context of the study given that the sampled farmers are mainly subsistence farmers and thus may have a good understanding of risk diversification on their farms, for example, planting different types of crops on the same piece of land at the same time to avoid total crop failure. We support this argumentation with the fact that none of the respondents chose 'Do not know' as the answer to the risk diversification question and also less than 1% of the respondents refused to answer the risk diversification question.

We further observe from Table 3 that about 35% of our respondents are financially literate—farmers who were able to correctly answer at least three out of the four questions in Table 1. Our result is largely consistent with the findings of Lusardi and Mitchell (2011) and Kalmi and Ruuskanen (2018) who report financial literacy rates of about 30% and 36% in the United States and Finland, respectively. However, these studies were conducted in developed countries, and the results may not be directly comparable to our findings from Madagascar, which is a developing country. In a developing country context, particularly in SSA, our finding is in line with the findings of Klapper et al. (2015) who report an adult financial literacy rate (15 years of age and older) of 38%, 35% and 33% for Madagascar, Malawi and Burkina Faso, respectively. Compared to Klapper et al. (2015), we observe a slightly lower financial literacy rate in Madagascar (35%). However, our finding is plausible given that our sample consists of farmers from rural areas of the country, who may have lower years of education and limited use of formal financial services compared to the average person in Madagascar living in an urban area. Also, Table 3 shows that just a little over 6% of the respondents correctly answered all four financial literacy questions, a finding that highlights the limited financial literacy rate of the farmers in the study districts. Furthermore, it is observed from Table 3 that a little over 7% of the respondents refused to answer at least one of the four financial literacy questions, whereas none of the respondents refused to answer all of the four financial literacy questions.

4.1.2 | Determinants of farmers' awareness of digital credit

Table 4 presents the estimation results for the determinants of farmers' awareness of digital credit in the study districts, differentiated by probit and IV probit estimates. Given that the objective of this study is to investigate the relationship between financial literacy and farmers' awareness of digital credit, first we control only for financial literacy in model (1). Considering that farmers' awareness of digital credit may not be entirely influenced by their financial literacy, we control for a number of farmers' socio-economic characteristics that may influence their awareness of digital credit in model (2). Additionally, we estimate the marginal effect of the independent variables in model (2) to determine, in percentage points, the average effect of each variable on farmers' awareness of digital credit in the study districts.

From model (2), it is observed that financial literacy has a positive and statistically significant effect on farmers' awareness of digital credit, suggesting that farmers in the study districts who are financially literate are more likely to be aware of digital credit relative to their counterparts who are not financially literate. This is expected in the study setting given the limited access to formal financial services in rural areas of Madagascar in general and for farmers in particular. Furthermore, it is observed from model (2) that farmers' awareness of digital credit in the study districts is influenced by their age, years of education, monthly income and access to remittances during the past 12 months. Also, when looking at the individual effect of the various independent variables (model 2) on farmers' awareness of digital credit in the study districts, it is observed from Table 4 that financial literacy has the highest effect (marginal effect of 15.67%), followed by access to remittance (marginal effect of 12.15%) and farmers' use of a mobile money account (marginal effect of 9.39%).

TABLE 4 Determinants of farmers' awareness of digital credit.

