Does Financial Literacy Improve Financial Inclusion in Developing Countries? A Nonlinearity and Quantile Regression Analysis

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Abstract: This study investigated the nexus between financial literacy and financial inclusion using the cross-section threshold regression model and the quantile regression technique. The sample covered 73 developing countries categorised as lower-middle-income or upper-middle-income economies. The main results of the threshold model revealed that financial literacy had no inverted U-shaped effect on financial inclusion in the sample of developing countries. This situation indicated that financial literacy had a linear or monotone relationship with financial inclusion. The quantile regression model was used to compare the findings in this investigation. The empirical result indicated that the financial literacy variable had a limited impact on the conditional distribution of financial inclusion. However, the coefficient values were much larger at high than low quantiles. This study's results are necessary for policymakers and financial institutions to implement financial literacy programs targeted at specific behaviours and underserved populations in developing countries.

Keywords: Financial literacy, financial inclusion, threshold estimation, quantile regression estimation
JEL classification: C10, E02, G20, O11

1. Introduction

There is a rising attention in assessing the relationship between financial knowledge and various well-being measures. Financial literacy is a critical aspect of economic well-being and has grown more crucial than ever due to the increasing complexity of

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available financial services products (Corsini & Giannelli, 2021). In the mid-1990s, when the Jump$tart Coalition was founded in the United States, financial education became a vital policy priority. One of the highlights of this programme was the financial literacy survey conducted among young American adults as part of the initiative to evaluate the level of financial literacy. Because of the fast changing global financial markets and the recurrence of global crises that result in bankruptcy and debt problems, financial management programs for businesses are in great demand (Hussain et al., 2018). Additionally, despite various attempts to reduce access barriers, trust issues and a lack of financial knowledge have become major deterrents to formal banking goods and services (Frisancho, 2020). Financial knowledge might support households in financial decisions and cope with economic shocks (Zhang et al., 2021). Thus, policymakers worldwide have redirected their attention to financial literacy.

Financial literacy is defined variably in the literature. Huston (2010) described financial literacy in two dimensions: knowledge understanding and applying knowledge in personal finance. Meanwhile, Askar et al. (2020) referred financial literacy as the ability of a person to understand financial principles and handle financial resources. According to OECD (2014), financial literacy is the awareness, knowledge, skill, attitude, and understanding to manage financial risk before making intelligent decisions in varied financial settings to improve social well-being and economic activity. Alternatively, Lusardi and Mitchell (2014) emphasised that financial literacy is a person's knowledge of finance and capacity to evaluate before making a decision.

Financial inclusion is the process of providing low-income people with access to formal financial services (Adil & Jalil, 2020; Allen et al., 2016; Beck et al., 2007; Fouejieu et al., 2020; Kling et al., 2020; Omar & Inaba, 2020; Ozili, 2018). In literature, building financial knowledge has been positively linked to increasing the saving level, improving access to employment, investment behaviour and borrowing practices that can help reduce inequality (Fouejieu et al., 2020; Hu et al., 2021; Lusardi, 2019; Zins & Weill, 2016). Access to financial services is vital for fostering social wellbeing, inclusive growth, equality and capacity building (Kebede et al., 2021). When dealing with financial services, it is crucial to address the advantages and drawbacks (Madeira & Margaretic, 2022). Unfortunately, populations that are still financially illiterate among the people with low incomes, especially in developing countries, do not have appropriate information and methods for engaging in financial activities (Bongomin et al., 2020; Ofosu-Mensah Ababio et al., 2020) . In addition, financial products such as loans, credit cards, mortgage products and pension plans are increasingly sophisticated (Davoli & Rodríguez-Planas, 2020; Iterbeke et al., 2020). Therefore, financial illiteracy has become a persistent obstacle to financial inclusion (Grohmann et al., 2018; Koomson et al., 2019; Lyons & Kass-Hanna, 2019), which requires further investigation (Sabri & Aw, 2019; Ofosu-Mensah Ababio et al., 2020).

This paper analyses the impact of financial literacy on financial inclusion in developing economies. There is a lack of research exploring the effectiveness of financial literacy and if financial exclusion persists, it will create adverse conditions for developing nations (Lyons et al., 2019). It could harm those financially excluded by growing inequality and poverty levels (GPFI, 2020). Figure 1 illustrates how financial literacy and the financial inclusion index are interconnected in selected developing

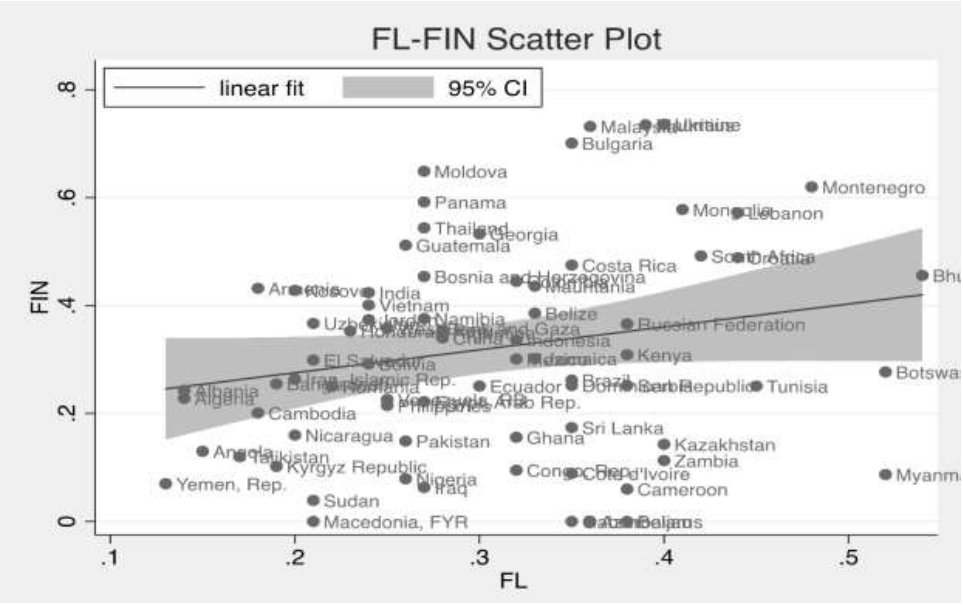

Figure 1. Scatter plot of financial literacy (FL) and the financial inclusion index (FIN) in 2014
Source: Primary data, authors' estimation.

economies. Financial literacy and financial inclusion were higher in emerging countries and lower in African nations. Therefore, further testing on the financial literacy and financial inclusion relationship was reasonable in determining whether the nexus remained positive or otherwise. The present study hypothesised that financial literacy is a crucial predictor of financial inclusion and questioned whether there was a nonlinear relationship between financial literacy and financial inclusion.

This study has contributed to the current debate in several aspects. First, this paper explores how financial literacy impacts the financial inclusion of developing nations. Many previous empirical studies concerning financial literacy have concentrated on developed nations (Askar et al., 2020; Khan et al., 2022) but still limited in the context of developing countries (Lyons et al., 2019). It has been observed that past research concentrated on survey methods conducted in advanced nations. Thus, this study addresses the gap left by previous studies focusing on aggregate countries' macro data to analyse the role of financial literacy on financial inclusion in emerging economies (Khan et al., 2022). Secondly, this study tested a threshold regression model to explain the ongoing discussion around the nexus of financial literacy and financial inclusion. Additional research was required to ascertain whether financial literacy was linearly or nonlinearly related to financial inclusion. It was essential to examine whether there was an optimal level of financial literacy promoting financial inclusion. Thirdly, this study has contributed to the current field by using financial inclusion indices constructed based on multidimensional financial inclusion. In earlier studies, financial inclusion was proxied by a single metric. However, this paper employed the approach suggested by Sarma

(2012) and analysed additional supply-side indicators. Finally, the present study has also emphasised the quantile regression approach as an extension of linear regression to compare the outcome of the findings for the conditional mean model.

The remaining sections of this work are structured as follows: the second section discusses existing literature and details the theoretical framework used in this study. The third section outlines the data, empirical models and econometric techniques used in the analysis. Section 4 reports and discusses the empirical results and their interpretation. The concluding part provides an overview of the main findings and policy consequences.

2. Theoretical Background and Literature Review

2.1 Financial Literacy–Financial Inclusion Relationship

There has been a growing amount of literature concerning financial literacy and its relationship to; financial capabilities, saving and investment behaviours. The theory of planned behaviour (TPB) can be applied in the present study by exploring how financial literacy has developed through education, awareness and attitude which might influence an individual's decision to engage in particular behaviours. If an individual has a high level of belief in something, it is considered the driving factor in any person's action and actions. Thus, attitudes, subjective norms and perceived behavioural control will determine an individual's behaviour in various situations, such as saving money consistently and acquiring credit (Ajzen, 1991). The intervention of financial literacy has played a crucial role in fostering financial inclusion and the development of financial skills that promote the use of financial services among underprivileged and vulnerable communities (Adetunji & David-West, 2019; Kumari et al., 2020; Morgan & Long, 2020; Philippas & Avdoulas, 2020).

Related studies by Altman (2012) and Lusardi and Mitchell (2014) linked financial education, quality knowledge and financial literacy. According to the authors, financial education could improve judgement on financial issues, especially pension payments, usage of credit cards, budgeting for families, mortgages, and stock market investments. Furthermore, enhancing relevant knowledge and emphasising quality has enabled financial education as a critical factor to be used efficiently and contributed to financial literacy (Lusardi & Mitchell, 2014). In the same vein, Potrich et al. (2016) illustrated that financial education was a method of development designed to facilitate people in making the right decisions and handling personal finance effectively. Financial literacy relates to how such knowledge and skills are used (Potrich et al., 2016).

