**ISSN** 1816-6075 (Print), 1818-0523 (Online)
**Journal of System and Management Sciences**
Vol. 13 (2023) No. 5, pp. 88-106
DOI:10.33168/JSMS.2023.0506

# Digital Financial Inclusion: Covid-19 Pandemic as a Catalyst for Adoption

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**Abstract.** In the last decade, the emergence of FinTech has played a crucial role in advancing financial inclusion in developing countries. The Covid-19 Pandemic has further accelerated the adoption of digital platforms due to the restrictions on movement. This study aims to investigate the impact of mobile banking on digital financial inclusion (DFI) during the pandemic in low and lower-middle-income countries. The sample of the study comprised 43 countries, and Principal Component Analysis and the OLS method were utilized to determine the DFI index and the factors affecting DFI. The study discovered that formal financial account ownership had an inverse relationship with DFI. Furthermore, the receipt of public and private wages and payment of utilities through digital platforms had a positive effect on DFI. However, financial literacy had a positive impact on DFI. Therefore, the development of digital payment infrastructure and the promotion of financial literacy is crucial to enhance DFI sustainably in low and lower-middle-income countries.

**Keywords:** digital financial inclusion, mobile banking, FinTech, financial literacy, Covid-19 pandemic, principal component analysis

# 1. Introduction

The magnitude of financial inclusion (FI) in the development of the financial sector and the overall economy is a key indicator for sustainable growth (Lenka, 2021). It is a path to enhance inclusiveness in economic growth by enabling the unbanked population to access the means for savings, investment, and insurance (Morgan, 2022) towards improving household income and reducing income inequality (Ibrahim & Aliero, 2020). Evidence suggests that FI can provide significant development advantages to vulnerable and underserved populations by providing digital financial services (Hollanders, 2020; Lenka, 2021; Morgan, 2022; Salampasis & Mention, 2018; Zetzsche et al., 2019; Wang & Ji, 2022). The ongoing Covid-19 outbreak has reinforced the demand for increased DFI (World Bank, 2020) that involves using cost-saving digital methods to reach currently unbanked or financially excluded populations to meet their needs responsibly and cost-effectively. The disruption in the traditional approach to accessing financial services has prompted the use of digital finance (IMF, 2022). It is also a critical building block for the digital development of the nation.

The progress of digitalisation in financial services has guided the advent of digital finance or financial technology (FinTech). FinTech is a crucial factor of FI, potentially transforming finance, economies and societies (Arner et al., 2020). To support sustainability through FI and development, digital financial transformation or FinTech is at the centre of global policy attention (Arner et al., 2020). About two billion adults are unbanked as a result, are denied opportunities to improve their lives. DFI can affordably fill this gap (GPFI, 2016). Therefore, two leading foci in transforming finance to support the UN SDGs are financial technology and FI (Arner et al., 2020).

While fighting the Pandemic with different measures (such as social distancing), the traditional way of accessing financial services was disrupted, accelerating the use of digital finance. Adopting digital finance platforms is noteworthy progress in different regions [IMF, 2022]. The value of mobile banking transactions in low-income countries has increased from 40% to 70% of the GDP. For middle-income countries, mobile and digital banking transactions have increased from 225% to 324% of GDP from 2019 to 2021 [IMF, 2022].

Consequently, the effect of the Covid-19 outbreak on DFI through digital finance is another area to explore in the financial literature. A number of studies have indicated that digital financial services can contribute to development, particularly when it comes to financial inclusion (Lenka, 2021; Morgan, 2022; Salampasis & Mention, 2018; Zetzsche et al., 2019; Hollanders, 2020). The World Bank and the International Monetary Fund (IMF) have also found that during the pandemic, DFS has become even more critical to reach vulnerable and underserved populations in a cost-effective manner. (World Bank, 2020; IMF, 2022). Some studies have also observed that some households in India and Africa have gone digital for the first time due to social distance and quarantine measures during this time (Ray et al., 2022; Mhlanga, 2022). Studies have investigated the impact of DFI in different economies with a focus on individual and household characteristics, as well as digital fraud during the Pandemic (Ahmad & Jiang, 2020; Ashenafi & Dong, 2022; Hundal & Zinakova, 2021; Mugume & Bulime, 2022).

The recent pandemic's impact on the financial sector in low- and lower-middle-income countries, where a large population is unbanked, has not been adequately addressed. Therefore, using macro-level survey data from the World Bank, IMF, and Global Finlit Survey (GFS, 2022), this study focuses on the gap by exploring different drivers of DFI during the Covid-19 outbreak in low and lower-middle-income countries. Specifically, this study uncovers the following issues:

- How did using mobile banking services during the Pandemic contribute to DFI in low and lower-middle-income countries?
- How have macroeconomic factors impacted DFI in mobile banking during the recent Pandemic?

This study helps determine the contributing factors to DFI in low and low-middle-income countries where a large population is financially excluded. It contributes to the existing field of research by examining the role that mobile money (MM) plays in public and private sector wage payments. It adds

to the literature on contextual factors like financial literacy (FL) programmes and digital utility payments that governments can employ to encourage the adoption of traditional FI and DFI.

# 2. Literature Review

## 2.1. Financial Inclusion (FI) and Digital Financial Inclusion (DFI)

An integral part of FI is making affordable and valuable financial products and services accessible to both individuals and businesses responsibly and sustainably. FI relies heavily on access to accounts, enabling account holders to conduct secure and efficient financial transactions, plan for future investments, and respond to unforeseen circumstances (Arner et al., 2020).

Nevertheless, FI in developing countries remains difficult due to the limited capacity of formal financial institutions, the associated high costs and risks, and the absence of formal documentation. Financial institutions also impose fees and charges, making entering the system more difficult. FI directly impacts economic growth, gender equality, decent work, and reduced inequity. Similarly, it indirectly impacts goals like eliminating poverty and hunger and ensuring quality education (Beck, 2020; David-West, 2015). The microfinance model has been instrumental in expanding financial services in developing countries. In developing countries where the traditional banking system has been unable to reach a large population, microfinance has played a significant role in expanding financial services. However, Muhammad Yunus' pioneering group lending model has been criticised for its dependence on donor funding, credit focus, labour intensity, and lack of profitability. Unbanked individuals do not benefit from this financial service (Beck, 2020; Cull et al., 2009).