Variable	Probit estimates			IV probit estimates		
	Coefficient Model (1)	Coefficient Model (2)	Marginal effect (Delta method)	1st stage	2nd stage	Marginal effect (Delta method)
				Coefficient Model (3)	Coefficient Model (4)	
Financial literacy (Yes = 1)	0.8170*** (0.1577)	0.5525*** (0.1759)	0.1567*** (0.0474)	-	1.9430*** (0.5925)	0.4620*** (0.0986)
Age (years)		-0.0192*** (0.0071)	-0.0054*** (0.0020)	-0.0017 (0.0022)	-0.0120 (0.0091)	-0.0029 (0.0024)
Education (years)		0.1244*** (0.0227)	0.0353*** (0.0053)	0.0209*** (0.0066)	0.0532 (0.0613)	0.0127 (0.0156)
Gender (Male = 1)		-0.0761 (0.1695)	-0.0216 (0.0481)	0.0082 (0.0686)	-0.1979 (0.1549)	-0.0470 (0.0356)
Mobile money account (Yes = 1)		0.3312 (0.2133)	0.0939 (0.0594)	0.2018*** (0.0611)	-0.0874 (0.3360)	-0.0208 (0.0785)
Monthly income (MGA)		0.0000*** (0.0000)	0.0000*** (0.0000)	-0.0000 (0.0000)	0.0000* (0.0000)	0.0000* (0.0000)
Remittance (Yes = 1)		0.4286** (0.1974)	0.1215** (0.0545)	-0.0395 (0.0668)	0.4097** (0.1799)	0.0974** (0.0463)
Household head (Yes = 1)				0.1499** (0.0719)	-	
Constant	-0.5334*** (0.0954)	-1.9728*** (0.4756)		0.0069 (0.1252)	-1.4077* (0.7710)	
Number of observations	295	295		295	295	
<i>Goodness-of-fit measures</i>						
Log likelihood	-185.5775	-147.5350			-325.3445	
Prob > chi2	0.0000	0.0000			0.0000	
Wald test of exogeneity (p-value)					0.1893	

Notes: ***, ** and * indicates statistical significance at the 1%, 5% and 10% levels, respectively. Standard error in parenthesis.

Abbreviation: MGA, Malagasy Ariary.

Considering that financial literacy may be endogenous, the estimates in model (2) may be biased. Therefore, we turn our attention to models (3) and (4) of the IV probit estimates in Table 4 to investigate the determinants of farmers' awareness of digital credit in the study districts. Also, the marginal effect of the independent variables in model (4) are reported. From model (4), the Wald test of exogeneity of the independent variables in the model indicates that we can accept the null hypothesis that the variables in the model are exogenous (p -value of 0.1893), and hence, it could be argued that the model does not suffer from any endogeneity problem. In this respect, it is observed from model (3) that being a household head (the IV)² has a positive and statistically significant effect on the

²Even though there is no proper test of instrument validity for limited dependent variable models (e.g. probit, logit), we applied the `ivreg2` module in `stata`—used for models with a continuous dependent variable with endogenous regressor(s)—to check the validity and relevance of our instrument. We

financial literacy of farmers, highlighting the importance of the variable 'household head' in addressing the potential endogeneity concerns in the study. From model (4), it is observed that financial literacy has a positive and statistically significant effect on farmers' awareness of digital credit in the study districts. This finding is consistent with what is observed in model (2). As a result, from models (2) and (4), we can accept the hypothesis of the study which states that 'Financial literacy has a positive and statistically significant effect on farmers' awareness of digital credit'.

Furthermore, the results in model (4) show that farmers' monthly income and their access to remittances during the past 12 months have a positive and statistically effect on their awareness of digital credit. This is largely consistent with what is observed in model (2). What is surprising to observe from the results of the IV probit estimates in model (4) is the non-significance of the farmers' years of education on their awareness of digital credit in the study district even though the coefficient is positive as expected a priori.

Also, following the IV probit estimates, it is observed that financial literacy has the highest marginal effect on farmers awareness of digital credit in the study districts (46.20%), followed by access to remittance (marginal effect of 9.74%) and the farmers' gender (marginal effect of 4.70%). Our results suggest that farmers in the study districts who are financially literate are about 46% more likely to be aware of digital credit compared to their peers who are not financially literate. The marginal effect of financial literacy on farmers' awareness of digital credit based on the IV probit estimates suggests that the probit model—model (2)—underestimates the effect of financial literacy on farmers' awareness of digital credit in the study districts.

