CHAPTER 6

DIGITAL FINANCIAL INCLUSION, ISLAMIC BANKING STABILITY AND SUSTAINABLE ECONOMIC GROWTH

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Abstract

In the current 4th industrial revolution, digital finance is at the forefront of banking infrastructure and sustainable economic growth. It is becoming the baseline in conventional and Islamic banks alike. However, both the negative and positive effects of financial inclusion bring the question of whether digital finance can be the solution. This study intends to examine the role of digital financial inclusion (DFI) in promoting sustainable economic growth through Islamic banking stability using the unbalanced panel data by deploying panel corrected standard errors and two-stage least square-instrument variable techniques. The study also aims to focus on the impact, prospect, and the challenges of DFI and how the proper application of DFI can bring sustainable financial growth to achieve the SDGs. Our results suggest that DFI endorsement may ensure sustainable economic growth and stability within banks, specifically Islamic banks, which is a step towards SDGs achievement.

Keywords: Islamic banks, digitization, Fin-Tech, sustainable economic growth, banking stability, sustainable development goals

1. Introduction

Digital financial inclusion (DFI) is not far different from the notion of financial inclusion (FI), rather it is the extension phase of FI where advanced technology is being entertained. Technology changes the conventional behaviour of the financial sector by providing easy access to various financial services in profound ways. Over the years, all countries in the world have been trying to find a proper way to implement the latest technology in the financial sector. In this regard, in recent years, DFI is seen as a changing agent that can bring a revolutionary development in the overall financial sector of the world (Ozili, 2018). Indicating the world financial analysts, Jamie Caruana, the General Manager of the Bank for International Settlements, states, “(they) have the opportunity - and indeed the responsibility - to prepare the standard-setting world for both the risks and the rewards of the digitization of financial services” (CGAP., 2015). Besides, the recent Covid-19 pandemic has put forward the implementation of digital financial services (DFS) to accelerate and enhance FI, amid social distancing and containment measures. DFI, basically, refers to those financial services that can be enjoyed through electronic devices in a cashless manner without much pain by which both the service providers and receivers can be benefitted (Klapper, 2017).

Reckoning the undeniable impact and importance of DFI, the prominent Islamic banking sector, one of the well-known dominating sectors of the world economy (Ahmed et al., 2015), is also on its way to a fully fledged implementation of DFS (e.g. Fintech, E-wallet and other cashless transactions) in a full fledge. Many Islamic banks globally have launched a minimum range of digital finance services and other banks are paving the way towards the same experience since wider inclusion of easily accessible financial services can help banks to attain stability (Ahamed & Mallick, 2019), push for financial advancement (Demirguc-Kunt et al., 2015), and advance the global financial sector (Iqbal & Llewellyn, 2002). DFS are more efficient, productive, faster and cheaper than any other conventional methods of financial services. Therefore, Islamic banking sector is considering the inclusion of DFS as it ensures banking stability which conveys the message of the economic stability of any country and consequently works towards reaching the sustainable development goals (SDGs) by 2030 (Banna et al., 2020). Furthermore, one of the prime focused areas of the SDGs is to have sustainable economic growth that can be attained through the banking sector. Attainment of the SDGs becomes impossible without filling a huge investment gap. There is a \$2.5 trillion investment gap to close in order to achieve the SDGs by 2030 (Wilson, 2016, July) which can be reduced by the banking sector along with other financial institutions (Niculescu, 2017).