Meanwhile, Montano and Kasprzyk (2008) highlighted that individuals' personal experiences could also affect and determine their approaches to decision-making related to financial management. Individual differences in their experiences could serve as a reference for decision making. Thus, the underlying principles associated with a particular behaviour for diverse groups may differ (Montano & Kasprzyk, 2008). Further, Lusardi and Mitchell (2014) found that individuals were accountable for their financial decisions, so financial literacy was recognised as an individual's perceived influence on their financial choices. An individual will not demonstrate accepted financial conduct

unless the person values that behaviour and is subject to control over the importance of that attitude. The primary determinants of the intentions and acts of an individual are known as salient beliefs.

However, financial market imperfections create uncertainty and restrictions for vulnerable people with limited resources and information (Lyons et al., 2019). In addition, underprivileged people have limited savings to invest in financial education and inadequate credit collateral. They may not benefit from financial literacy and investment opportunities until the barriers to access are eliminated. Therefore, it is reasonable to expect that the impact of financial literacy is modest for those with restricted access to financial products and activities. Basing on these theoretical concepts, provides essential insight when exploring the relationship between financial literacy and financial inclusion for underserved populations in developing countries.

2.2 Empirical Literature

Previous empirical studies have shown an association between financial literacy and financial inclusion in single-country and selected developed and developing economies. To date, several studies (e.g. Adetunji & David-West, 2019; Ali et al., 2020; Bongomin et al., 2018; Bongomin et al., 2020; Cwynar et al., 2019; Lo Prete, 2022; Loke et al., 2022; Nguyen & Doan, 2020; Noor et al., 2020; Pangestu & Karnadi, 2020; Yong et al., 2018) have shown that financial literacy has been positively linked to financial inclusion. Cwynar et al. (2019) posited a positive relationship between financial literacy using educational attainment as a proxy and debt literacy in developed countries. Meanwhile, Ali et al. (2020) and Pangestu and Karnadi (2020) also found that financial literacy positively affected savings decisions and financial inclusion in developing countries, like Indonesia. Alternatively, Ali et al. (2020) used a different approach and employed an analytic network process (ANP) in their study. Unlike Ali et al. (2020), Pangestu and Karnadi (2020) used an online survey methodology involving students to investigate the impact of financial literacy on the students' actions and how they behaved in their savings decisions. Likewise, the findings were consistent with recent studies by Adetunji and David-West (2019) and Nguyen and Doan (2020), who claimed that financial literacy was vital and would impact savings behaviour in developing countries. Adetunji and David-West (2019) found that financial knowledge significantly influenced individual decisions to open savings accounts and financial activities in Nigeria. Alternatively, Nguyen and Doan (2020) also examined the factors influencing the conduct of personal savings and emphasised the contribution of financial literacy based on a province in Vietnam.

Nevertheless, other studies have found the impact of financial literacy on financial inclusion indicators such as deposit and saving account ownership was modest or insignificant (Cole et al., 2011; Jamison et al., 2014). A study by Lyons et al. (2019) found that poor communites in the Middle East and North Africa (MENA) tended to be less responsive to the impacts of financial literacy than less vulnerable groups due to financial access barriers. Meanwhile, a recent study by Liu et al. (2021) found a negative relationship between financial literacy and financial inclusion in Pakistan due to religious concerns.

On the other hand, Bongomin et al. (2018) and Bongomin et al. (2020) revealed the critical role of cognition and social networks as moderating variables in the relationship between financial literacy and financial inclusion. Bongomin et al. (2018) highlighted that awareness, as a significant behaviour, was usually affected by the poor people's cultural-cognitive structures and cultural practices in Uganda. Alternatively, the recent study by Bongomin et al. (2020) found that social networks proxying the intermediation role of microcredit institutions in rural areas played a crucial role in fostering the relationship between financial literacy and financial inclusion. Meanwhile, in a previous study by Yong et al. (2018), alternative data concerning the sample population in Malaysia's urban areas reflected financial literacy in the upper-middle-income economy. The author used a questionnaire involving working adults to measure financial literacy and employed structural equation modelling methods. The study by Yong et al. (2018) concluded that the significant role of financial education and awareness could affect behaviour toward overall financial literacy. This study showed that financial competency was substantial and could influence future financial behaviour among Malaysia's younger generation. However, the generalisability of these studies remains problematic. These studies have been based on observations of data explicitly collected from the low-income group in Uganda and the urban population in the case of Malaysia. This situation, in turn, may lead to a high degree of sample bias.

Another line of evidence has also focused on demographic characteristics, particularly among students and the youth population, to evaluate the roles of financial literacy, financial knowledge, financial attitude, financial behaviour and the impact on access to financial services (Andreou & Philip, 2018; Jain, 2022; Kagotho et al., 2018; Larracilla-Salazar et al., 2019; Rahmawati et al., 2019; Wu et al., 2017). A recent study by Jain (2022) discovered the crucial role of financial education on financial literacy to achieve a sustainable financial system. Larracilla-Salazar et al. (2019) reported that students in Mexico applied knowledge and skills regarding financial management when choosing financial products, such as savings products, investments and loans offered in the market. This finding was consistent with Rahmawati et al. (2019) and Wu et al. (2017). They discovered the crucial role of financial awareness and attitude among youths, which was also driven by the influence of their family members. Rahmawati et al. (2019) analysed the financial literacy of university students in Indonesia and how their family's level of education, especially their parents, could affect financial inclusion.

Similarly to the above study, Wu et al. (2017) investigated the role of parents in Ghana in how they could influence their children aged between 9 to 26 years concerning financial activities that the young generation could benefit from. The authors employed the ordinary least squares (OLS) model. Their findings showed a positive relationship between the sampled children's experiences visiting banks with their parents and the youths' financial understanding and attitude. Although it has been reported that financial education is critical for students, there have been no controlled studies comparing differences in the context of the adult population, as their financial requirements are different.

On the other hand, previous studies have also documented that gender heterogeneities could determine the relationship between financial literacy and financial inclusion (Koomson et al., 2019; Kumari & Ferdous Azam, 2019; Tinghög et al., 2021).

Gender factors have often been seen as having the potential to affect an individual's participation in financial activities due to patterns of behaviour that vary between men and women. For example, the study by Koomson et al. (2019) in Ghana showed that women household participants who had been interested in financial learning were more likely to have bank account ownership. Despite this, Kumari and Ferdous Azam (2019) found that financial literacy positively impacted empowering women under the poverty line in Sri Lanka, supported by the mediation role of financial inclusion. The authors examined this issue using primary data collected through a questionnaire. However, this previous study did not discuss the role of women in semi-urban and urban areas. No controlled studies have compared the multidimensional financial inclusion and economic empowerment process.

Overall, the results have remained inconclusive concerning to what extent financial literacy has contributed to financial inclusion in developing countries. Some studies have only shown results from a single country with limited financial inclusion indicators. Thus, this study indicates the importance of comprehending the role of financial literacy, particularly in a cross-country sample with various dimensions of financial inclusion.

3. Data, Empirical Model and Estimation Methods

3.1 Data and Descriptive Statistics

This study employed cross-sectional estimates to investigate the relationship between financial literacy and financial inclusion. The analysis used macro data from 73 developing countries for the year 2014.[1] As a proxy for financial literacy, this study employed the Standard & Poor's (S&P) Global Financial Literacy Survey dataset following Klapper et al. (2015), Grohmann et al. (2018), Klapper and Lusardi (2019) and Lo Prete (2022). The most recent S&P Global FinLit Survey dataset relating to financial literacy pertains to 2014. The dataset was used because it is technically sound and includes data for developing countries. The S&P survey was the first and remains the most comprehensive global indicator of financial literacy, assessing perceptions of four main financial notions: risk diversification, inflation, numeracy, and compound interest (Klapper & Lusardi, 2019; Lo Prete, 2022). The financial inclusion data as a dependent variable was proxied by the multidimensional financial inclusion index computation by Sarma (2012). Financial inclusion indices were constructed using three dimensions of financial inclusion: accessibility, availability and usage of the formal financial system in the population. For robust analysis, this study also included three other measures to represent financial inclusion as a dependent variable: the deposit account penetration rate per 1000 adults (DEP), the number of bank ATMs per 100,000 adults (ATM) and outstanding loan accounts over GDP (CRE). These indicators have frequently been used previously as proxy measures of financial inclusion. Financial inclusion data was gathered from the Financial Access Survey (FAS) of the International Monetary Fund (IMF) and the Global Findex database.

[1] For a list of countries refer to Appendix A.

Next, financial depth (FD), initial income (GDPPC), human capital (HC) and interest rate (INT) were selected as control variables affecting financial inclusion. FD, measured as domestic credit to the private sector as a percentage of the GDP, was used as a proxy for the depth of banking sector growth in this research (Beck et al., 2007; Le et al., 2019; Levine, 2005). GDPPC reflects the income level earned from economic activity participation over time in a country. It was measured in US dollars using the 2010 constant price. HC refers to the level of knowledge, skills and experience of individual workers quantified in cost or value to an organisation or country. This study employed life expectancy as a proxy of human capital because an extended lifespan improves the accumulation of experiences for productivity and competency (Oster et al., 2012). Meanwhile, INT may affect savings and investments directly related to financial sector growth (Dabla-Norris et al., 2021; Evans, 2016; Uddin et al., 2017; Yang & Liu, 2016). All data for each developing country was taken from the World Bank's *World Development Indicators*. All variables were expressed in logarithm form to minimise variations in the data. In ensuring unbiased estimations, the outliers were excluded from the analysis as proposed by Cook (1977).