4.2 | Robustness check

Our results suggest that financial literacy has a positive and statistically significant effect on farmers' awareness of digital credit. To check the robustness of our results, we measure financial literacy as a continuous variable instead of a binary variable as in models in Table 4. Thus, we measure financial literacy on a 5-point scale—from 0 (*very low financial literacy*) to 4 (*very high financial literacy*)—based on farmers' responses to the financial literacy questions in Table 1. Accordingly, a financial literacy score of 0 indicates that a farmer wrongly answered all the four financial literacy questions in Table 1, and a financial literacy score of 4 indicates that a farmer correctly answered all the four financial literacy questions. Similarly, a financial literacy score of 1, 2 or 3 indicates that a farmer correctly answered only 1, 2 or 3 questions in Table 1, respectively. The estimation results for the determinants of farmers' awareness of digital credit with financial literacy as a continuous variable is presented in Table 5. From models (6) and (8), it is observed that financial literacy has a positive and statistically significant effect on farmers' awareness of digital credit, a finding that is consistent with our findings about the effect of financial literacy on farmers' awareness of digital credit in models (2) and (4) in Table 4. Our robustness check in Table 5 shows that our results are largely robust, highlighting the importance of financial literacy for farmers' awareness of digital credit in the study districts.

4.3 | Discussion

Our results suggest that financial literacy has a positive and statistically significant effect on farmers' awareness of digital credit in the study districts. It has been established that digital credit has the potential to serve the credit needs of individuals in low-income countries, particularly for those who do not have access to formal credit markets (e.g. Benami & Carter, 2021; Björkegren et al., 2022; Brailovskaya et al., 2021; Francis et al., 2017; Robinson et al., 2022; Suri et al., 2021). Farmers in the study districts could only take advantage of or use digital credit if they are aware of

record an *F*-statistics value of 4.2362, which is below the threshold value of 10 suggested by Staiger and Stock (1997) for a strong instrument. However, our instrument 'household head' is valid and relevant for the study following the results of models (3) and (4) in Table 4 and the importance of the household head in the financial decisions of the household in the study setting.

TABLE 5 Determinants of farmers' awareness of digital credit with financial literacy measured as a continuous variable.

Variable	Probit estimates			IV probit estimates		
	Coefficient Model (5)	Coefficient Model (6)	Marginal effect (Delta method)	1st stage	2nd stage	
				Coefficient Model (7)	Coefficient Model (8)	Marginal effect (Delta method)
Financial literacy ^a	0.3484*** (0.0805)	0.1784** (0.0889)	0.0516** (0.0251)	-	0.9613*** (0.2346)	0.2618*** (0.0626)
Age (years)		-0.0187*** (0.0070)	-0.0054*** (0.0020)	-0.0071 (0.0048)	-0.0060 (0.0100)	-0.0016 (0.0027)
Education (years)		0.1264*** (0.0230)	0.0365*** (0.0055)	0.0523*** (0.0140)	0.0273 (0.0626)	0.0074 (0.0170)
Gender (Male = 1)		-0.0678 (0.1670)	-0.0196 (0.0483)	0.0692 (0.1320)	-0.2180 (0.1402)	-0.0594 (0.0385)
Mobile money account (Yes = 1)		0.4053* (0.2105)	0.1172** (0.0594)	0.2692** (0.1294)	-0.0002 (0.2976)	-0.0001 (0.0811)
Monthly income (MGA)		0.0000*** (0.0000)	0.0000*** (0.0000)	-0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Remittance (Yes = 1)		0.3824* (0.1966)	0.1105** (0.0555)	0.0553 (0.1410)	0.2184 (0.1955)	0.0595 (0.0531)
Household head (Yes = 1)		-		0.2466* (0.1370)	-	
Constant	-0.9736*** (0.1891)	-2.2144*** (0.4912)		1.4620*** (0.2705)	-2.5531*** (0.5244)	
Number of observations	295	295		295	295	
<i>Goodness-of-fit measures</i>						
Log likelihood	-188.9609	-150.1726		-545.6081		
Prob > chi2	0.0000	0.0000		0.0000		
Wald test of exogeneity (p-value)				0.1375		

Notes: ***, ** and * indicates statistical significance at the 1%, 5% and 10% levels, respectively. Standard error in parenthesis.

Abbreviation: MGA, Malagasy Ariary.