As a result, FinTech has appeared as a major player in the financial sector, filling the gaps left by traditional banking and microfinance with flexibility and universality (Mohamed & Ali, 2022, ). Technology has made it more convenient and effortless to avail and utilize financial services. The programme aims to include disadvantaged and underserved populations in the formal financial system (Salampasis & Mention, 2018). DFI is efficient for three reasons: mobile technology makes it more accessible, reduced cost because of cloud computing, and efficient risk assessment through big data technology. In 2020, mobile banking generated 41.4 billion transactions worth USD 767 billion, representing a significant increase in global transactions. Between 2017 and 2021, mobile banking accounts increased by 12%, while financial institution accounts increased by 7%.

The critical advantages of mobile banking over traditional financial institutions, like reduced cost, viable small and few transactions, less costly agent network, and reduced geographic barriers, have made it a suitable alternative for individuals living in the informal economy (Arner, 2020) in the low-income group and developing countries. Mobile banking has become a significant part of the formal financial system in accessing formal financial services for the individuals at the pyramid's base (Lal & Sachdev, 2015). According to Global Partnership for Financial Inclusion (GPFI), FI is on the rise, with a steady growth of 515 million new accounts from 2014 to 2017 through conventional financial institutions and mobile banking services (GPFI, 2022). Though mobile banking account is growing in all regions, the penetration in West Africa is remarkable. In low-income group countries, per 1000 adults, there are twice as mobile banking accounts as traditional bank accounts (FAS IMF, 2022). Within a short period, this change in technology in finance has dramatically increased the FI of India, Russia, China and East Africa (Arner, 2020).

## 2.2. Digital Financial Inclusion (DFI) Index and Determinants

### 2.2.1 DFI Index

Several studies have examined the determinants of FI, DFI and the role of FinTech in different regions (Ashenafi & Dong, 2022; Ahmad & Jiang, 2020; Mugume & Bulime, 2022; Okello et al., 2018;

Mndolwa & Alhassan, 2020; Nathan et al., 2022). Existing literature presents a variety of methods to measure FI across economies. Amidzic et al. (2014) developed a FI index based on depositor and borrower demographics and geographic penetration. Sarma and Pais (2011) have developed a multidimensional FI index by combining availability, accessibility and usage dimension. Camara and Tuesta (2015) examined the dimension of the barrier along with usage and access dimensions.

Studies often examine bank branches, ATMs, deposits and loan accounts as determinants of FI (Ashenafi & Dong, 2022). However, the bank branches, ATMs, deposits and loan accounts are only one aspect of FI. It is the supply side or the drivers of access. It is equally significant to consider the demand side or the usage drivers (Sahay et al., 2020). According to the author, DFI has evolved from a "spend" to a "lend" to fill the gap in payment and lending spheres where formal financial institutions do not exist.

Lashitew et al. (2019) measured DFI adoption by the number of MM accounts and the percentage of adults sending and receiving money. However, Sahay et al. (2020) constructed a comprehensive FI index for developing and emerging economies. The index comprises both formal FI and DFI for 2014 and 2017. For both indexes, the authors consider the "access" and the "usage" categories. The access index for DFI includes mobile subscription per 100 people, rate of internet penetration and registered MM agent. The usage index is based on the percentage of MM accounts, internet penetration rate, and smartphone users to receive salaries, pay bills and utilities (Sahay et al., 2020).

Similarly, Nguyen (2020) utilises MM accounts as access, MM agents as availability and MM transactions as usage in developing the DFI index. In a recent study, Mugume & Bulime (2022) examined the use of different digital financial services in the last three months during the Covid-19 outbreak as a proxy to measure DFI.

### 2.2.2 Determinants of DFI:

The lack of financial access in low- and lower-middle-income nations drives mobile banking inclusion. Mobile banking has proven successful in rural areas where bank branches are not commercially viable (Munyegera & Matsumoto, 2016). It fosters the modernisation of the unbanked economy. Therefore, digital financial access is expected to be negatively influenced by standard indicators of formal financial access, like the number of bank accounts and ATMs (Demirguc Kunt et al., 2015; Lashitew et al., 2019).

Studies have observed that the Pandemic has augmented the adoption of DFI in emerging markets and G20 countries (Khera et al., 2022; Ray et al., 2022). As a result of the Pandemic, some households in India have embraced digital payments for the first time (Ray et al., 2022). Better infrastructure and increased investment in FinTech can promote the adoption of digitised financial services through payment services (Mpofu & Mhlanga, 2022). People were forced to utilise digital banking services for the first time during the Pandemic due to social distancing and quarantine measures (Mhlanga, 2022). According to the World Bank Findex survey, since the onset of the Pandemic, 6% of adults in developing nations have made digital payments for the first time (Demirgüç-Kunt et al., 2022). At the same time, government and non-government organisations have increasingly used digital platforms to advance cash to vulnerable individuals. Using digital financial platforms by government and private organisations can significantly increase the number of mobile banking accounts in low-inclusion economies (Adegoke, 2020; Gronbach, 2020; Sahay et al., 2020).

Existing literature on FI highlights the importance of FL in shaping how individuals save their money at formal and informal financial institutions (Adetunji & David, 2019; Sahay et al., 2020; Morgan & Trinh, 2020). FL denotes personal knowledge in understanding the basics of financial matters (Nathan et al., 2022). Among adult Nigerians, improvements in FL were likely to positively impact accessing formal and informal financial services like savings and borrowings (Adetunji & David, 2019). Moreover, FL has several potential benefits for the financial system. It increases the demand for bank accounts, saving propensity and better risk management. In addition, Cole et al. (2011) observed that

in FL, low-cost channels improvise access to financial services. Therefore, the present study expects a positive effect of FL on DFI in the low and lower-middle-income group countries.

Several studies have observed that macroeconomic factors, such as GDP per capita, literacy rate, and internet penetration, significantly affect FI levels in different regions (Evans & Adeoye, 2016; Sarma & Pais, 2011; Sahay et al., 2020). Hence, the following hypotheses are developed:

- Hypothesis 1: Formal institutional account relationship has a negative effect on digital FI.
- Hypothesis 2: The number of ATMs has a negative effect on digital FI.
- Hypothesis 3: Receipt of public wages through mobile banking positively affects DFI during the recent Pandemic.
- Hypothesis 4: Receipt of private wages through mobile banking positively affects DFI during the Pandemic.
- Hypothesis 5: Digital merchant payments for the very first time during the Pandemic positively affected DFI.
- Hypothesis 6: Utility payment through mobile phones for the first time positively affected DFI during the Pandemic.
- Hypothesis 7: FL rate positively affects the DFI of the country.
  Hypothesis 8: GDP growth positively affects the country's DFI.