To meet this huge investment gap to attain the SDGs, scholars, including Islamic financial scholars, foresee the prospects of DFI through a wider lens as DFI is the extension of FI that was successful after the 2007-09 global financial crisis (GFC) which caused 15 trillion USD loss from the global financial sector (Ahmed et al., 2015). In this current situation of the pandemic, the implementation of DFI is seen more timely since the unexpected Covid-19 pandemic has created an unexplainable burden on the global financial market as most of the countries have announced stimulus packages to boost their economy which will ultimately put pressure on the banking sector. Hence, it is expected that DFI will play a crucial role during the crisis period to retain banking stability (Ahamed & Mallick, 2019), particularly the stability of the Islamic banking sector (Ahmed et al., 2015) that has been proven to be more stable as compared to their counterpart during and after the crisis. Studies show that FI have already played a significant positive role in promoting banking stability (e.g., Ahamed & Mallick, 2019) by keeping the economy alive (such as, helping people and business to do their daily financial transactions in a cashless and contactless manner, providing aid to the poor people specially the unbanked people by using mobile money services) in spite of lockdowns, quarantines, travel restrictions, and other social distancing measures due to Covid-19 crisis. However, DFI, in turn, may also affect financial stability distressingly with excessive financial innovations (Mani, 2016), for instance, because the rapid increase of DFS by both bank and non-bank financial institutions will disrupt the regulatory and supervisory activities by the regulatory authority, confidential data may be leaked in cyberattacks, money laundering and financing in terrorism may increase. However, both the negative and positive effects of FI and DFI bring the question of whether the proper implementation of digital finance in the Islamic banking sector can be a solution for attaining inclusive economic growth or not. Hence, this paper intends to, in the context of the Islamic banking industry, investigate how DFI promotes sustainable economic growth through ensuring banking stability.

Despite realising the unavoidable importance of the implementation of DFI, studies are very rarely found except a few like Ahamed and Mallick (2019) who show the impact of FI (not DFI) on bank stability in general, Ozili (2018) and Koh et al. (2018) who draw the prospects and the challenges of DFI, and Arner et al. (2018) who sketch a framework for digital financial transformation. Besides, Chuen and Deng (2017b) in their volume 1, show the importance of mobile technology in the banking sector through the advancement of cryptocurrency, FinTech, and InsurTech. They emphasize on drawing a new business model for the banking industry focusing on both digital banking and engineering theories and

developments that encourage innovation. Also, in their volume 2, Chuen and Deng (2017a) show the developments of future finance by analysing the recent innovations in the financial sector and providing feasible solutions for banks and start-ups to grow. Therefore, very few studies have attempted to investigate the link between digital financial inclusion and bank stability which are mostly theoretical in nature mainly focusing on the conventional rather than Islamic banking sector. However, our study aims to empirically investigate the impact of DFI on Islamic banking stability that consequently leads to achieving inclusive economic growth. Hence, this empirical study is expected to contribute to the existing literature by showing how the proper application of DFI ensures Islamic banking stability, especially in the post-Covid-19 pandemic since during and after the pandemic, physical transactions or other banking functions are hindered due to lockdown and social distancing measures, which is a means that leads to sustainable economic growth and subsequently helps attain the SDGs. Moreover, this study also adds value to the literature by explicating the impact, prospect, and the challenges of DFI by suggesting policies to surmount those challenges.

In this regard, the study has used the data of 183 banks of 22 countries from the year 2011 to 2018 from Orbis bank-focus, Global Findex and financial access survey (FAS) databases by deploying panel corrected standard errors and two-stage least square-instrument variable techniques. The results suggest that DFI leads to inclusive economic growth and an integrated inclusion of digital finance by Islamic banks is not only a phenomenon for attaining the SDGs, rather it brings the financial stability of the bank itself. The findings also show that the interaction effect of DFI with GDP which denotes the robustness of the above results and suggest that accelerating digital finance in the sample countries through Islamic banks is considered as one of the significant means for the banking sector stability that subsequently leads to sustainable economic growth.

The organisation of the remaining portion of the paper goes in the following order. Section two displays an account of the literature review while methodology is drawn in Section three. Section four and Section five respectively illustrates the analysis and conclusion with policy recommendations.

2. Literature review

This section gives an account of the comparison of DFI and FI and their relation to bank stability and inclusive economic growth. In this regard, the study of Siddik and Kabiraj (2020) shows the impact of digital finance on FI and how the proper implementation of DFI can spur inclusive economic growth by eradicating poverty. DFI has brought a revolutionary

change in the financial sector as people of all economic classes can be included in the formal financial services by its proper execution as Ozili (2018) illustrates that the key aim of DFI is to provide formal financial services to the poor, rural, and unprivileged people. This proves that DFS delivered by any device connected to the internet has a long run impact on banking performance that helps banks to be financially stable and consequently gives benefits to the government through generating higher tax revenue (Manyika et al., 2016).