^aMeasured on a scale from 0 (*very low financial literacy*) to 4 (*very high financial literacy*).

it. It has been suggested that one of the key barriers to the uptake of financial service products (e.g. mobile money) is the lack of product knowledge/awareness (FinScope, 2020). This study has shown that one possible way of increasing the awareness of digital credit among farmers in the study districts is to increase the financial literacy of farmers. This is particularly important in the study setting considering the limited availability of formal financial institutions in the country (Demirguc-Kunt et al., 2018; World Bank, 2018), particularly for those living in rural areas—mainly farmers. Relating the findings of this study to previous literature, our finding is consistent with Morgan and Trinh (2019) who show a positive relationship between financial literacy and individuals' awareness of financial technology products. Also, our finding is in line with the findings of Carpena et al. (2011) and Dalkilic and Kirkbesoglu (2015) who indicate

that a higher level of financial literacy is positively correlated with individuals' awareness of formal financial products, although both studies focused on conventional financial products and not digital financial products.

Regarding the role of farmers' socio-economic characteristics on their awareness of digital credit, our findings suggest older farmers in the study districts are less likely to be aware of digital credit. This is not surprising considering that digital credit is a recent innovation and it is argued that the users are more likely to be young (less than 35 years old) (Cook & McKay, 2015). This finding is in line with Morgan and Trinh (2019) who observed a similar relationship between individuals' age and their awareness of financial technology products. Furthermore, our results suggest that farmers in the study districts who have higher monthly income are more likely to be aware of digital credit compared to their counterparts who have lower monthly income.

Also, our results suggest that farmers who have access to remittance during the past 12 months are more likely to be aware of digital credit. This is because the presence of formal financial institutions in rural areas of Madagascar is particularly low (Consumer Survey Highlights, 2016); therefore, remittances to rural farmers is more likely to be delivered via mobile phones, which could be disbursed through a mobile money agent in the farmers' community. This makes it more likely for farmers in the study districts who received remittance during the past 12 months to be aware of digital credit relative to their counterparts who received no remittance during the same period.

Furthermore, our results suggest that farmers' years of education does not have a statistically significant influence—from the model (4)—on their awareness of digital credit although the effect is positive. The non-statistically significant influence of the positive coefficient of education is surprising at first, in particular, considering that digital credit happens over a mobile phone and it requires some degree of reading and numerical skills for operation. Also, it could be argued that individuals with higher years of formal education are more likely to overcome the informational barriers to the awareness of digital credit relative to their counterparts with lower years of education. However, this finding is plausible considering that the adult literacy rate (15 years of age and older) in Madagascar is high (68% for females and 75% for males) (Madagascar National Education Profile, 2018), which could possibly diminish the importance of farmers' years of education for their awareness of digital credit.

Interesting to highlight from this study is the fact that the use of a mobile money account does not necessarily lead to the awareness of digital credit for farmers. This is a surprising yet important observation given that a mobile money account is a precondition for the use of digital credit. Furthermore, the findings of the study reveal that farmers' awareness of digital credit in the study districts is independent from gender, a surprising finding given that the users of digital credit are more likely to be men as observed by Kaffenberger and Totolo (2018).

5 | CONCLUSION

The limited presence of formal financial institutions in rural areas of developing countries compared to urban areas, particularly in SSA, has been highlighted in literature. As a result, a large number of people in rural areas, mainly farmers, are excluded from formal credit markets. A recent innovation that has the ability to improve the situation is digital credit. However, it is argued that digital credit is mostly out of reach or not used by individuals characterised by irregular income, such as those who receive their income primarily through farming or casual work—largely in rural areas.

A possible reason for the low uptake of digital credit among these groups of individuals could be that they may not be aware of digital credit. One of the key factors often identified in literature for the poor awareness of financial products by people in developing countries is low financial literacy. In this study, we have investigated whether financial literacy influences farmers' awareness of digital credit in rural Madagascar. In doing so, we have applied multiple choice questions that demonstrate farmers' understanding of the four fundamental concepts for financial decision making: numeracy (interest rate), interest compounding, inflation and risk diversification (Klapper et al., 2015). Additionally, we have also provided insights into the determinants of farmers' awareness of digital credit in the study districts.