# 3. Methodology

This research aims to explore the potential causal effect of the Covid-19 outbreak on DFI among low and lower-middle nations in a cross-sectional study framework. The methodology of the present study is consistent with different studies in the area of FI. The assumption behind the study is derived from the theory of intermediation that recognised the role of DFI as one of the drivers of the growth of FI. According to the theory of intermediation, a third party can intervene between two parties if this third party presents a better deal for the first and second parties. Intermediaries can lower the existing cost or create a market that does not exist.

## 3.1. Data and Sample

The study utilises data from the Global Findex Database 2022 by the World Bank, the database on FI. The survey is conducted among randomly selected, nationally representative samples on accessing and using financial services. The data represent the percentage of respondents who were 15 years and above. Global Findex data is traditionally collected through face-to-face interviews, in case of telephone coverage less than 80% of the population. Because of mobility restrictions during Covid-19, face-to-face interviews were not conducted in some countries in 2021. In the case of face-to-face surveys, the primary sampling units are nationally representative of the adult population and stratified by population size, geography or both. Within the selected households, eligible respondents are selected by the Kish grid method. Instead, in the case of phone-based economies, respondents were selected using random digit dialling (Demirgüç-Kunt et al., 2022). Other sources of data are the Global Finlit Survey (GFS, 2022), the World Development Indicators and the IMF Financial Access Survey.

This study focused on low- and lower-middle-income nations only. The World Bank 2022-2023 country lending group comprises 82 countries with low and lower middle incomes. Due to the unavailability of data, such as the registered number of mobile money agents and the financial literacy rate, the final study is conducted on 43 economies for 2021. The use of the Global Findex database may result in potential bias. Due to the fact that this survey is based on a nationally representative sample, it may not reflect the same results in sub-national or specific populations. In addition, respondents may provide biased information.

## 3.2. Variables

The present study has adopted different variables from the literature on DFI or mobile banking. The present empirical study uses FinTech-driven FI or DFI as the dependent variable. Following the existing empirical evidence, the Digital Financial Index is used as a proxy measure of DFI (Mugume & Bulime, 2022; Nguyen, 2020). The Digital Financial Index represents the access and use of mobile banking transactions in the previous year (2021). Specifically, the Digital Financial Index accounts for the access and usage indicators following Sahay et al. (2020). The access variables are mobile subscription rate, access to internet rate and the number of mobile agents. Instead, usage indicators are the number of mobile banking accounts, borrowing in mobile banking a/c, and the natural logarithm (LN) of the number of MM transactions. Table 1 presents the variables used to compute the index used in the present study.

Table 1: Summary of Variables

| DFI Index Components | Description | Source |
|---|---|---|
| **Access** | | |
| Mobile subscription rate | Mobile subscription per 100 people | WB |
| Internet penetration rate | % Of the population having internet access | WB |
| MM agent | Number of registered MM agents per 100,000 adults | WB |
| **Usage** | | |
| Mobile banking A/C | % Of adults who have a mobile account | ITU |
| Borrowing in mobile banking A/C | % Of adult borrowing in mobile banking A/C | ITU |
| Number of MM transactions | Number of transactions made during the year | IMF |
| **Independent Variables** | | |
| Account ownership at Financial Institutions (FINA/C) | % Of adults having an account in a financial institution | WB |
| Number of ATM (ATMs) | Number of ATMs per 100,000 people | IMF |
| Receipt of Public sector wage (PublicWage) | % Of adults received public sector wages through a mobile phone | WB |
| Receipt of Private sector wage (PrivateWage) | % Of adults received private sector wages through a mobile phone | WB |
| Digital merchant payment (DigMPayment) | % Of adults made digital merchant payments first time since Covid-19 | WB |
| Digital utility payment (DigUPayment) | % Of adults made utility payments first time since Covid-19 | WB |
| FL rate (Finliteracy) | % Of adults able to understand and use financial skills | GFS |
| GDP growth (GGDP) | Annual growth of GDP | WB |

Source: Sahay et al. (2020) and authors of the present study.
GFS: Global Finlit Survey, 2022; IMF: IMF Financial Access Survey, ITU: International Telecommunication Union, WB: Global Findex database, World Bank

The independent variable includes financial account ownership, number of ATMs, receipt of public sector wages, private sector wages and government payment through mobile banking and digital merchant payment during the Covid-19 outbreak, FL rate and GDP growth rate. For the econometric analysis, these explanatory variables are adopted based on existing literature on FI (Lashitew et al., 2019; Mugume & Bulime, 2022; Nguyen, 2020; Sahay et al., 2020). To observe the effect of the Pandemic, the indicators pertaining to the use of mobile banking, namely receipts of public and private

sector wages and digital merchant payments and utility payments for the first time since Covid-19 through mobile phones, are included.

The socioeconomic factors described by FL and GDP growth are obtained from the Global Finlit Survey (GFS, 2022), World Development Indicators, and IMF Financial Access Survey.

### 3.3. Model

Based on the existing studies, the present study formulates a DFI index for different countries through principal component analysis (PCA) (Sahay et al., 2020; Mugume & Bulime, 2022; Camara & Tuesta, 2015). It constructed the DFI index for each country based on a combination of DFI parameters: mobile banking account, borrowings in mobile banking, use of mobile banking to send money, total MM transactions, mobile subscription rate, internet penetration rate and registered MM agent.

Following Sahay et al. (2020) a two-stage PCA is used to construct the DFI index. In the first stage, the sub-indices for "access" and "usage" for DFI are constructed based on the parameters in Table (1). In the second stage, PCA combines these sub-indices for the overall DFI index. w is the weight assigned to each sub-component and i refers to the country studied. As the sub-indices possess highly interrelated parameters, instead of estimating the overall index in one stage, the sub-indices are initially estimated. Since, in the case of highly correlated indicators, PCA is biased towards the weight of indicators, this is a preferred strategy to minimise the problem (Sahay et al., 2020). The following expression enumerates the DFI index:

$$DFI_i = w_1 F^a{}_i + w_2 F^u{}_{i+} \varepsilon_i \quad (1)$$

Here, DFIi = Digital Financial Index for country i. w is the weight of each sub-indices, $F^a$ and $F^u$ (Sub-indices for access and usage) and $\varepsilon_i$ is the variation due to error. Later, to study the effect of the recent Pandemic on DFI in low and lower-middle-income group countries, the following econometric model is examined:

$$Y_i = \alpha_0 + \alpha_1\ FinA/C_i + \alpha_2\ ATM_i + \alpha_3\ PublicWage_i + \alpha_4\ PrivateWage_i + \alpha_5\ DigMPayment_i + \alpha_6\ DigUPayment_i + \alpha_7\ FinLiteracy_i + \alpha_8\ GGDP_i + \beta_i \quad (2)$$