According to Gomber et al. (2017), DFS includes innovative financial products, finance related software and a great way of interaction and communication with the customers and such services are provided by FinTech and other finance related service providers. It can transform people from cash-based to cashless transactions where they need a mobile phone which is owned by almost 50% of people in the developing countries (World Bank Group, 2013). Most of the countries of the world are turning to this service. According to Pénicaud and Katakam (2019), more than 80 countries in the world are launching DFS through mobile phones as it brings welfare to the people (CGAP, 2015).

The proper application of DFI increases the profitability of the banks that brings financial growth and stability (Ozili, 2018). To see the impact of SWIFT (an initial form of the digital revolution) on the stability of banking sector, Scott et al. (2017) conducted an empirical study examining 6848 banks of 29 American and European countries over a period from 1998 to 2005 and found a long-term positive impact on the profitability of the banking sector. Moreover, García and José (2016) also say that FI and financial stability goes in a parallel line.

As it is an ongoing research topic, studies scarcely show the impact of DFI from the empirical viewpoint. The recent study of Klapper et al. (2019) shows that through the means of DFS, informal business institutions can be registered as formal business institutions and help the government to collect taxes more easily by enforcing laws since in databases all the records are available and there is no way to escape. More tax collection contributes to the national revenue sector eventually makes the country's economic growth stable. Before launching the DFI in full pledge, the prime focus should be given to financial literacy. Financial literacy is an inseparable part of DFI that enables persons to enhance financial resilience. As a matter of fact, throughout the world only 33% adults have financial knowledge—that is they understand at least 3 out of the 4 main financial literacies: interest rates, interest compounding, inflation, and risk diversification (Klapper & Lusardi, 2019).

Furthermore, inclusive finance brings banking stability and financial sustainability. Taking a sample of 31 Asian countries from 2004 to 2016, the empirical study of Li et al.

(2019) finds that FI has an enormous positive influence on financial sustainability. Other empirical studies like Neaime and Gaysset (2018) on MENA countries, Beck et al. (2014) on African countries and Ahamed and Mallick (2019) on 86 countries also show a very significant impact of FI on bank stability as well as financial sustainability. In some cases, FI seems to be incomplete without the implementation of DFI that plays a role in accelerating financial inclusion. The empirical study of Senou et al. (2019) in the context of West Africa shows that the affordability, accessibility and availability of DFI should be taken into account to accelerate FI in that region. Moreover, DFI strengthens the functions of FI as stated the nexus between FI and DFI in the context of the Islamic banking sector is very strong and DFI fills the gap of FI by implementing the latest technological innovation (Moufakkir & Mohammed, 2020). Another very recent study of Banna et al. (2020) shows that FI after the GFC has played a very significant role in promoting the Islamic banking efficiency where they eventually suggested to implement DFI in the Islamic banking sector to keep up with the demand of time that will help augment banking stability and spur inclusive economic growth.

Realising the impact of DFI found through previous studies, Islamic banks have endorsed DFI significantly. Although there are a number of empirical studies pertaining to the role of FI, DFI and banking stability in terms of conventional banking and economic growth, we are unique in investigating the impact of DFI on Islamic banking stability eventually leading to sustainable economic growth. Since it is evident from the existing literature that the integration of digitization in the FI is a noble mechanism to reach out to the people with more convenient financial support through the utilization of technologies, the current study endeavours to dig deep into the opportunities and impacts of DFI to achieve sustainable economic growth through Islamic banking stability. Thus, the proposed study is expected to add value to the prompt implementation of inclusive digital finance in the Islamic banking sector which will ultimately facilitate the achievement of sustainable operation of financial institutions and contribute to sustainable economic growth.