Tables 1 and 2 present the descriptive statistics and a correlation matrix for each variable used in the estimation. FIN had a mean value of 0.33, while the minimum and maximum values of FIN were 0.04 and 0.83, respectively. It demonstrated how the financial inclusion index varies between countries and that further research was needed to discover whether disparities in financial literacy could explain the financial inclusion variation. The link between financial literacy and the financial inclusion variable was based on four indicators: FIN, DEP, ATM and CRE, which appeared positive. This sign indicated that high financial literacy might be associated with greater financial inclusion. The correlation coefficients between FIN, DEP, ATM, CRE and FL were 0.2128, 0.1560, 0.2248 and 0.1042, respectively. This coefficient implied that financial inclusion was not a strong predictor of financial literacy. All control variables: HC, FD and GDPPC were positively correlated with FIN. INT had a negative correlation with FIN.

Table 1. Descriptive statistics

Variables	Definition	Unit of measurement	Mean	Std. dev.	Min	Max
FIN	Financial inclusion index	Scale from 0 to 1	0.33	0.19	0.04	0.83
DEP	Deposit accounts per 1,000 adults	%	1044.63	705.80	28.17	3344.91
ATM	No. of ATMs per 100,000 adults	%	41.19	33.50	1.61	185.41
CRE	Outstanding loan accounts over GDP	%	43.90	27.90	6.00	157.97
FL	Financial literacy index	Scale from 0 to 1	0.30	0.09	0.13	0.54
FD	Financial depth	%	45.40	31.36	5.64	145.60
GDPPC	Initial income	current US$	5497.33	3807.35	1093.50	16054.50
HC	Life expectancy	total (years)	70.92	5.82	52.67	79.40
INT	Interest rate	%	7.69	5.91	0.41	32.77

Table 2. Correlation matrix

Variables	FIN	DEP	ATM	CRE	FL	HC	FD	INT	GDPPC
FIN	1.000								
DEP	0.8700	1.0000							
ATM	0.6350	0.5914	1.0000						
CRE	0.5835	0.2465	0.2975	1.0000					
FL	0.2128	0.1560	0.2248	0.1042	1.000				
HC	0.4058	0.3491	0.4351	0.2635	-0.1803	1.000			
FD	0.5677	0.3760	0.5564	0.6708	0.1388	0.3303	1.000		
INT	-0.2022	-0.2655	-0.0931	0.0801	0.0648	-0.1374	-0.2773	1.000	
GDPPC	0.4915	0.4536	0.6860	0.2678	0.2382	0.5430	0.3784	-0.1263	1.000

3.2 Constructing the Financial Inclusion Index

We applied the approach recommended by Sarma (2012) to construct a multi-dimensional index of financial inclusion (FIN). There are three essential dimensions included as a component index for the computation of financial inclusion index. The first dimension is the penetration of banking services measured by the number of deposit accounts with financial institutions per 1000 adults. The second dimension is the availability of financial services measured by the number of bank branches and ATM per 100,000 adult population. Third, the usage of financial services is proxied by outstanding loan accounts with financial institutions (% of GDP). The index is a number in the range between 0 and 1, where 0 indicates the lowest level of financial inclusion (complete financial exclusion) and 1 indicates a higher level of financial inclusion. The FIN is calculated by multiplying each dimension index as below:

$$FIN_i = \frac{1}{2}\left[\frac{\sqrt{p_k^2 + a_k^2 + u_k^2}}{\sqrt{n}} + \left(1 - \frac{\sqrt{\left(z - p_k\right)^2 + \left(z - a_k\right)^2 + \left(z - u_k\right)^2}}{\sqrt{n}} \right) \right] \quad (1)$$

where p_k, a_k, u_k represent the index/indicator value for the dimension measuring penetration, availability and usage. z denotes the weight attached to the indicator. Table A1 in the Appendix lists the FIN value for each developing country for 2014.

3.3 Empirical Model

This study investigated whether a linear or nonlinear relationship existed between financial literacy and financial inclusion. The theoretical model was based on Grohmann et al. (2018) as follows:

$$FI_i = \delta_0 + \beta_1 FL_i + \gamma X_i + \mu_i \quad (2)$$

where *FI* is a vector of financial inclusion variables, *FL* is financial literacy, *X* is a vector of control variables that affect financial inclusion in the country. The real GDP per

capita (*GDPPC*) as a proxy of the level of income, human capital (*HC*), financial depth (*FD*) and interest rate (*INT*) are included in the model as control variables while μ_i is the error term.

This study examined the impact of various levels of financial literacy on financial inclusion under different regimes in developing countries. Therefore, this study employed the cross-sectional threshold regression approaches suggested by Hansen (2000). The two threshold effect hypotheses of nonlinearity in this study were as follows:

$$H_0 : \beta_1 = \beta_2$$
$$H_1 : \beta_1 \neq \beta_2 \tag{3}$$

In equation (3), β represent the parameter vectors. The null hypothesis, H_0 is linear regression, while the alternative hypothesis, H_1 is nonlinear regression. Failure to reject the null hypothesis means that it is a linear regression. If the null hypothesis is rejected, it proves the existence of a two-regime model and the model becomes nonlinear. Financial literacy was both an explanatory and a threshold variable in this study. The threshold variable must be exogenous in time series data. The following is the structure of the model based on threshold regression:

$$FI_i = \begin{Bmatrix} \beta_0^1 + \beta_1^1 FL_i + \beta_2^1 X_i + e_i, & FL_i \leq \lambda \\ \beta_0^2 + \beta_1^2 FL_i + \beta_2^2 X_i + e_i, & FL_i \leq \lambda \end{Bmatrix} \tag{4}$$

where *FL* (financial literacy) is the threshold variable used to split the sample into regimes or groups, and λ is the unknown threshold parameter. For countries with a low or high regime, the effect of financial literacy on financial inclusion will be β_1^1 and β_1^2, respectively. Equation (4) mainly tested against the null hypothesis outlined in Equation (3). This modelling strategy allowed financial inclusion to vary based on whether financial literacy was below or above some unknown level of λ. Two concerns needed to be handled in this analysis. Firstly, it was necessary to determine the estimate of λ and the slope parameters of β_1 and β_2. Following Hansen (2000), this study used the Wald or LM statistic to estimate all possible values of λ, and the slope parameters as the value minimises the concentrated residual sum of squares error. Second, this became a non-standard inference problem because the threshold parameter γ was not defined under the null hypothesis. Thus, this study inferred that using the model-based bootstrap technique and the Wald or LM test statistics did not carry the conventional chi-square limits (Hansen, 1996, 2000). Next, Equation (4) can be written in the following threshold regression form:

$$FI_i = \beta_1^{'} FL_i I(q_i < \lambda) + \beta_2^{'} FL_i I(q_i \geq \lambda) + \gamma X_i + e_i \tag{5}$$

where $I(.)$ is the indicator function value, $\beta = (\beta_1^{'}, \beta_2^{'})$. The value 1 indicates that the argument indicator function is valid, and 0 denotes invalid. The threshold level is represented by q_i and the threshold parameter denoted by γ that divides the equation into two regimes: coefficients β_1 and β_2. FI_i is the dependent variable and FL_i is the independent variable, X_i is the vector of control variables (GDPPC, HC, FD and INT) that affect financial inclusion and e_i is the error term.

3.4 Estimation Method

3.4.1 Cross-section Threshold Regression

This analysis used the cross-section threshold regression technique to analyse further the non-monotonic effect of financial literacy on financial inclusion. Firstly, this study tested the null hypothesis of linearity $H_0 : \beta_1 = \beta_2$ against the threshold model. When a threshold value existed, the sample was estimated to be $FL_i \leq \gamma$ which refers to the first regime and $FL_i > \gamma$ to the second regime. This study adopted the cross-section threshold regression technique by Hansen (1996, 2000), who implemented a heteroscedasticity-consistent Lagrange multiplier (LM) bootstrap procedure to test the null hypothesis of a linear formulation against a threshold regression approach. Since the threshold parameter γ was not identified under the null hypothesis of the no-threshold effect, the p values were computed using a fixed bootstrap method. This approach becomes a non-standard inference problem and the Wald or Lagrange multiplier (LM) test statistics did not carry their conventional chi-square limits (Hansen 1996, 2000). Hansen (2000) showed that this approach gave correct p values asymptotically. The threshold regression model should be retested against a linear specification after dividing the original sample according to the threshold level if the hypothesis of $\beta_1 = \beta_2$ is rejected and a threshold level is identified. After this, the process was repeated until the $H_0 : \beta_1 = \beta_2$ could not be rejected any further.

3.4.2 Quantile Regression

This study used quantile regression to measure and project the inference about conditional quantile functions for the dependent variable. The Koenker and Bassett (1978) method of conditional quantile regression estimator was first introduced as a robust regression approach that makes it possible to estimate when the normative assumption of normality of the error term could not be strictly satisfied. Using the quantile regression technique, this approach could obtain information about points in the distribution of the dependent variable other than the conditional mean in the sampled countries (Bashir et al., 2020; Khan et al., 2020). The quantile regression technique is robust to outliers (Buchinsky, 1995) and can describe the entire conditional distribution of the dependent variable (Koenker & Bassett, 1978; Koenker & Hallock, 2001). In this analysis, the quantile regression equation was expressed as below:

$$FI_{it} = FL_i'\beta_\theta + \mu_{0i} : Q_\theta\left(FI_i|FL_i\right) = FL_i'\beta_\theta \tag{6}$$

where FI_{it} denotes the vector of financial inclusion variables in countries, FL_i is financial literacy, β_θ is the vector of parameters to be estimated for a given value of the quantiles θ and $Q_\theta\left(FI_i|FL_i\right)$ is the θth quantile of the conditional distribution of the economic uncertainty given the vector of explanatory variables, FL_i. The quantile values were determined by solving a minimisation problem involving the weighting of the related residuals. Quantile regression with robust and clustered standard errors was used in this application to determine whether the coefficients differed across conditional quantiles. The regression estimates were classified into nine different quantiles ranging from 0.10 to 0.90, namely; 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80 and 0.90.