Here, $Y_i$ = Digital Financial Index for country i. $\alpha_0$ and $\alpha_1$, $\alpha_2$, $\alpha_3$, $\alpha_4$, $\alpha_5$, $\alpha_6$, $\alpha_7$, $\alpha_8$ are the intercept and coefficients of the variables. $\beta_i$ is the variation due to error. The variable ATM is converted to the natural logarithm (LN) and other variables are in a percentage ranging from 0 to 1. The variables PublicWage, PrivateWage, DigMpayment and DigUpayment representing the data during the Pandemic are added to observe the effect on DFI in the studied countries. This study adopts the pooled ordinary least squares (OLS) technique. It estimates the econometric model (2) following Churchill & Marisetty (2020), Eze & Markjackson, (2020), Mugume, & Bulime (2022) and Sahay et al. (2020). However, to control for the possibility of varying variances of error term heteroscedasticity (Mugume & Bulime, 2022), the present study also exploits the Weighted Least squares (WLS) method. Other diagnostic tests, i.e., the correlation tests were conducted for multicollinearity.

### 3.4. Descriptive Analysis

Table 2 presents the summary statistics of the study. The study shows that the maximum percentage of mobile banking and formal institutional accounts is 30% and 86%, respectively. The mean formal bank account among the observed economies is 26%, far lower than the mean rate for lower-middle-income 58.5% (Demirgüç-Kunt et al., 2022). Similarly, the mean mobile banking account penetration rate is 11%, which is lower than the world average (27% for low-income countries) (Demirgüç-Kunt et al., 2022). Though the mean mobile subscription rate is 103 per 100 adults, the minimum subscription rate is only 12.7%. Though the maximum internet penetration rate is 91%, the mean rate is 46.7% for the country studied. Like other development indicators, the mean FL rate in the sample countries is very low (25.83%).

Table 2: Descriptive Statistics

| Variables | Observation | Mean | Std. Deviation | Maximum | Minimum |
|---|---|---|---|---|---|
| Mobile banking A/C | 43 | 0.112 | 0.11756 | 0.3 | 0.01 |
| Borrowing by MM | 43 | 0.023 | 0.03508 | 0.18 | 0.00 |
| Use of mobile phone to send money | 43 | 0.212 | 0.16545 | 0.69 | 0.02 |
| MM transaction | 43 | 1126353672 | 1392309272 | 4290780097 | 699080 |
| Mobile subscription | 43 | 103.33 | 33.70115 | 175.34 | 12.7 |
| Internet penetration | 43 | 0.467 | 0.22 | 0.91 | 0.05 |
| Registered mobile agents | 43 | 257642.58 | 754512.85 | 5000000 | 3419 |
| Fin account ownership | 43 | 0.2602 | 0.20057 | 0.86 | 0.05 |
| LN_ATM | 43 | 7.5 | 1.78575 | 12 | 3 |
| Receipt of public sector wages | 43 | 0.1985 | 0.1844 | 0.68 | 0.00 |
| Receipt of private sector wages | 43 | 0.0305 | 0.04116 | 0.23 | 0.00 |
| Digital merchant payment | 43 | 0.0318 | 0.05027 | 0.22 | 0.00 |
| Digital utility payment | 43 | 0.0635 | 0.04973 | 0.23 | 0.00 |
| Financial literacy | 43 | .25837 | .1260426 | 0.52 | 0.12 |
| GDP growth | 43 | 0.041137 | 0.0574839 | .1253 | -0.2074 |

### 3.5. Correlation Matrix

To test the causal relationships between the variables and control multicollinearity in the regression analysis, the Pearson correlation test was conducted at a 5% significant level. Appendix C presents the correlation coefficient of the linear association of the parameters used in the study. The result shows that the coefficients are less than 0.8, representing the absence of multicollinearity between variables (Studemund, 2001).

## 4. Empirical Result

### 4.1 Estimation of the DFI Index

In the PCA method, sub-indices' eigenvalues are estimated for the latent variable "access" and "usage". Eigenvalue greater than 1 is considered for the analysis (Kaiser, 1960). The first stage result for the PCA is presented in Table 3. The eigenvalues for the PCA are 1.51, 1.00 (access) and 3.18, 1.42 (usage). Appendix B presents the weights assigned to each component for access and usage dimension.

Table 3: Principal component analysis for sub-indices

| Components | Eigenvalues | Proportion | Cumulative |
|---|---|---|---|
| Access | | | |
| Comp 1 | 1.513 | 0.66 | 0.66 |
| Comp 2 | 1.001 | 0.34 | 1.00 |
| Usage | | | |
| Comp 1 | 3.18 | 0.64 | 0.64 |
| Comp 2 | 1.42 | 0.36 | 1.00 |

After assigning the extracted weights the sub-indices for access and uses of DFI are computed. In the 2nd stage of PCA, the weights for the DFI index are calculated by adapting the same method on access and usage sub-indices.

Table 4 presents the results for PCs for DFI for the study. The eigenvalues of the two components are 1.16 and 0.236. Since the first component's eigenvalue is >1, it is considered to find the weights assigned to the PCs. The first component that explains 75.7% of the variance is contributed by both sub-indices (i.e., access and usage) is the latent variable, DFI, in the present study. The KMO test result (Table 5) presents the suitability of the factors.

Table 4: Principal component analysis for DFI

| Component | Eigenvalue | Proportion | Cumulative |
|---|---|---|---|
| Comp 1 | 1.16 | 0.757 | 0.757 |
| Comp 2 | 0.236 | 0.243 | 1.000 |

Table 5: Overall KMO test result for both stage of PCA

| Stage | Variable | KMO result |
|---|---|---|
| 1st stage | Access | 0.609 |
| | Usage | 0.618 |
| 2nd stage | DFI | 0.645 |

## 4.2 OLS Result:

After estimating the DFI index to observe the effect of the Pandemic on DFI in low and lower-middle-income group nations, the econometric model, equation (2), was examined. Table 7 presents the OLS and WLS result of the study. The OLS estimates are compared with WLS estimation with standard error to account for heteroscedasticity and the varying variance of the error term (Mugume & Bulime, 2022; Stock & Watson, 2003). WLS provides an efficient method of estimation in case of small data sets. Moreover, in case of varying variance, WLS with weights yields the most precise parameter estimates possible (Stock & Watson, 2003). Therefore, WLS is consistent with OLS estimation.