Our results show that farmers who are financially literate are more likely to be aware of digital credit relative to their counterparts who are not financially literate. Additionally, we find that farmers' awareness of digital credit in the

study districts is influenced by their age, monthly income and access to remittance during the past 12 months. Our study highlights the importance of financial literacy, amongst other factors, for farmers' awareness of digital credit in the study districts. This is particularly important in the study setting considering that the majority of the people in Madagascar live in rural areas with very limited access to formal financial services. Previous studies suggest that digital credit has the potential to serve the credit needs of people in rural areas—particularly, for small credit amount (e.g. up to €50). However, people in rural areas of Madagascar and those in the study districts can only use digital credit if they are aware of the innovative financial product. Our study reveals that less than half of the sampled farmers (about 41%) are aware of digital credit. This brings to light the importance of creating awareness about digital credit in Madagascar if digital credit is to be adopted by farmers in rural areas of the country.

From a policy perspective, based on the findings of the study, we can encourage digital credit providers and policy-makers to design appropriate strategies to create awareness about digital credit among farmers. Our study has shown that improving the financial literacy of farmers is one possible way of increasing awareness of digital credit among farmers in the study districts. In this respect, policy interventions could be designed to adapt the school curricula in Madagascar to increase individuals' financial skills considering that majority of the sampled farmers have attained some level of formal education. It is worth noting that an incentivisation of the financial literacy questions could have an effect on the results. Thus, in follow-up studies, the effect of incentivised financial literacy questions should be analysed. Also, this study focuses on the four main concepts of individuals' financial decision making (Klapper et al., 2015). As a result, future studies should take into account individuals' behavioural and attitudinal dimensions when measuring financial literacy of farmers. Furthermore, due to data limitations, we are not able to investigate the effect of financial literacy on farmers' adoption of digital credit in the study districts. As a result, future studies should focus on investigating the relationship between financial literacy and farmers' adoption of digital credit in Madagascar or in other countries in SSA. Finally, future studies could check the validity of our results by replicating our study with rural farmers in other countries in SSA as the conditions in Madagascar may not be applicable in other country context.

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CONFLICT OF INTEREST STATEMENT

The authors have declared that no competing interest exists.

DATA AVAILABILITY STATEMENT

The data used for this study is accessible on request from the corresponding author.

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REFERENCES

- Abubakar, H. A. (2015). Entrepreneurship development and financial literacy in Africa. *World Journal of Entrepreneurship, Management and Sustainable Development*, 11(4), 281–294. <https://doi.org/10.1108/WJEMSD-04-2015-0020>
- Adegbite, O. O., & Machethe, C. L. (2020). Bridging the financial inclusion gender gap in smallholder agriculture in Nigeria: An untapped potential for sustainable development. *World Development*, 127, 104755. <https://doi.org/10.1016/j.worlddev.2019.104755>
- Adetunji, O. M., & David-West, O. (2019). The relative impact of income and financial literacy on financial inclusion in Nigeria. *Journal of International Development*, 31(4), 312–335. <https://doi.org/10.1002/jid.3407>