4. Empirical Results

This study applied the threshold method from Hansen (2000) to determine a minimum value as required. The role of financial literacy on access to financial activities was estimated using Equation (4) for financial inclusion variables. This study also included four different proxies: FIN, DEP, ATM and CRE, representing the distinct dimensions of financial inclusion. In addition, control variables, namely HC, FD, INT and GDPPC were included in the baseline model. After eliminating all outliers, the analysis of the study began by determining the minimum value of the threshold level for financial literacy. In that case, a nation was perceived to have a poor level of financial literacy if the level percentage was less than the threshold level. In contrast, a country was considered to have a higher financial literacy rate if it exceeded the threshold level.

Table 3 assessed the null hypotheses of no threshold against the possibility of threshold allowing heteroskedastic errors (white corrected). The results showed that the p-value of the hypothesis of no threshold effects determined using the bootstrap method with 5000 replications and a 15% trimming percentage could not be rejected. The bootstrap p-values were insignificant suggesting that the relationship between financial literacy and financial inclusion was monotonic. These results also indicated that all models had no threshold effects, and the sample could not be split into two regimes. This research illustrated a dynamic relationship between the role of financial literacy and financial inclusion, where financial knowledge did not significantly contribute to financial inclusion in underdeveloped countries. The growing sophistication of financial products available on the market may be causing a decline in getting financial knowledge among low-income populations in developing nations (Grohmann, 2018). Therefore, the financial inclusion rate is low if the financial literacy level remains weak.

Table 4 shows the empirical results of Equation (2), which examines the role of financial literacy on financial inclusion. Thus, the recent study focused on the linear model of OLS estimation without a threshold since the result provided that all models did not favour threshold effects, and the sample could not be divided into two regimes. Based on Model 2a, where the dependent variable was FIN, the OLS linear regression results showed that the coefficient was positive and statistically insignificant in developing countries' financial inclusion variables. This finding may have implied that FL did not have a significant impact on financial inclusion decisions which was consistent

Table 3. Threshold estimates of financial inclusion

	Model 1a FIN	Model 1b DEP	Model 1c ATM	Model 1d CRE
First sample split				
LM test for no threshold	8.0467	11.5674	6.7202	8.0054
Threshold estimate	0.33	0.28	0.41	0.25
95% confidence interval	[0.13,0.54]	[0.13,0.54]	[0.22,0.41]	[0.24,0.35]
Heteroskedasticity test (p-value)	0.7468	0.5736	0.9389	0.05072*
Bootstrap p-value	0.651	0.1178	0.8656	0.5684

Note: ***, ** and * indicate the significance at the 1%, 5% and 10% levels, respectively.

Table 4. Linear model OLS without threshold

	Model 2a FIN	Model 2b DEP	Model 2c ATM	Model 2d CRE
Constant/intercept	-10.7784***	-11.0780**	-1.4849***	-0.7718***
	(2.4011)	(6.5052)	(3.4791)	(2.2425)
FL	0.1085	0.2670	-0.3378	-0.0118
	(0.1401)	(0.3273)	(0.2282)	(0.1288)
HC	1.5871**	3.6144**	-1.2401	0.3908
	(0.6478)	(1.8350)	(0.9580)	(0.5205)
FD	0.5862***	0.2997	0.7797***	0.8029***
	(0.0926)	(0.2293)	(0.1490)	(0.0532)
INT	-0.0363	-0.1079	0.0186	0.0321
	(0.0610)	(0.0873)	(0.0546)	(0.0634)
GDPPC	0.0985	0.2049	0.8231***	-0.0364
	(0.0716)	(0.1752)	(0.1270)	(0.0583)
R-sq	0.6370	0.3161	0.7117	0.7360
Heteroskedasticity test (p-value)	0.7468	0.5736	0.9389	0.0507
Number of Observations	73	58	69	68
Degrees of freedom	67	52	63	62

Note: ***, ** and * indicate the significance at the 1%, 5% and 10% levels, respectively.

with empirical work by Bongomin et al. (2017), Crossan et al. (2011), Dvorak and Hanley (2010) and Sayinzoga et al. (2016). Despite this finding, there were explanations for why financial literacy was not a successful predictor of financial inclusion in this population sample.

Models 2b, 2c and 2d in Table 4 were based on DEP, ATM and CRE as dependent variables, respectively. The analysis was repeated using different financial inclusion dimensions to test the validity of the OLS estimates. The findings demonstrated that financial literacy responded differently to other financial inclusion measures. In Model 2b, the result of DEP as a dependent variable was similar in coefficient sign to those obtained using FIN. The findings indicated that the coefficient estimates of FL were positive but statistically insignificant in influencing the financial inclusion variables. In contrast, when ATM and CRE measured the financial inclusion variables for Models 2c and 2d, respectively, the coefficient signs for FL were statistically negative and insignificant. One of the possible reasons the underserved population in developing countries might face challenges in understanding financial principles is a lack of appropriate financial knowledge. Individuals in least-developed economies might choose to save formally or prefer informal ways (Kumar et al., 2019; Morgan & Trinh, 2017). Financial knowledge could impact attitudes, which determine particular behaviours of low-income households towards good money and credit management. Thus, less financial knowledge may drive behavioural and financial decisions from more advanced to informal capital accumulation methods.

Table 5. Financial literacy on financial inclusion index (FIN): quantile regression

Variables	Q0.1	Q0.2	Q0.3	Q0.4	Q0.5	Q0.6	Q0.7	Q0.8	Q0.9
FL	-0.284	0.026	0.100	0.070	0.034	0.169	0.346	0.374	0.357
	(0.268)	(0.205)	(0.193)	(0.207)	(0.224)	(0.259)	(0.247)	(0.271)	(0.307)
HC	0.575	0.761	1.182	1.638**	1.942***	1.886**	2.084*	2.478	-0.871
	(1.281)	(0.851)	(0.725)	(0.621)	(0.697)	(0.824)	(1.205)	(1.646)	(2.047)
FD	0.627***	0.669***	0.635***	0.581***	0.592***	0.576***	0.596***	0.455**	0.352
	(0.156)	(0.116)	(0.116)	(0.095)	(0.105)	(0.138)	(0.169)	(0.226)	(0.238)
INT	-0.067	0.032	0.048	-0.043	-0.015	-0.015	0.061	-0.094	-0.022
	(0.104)	(0.090)	(0.078)	(0.069)	(0.069)	(0.079)	(0.096)	(0.097)	(0.114)
GDPPC	0.178	0.211**	0.204**	0.146	0.114	0.071	-0.001	0.027	0.017
	(0.140)	(0.089)	(0.086)	(0.094)	(0.106)	(0.103)	(0.119)	(0.158)	(0.228)
Constant	-8.209*	-9.022***	-10.490***	-11.510***	-12.600***	-11.700***	-11.810**	-12.780**	2.089
	(4.688)	(2.981)	(2.383)	(2.159)	(2.482)	(3.043)	(4.527)	(6.569)	(7.696)
Obs.	73	73	73	73	73	73	73	73	73

Notes: Dependent variable is the financial inclusion index (FIN). Obs. is the number of observations. Lower quantile (e.g., Q0.1) signify low financial inclusion nations.
***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Concerning the control variable, the coefficients of HC and FD were positive and statically significant, consistent with the theory. HC, proxied by life expectancy, anticipated that age extension would translate into higher productivity and wages because labour would be equipped with the necessary experience. Consequently, more significant income contributed to more savings and increased financial inclusion. The role of FD was also vital in impacting financial inclusion because a higher degree of financial growth can increase banking liquidity and improve financial intermediation in the country. Instead, GDPPC demonstrates substantial results only in Model 2c, while INT indicates insignificant results across all models.

This study utilised the quantile regression model of FL and FIN as an extension of linear regression. Table 5 illustrates the quantile regression estimate on the coefficient distributions and magnitude of the effects of each variable. The estimates are for 0.10, 0.20,0.30, 0.40, 0.50, 0.60, 0.70, 0.80 and 0.90 quantiles. The financial literacy variable was equal throughout the quantiles. The quantile regression estimation also suggested that the financial literacy variable was not statistically significant throughout various quantiles in the conditional distribution of the financial inclusion. Similar results from analyses using other financial inclusion measures can be found in Tables A2, A3 and A4 in the Appendix.[2] Figure 2 depicts the coefficient plot of the FL from

[2] The quantile regression results for the remaining financial inclusion dimension (DEP, ATM and CRE) have not been reported to save space. The results can be found in the appendix.