The result shows that possession of financial institution accounts and the number of ATMs is negatively associated with the DFI index. However, both OLS and WLS estimations found a statistically significant association between the number of financial institution accounts and the digital financial index, which supports H1. Specifically, a 1% increase in financial institutional accounts will decrease the adaptation of DFI by 7% (OLS estimation). However, since the "number of ATMs" is not statistically significant in any of the estimations, hypothesis 2 about another indicator of institutional FI is not supported. In OLS estimation, both public sector and private sector wages are significantly and positively associated with DFI, supporting hypothesis 3 and hypothesis 4 of the present study. Though in WLS, only public sector wages are statistically and positively associated with DFI at a 1% significance level. The results reveal that MM's 1% increase in public sector wages will increase DFI by 11%.

Table 7: Determinants of DFI during the Covid-19 Pandemic

| Dependent Variable | DFI Index | | | |
|---|---|---|---|---|
| | OLS | P value | WLS | P value |
| Constant | 0.030 | | 0.062 | 0.40 |
| | (0.016) | | (0.012) | |
| Fin Ins A/C | -0.070* | 0.01 | -0.060* | 0.000 |
| | (0.025) | | (0.016) | |
| LN_ATM | -0.002 | 0.07 | -0.006 | 0..428 |
| | (0.002) | | (0.001) | |
| Public sector wages | 0.121 * | 0.001 | 0.111* | 0.007 |
| | (0.027) | | (0.019) | |
| Private sector wages | 0.231** | 0.05 | 0.224 | 0.325 |
| | (0.176) | | (0.135) | |
| Digital merchant payment | 0.098 | 0.06 | 0.171 | 0..397 |
| | (0.115) | | (0.084) | |
| Digital utility payment | 0.035* | 0.01 | 0.052* | 0.000 |
| | (0.047) | | (0.046) | |
| Financial Literacy | 0.001** | 0.05 | 0.001** | 0.015 |
| | (0.001) | | (0.001) | |
| GDP growth | 0.002 | 0.06 | 0.001 | 0.159 |
| | (0.001) | | (0.001) | |
| $R^2$ | 0.861 | | 0.782 | |
| N | 46 | | 46 | |
| F | 23.32 | 0.000 | 16.16 | 0.000 |

Note: Standard errors are presented in the parenthesis

In both estimations, digital merchant payment has no statistically significant association with digital merchant payment during the Covid-19 outbreak. Therefore, hypothesis 5 of the study is not supported. Conversely, the study results show that digital utility payments during the Pandemic increased DFI, which is statistically significant at the 1% level. Hence, the result supports hypothesis 6.

Moreover, the result suggests that the economy's FL rate has a pronounced positive effect on DFI. Both models show statistical significance at the 5% level, thereby supporting hypothesis 7. However, another macroeconomic indicator, GDP growth, was not significantly associated with DFI in any estimation.

## 5. Discussion

Since financial institutional accounts indicate the number of people with formal institutions or banks, studies among African economies show that digital banking is widely spread where formal accounts are low or difficult to access for the masses. The present study also finds an inverse association between digital finance adoption and formal banking account. This study's results are commensurate with the existing evidence (Demirguc Kunt et al., 2015, Lashitew et al., 2019) of the negative association between formal financial institutions and the diffusion of DFI. Therefore, digital platforms can enhance FI and widen the benefits through savings and secured payment systems in low- and lower-middle-income nations where formal institutional account ownership is very low. The digitalised approach can provide advances in FI across low and lower-middle-income nations. The limited ability of formal financial institutions due to cost and associated risk to include the lower income group population of

the economy can be surpassed by the adoption of DFI.

To measure the effects of the Pandemic on DFI, this study observed the receipt of public and private wages in the mobile banking account and merchant and utility payments for the first time during this period. Both OLS and WLS estimations show that receipt of public wages at mobile banking accounts statistically significantly influences DFI during the Pandemic. Moreover, the receipt of private sector wages is statistically significant in the OLS estimation, proving a positive influence on adopting digital financial services. The result supports the evidence of Adegoke (2020), Gronbach (2020) and Sahay et al. (2020) for slower economies.

In the case of merchant and utility payment first time during Covid-19, only payment of utilities shows a significant positive influence on DFI. This reveals that government restrictions on movement and fear of contamination have amplified FI

Because of movement restrictions and fear of contamination, people have chosen the alternative safer way to perform financial transactions. This result is consistent with the findings by Mugume & Bulime (2022), Mburu (2020) and Lukama (2020) in African economies. The insignificant result for merchandise payment may be due to the absence of proper infrastructure to make payments in the countries studied. Therefore, the development of digital payment infrastructure, an increase in internet penetration and mobile subscription will enhance the adult population to utilise the digital platform.

Though existing studies observed access to finance to be closely linked with economic growth (Lashitew et al., 2019; Inoue & Hamori, 2016), the present study does not find any statistically significant relationship between the growth of GDP and DFI. This result aligns with the result of Ashenafi and Dong (2022), where GDP growth is found to have no statistical relation with FI. Moreover, this study observes a significant positive influence of FL on DFI that supports the findings of Jünger and Mietzner (2020), Adetunji and David (2019), Bruhn et al. (2016) and Cole et al. (2011).

As a result of the above findings, this study poses a number of policy implications that could be incorporated into DFI for these economic groups. The positive association of Public and private wages in mobile banking suggests that employers and governments can collaborate to promote the adoption of digital wage payments. This will encourage workers to use digital financial services which can be achieved through incentives, education campaigns, and regulatory measures

Since educating at a young age offers various benefits along with financial behaviour (Bruhn et al., 2016), FL should be introduced at the school level. School-based interactive education programmes relating to spending, savings and budgeting can benefit children in developing basic financial capabilities. For adults, following Morocco, national tv channels can show entertainment-based programmes on financial awareness, literacy and skills (World Bank Group, 2016).

Along with FL, digital literacy is another important dimension to be adapted. Therefore, considering the cybersecurity risk and consumer protection, the government in low and lower-middle-income nations should promote financial and digital literacy to ensure greater inclusion. UN principle for responsible digital payments also emphasises building trust and mitigating risk in digital payments towards sustainable inclusion.

## 6. Conclusion

The evolution of digital technologies in financial services has led to the emergence of digital finance, which is a key driver for FI with the potential to transform finance, economies and societies. Mobile banking has created a new global financial horizon, transforming millions of lives from informal or unbanked to digital economies in developing and low-income nations. The Covid-19 outbreak has amplified the diffusion of digital financing in countries with low formal financial inclusion. Employing macro-level cross-sectional data, this study investigates different factors of DFI during the Pandemic. The result presents that the adaptation of DFI is driven by the number of financial institution accounts, receipt of public wages and utility payments during the Pandemic period and the FL rate of the economy.