3. Methodology

We designed our analysis into two folds. First, we examined the impact of DFI and their interaction effect with GDP on Islamic banking stability to see how DFI helps to achieve sustainable economic growth through Islamic banks. Second, this study sheds light on the impact, challenges, and the way forward of the DFI that can bring sustainable economic growth to achieve the SDGs. The following data and methods have been used to analyse the former one. Previous literature and various reports were used to analyse the latter one.

3.1. Data

Though a good number of financial companies along with the banking sector are rendering finance-related services, this study, however, merely considers the data of the banking sector, more specifically, the Islamic banking sector. Initially, the study has considered the annual data of 223 Islamic banks from all countries offering Islamic banking services. After that, due to the data unavailability and missing values, some banks have been excluded from the sample. Finally, the unbalanced panel data of 183 banks in 22 countries (in Appendix A1) from 2011 to 2018 have been considered as we intend to see the after-GFC effect. We take multiple countries into account as we assume that the nature of operational activities of Islamic banks is similar (Banna et al., 2020). The data is from various sources: i) Orbis Bank-Focus database for bank-specific data; ii) IMF-Financial Access Survey (FAS) and Global Findex for DFI data; and iii) World Bank-WDI database and previous literature for macroeconomic and instrumental variables.

3.2. Methods

Bank stability

Following Kim et al. (2020), this study uses two financial stability measures: a) Z-score and b) volatility of ROAA. Z-score has gained a wider acceptance in the banking and finance literature as an unbiased parameter of bank riskiness (Fang et al., 2014). Z-score is measured as:

$$Z - score_{it} = \frac{ROAA_{it} + EQT_{it}}{\sigma(ROAA)_{it}} \quad (1)$$

Where $ROAA_{it}$, EQT_{it} and $\sigma(ROAA)_{it}$ are the return on average assets, the equity to assets ratio, and the 2-year rolling standard deviation of ROAA of bank i in year t , respectively. The score can be interpreted in the way that if the mean is higher than the number of standard deviations, the returns would have to fall before all equity in the bank becomes depleted (Ahamed & Mallick, 2019). The natural logarithm of Z-score has been used in this study to minimise the skewness. Besides, the natural logarithm of the volatility of ROAA [$\ln(\text{sd}(\text{ROAA}))$] has also been considered as banking stability for this study. We interpret that, a bank with less volatility of ROAA has displayed more stability.

Digital financial inclusion proxies

As the purpose of this study is to test the role of DFI in the stability of Islamic banks to promote sustainable economic growth, digital financial inclusion proxies have been measured

using the data of FAS database from 2011 to 2018. In this regard, both the digital financial outreach (supply side) and usage (demand side) penetrations have been considered for DFI based on the previous studies (e.g., Ahamed & Mallick, 2019; Banna & Alam, 2020; Banna et al., 2020). Previous literature considered financial inclusion accounting for the number of ATMs, bank branches, and bank accounts as proxies; whereas, this study considers digital financial inclusion taking the number of mobile money agent outlets, mobile money accounts, and mobile and internet banking transactions (Siddik & Kabiraj, 2020) as proxies. Since this study deals with digital financial inclusion, we, therefore, choose the variables related to those financial services that can be enjoyed through electronic devices in a cashless manner. As a part of geographic and demographic outreach penetrations, mobile money agent outlets per 100,000 adults, as well as per 1,000 km² have been considered, while the number of mobile money accounts per 1,000 adults, as well as mobile money and internet banking transactions per 1,000 adults, have been considered as a part of the usage of digital financial service penetration. We endorse mobile money, a digitised technology, which allows people to retrieve, save, and spend money using a mobile device (Subramaniam, 2020). The rapid pace of mobile money (digital financial inclusion) broadens the room and spectrum of financial services to reach the poorest and most remote parts of the society which were the biggest obstacles for financial inclusion since these poor and rural people are away from formal banking facilities, and they have a shortage of the minimum balance required to open a bank account aside from the obstacle of their conservative religious outlook. The mobile and internet banking, on one hand, has banked the unbanked and, but on the other hand, has enhanced banking stability through minimising operational costs and maximising efficiency and productivity. Apart from that, we also consider “Made or received digital payments in the past year (% age 15+)” as a proxy of DFI for the robustness of our study. However, due to data unavailability of some DFI components, we could not develop a single index of DFI using principal components analysis.