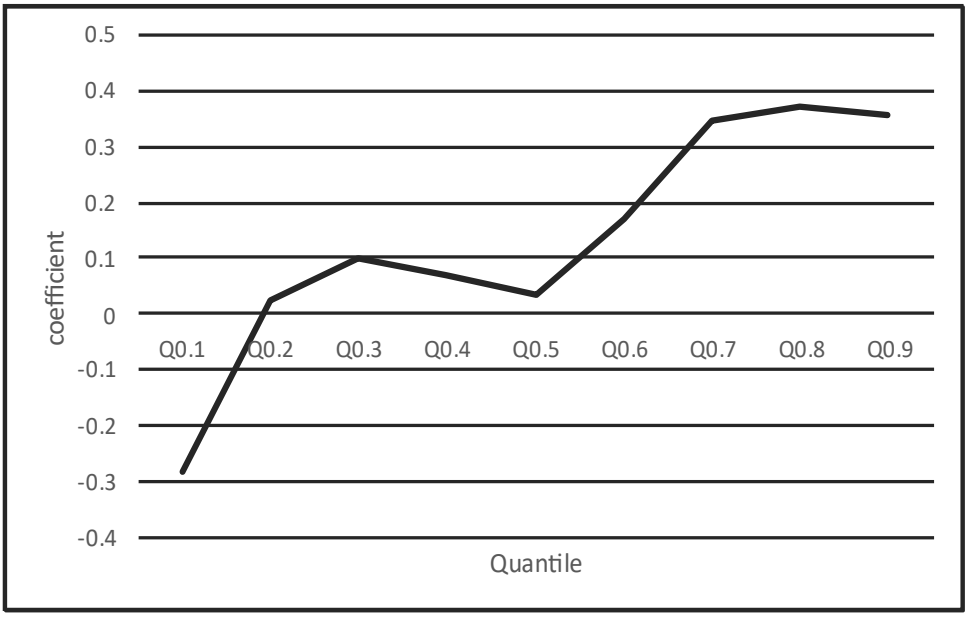

Figure 2. Coefficient of financial literacy at different quantiles of financial inclusion

the 10 per cent quantile to the 90 per cent quantile, which serves as the primary measure for financial inclusion in this research. What stands out in this chart is that the coefficient of FL showed an upward trend. Towards the lower percentile of the distribution (10th per cent quantiles), the coefficients of FL were negative. However, the coefficient of FL turned to positive and increased after the median quantiles (20th per cent and above).

The quantile regression results in Table 5 also suggest that HC, FD and GDPPC had a significant positive impact on financial inclusion at the various distributions of financial inclusion. The results show that FD had played a significant role in promoting financial inclusion at the low quantiles, but the magnitude of this effect decreases towards the high quantiles level. Meanwhile, the HC variable revealed a different pattern. The coefficient signs of HC are positive and significant between the 40th and 70th quantiles. Figure 3 illustrates the graphical results of the slope coefficient for each variable against the quantiles and conditioning of financial inclusion. The estimated response of the FD to the FIN was positive and statistically significant between the 10th and 80th quantiles. As for the control variable, the results indicate that FD and HC positively affect the country's financial inclusion. This is consistent with the literature which has shown the critical role of financial development (Oanh et al., 2023; Rasheed et al., 2016) and human capital (Abdelghaffar et al. 2023; Ofosu-Mensah Ababio et al. 2020) in improving financial inclusion. Hence, developing countries with low levels of financial inclusion are advised to prioritise enhancing financial literacy to empower individuals and utilise financial services more effectively.

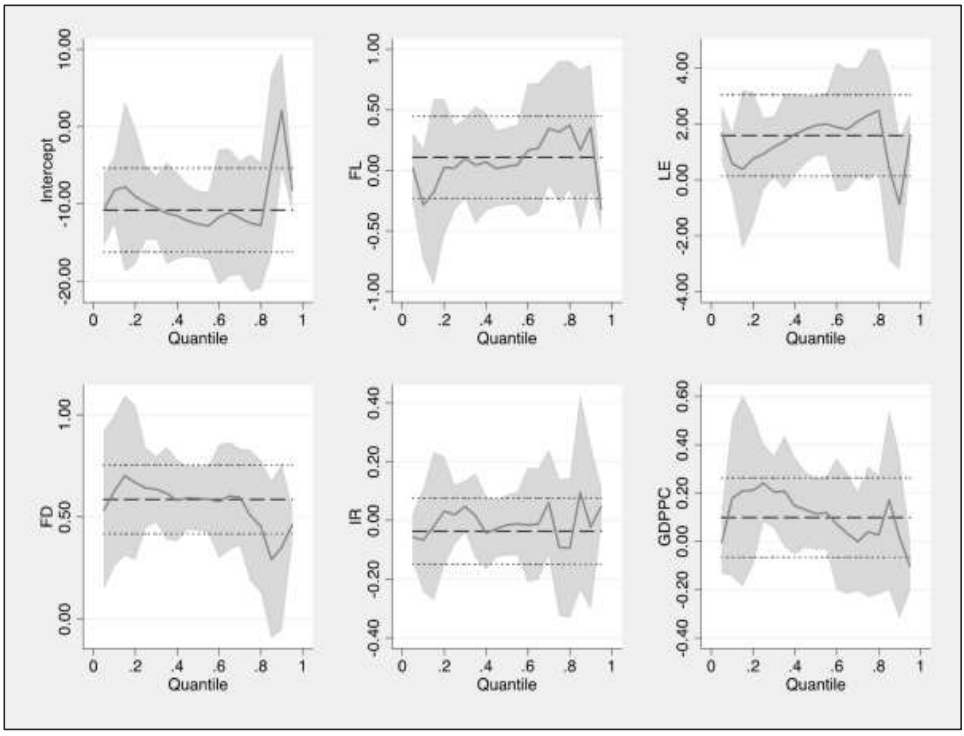

Figure 3. Quantile regression graph

5. Robustness Check

A robustness check was conducted in this study to validate the estimated sensitivity of the result and strengthen the empirical findings. The estimation was reviewed again and supplemented with additional methods to confirm whether a nonlinear effect existed between financial literacy and financial inclusion. The robustness checks involved estimating the model using a quadratic function by including the square term to measure financial literacy indicators to the current sample and then applying the Lind and Mehlum U-shape test. The empirical results are presented in Tables 6 and 7, respectively. The empirical result for Model 3a presented in Table 6 demonstrated that the indicator of financial literacy and the squared term was insignificant determinants of the financial inclusion index. Besides, Models 3b, 3c and 3d also showed signs of the non-existence of nonlinear relationship, regardless of the financial inclusion measure, is represented by DEP, ATM and CRE, respectively. The coefficients on FL and its squared term were negative for Models 3a, 3c, and 3d while positive for Model 3b; however, the coefficient was statistically insignificant. This outcome indicated that financial literacy had a linear or monotone relationship with financial inclusion. The empirical result supported this study's earlier conclusion that finance literacy-financial inclusion is a no-threshold model.

Table 6. Robustness checks using a quadratic regression model

	Model 3a FIN	Model 3b DEP	Model 3c ATM	Model 3d CRE
FL	-0.644	0.662	-1.340	-0.029
	(0.906)	(1.560)	(1.319)	(0.878)
SQFL	-0.292	0.155	-0.395	-0.007
	(0.329)	(0.550)	(0.508)	(0.356)
HC	1.588**	3.596*	-1.177	0.392
	(0.680)	(1.932)	(1.017)	0.531)
FD	0.582***	0.306	0.771***	0.803***
	(0.099)	(0.240)	(0.163)	(0.055)
INT	-0.032	-0.109	0.021	0.032
	(0.064)	(0.094)	(0.058)	(0.068)
GDPPC	0.094	0.208	0.812***	-0.037
	(0.074)	(0.184)	(0.130)	(0.064)
Constant	-11.190***	-10.810	-2.229	-0.784
	(2.479)	(6.721)	(3.916)	(2.174)
Observations	73	58	69	68
R-squared	0.640	0.317	0.714	0.736

Notes: Robust standard errors are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7. Robustness checks using Lind and Mehlum's (2010) U-test

	Model 4a FIN	Model 4b DEP	Model 4c ATM	Model 4d CRE
Extreme point	-1.105	-2.140	-1.699	-2.170
Lower bound slope	0.546	0.031	0.270	-0.002
	(0.124)		(0.370)	
Upper bound slope	-0.285	0.471	-0.854	-0.020
	(0.289)		(0.117)	
Overall U test	0.560	–	0.330	–
T-state	0.289	–	0.370	–

Notes: Robust standard errors are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

This research also employed the U-test developed by Lind and Mehlum (2010) as a further robustness check in Table 7. The rejection of the null hypothesis confirms the nonlinear link between financial literacy and financial inclusion. The test statistics were insignificant, indicating no U-shaped or inverted U-shaped association between financial literacy and financial inclusion. Thus, our analysis validated the consistency of the findings based on both estimations

5. Conclusions

This research analyses the relationship between financial literacy and financial inclusion using cross-sectional threshold and quantile regression. The results showed that financial literacy had no inverted u-shaped effect on financial inclusion in the sample of developing countries. In addition, all financial inclusion variables were investigated to determine the validity of the OLS estimations in this study. The results indicated that the coefficient estimates of financial literacy were statistically insignificant regarding the likelihood of improving financial access in developing countries. This study used a quantile regression model to compare the results. Although the coefficient effect was much more potent at higher quantiles, the empirical result indicated that the financial literacy variable was not statistically significant at various points in the conditional distribution of the financial inclusion variables. These findings were also verified by the quadratic model and Lind and Mehlum's (2010) U-test, demonstrating that the financial literacy model was either linear or monotone. There was no U-shaped or inverted relationship between financial literacy and financial inclusion.

Therefore, the findings are necessary for authorities to establish financial regulations to improve financial inclusion. In developing economies, the underserved community continues to be excluded from financial services and activities due to a lack of confidence in these services and activities. Hence, financial institutions must develop training programmes that target specific groups and behaviours to increase their understanding and confidence in the benefits of various financial products and prospects. In addition, individuals have difficulty acquiring access to financial services since their financial markets and institutions are underdeveloped. Policymakers should prioritise raising the level of financial development and introducing new and innovative financial services into the marketplace to attract more financially excluded customers. Additional studies are necessary to understand the association between financial knowledge and financial inclusion. As a result of the limited availability of financial literacy datasets, future studies should consider utilising large panel datasets and longitudinal research methodologies. Future research could be conducted from either a global or developed country perspective to examine how cultural and institutional variations may influence the benefits of financial knowledge on access to financial activities.