The rate of formal financial institution accounts is observed to affect the adoption of DFI inversely. Moreover, receipt of public wages and payment of utilities by mobile banking for the first time during the pandemic has a positive effect on the DFI in low-income countries. In addition, FL positively influences the adoption of DFI among the countries studied.

The study contributes by filling the gap by analysing the effect of the Pandemic on DFI. Moreover, this study focuses on the low and lower-middle-income group countries, where DFI is an ideal substitute for traditional FI. It contributes to the existing field of research by studying the role that MM plays in public and private sector wage payments. This study also emphasises the importance of developing policies related to FL programmes and digital utility payments to facilitate the adoption of both traditional and DFI. The study results are robust for employing alternative estimations.

The present study has some limitations. Firstly, due to the unavailability of data, the study did not cover all lower-middle-income countries. All of the components of digital finance, like insurance and remittance, could not be included, resulting in underestimating the real picture of DFI. Furthermore, the study's data captures only some aspects of the financial services industry.

Trust is an inevitable issue in digital platforms. Future research can be done on the effect of FinTech on DFI by SMEs in developing countries. Moreover, research can shed light on how FinTech can contribute to closing the gender gap. It may be possible to conduct future research on the strategic move applied by the FinTech players to gain the trust of the end-users in the African economies where mobile banking has gained popularity over traditional banking relationships. Furthermore, women often are excluded from financial services in low-income countries, so future research can explore how MM services can promote gender equality and cater to women's needs.

## Appendix A: Sample country list

| Sl. | Country | Income Group |
|---|---|---|
| 1 | Algeria | Lower middle income |
| 2 | Bangladesh | Lower middle income |
| 3 | Benin | Lower middle income |
| 4 | Bolivia | Lower middle income |
| 5 | Burkina Faso | Low income |
| 6 | Cambodia | Lower middle income |
| 7 | Cameroon | Lower middle income |
| 8 | Congo, Rep. | Lower middle income |
| 9 | Cote d'Ivoire | Lower middle income |
| 10 | Egypt, Arab Rep. | Lower middle income |
| 11 | El Salvador | Lower middle income |
| 12 | Ghana | Lower middle income |
| 13 | Guinea | Low income |
| 14 | Honduras | Lower middle income |
| 15 | Indonesia | Lower middle income |
| 16 | Iran, Islamic Rep. | Lower middle income |
| 17 | Kenya | Lower middle income |
| 18 | Kyrgyz Republic | Lower middle income |
| 19 | Lao PDR | Lower middle income |
| 20 | Liberia | Low income |
| 21 | Malawi | Low income |
| 22 | Mali | Low income |
| 23 | Mongolia | Lower middle income |
| 24 | Morocco | Lower middle income |
| 25 | Mozambique | Low income |
| 26 | Myanmar | Lower middle income |
| 27 | Nepal | Lower middle income |
| 28 | Nicaragua | Lower middle income |
| 29 | Nigeria | Lower middle income |
| 30 | Pakistan | Lower middle income |
| 31 | Philippines | Lower middle income |
| 32 | Senegal | Lower middle income |
| 33 | Sierra Leone | Low income |
| 34 | South Sudan | Low income |
| 35 | Sri Lanka | Lower middle income |
| 36 | Tajikistan | Lower middle income |
| 37 | Tanzania | Lower middle income |
| 38 | Togo | Low income |
| 39 | Tunisia | Lower middle income |
| 40 | Uganda | Low income |
| 41 | West Bank and Gaza | Lower middle income |
| 42 | Zambia | Lower middle income |
| 43 | Zimbabwe | Lower middle income |

Appendix B: Principal component loading and cumulative variance explained by Principal components

| | **Comp 1** | **Unexplained** |
|---|---|---|
| **Access** | | |
| Mobile Subscription rate | 0.660 | 0.34 |
| Internet penetration rate | 0.757 | 0.243 |
| MM agent | 0.595 | 0.405 |
| **Usage** | | |
| Mobile banking account | 0.787 | 0.213 |
| Borrowing by mobile account | 0.875 | 0.125 |
| Use of mobile to send money | 0.898 | 0.102 |
| MM transactions | 0.671 | 0.329 |

Appendix C: Correlation Matrix among the variables

| | Fin Ins A/C | ATM | Mobile banking A/C | Borrowing by mobile banking | mobile phone to send money | Private sector wages | Public sector wages | Digital merchant payment | Utility payment | Bills payment | Mobile subscription | Internet Penetration | Mobile Agents | Financial Literacy | GDP growth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fin Ins A/C | 1.00 | | | | | | | | | | | | | | |
| ATM | .46** | 1.000 | | | | | | | | | | | | | |
| MM A/C | -.66** | -0.27 | 1.00 | | | | | | | | | | | | |
| Borrowing by mobile banking | -.42** | -0.14 | .71** | 1.00 | | | | | | | | | | | |
| Mobile phone to send money | -0.20 | -0.12 | .64** | .72** | 1.000 | | | | | | | | | | |
| Private sector wages | -0.208 | -0.11 | .36* | .52** | .797** | 1.000 | | | | | | | | | |
| Public sector wages | .31* | 0.19 | -0.08 | 0.18 | .487** | .65** | 1.00 | | | | | | | | |
| Digital merchant payment | -.38** | -0.11 | .55** | .47** | .642** | .70** | 0.22 | 1.00 | | | | | | | |
| Utility payment | 0.17 | 0.05 | 0.24 | .514** | .69** | .62** | .52** | .44** | 1.00 | | | | | | |
| Bills payment | .49** | 0.07 | -0.27 | -0.125 | 0.02 | 0.12 | .36* | 0.04 | 0.28 | 1.00 | | | | | |
| Mobile subscription | .40** | 0.07 | -0.13 | -0.035 | 0.19 | 0.11 | .29* | -0.06 | 0.26 | 0.28 | 1.00 | | | | |
| Internet Penetration | .59** | 0.01 | -.46** | -0.233 | 0.03 | 0.12 | .45** | -0.24 | 0.23 | .40** | .59** | 1.00 | | | |
| Mobile Agents | 0.012 | .32* | -0.31 | 0.093 | -0.07 | -0.04 | 0.1 | -0.03 | -0.02 | 0.07 | 0.13 | -0.04 | 1.00 | | |
| Financial Literacy | 0.043 | 0.014 | 0.19 | .316* | .38** | .36* | .30* | 0.22 | .34* | 0.12 | .45** | 0.29 | 0.10 | 1.00 | |
| GDP growth | 0.12 | 0.11 | 0.05 | 0.03 | 0.01 | -0.06 | -0.09 | 0.06 | 0.11 | 0.22 | 0.14 | 0.05 | 0.04 | -0.18 | 1.00 |

## References

Adegoke, Y. (2020). Digital platforms have been a boon for social assistance in African countries during the pandemic. *Quartz Africa* 9.