- Beck, T., Demircug-Kunt, A., & Peria, M. S. M. (2007). Reaching out: Access to and use of banking services across countries. *Journal of Financial Economics*, 85(1), 234–266. <https://doi.org/10.1016/j.jfineco.2006.07.002>
- Beckmann, E. (2013). Financial literacy and household savings in Romania. *Numeracy*, 6(2), 1–22. <https://doi.org/10.5038/1936-4660.6.2.9>
- Benami, E., & Carter, M. R. (2021). Can digital technologies reshape rural microfinance? Implications for savings, credit, & insurance. *Applied Economic Perspectives and Policy*, 43(4), 1196–1220. <https://doi.org/10.1002/aepp.13151>
- Björkegren, D., Blumenstock, J., Folajimi-Senjobi, O., Mauro, J., & Nair, S. R. (2022). Instant loans can lift subjective well-being: A randomized evaluation of digital credit in Nigeria (no. 2202.13540).
- Blechman, J. G. (2016). Mobile credit in Kenya and Tanzania: Emerging regulatory challenges in consumer protection, credit reporting and use of customer transactional data. *The African Journal of Information and Communication*, 2016, 61–61.
- Boisclair, D., Lusardi, A., & Michaud, P. C. (2017). Financial literacy and retirement planning in Canada. *Journal of Pension Economics & Finance*, 16(3), 277–296. <https://doi.org/10.1017/S1474747215000311>
- Brailovskaya, V., Dupas, P., & Robinson, J. (2021). Is digital credit filling a hole or digging a hole? Evidence from Malawi (no. w29573). National Bureau of Economic Research.
- Carpena, F., Cole, S. A., Shapiro, J., & Zia, B. (2011). Unpacking the causal chain of financial literacy. World Bank Policy Research Working Paper, (5798).
- Chen, G., & Mazer, R. (2016). Instant, automated, remote: The key attributes of digital credit. CGAP Blog, Washington DC.
- Clark, R., Lusardi, A., & Mitchell, O. S. (2017). Employee financial literacy and retirement plan behavior: A case study. *Economic Inquiry*, 55(1), 248–259. <https://doi.org/10.1111/ecin.12389>
- Cole, S. A., Sampson, T. A., & Zia, B. H. (2009). *Financial literacy, financial decisions, and the demand for financial services: Evidence from India and Indonesia* (pp. 9–117). Harvard Business School.
- Consumer Survey Highlights. (2016). Madagascar 2016. Finmark Trust, Johannesburg, South Africa. <https://www.mfw4a.org/publication/consumer-survey-highlights-madagascar-2016>
- Cook, T., & McKay, C. (2015). How M-Shwari works: The story so far. Consultative group to assist the poor (CGAP) and financial sector deepening (FSD).
- Dalkilic, N., & Kirkbesoglu, E. (2015). The role of financial literacy on the development of insurance awareness. *International Journal of Economics and Finance*, 7(8), 272–280. <https://doi.org/10.5539/ijef.v7n8p272>
- Demircug-Kunt, A., Klapper, L., Singer, D., Ansar, S., & Hess, J. (2018). *The Global Findex database 2017: Measuring financial inclusion and the fintech revolution*. The World Bank.
- Disney, R., & Gathergood, J. (2013). Financial literacy and consumer credit portfolios. *Journal of Banking & Finance*, 37(7), 2246–2254. <https://doi.org/10.1016/j.jbankfin.2013.01.013>
- Donkin, C. (2017). MVola launches mobile money loans in Madagascar. <https://www.mobileworldlive.com/featured-content/money-home-banner/mvola-launches-mobile-money-loans-in-madagascar>
- Dupas, P., Green, S., Keats, A., & Robinson, J. (2012). Challenges in banking the rural poor: Evidence from Kenya's western province (no. w17851). National Bureau of Economic Research.
- FinScope Survey. (2020). Financial inclusion in Rwanda. Access to finance Rwanda. <https://afr.rw/downloads/finscope-survey-2020-report/>
- Francis, E., Blumenstock, J., & Robinson, J. (2017). Digital credit: A snapshot of the current landscape and open research questions. CEGA White Paper.
- Grohmann, A., Klühs, T., & Menkhoff, L. (2018). Does financial literacy improve financial inclusion? Cross country evidence. *World Development*, 111, 84–96. <https://doi.org/10.1016/j.worlddev.2018.06.020>
- Gui, Z., Huang, Y., & Zhao, X. (2021). Whom to educate? Financial literacy and investor awareness. *China Economic Review*, 67, 101608. <https://doi.org/10.1016/j.chieco.2021.101608>
- Gupta, K., & Kaur, J. (2014). A study of financial literacy among micro entrepreneurs in district Kangra. *International Journal of Research in Business Management*, 2(2), 63–70.
- Hasan, M., Le, T., & Hoque, A. (2021). How does financial literacy impact on inclusive finance? *Financial Innovation*, 7(1), 40. <https://doi.org/10.1186/s40854-021-00259-9>
- Hidayat, S. E., Rafiki, A., & Svyatoslav, S. (2020). Awareness of financial institutions' employees towards Islamic finance principles in Russia. *PSU Research Review*, 4(1), 45–60. <https://doi.org/10.1108/PRR-08-2019-0026>
- Hütten, M., Maman, D., Rosenhek, Z., & Thiemann, M. (2018). Critical financial literacy: an agenda. *International Journal of Pluralism and Economics Education*, 9(3), 274–291. <https://doi.org/10.1504/IJPEE.2018.093405>
- Hwang, B., & Tellez, C. (2016). *The proliferation of digital credit deployments*. CGAP Blog.
- International Monetary Fund. (2021). International financial statistics and data files. <https://data.worldbank.org/indicator/FPCPI.TOTL.ZG?locations=MG>
- Johnen, C., Parlasca, M., & Mußhoff, O. (2021). Promises and pitfalls of digital credit: Empirical evidence from Kenya. *PLoS ONE*, 16(7), e0255215. <https://doi.org/10.1371/journal.pone.0255215>
- Kaffenberger, M., & Totolo, E. (2018). A digital credit revolution: Insights from borrowers in Kenya and Tanzania. CGAP Blog, Washington DC.