References

Abdelghaffar, R.A., Emam, H.A., & Samak, N.A. (2023). Financial inclusion and human development: Is there a nexus? *Journal of Humanities and Applied Social Sciences, 5*(3), 163–177. https://doi.org/10.1108/jhass-11-2021-0178

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

Adil, F., & Jalil, A. (2020). Determining the financial inclusion output of banking sector of Pakistan—supply-side analysis. *Economies, 8*(2), Article 8020042. https://doi.org/10.3390/economies8020042

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211.

Ali, M.M., Devi, A., Furqani, H., & Hamzah, H. (2020). Islamic financial inclusion determinants in Indonesia: An ANP approach. *International Journal of Islamic and Middle Eastern Finance and Management, 13*(4), 727–747. https://doi.org/10.1108/IMEFM-01-2019-0007

Allen, F., Demirguc-Kunt, A., Klapper, L., & Martinez Peria, M.S. (2016). The foundations of financial inclusion: Understanding ownership and use of formal accounts. *Journal of Financial Intermediation, 27*, 1–30. https://doi.org/10.1016/j.jfi.2015.12.003

Altman, M. (2012). Implications of behavioural economics for financial literacy and public policy. *Journal of Socio-Economics, 41*(5), 677–690. https://doi.org/10.1016/j.socec.2012.06.002

Andreou, P.C., & Philip, D. (2018). Financial knowledge among university students and implications for personal debt and fraudulent investments. *Cyprus Economic Policy Review, 12*(2), 3–23.

Askar, M.W., Ouattara, B., & Zhang, Y.-F. (2020). *Financial literacy and poverty reduction: The case of Indonesia* (ADBI Working Paper 1097). Tokyo: Asian Development Bank Institute. https://www.adb.org/publications/financial-literacy-poverty-reduction-case-indonesia

Bashir, M.F., MA, B., Shahbaz, M., & Jiao, Z. (2020). The nexus between environmental tax and carbon emissions with the roles of environmental technology and financial development. *PLoS ONE, 15*(11), Article e0242412. https://doi.org/10.1371/journal.pone.0242412

Beck, T., Demirgüç-Kunt, A., & Levine, R. (2007). Finance, inequality and the poor. *Journal of Economic Growth, 12*, 27–49. https://doi.org/10.1007/s10887-007-9010-6

Bongomin, G.O.C, Munene, J.C., Ntayi, J.M., & Malinga, C.A. (2017). Financial literacy in emerging economies: Do all components matter for financial inclusion of poor households in rural Uganda? *Managerial Finance, 43*(12), 1310–1331. https://doi.org/10.1108/MF-04-2017-0117

Bongomin, G.O.C., Munene, J.C., Ntayi, J.M., & Malinga, C.A. (2018). Nexus between financial literacy and financial inclusion: Examining the moderating role of cognition from a developing country perspective. *International Journal of Bank Marketing, 36*(7), 1190–1212. https://doi.org/10.1108/IJBM-08-2017-0175

Bongomin, G.O.C., Ntayi, J.M., & Malinga, C.A. (2020). Analyzing the relationship between financial literacy and financial inclusion by microfinance banks in developing countries: Social network theoretical approach. *International Journal of Sociology and Social Policy, 40*(11/12), 1257–1277. https://doi.org/10.1108/IJSSP-12-2019-0262

Buchinsky, M. (1995). Estimating the asymptotic covariance matrix for quantile regression models a Monte Carlo study. *Journal of Econometrics, 68*(2), 303–338. https://doi.org/10.1016/0304-4076(94)01652-G

Cole, S., Sampson, T., & Zia, B. (2011). Prices or knowledge? What drives the demand for financial services in developing countries. *Journal of Finance, 66*(6), 1933–1967. https://doi.org/10.1111/j.1540-6261.2011.01696.x

Cook, R.D. (1977). Detection of influential observation in linear regression. *Technometrics, 19*(1), 15–18. https://doi.org/10.1080/00401706.1977.10489493

Corsini, L., & Giannelli, G.C. (2021). Economics education and financial literacy acquisition: Evidence from a field experiment. *Journal of Behavioral and Experimental Finance, 32*, Article 100556. https://doi.org/10.1016/j.jbef.2021.100556

Crossan, D., Feslier, D., & Hurnard, R. (2011). Financial literacy and retirement planning in New Zealand. *Journal of Pension Economics & Finance, 10*(4), 619–635. https://doi.org/10.1017/S1474747211000515

Cwynar, A., Cwynar, W., & Wais, K. (2019). Debt literacy and debt literacy self-assessment: The case of Poland. *Journal of Consumer Affairs, 53*(1), 24–57. https://doi.org/10.1111/joca.12190

Dabla-Norris, E., Ji, Y., Townsend, R.M., & Unsal, D.F. (2021). Distinguishing constraints on financial inclusion and their impact on GDP, TFP, and the distribution of income. *Journal of Monetary Economics, 117*, 1–18. https://doi.org/10.1016/j.jmoneco.2020.01.003

Davoli, M., & Rodríguez-Planas, N. (2020). Culture and adult financial literacy: Evidence from the United States. *Economics of Education Review, 78*, Article 102013. https://doi.org/10.1016/j.econedurev.2020.102013

Dvorak, T., & Hanley, H. (2010). Financial literacy and the design of retirement plans. *Journal of Socio-Economics, 39*(6), 645–652. https://doi.org/10.1016/j.socec.2010.06.013

Evans, O., & Adeoye, B. (2016). Determinants of financial inclusion in Africa: A dynamic panel data approach. *University of Mauritius Research Journal, 22*, 310–336.

Fouejieu, A., Sahay, R., Cihak, M., & Chen, S. (2020). Financial inclusion and inequality: A cross-country analysis. *Journal of International Trade and Economic Development, 29*(8), 1018–1048. https://doi.org/10.1080/09638199.2020.1785532

Frisancho, V. (2020). The impact of financial education for youth. *Economics of Education Review, 78*, Article 101918. https://doi.org/10.1016/j.econedurev.2019.101918

GPFI (Global Partnership for Financial Inclusion). (2020). *G20 2020 Financial Inclusion Action Plan.* October, 1–23. https://www.gpfi.org/sites/gpfi/files/sites/default/files/G20%202020%20Financial%20Inclusion%20Action%20Plan.pdf

Grohmann, A. (2018). Financial literacy and financial behavior: Evidence from the emerging Asian middle class. *Pacific-Basin Finance Journal, 48*, 129–143. https://doi.org/10.1016/j.pacfin.2018.01.007

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

Hansen, B.E. (1996). Inference when a nuisance parameter is not identified under the null hypothesis. *Econometrica, 64*(2), 413–430. https://doi.org/10.2307/2171789

Hansen, B.E. (2000). Sample splitting and threshold estimation. *Econometrica, 68*(3), 575–603. https://doi.org/10.1111/1468-0262.00124

Hu, Y., Liu, C., & Peng, J. (2021). Financial inclusion and agricultural total factor productivity growth in China. *Economic Modelling, 96*, 68–82. https://doi.org/10.1016/j.econmod.2020.12.021

Hussain, J., Salia, S., & Karim, A. (2018). Is knowledge that powerful? Financial literacy and access to finance: An analysis of enterprises in the UK. *Journal of Small Business and Enterprise Development, 25*(6), 985–1003. https://doi.org/10.1108/JSBED-01-2018-0021

Huston, S.J. (2010). Measuring financial literacy. *Journal of Consumer Affairs, 44*(2), 296–316. https://doi.org/10.1111/j.1745-6606.2010.01170.x

Iterbeke, K., De Witte, K., Declercq, K., & Schelfhout, W. (2020). The effect of ability matching and differentiated instruction in financial literacy education. Evidence from two randomised control trials. *Economics of Education Review, 78*, Article 101949. https://doi.org/10.1016/j.econedurev.2019.101949

Jain, K. (2022). An insight into financial literacy of University faculties: A case study of University of Rajasthan employees, India. *Social Sciences & Humanities Open, 5*(1), Article 100262. https://doi.org/10.1016/j.ssaho.2022.100262

Jamison, J., Karlan, D., & Zinman, J. (2014). *Financial education and access to savings accounts: Complements or substitutes? Evidence from Ugandan Youth Clubs* (NBER Working Paper 20135). Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w20135

Kagotho, N., Ssewamala, F.M., Patak-Pietrafesa, M., & Byansi, W. (2018). Testing the financial capability framework: Findings from YouthSave-Impact study Kenya. *Social Work, 63*(1), 67–74. https://doi.org/10.1093/sw/swx056

Kebede, J., Selvanathan, S., & Naranpanawa, A. (2021). Foreign bank presence, institutional quality, and financial inclusion: Evidence from Africa. *Economic Modelling, 102*, Article 105572. https://doi.org/10.1016/j.econmod.2021.105572

Khan, F., Siddiqui, M.A., & Imtiaz, S. (2022). Role of financial literacy in achieving financial inclusion: A review, synthesis and research agenda. *Cogent Business & Management, 9*(1), Article 2034236. https://doi.org/10.1080/23311975.2022.2034236

Khan, H., Khan, I., & Binh, T.T. (2020). The heterogeneity of renewable energy consumption, carbon emission and financial development in the globe: A panel quantile regression approach. *Energy Reports, 6*, 859–867. https://doi.org/10.1016/j.egyr.2020.04.002

Klapper, L., & Lusardi, A. (2019). Financial literacy and financial resilience: Evidence from around the world. *Financial Management, 49*(3), 589–614. https://doi.org/10.1111/fima.12283

Klapper, L., Lusardi, A., & Oudheusden, P. van. (2015). *Financial literacy around the world: Insights from the Standard & Poor's Rating Services Global Financial Literacy Survey*. https://gflec.org/wp-content/uploads/2015/11/Finlit_paper_16_F2_singles.pdf

Kling, G., Pesqué-Cela, V., Tian, L., & Luo, D. (2020). A theory of financial inclusion and income inequality. *European Journal of Finance, 28*(1), 137–157. https://doi.org/10.1080/1351847X.2020.1792960

Koenker, R., & Bassett, G. (1978). Regression quantiles. *Econometrica, 46*(1), 33–50. https://doi.org/10.2307/1913643

Koenker, R., & Hallock, K.F. (2001). Quantile regression. *Journal of Economic Perspectives, 15*(4), 143–156.