Adetunji, O. M., & David-West, O. (2019). The relative impact of income and financial literacy on financial inclusion in Nigeria. *Journal of International Development*, Vol. 31, No. 4, 312-335.

Ahmad, A. H., Green, C., & Jiang, F. (2020). Mobile banking, financial inclusion and development: A review with reference to African experience. *Journal of Economic Surveys* Vol. 34, No. 4, 753-792.

Alghamdi, A. (2021). Impact of the COVID-19 pandemic on the social and educational aspects of Saudi university students' lives. *PLoS One*, Vol. 16, No. 4), e0250026.

Alliance for Financial Inclusion [AFI]. (2022), National Financial Inclusion Strategies: Current State of Practice. Available at https://www.afi-global.org/publications/national-financial-inclusion-strategies-current-state-of-practice-2022/ (accessed on 5 January, 2023).

Amidžic, G., Massara, M. A., & Mialou, A. (2014), *Assessing countries' financial inclusion standing-A new composite index*. International Monetary Fund.

Arner, D. W., Buckley, R. P., Zetzsche, D. A., & Veidt, R. (2020), Sustainability, FinTech and financial inclusion. *European Business Organization Law Review*, Vol. 21, No. 1, 7-35.

Ashenafi, B. B., & Dong, Y. (2022). Financial Inclusion, Fintech, and Income Inequality in Africa. *FinTech* Vol. 1, No. 4, 376-387.

Beck, T. (2020). Fintech and financial inclusion: Opportunities and pitfalls (No. 1165). ADBI Working Paper Series.

Bruhn, M., de Souza Leão, L., Legovini, A., Marchetti, R., & Zia, B. (2016), The impact of high school financial education: Evidence from a large-scale evaluation in Brazil. *American Economic Journal: Applied Economics*, Vol. *8*, No. 4, 256-295.

Camara, N. and Tuesta, D. (2015), "Factors that matter for financial inclusion: evidence from Peru", *Aestimatio*, Vol.10, 10-31.

Churchill, S., & Marisetty, V. (2020), Financial inclusion and poverty: A tale of forty-five thousand households. *Applied Economics*, Vol. 52, No. 16, 1777–1788

Cole, S., Sampson, T., & Zia, B. (2011). Prices or knowledge? What drives demand for financial services in emerging markets? *The Journal of Finance*, Vol. 66, No. 6, 1933-1967.

Coulibaly, S. (2022), An analysis of the factors affecting the financial inclusion in Côte d'Ivoire. *International Journal of Finance & Banking Studies (2147-4486)*, Vol. *11*, No.1, 69-84.

Cull, R., Demirgüç-Kunt, A., & Morduch, J. (2009), Microfinance meets the market. *Journal of Economic perspectives*, Vol. *23, No.* 1, 167-92.

David-West, Olayinka. (2015). The path to digital financial inclusion in Nigeria: Experiences of Firstmonie. *Journal of Payments Strategy & Systems* Vol. 9, 256–73.

Demirgüç-Kunt, Asli, Leora Klapper, Dorothe Singer, and Saniya Ansar (2022), "Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19". Washington, DC.

Eze, G., & Markjackson, D. (2020), Determinants of financial inclusion in Nigeria. *Journal of Economics and Finance*, Vol. 11, No. 1, 14–22.

Financial Access Survey, IMF [ FAS, IMF] (2022), Available at https://data.imf.org/?sk= E5DCAB7E - A5CA-4892-A6EA- 598B5463A34C (accessed on 10 December 2022).

Global Finlit Survey [GFS] (2020), Financial Literacy around the world. Available at https://gflec.org/initiatives/sp-global-finlit-survey/

Global Partnership for Financial Inclusion (GPFI). (2016), G20 High-Level Principles for Digital Financial Inclusion. available at: https://www.gpfi.org/publications/g20-high-level-principles-digital-financial-inclusion (accessed on 5 December 2022).

Global Partnership for Financial Inclusion (GPFI). (2022), Available at: https://www.gpfi.org/data (accessed on 5 December 2022).

Gronbach, L. (2020), South Africa's social protection response to the COVID-19 pandemic. Internal policy centre for inclusive growth. University of Cape Town.

Hollanders, M. (2020). FinTech and financial inclusion: Opportunities and challenges. *Journal of payments strategy & systems*, Vol. *14*, No. 4, 315-325.

Hundal, S., & Zinakova, T. (2021), Financial Technology in the Finnish Banking sector and its impact on stakeholders in the wake of Covid-19. *Risk Governance & Control: Financial Markets & Institutions*, Vol. 11, No. 1, 8-19.

Ibrahim, S. S., & Aliero, H. M. (2020), Testing the impact of financial inclusion on income convergence: Empirical evidence from Nigeria. *African Development Review*, Vol. 32, No. 1, 42–54.

IMF, Financial Access Survey Results [IMF] (2022), Available at: https://www.imf.org/en /News/ Articles / 2022/10/04/pr22332-imf-releases-the-2022-financial-access-survey-results (accessed on 9 December, 2022).

Inoue, T., & Hamori, S. (2016), Financial access and economic growth: Evidence from Sub-Saharan Africa. *Emerging Markets Finance and Trade, Vol. 52, No.*3, 743-753.

Jünger, M., & Mietzner, M. (2020), Banking goes digital: The adoption of FinTech services by German households. *Finance Research Letters*, Vol. 34, 101260.

Kaiser, H.F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement, Vol.* 20, 141-151.

Khera, P., Ng, S., Ogawa, S., & Sahay, R. (2022). Measuring digital financial inclusion in emerging market and developing economies: A new index. *Asian Economic Policy Review*, Vol. 17, No. 2, 213-230.

Lal, R., & Sachdev, I. (2015), Mobile banking services: *Design and development for financial inclusion*. Boston, MA: Harvard Business School.

Lashitew, A. A., van Tulder, R., & Liasse, Y. (2019), Mobile phones for financial inclusion: What explain the diffusion of mobile banking innovations? *Research Policy*, Vol. 48, No. 5, 1201-1215.