Bank-specific and macro-economic variables

We control both the bank-specific and macroeconomic variables. Following Fang et al. (2014), the ratio of total loans over total assets (Loan ratio - LR) has been used to account for liquidity risk of a particular bank. To control potential size effect and the loan portfolio risk of an individual bank, the study has considered the logarithm of total assets (Bank size - SIZE) and the ratio of loan loss provision to total loans (Loan loss provision - LLP) respectively. The ratio of other operating income to total operating income (Revenue diversification- RD) has been considered to control the ambiguous effect of off-balance sheet activities. Since excessive risk-taking tendency can be reduced by better management quality,

the ratio of total earning assets to total assets (Management quality - MQ) has been taken into consideration. The equity ratio (Capitalisation - CAP) has been used to control the capital risk as well-capitalised banks have the less risk-taking tendency. This paper uses several macroeconomic variables such as annual GDP growth (GDP) to control business cycle and economic growth, and good governance to control institutional effect. Good governance (GG) index is constructed using standardised approach of Kaufmann et al. (2010) governance indicators which are consisted of six components such as, Control of Corruption, Government Effectiveness, Political Stability and Absence of Violence/Terrorism, Regulatory Quality, Rule of Law, and Voice and Accountability.

Estimation technique

To examine the impact of DFI and its interaction effect with GDP on Islamic banking stability, the following baseline regression analysis has been used in this study.

$$Y_{ijt} = \alpha + \beta DFI_{jt} + \gamma Z_{ijt} + \vartheta M_{jt} + \varphi (GDP \times DFI)_{j,t} + \varepsilon_{ijt} \quad (1)$$

Where, $Y_{ijt} = \ln(\text{Z-score})$ and $\ln(sd(ROAA))$ as dependent variables which are considered as proxies for bank stability of bank i of country j in year t .

DFI_{jt} = Digital Financial Inclusion proxy in which the individual components of country j in year t have been considered for the analysis.

Z_{ijt} = bank-specific factors of bank i of country j in year t (such as *SIZE*, *LR*, *LLP*, *RD*, *MQ* and *CAP*).

M_{jt} = Macroeconomic factors of country j in year t (such as *GDP* and *GG*).

$(GDP \times DFI)_{j,t}$ = the interaction effect of GDP and DFI of country j in year t .

$\beta, \gamma, \vartheta, \varphi$ = Coefficients of the variables, α = Constant, ε_{ijt} = Error term.

Following Alfadli and Rjoub (2019), this study uses panel-corrected standard errors (PCSE) method (Beck and Katz (1995)) to examine the fundamental relationship between the variables. There are mainly two reasons behind choosing this method: i) it reduces the problems prevailing to cross-sectional dependence and sequential correlation and ii) it determines, using a suitable instrument, the likelihood of endogeneity among some of the independent as well as dependent factors in a particular model (Alfadli & Rjoub, 2019). Besides, following Kim et al. (2020), Panel Two-Stage Least Squares - Instrumental Variables (2SLS-IV) method has been used to mitigate possible endogeneity issues for the robustness of the results.

4. Results and Analysis

The results of the relationship between bank stability and DFI as well as the interaction effect of DFI with GDP on bank stability have been illustrated in this section. In addition to these, the impact, challenges, and the way-forward of DFI have also been discussed here.