Koomson, I., Villano, R.A., & Hadley, D. (2019). 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

Kumar, A., Pal, R., & Pal, R. (2019). Usage of formal financial services in India: Demand barriers or supply constraints? *Economic Modelling, 80*, 244–259. https://doi.org/10.1016/j.econmod.2018.11.010

Kumari, D.A.T., & Ferdous Azam, S.M. (2019). The mediating effect of financial inclusion on financial literacy and women's economic empowerment: A study among rural poor women in Sri Lanka. *International Journal of Scientific and Technology Research, 8*(12), 719–729.

Kumari, D.A.T., Ferdous Azam, S.M., & Khalidah, S. (2020). Financial literacy: As a tool for enhancing financial inclusion among rural population in Sri Lanka. *International Journal of Scientific and Technology Research, 9*(4), 2595–2605.

Larracilla-Salazar, N., Peña-Osorio, I.Y., & Molchanova, V.S. (2019). Education and financial inclusion. An empirical study in students of higher education. *European Journal of Contemporary Education, 8*(4), 810–818.

Le, Q.H., Ho, H.L., & Vu, T.D. (2019). Financial depth and economic growth: Empirical evidence from ASEAN+3 countries. *Management Science Letters, 9*, 851–864. https://doi.org/10.5267/j.msl.2019.3.003

Levine, R. (2005). Finance and growth: Theory and evidence. In P. Aghion & S.N. Durlauf (Eds.), *Handbook of Economic Growth, 1*(A), (chapter 12, pp. 865–934). Elsevier. https://doi.org/10.1016/S1574-0684(05)01012-9

Lind, J.T., & Mehlum, H. (2010). With or without U? The appropriate test for a U-shaped relationship. *Oxford Bulletin of Economics and Statistics, 72*(1), 109–118. https://doi.org/10.1111/j.1468-0084.2009.00569.x

Liu, S., Gao, L., Latif, K., Dar, A.A., Zia-UR-Rehman, M., & Baig, S.A. (2021). The behavioral role of digital economy Adaptation in sustainable financial literacy and financial inclusion. *Frontiers in Psychology, 12*, Article 742118. https://doi.org/10.3389/fpsyg.2021.742118

Lo Prete, A. (2022). Digital and financial literacy as determinants of digital payments and personal finance. *Economics Letters, 213*, Article 110378. https://doi.org/10.1016/j.econlet.2022.110378

Loke, Y.J., Chin, P.N., & Hamid, F.S. (2022). Financial literacy in Malaysia, 2015–2018. Malaysian *Journal of Economic Studies, 59*(2), 171–197. https://doi.org/10.22452/MJES.vol59no2.1

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., & Mitchell, O.S. (2014). The economic importance of financial literacy: Theory and evidence. *Journal of Economic Literature, 52*(1), 5–44. https://doi.org/10.1257/jel.52.1.5

Lyons, A.C., Grable, J., & Zeng, T. (2019). *Impacts of financial literacy on the loan decisions of financially excluded households in the People's Republic of China* (ADBI Working Paper no. 923). Tokyo, Japan: Asian Development Bank Institute. https://doi.org/10.2139/ssrn.3370021

Lyons, A.C., & Kass-Hanna, J. (2019). Financial inclusion, financial literacy and economically vulnerable populations in the Middle East and North Africa. *Emerging Markets Finance and Trade, 57*(9), 2699–2738. https://doi.org/10.1080/1540496X.2019.1598370

Madeira, C., & Margaretic, P. (2022). The impact of financial literacy on the quality of self-reported financial information. *Journal of Behavioral and Experimental Finance, 34*, Article 100660. https://doi.org/10.1016/j.jbef.2022.100660

Montano, D.E., & Kasprzyk, D. (2008). Theory of reasoned action, theory of planned behavior, and the integrated behavioral model. In K. Glanz, B.K. Rimer, & K. Viswanath (Eds.), *Health behavior and health education: Theory, research and practice* (4th ed., pp. 67–96). Jossey-Bass.

Morgan, P.J., & Long, T.Q. (2020). Financial literacy, financial inclusion, and savings behavior in Laos. *Journal of Asian Economics, 68*, Article 101197. https://doi.org/10.1016/j.asieco.2020.101197

Morgan, P.J., & Trinh, L.Q. (2017). *Determinants and Impacts of financial literacy in Cambodia and Viet Nam* (ADBI Working Paper no. 754). Tokyo, Japan: Asian Development Bank Institute.

Nguyen, V.T., & Doan, M.D. (2020). The correlation between financial literacy and personal saving behavior in Vietnam. *Asian Economic and Financial Review, 10*(6), 590–603. https://doi.org/10.18488/journal.aefr.2020.106.590.603

Noor, N., Batool, I., & Arshad, H.M. (2020). Financial literacy, financial self-efficacy and financial account ownership behavior in Pakistan. *Cogent Economics and Finance, 8*(1), Article 1806479. https://doi.org/10.1080/23322039.2020.1806479

Oanh, T.T.K., Van, L.T.T., & Dinh, L.Q. (2023). Relationship between financial inclusion, monetary policy and financial stability: An analysis in high financial development and low financial development countries. *Heliyon, 9*(6), Article e16647. https://doi.org/10.1016/j.heliyon.2023.e16647

OECD. (2014). *PISA 2012 results: Students and money: Financial literacy skills for the 21st century* (Volume VI). OECD Publishing. https://doi.org/10.1787/19963777

Ofosu-Mensah Ababio, J., Attah-Botchwey, E., Osei-Assibey, E., & Barnor, C. (2020). Financial inclusion and human development in frontier countries. *International Journal of Finance & Economics, 26*(1), 42–59. https://doi.org/10.1002/ijfe.1775

Omar, M.A., & Inaba, K. (2020). Does financial inclusion reduce poverty and income inequality in developing countries? A panel data analysis. *Journal of Economic Structures, 9*, Article 37. https://doi.org/10.1186/s40008-020-00214-4

Oster, E., Shoulson, I., & Dorsey, E.R. (2012). *Limited life expectancy, human capital and health investment: Evidence from Huntington disease* (NBER Working Paperno. 17931). Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w17931

Ozili, P.K. (2018). Impact of digital finance on financial inclusion and stability. *Borsa Istanbul Review, 18*(4), 329–340. https://doi.org/10.1016/j.bir.2017.12.003

Pangestu, S., & Karnadi, E.B. (2020). The effects of financial literacy and materialism on the savings decision of generation Z Indonesians. *Cogent Business & Management, 7*(1), Article 1743618. https://doi.org/10.1080/23311975.2020.1743618

Philippas, N.D., & Avdoulas, C. (2020). Financial literacy and financial well-being among generation-Z university students: Evidence from Greece. *European Journal of Finance, 26*(4–5), 360–381. https://doi.org/10.1080/1351847X.2019.1701512

Potrich, A.C.G., Vieira, K.M., & Mendes-Da-Silva, W. (2016). Development of a financial literacy model for university students. *Management Research Review, 39*(3), 356–376. https://doi.org/10.1108/MRR-06-2014-0143

Rahmawati, S.A., Narmaditya, B.S., Wibowo, A., Wulandari, D., Hardinto, P., Prayitno, P.H., & Utomo, S.H. (2019). Family economic education, financial literacy and financial inclusion among university students in Indonesia. *International Journal of Scientific and Technology Research, 8*(12), 1291–1294.

Rasheed, B., Law, S-H., Chin, L., & Habibulah, M.S. (2016). The role of financial inclusion in financial development: International evidence. *Abasyn University Journal of Social Sciences, 9*(2), 330–348.

Sabri, M.F., & Aw, C-X.E. (2019). Financial literacy and related outcomes: The role of financial information sources. *International Journal of Business and Society, 20*(1), 286–298.

Sarma, M. (2012). *Index of financial inclusion – A measure of financial sector inclusiveness* (Berlin Working Papers on Money, Finance, Trade and Development, no. 07/2012). Berlin: University of Applied Sciences (HTW).

Sayinzoga, A., Bulte, E.H., & Lensink, R. (2016). Financial literacy and financial behaviour: Experimental evidence from rural Rwanda. *Economic Journal, 126*(594), 1571–1599. https://doi.org/10.1111/ecoj.12217

Tinghög, G., Ahmed, A., Barrafrem, K., Lind, T., Skagerlund, K., & Västfjäll, D. (2021). Gender differences in financial literacy: The role of stereotype threat. *Journal of Economic Behavior and Organization, 192*, 405–416. https://doi.org/10.1016/j.jebo.2021.10.015

Uddin, A., Chowdhury, M.A.F., & Islam, M.N. (2017). Determinants of financial inclusion in Bangladesh: Dynamic Gmm & quantile regression approach. *Journal of Developing Areas, 51*(2), 221–237. https://doi.org/10.1353/jda.2017.0041

Wu, S., Despard, M.R., & Chowa, G. (2017). The role of parents in introducing children to financial services: Evidence from Ghana-YouthSave. *Journal of Family and Economic Issues, 38*, 453–462. https://doi.org/10.1007/s10834-017-9519-6

Yang, G., & Liu, H. (2016). Financial development, interest rate liberalization, and macroeconomic volatility. *Emerging Markets Finance and Trade, 52*(4), 991–1001. https://doi.org/10.1080/1540496X.2015.1115294

Yong, C.C., Yew, S.Y., & Wee, C.K. (2018). Financial knowledge, attitude and behaviour of young working adults in Malaysia. *Institutions and Economies, 10*(4), 21–48.