Lenka, S. K. (2021), Relationship between financial inclusion and financial development in India: Is there any link? *Journal of Public Affairs*, e2722.

Lukama, T. (2020), New voices in Africa—Covid-19 as a catalyst for digital transformation. Available at https://www.institutmontaigne.org/en/analysis/new-voices-africa-covid-19-catalyst-digital-transformation (accessed on 15 December 2022)

Mburu, J. (2020), How COVID-19 has affected digital payments to merchants in Kenya. Financial Sector Deepening Kenya. Available at https://www.fsdkenya.org/blogs-publications/blog/how-covid-19-has-affected-digital-payments-to-merchants-in-kenya/ (accessed on 12 December 2022)

Mhlanga, D. (2022), COVID-19 and digital financial inclusion: Policies and innovation that can accelerate financial inclusion in a post-COVID world through fintech. *African Journal of Development Studies*, 79-100.

Mndolwa, F. D., & Alhassan, A. L. (2020), Gender disparities in financial inclusion: Insights from Tanzania. *African Development Review*, Vol. 32, No. 4, 578-590.

Mohamed, H., & Ali, H. (2022), Blockchain, Fintech, and Islamic finance: Building the future in the new Islamic digital economy. Walter de Gruyter GmbH & Co KG.

Morgan, P. J. (2022), Fintech and financial inclusion in Southeast Asia and India. *Asian Economic Policy Review*, Vol. 17, No. 2, 183-208.

Morgan, P. J., & Trinh, L. Q. (2020), Fintech and financial literacy in Viet Nam 1154. ADBI Working Paper Series.

Mugume, R., & Bulime, E. W. (2022), Post-COVID-19 recovery for African economies: Lessons for digital financial inclusion from Kenya and Uganda. *African Development Review*, Vol. 34, S161-S176.

Mpofu, F. Y., & Mhlanga, D. (2022), Digital Financial Inclusion, Digital Financial Services Tax and Financial Inclusion in the Fourth Industrial Revolution Era in Africa. *Economies*, Vol. 1, No. 8, 184.

Munyegera, G. K., & Matsumoto, T. (2016), Mobile money, remittances, and household welfare: Panel evidence from rural Uganda. *World Development*, Vol. *7*, 127-137.

Nathan, R. J., Setiawan, B., & Quynh, M. N. (2022), Fintech and financial health in Vietnam during the COVID-19 pandemic: In-depth descriptive analysis. *Journal of Risk and Financial Management*, Vol. 15, No. 3, 125.

Ndanshau, M.O.A, & Njau, F.E. (2021), Empirical Investigation into Demand-Side Determinants of Financial Inclusion in Tanzania. *African Journal of Economic Review*, Vol. 9, No. 1, 172-190. https://doi.org/10.22004/ag.econ.308771

Nguyen, T. T. H. 2020. Measuring financial inclusion: a composite FI index for the developing countries. *Journal of Economics and Development*, Vol. 23, No. 1, 77-99.

Okello Candiya Bongomin, G., Ntayi, J. M., Munene, J. C., & Malinga, C. A. (2018), Mobile banking and financial inclusion in sub-Saharan Africa: the moderating role of social networks. *Journal of African Business*, Vol. 19, No. 3, 361-384.

Stock, J. H., & Watson, M. W. (2003), *Introduction to econometrics*. Boston: Addison Wesley.

Omar, M.A., & Inaba, K. (2020), Does financial inclusion reduce poverty and income inequality in developing countries? A panel data analysis. *Journal of Economic Structure,* Vol. 9, No. 1, 37.

Raithatha, R. 2022. Findex (2021), data: Why mobile banking is now a mainstream financial service. Mobile for Development. Available at : https://www.gsma.com/mobilefordevelopment/blog/findex-2021-data-why-mobile-money-is-now-a-mainstream-financial-service/ (accessed on December 5, 2022).

Ray, S., Morgan, P. J., & Thakur, V. (2022), Digital Financial Inclusion and Literacy from a G20 Perspective. Available at: https://www.adb.org/sites/default/files/publication/843526/adbi-digital-financial-inclusion-and-literacy-g20-perspective.pdf (accessed on 9 December 2022)

Sahay, M. R., von Allmen, M. U. E., Lahreche, M. A., Khera, P., Ogawa, M. S., Bazarbash, M., & Beaton, M. K. (2020), The promise of fintech: Financial inclusion in the post COVID-19 era. International Monetary Fund.

Salampasis, D., & Mention, A. L. (2018), FinTech: Harnessing innovation for financial inclusion. In *Handbook of Blockchain, Digital Finance, and Inclusion,* Vol.2, 451-461

Sarma M, Pais J (2011), Financial inclusion and development. *Journal of International Development* Vol. 23, No. 5, 613–628

Schueffel, P. (2016), Taming the beast: A scientific definition of fintech. Journal of Innovation Management, Vol. 4, No. 4, 32-54.

Songwe, V. (2020). The role of digitalization in the Decade of Action for Africa. *Retrieved from tralac. org: https://www. tralac. org/news/article/14900-the-role-of-digitalization-in-the-decade-of-action-for-africa. html*.

Studemund, A. H. (2001), Using econometrics: A practical guide. Addison Wesley Inc.

Sun, T. (2018), Balancing innovation and risks in digital financial inclusion—experiences of ant financial services group. In Handbook of Blockchain, Digital Finance, and Inclusion, Volume 2. Academic Press. pp. 37-43.

Thorsten 2020: Fintech and financial inclusion: Opportunities and pitfalls, 1165, ADBI Working Paper Series. Asian Development Bank Institute (ADBI), Tokyo.

World Bank 2020. Financial Inclusion, Financial inclusion is a key enabler to reducing poverty and boosting prosperity. Available at: https://www.worldbank.org/en/topic/ financial inclusion /overview (accessed on 10 December, 2022).

World Bank Group. 2016. Morocco Financial Inclusion and Capability Survey. Available at https://www.worldbank.org/en/topic/financialinclusion/publication/2014-morocco-financial-inclusion-and-capability-survey (World Bank. Accessed on January 22, 2023).

Zetzsche, D. A., Buckley, R. P., & Arner, D. W. (2019). FinTech for financial inclusion: driving sustainable growth. *Sustainable Development Goals: Harnessing Business to Achieve the SDGs through Finance, Technology, and Law Reform*, 177-203.

Zhang, L. L., & Kim, H. (2020). The influence of financial service characteristics on use intention through customer satisfaction with mobile fintech. *Journal of System and Management Sciences*, *10*(2), 82-94.