- Kalmi, P., & Ruuskanen, O. P. (2018). Financial literacy and retirement planning in Finland. *Journal of Pension Economics & Finance*, 17(3), 335–362. <https://doi.org/10.1017/S1474747217000270>
- Kass-Hanna, J., Lyons, A. C., & Liu, F. (2021). Building financial resilience through financial and digital literacy in South Asia and Sub-Saharan Africa. *Emerging Markets Review*, 51, 100846.
- Klapper, L., Lusardi, A., & Van Oudheusden, P. (2015). Financial literacy around the world. Washington DC: World Bank.
- Koomson, I., Villano, R. A., & Hadley, D. (2020). Intensifying financial inclusion through the provision of financial literacy training: a gendered perspective. *Applied Economics*, 52(4), 375–387. <https://doi.org/10.1080/00036846.2019.1645943>
- Kulkarni, L., & Ghosh, A. (2021). Gender disparity in the digitalization of financial services: challenges and promises for women's financial inclusion in India. *Gender, Technology and Development*, 25(2), 233–250. <https://doi.org/10.1080/09718524.2021.1911022>
- Kuruville, C. R. R., & Hari Kumar, P. N. (2018). A study on the relationship between financial literacy and financing preferences among entrepreneurs. *International Journal of Management Studies*, 5(4), 9.
- Liu, W., Wang, B., Wang, C., & Han, K. (2023). The effect of financial literacy on rural households insurance participation: Evidence from farmers in southwest China. *Asia-Pacific Journal of Accounting & Economics*, 30(1), 139–155.
- Lusardi, A. (2019). Financial literacy and the need for financial education: Evidence and implications. *Swiss Journal of Economics and Statistics*, 155(1), 1–8. <https://doi.org/10.1186/s41937-019-0027-5>
- Lusardi, A., & de Bassa Scheresberg, C. (2013). Financial literacy and high-cost borrowing in the United States (no. w18969). National Bureau of Economic Research.
- Lusardi, A., Michaud, P. C., & Mitchell, O. S. (2017). Optimal financial knowledge and wealth inequality. *Journal of Political Economy*, 125(2), 431–477. <https://doi.org/10.1086/690950>
- Lusardi, A., & Mitchell, O. S. (2011). Financial literacy around the world: an overview. *Journal of Pension Economics & Finance*, 10(4), 497–508. <https://doi.org/10.1017/S1474747211000448>
- Lusardi, A., & Tufano, P. (2015). Debt literacy, financial experiences, and overindebtedness. *Journal of Pension Economics & Finance*, 14(4), 332–368. <https://doi.org/10.1017/S1474747215000232>
- Madagascar National Education Profile. (2018). Education policy data centre. Washington, DC.
- Maji, S. K., & Laha, A. (2022). Financial literacy and its antecedents amongst the farmers: Evidence from India. *Agricultural Finance Review*, 83(1), 124–143.
- McKee, K., Kaffenberger, M., & Zimmerman, J. M. (2015). Doing digital finance right: The case for stronger mitigation of customer risks. CGAP Blog, Washington DC.
- Miller, M., Reichelstein, J., Salas, C., & Zia, B. (2014). Can you help someone become financially capable? A meta-analysis of the literature. A Meta-Analysis of the Literature (January 1, 2014). World Bank Policy Research Working Paper, (6745).
- Morgan, P. J., & Trinh, L. Q. (2019). Fintech and financial literacy in the Lao PDR (No. 933). Asian Development Bank Institute.
- Mpuga, P. (2010). Constraints in access to and demand for rural credit: Evidence from Uganda. *African Development Review*, 22, 115–148. <https://doi.org/10.1111/j.1467-8268.2009.00230.x>