Zhang, Y., Jia, Q., & Chen, C. (2021). Risk attitude, financial literacy and household consumption: Evidence from stock market crash in China. *Economic Modelling, 94*, 995–1006. https://doi.org/10.1016/j.econmod.2020.02.040

Zins, A., & Weill, L. (2016). The determinants of financial inclusion in Africa. *Review of Development Finance, 6*(1), 46–57. https://doi.org/10.1016/j.rdf.2016.05.001

Appendix

Table A1. List of developing countries and their financial inclusion index (FIN)

No.	Country	FIN	No.	Country	FIN
1.	Albania	0.243	38.	Kenya	0.309
2.	Algeria	0.228	39.	Kosovo	0.428
3.	Angola	0.130	40.	Kyrgyz Republic	0.102
4.	Argentina	0.350	41.	Lebanon	0.572
5.	Armenia	0.432	42.	Malaysia	0.732
6.	Bangladesh	0.255	43.	Mauritania	0.436
7.	Belize	0.386	44.	Mauritius	0.735
8.	Bhutan	0.456	45.	Mexico	0.301
9.	Bolivia	0.292	46.	Moldova	0.649
10.	Bosnia	0.454	47.	Mongolia	0.578
11.	Botswana	0.277	48.	Montenegro	0.620
12.	Brazil	0.262	49.	Myanmar	0.087
13.	Bulgaria	0.701	50.	Namibia	0.376
14.	Cambodia	0.201	51.	Nicaragua	0.160
15.	Cameroon	0.060	52.	Nigeria	0.079
16.	China	0.340	53.	Pakistan	0.149
17.	Colombia	0.445	54.	Panama	0.592
18.	Congo, Rep.	0.095	55.	Peru	0.355
19.	Costa Rica	0.475	56.	Philippines	0.215
20.	Cote d'Ivoire	0.089	57.	Romania	0.250
21.	Croatia	0.489	58.	Russian Federation	0.366
22.	Dominican Republic	0.252	59.	Serbia	0.252
23.	Ecuador	0.251	60.	South Africa	0.492
24.	Egypt, Arab Rep.	0.222	61.	Sri Lanka	0.174
25.	El Salvador	0.299	62.	Sudan	0.039
26.	Gabon	0.138	63.	Tajikistan	0.120
27.	Georgia	0.533	64.	Thailand	0.544
28.	Ghana	0.156	65.	Tunisia	0.251
29.	Guatemala	0.512	66.	Turkey	0.830
30.	Honduras	0.353	67.	Ukraine	0.736
31.	India	0.424	68.	Uzbekistan	0.367
32.	Indonesia	0.336	69.	Venezuela, RB	0.226
33.	Iran, Islamic Rep.	0.264	70.	Vietnam	0.401
34.	Iraq	0.063	71.	West Bank and Gaza	0.358
35.	Jamaica	0.302	72.	Yemen, Rep.	0.070
36.	Jordan	0.374	73.	Zambia	0.113
37.	Kazakhstan	0.143			

Table A2. Financial literacy on the number of deposit account per 1000 adults (DEP): A quantile regression

Variables	Q0.1	Q0.2	Q0.3	Q0.4	Q0.5	Q0.6	Q0.7	Q0.8	Q0.9
FL	0.231	0.114	0.201	0.408	0.298	0.336	0.048	0.072	-0.083
	(0.836)	(0.484)	(0.545)	(0.568)	(0.562)	(0.530)	(0.438)	(0.339)	(0.316)
HC	7.723*	6.409*	6.789*	6.030	3.774	3.222	3.727	2.481	-0.663
	(4.080)	(3.655)	(3.545)	(3.767)	(3.762)	(3.425)	(2.978)	(2.920)	(2.831)
FD	0.087	0.246	0.260	0.243	0.529**	0.495**	0.562**	0.450*	0.620**
	(0.596)	(0.279)	(0.241)	(0.227)	(0.227)	(0.234)	(0.227)	(0.234)	(0.277)
INT	-0.006	-0.057	-0.084	-0.222	-0.085	-0.153	-0.137	-0.131	-0.269
	(0.140)	(0.105)	(0.124)	(0.148)	(0.165)	(0.159)	(0.155)	(0.154)	(0.181)
GDPPC	0.118	0.215	0.138	0.080	0.139	0.234	0.131	-0.001	0.250
	(0.354)	(0.273)	(0.291)	(0.292)	(0.311)	(0.300)	(0.266)	(0.255)	(0.222)
Constant	-28.03**	-23.61*	-24.41*	-19.87	-11.96	-9.94	-11.71	-4.70	6.21
	(13.02)	(13.01)	(12.77)	(13.60)	(13.26)	(12.21)	(10.91)	(11.12)	(11.02)
Obs.	58	58	58	58	58	58	58	58	58

Notes: Dependent variable is number of deposit account per 1000 adults (DEP). Obs. is the number of observations.
Lower quantile (e.g., Q0.1) signifies a low number of deposit accounts per 1000 adults nations.
***, ** and * indicate significance at 1%, 5% and 10% levels, respectively.

Table A3. Financial literacy on the number of bank ATMs per 100,000 adults (ATM): A quantile regression

Variables	Q0.1	Q0.2	Q0.3	Q0.4	Q0.5	Q0.6	Q0.7	Q0.8	Q0.9
FL	-0.429	-0.339	-0.530	-0.487	-0.442	-0.281	-0.253	-0.255	0.072
	(0.530)	(0.485)	(0.475)	(0.344)	(0.265)	(0.238)	(0.227)	(0.258)	(0.434)
HC	-1.717	1.300	-1.204	-0.924	-0.678	-1.235	-1.163	-0.612	0.616
	(2.321)	(2.035)	(1.800)	(1.408)	(1.215)	(0.995)	(0.738)	(1.517)	(2.271)
FD	1.038***	0.576*	0.589**	0.617***	0.608***	0.723***	0.669***	0.639***	0.793***
	(0.285)	(0.338)	(0.289)	(0.222)	(0.180)	(0.132)	(0.147)	(0.195)	(0.268)
INT	-0.0617	0.003	0.105	0.067	0.093	0.056	0.037	0.031	-0.090
	(0.177)	(0.127)	(0.107)	(0.084)	(0.072)	(0.062)	(0.072)	(0.114)	(0.137)
GDPPC	0.685***	0.622***	0.836***	0.911***	0.964***	0.868***	0.870***	0.879***	0.395
	(0.204)	(0.218)	(0.200)	(0.158)	(0.131)	(0.118)	(0.109)	(0.209)	(0.264)
Constant	-0.168	-10.420	-1.678	-3.290	-4.675	-1.556	-1.573	-3.812	-4.572
	(8.821)	(7.582)	(6.699)	(5.415)	(4.595)	(3.871)	(2.941)	(5.538)	(8.109)
Obs.	69	69	69	69	69	69	69	69	69

Notes: Dependent variable is number of bank ATMs per 100,000 adults (ATM). Obs. is the number of observations.
Lower quantile (e.g., Q0.1) signify low number of bank ATMs per 100,000 adults nations.
***, ** and * indicate significance at 1%, 5% and 10% levels, respectively.

Table A4. Financial literacy on the number of credit account (CRE): A quantile regression

Variables	Q0.1	Q0.2	Q0.3	Q0.4	Q0.5	Q0.6	Q0.7	Q0.8	Q0.9
FL	-0.180	0.040	0.009	-0.002	0.047	0.004	0.010	-0.063	-0.177
	(0.255)	(0.223)	(0.156)	(0.098)	(0.084)	(0.067)	(0.086)	(0.114)	(0.219)
HC	0.264	1.875*	0.718	0.131	0.103	-0.005	0.154	0.517	1.121
	(1.314)	(1.015)	(0.782)	(0.545)	(0.391)	(0.287)	(0.370)	(0.500)	(1.849)
FD	0.815***	0.805***	0.843***	0.836***	0.894***	0.898***	0.875***	0.833***	0.765***
	(0.078)	(0.085)	(0.081)	(0.067)	(0.062)	(0.056)	(0.061)	(0.069)	(0.112)
INT	0.031	-0.051	-0.045	-0.020	-0.019	-0.012	-0.011	-0.017	-0.022
	(0.085)	(0.074)	(0.064)	(0.049)	(0.040)	(0.031)	(0.037)	(0.043)	(0.101)
GDPPC	0.032	-0.102	-0.009	0.025	0.007	0.030	0.037	0.028	-0.001
	(0.143)	(0.105)	(0.074)	(0.044)	(0.036)	(0.029)	(0.035)	(0.053)	(0.092)
Constant	-1.441	-6.535*	-2.464	-0.224	-0.066	0.138	-0.474	-1.815	-3.940
	(4.784)	(3.672)	(2.958)	(2.072)	(1.447)	(1.005)	(1.281)	(1.852)	(7.505)
Obs.	72	72	72	72	72	72	72	72	72

Notes: Dependent variable is the number of credit accounts (CRE). Obs. is the number of observations. The lower quantile (e.g., Q0.1) signifies a low number of credit account (CRE) nations.
***, ** and * indicate significance at 1%, 5% and 10% levels, respectively.