- Munyegera, G. K., & Matsumoto, T. (2016). Mobile money, remittances, and household welfare: Panel evidence from rural Uganda. *World Development*, 79, 127–137. <https://doi.org/10.1016/j.worlddev.2015.11.006>
- Munyegera, G. K., & Matsumoto, T. (2018). ICT for financial access: Mobile money and the financial behavior of rural households in Uganda. *Review of Development Economics*, 22(1), 45–66. <https://doi.org/10.1111/rode.12327>
- Ozili, P. K. (2021). Financial inclusion research around the world: A review. *Forum for Social Economics*, 50(4), 457–479. <https://doi.org/10.1080/07360932.2020.1715238>
- Pandey, A., Kiran, R., & Sharma, R. K. (2022). Investigating the impact of financial inclusion drivers, financial literacy and financial initiatives in fostering sustainable growth in north India. *Sustainability*, 14(17), 11061. <https://doi.org/10.3390/su141711061>
- Robinson, J., Park, D. S., & Blumenstock, J. E. (2022). The impact of digital credit in developing economies: A review of recent evidence.
- Sarfo, Y., Mushhoff, O., Weber, R., & Danne, M. (2021). Farmers' willingness to pay for digital and conventional credit: Insight from a discrete choice experiment in Madagascar. *PLoS ONE*, 16(11), e0257909. <https://doi.org/10.1371/journal.pone.0257909>
- Sayinzoga, A., Bulte, E. H., & Lensink, R. (2016). Financial literacy and financial behaviour: Experimental evidence from rural Rwanda. *The Economic Journal*, 126(594), 1571–1599. <https://doi.org/10.1111/econj.12217>
- Sekabira, H., & Qaim, M. (2017). Mobile money, agricultural marketing, and off-farm income in Uganda. *Agricultural Economics*, 48(5), 597–611. <https://doi.org/10.1111/agec.12360>
- Staiger, D., & Stock, J. H. (1997). Instrumental variables regression with weak instruments. *Econometrica*, 65(3), 557–586.
- Stango, V., & Zinman, J. (2009). Exponential growth bias and household finance. *The Journal of Finance*, 64(6), 2807–2849. <https://doi.org/10.1111/j.1540-6261.2009.01518.x>
- Sun, R., Zhang, H., Turvey, C. G., & Xiong, X. (2021). Impact of financial literacy on retirement financial portfolio: Evidence from China. *Asian Economic Journal*, 35(4), 390–412. <https://doi.org/10.1111/asej.12256>

- Suri, T., Bharadwaj, P., & Jack, W. (2021). Fintech and household resilience to shocks: Evidence from digital loans in Kenya. *Journal of Development Economics*, 153, 102697. <https://doi.org/10.1016/j.jdeveco.2021.102697>
- Wang, S., Cao, P., & Huang, S. (2022). Household financial literacy and relative poverty: An analysis of the psychology of poverty and market participation. *Frontiers in Psychology*, 13, 898486. <https://doi.org/10.3389/fpsyg.2022.898486>
- World Bank. (2018). Madagascar financial inclusion project (P161491). *World bank document*. The World Bank. Available at: <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/938621515678904319/madagascar-financial-inclusion-project>
- World Food Program. (2019). Madagascar country strategic plan (2019–2024). World Food Program, Rome.
- Yeh, T. M. (2022). An empirical study on how financial literacy contributes to preparation for retirement. *Journal of Pension Economics & Finance*, 21(2), 237–259. <https://doi.org/10.1017/S1474747220000281>

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