4.1. Digital financial inclusion and bank stability

Descriptive statistics

The descriptive statistics of bank stability, SIZE, LR, LLP, RD, MQ, CAP, GDP, GG, and DFI are illustrated in Table 1. The table exhibits the descriptive statistics (mean, standard deviation-SD, and minimum-maximum values) of each variable in the sample. From this table few observations are very notable. First, the ln (Z-score) has an average value of 4.12 with an SD of 1.64, indicating that to annihilate bank equity, ROAA would have to drop by an average of 4.12 times of their SD. Moreover, the mean value of the Islamic banks size and SD are 7.46 and 2.01 respectively. Hence, such high yearly variation is visible by these results. The sample countries, in an average manner, have achieved 3.76% growth in their GDP over the year 2011 to 2018. Furthermore, the sample countries, on average, have 239 and 79 mobile money agent outlets per 1000 km² and per 100k adults respectively. Moreover, the number of mobile money accounts and the number of mobile money and internet banking transactions per 1000 adults are approximately 143 and 3142, respectively. Figure 1 shows an upward trend of the DFI components in the sample countries over the period of 2011 to 2018. This suggests a higher quantity of Islamic banks showed an increase – in 2018 compared to 2011 – in mobile money accounts as well as mobile money and internet banking transactions.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
<u>Bank stability</u>					
Ln of z-score using roaa	950	4.123	1.643	-3.647	9.775
ln(sd(roaa))	976	1.421	1.668	-3.531	7.254
<u>Bank specific</u>					
Bank size	1169	7.458	2.004	.032	11.486
Loan ratio	1127	.571	.225	.002	1.747
Loan loss provision ratio	829	.008	.026	-.273	.426
Management quality	1152	.745	.213	0	.997
Revenue diversification	1162	.565	2.263	-68.768	26.94
Capitalisation	1169	.195	.247	-1.244	1
<u>Macroeconomic</u>					
GDP growth (annual %)	1464	3.756	4.102	-16.678	15.212
Good governance	1464	0	1.09	-1.988	2.892

DFI

Number of mobile money agent outlets per 1,000 km ²	1464	239.205	956.105	.219	6869.77
Number of mobile money agent outlets per 100k adults	1464	79.436	124.482	1.09	768.054
Number of mobile money accounts per 1,000 adults	696	143.513	239.577	.393	1548.237
Number of mobile money and internet banking transactions (during the reference year) per 1,000 adults	664	3141.994	8229.441	0	56469.45
Made or received digital payments in the past year (% age 15+)	1400	45.017	30.998	2.602	97.029

Instruments

Mobile Share	1464	.943	.032	.883	1
Borrowed from family or friends	1464	34.77	12.146	10.506	60.465

Notes: GDP = Gross Domestic Products, roaa = Return on Average assets, sd = Standard deviation. Source: Orbis bank focus, WDI and FAS

Figure 1. The trend of DFI in the sample countries (2011-2018)

To see the link between bank stability and DFI and the interaction effect of DFI with GDP on bank stability, initially the panel-corrected standard errors regression was considered. The study controls bank-specific variables such as, SIZE, LR, LLP, RD, MQ, CAP and macro-economic variables such as GDP, GG for our analysis.

We designed our analysis based on two main dimensions of bank stability: $\ln(z\text{-score})$ (model 1-4) and $\ln(sd(roaa))$ (model 5-8). Based on DFI, two main penetrations and four sub-penetrations such as financial outreach (both geographic and demographic) penetrations (Mobile money agent outlets per 1000 km² (model 1 & 5) and per 100k adults (model 2 & 6)) and financial usage penetration of the customers (number of mobile money accounts per 1000 adults (model 3 & 7) and mobile money and internet banking transactions per 1000 adults (model 4 & 8) were designed.

Table 2. Panel corrected standard errors regression

	Ln(Z-score)				ln(sd(ROAA))			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DFI	0.178** (0.074)	0.490*** (0.094)	0.262 (0.170)	0.062 (0.091)	-0.141* (0.072)	-0.431*** (0.092)	-0.271 (0.173)	-0.047 (0.087)
SIZE	0.133** (0.054)	0.125** (0.053)	0.389*** (0.102)	0.404*** (0.102)	-0.214*** (0.040)	-0.201*** (0.038)	-0.447*** (0.055)	-0.465*** (0.055)
LR	0.473 (0.608)	0.749 (0.604)	1.021 (0.839)	1.108 (0.891)	-0.932** (0.429)	-1.188*** (0.422)	-1.540*** (0.586)	-1.656*** (0.619)
LLP	-9.816*** (2.444)	-9.672*** (2.418)	-9.843*** (2.522)	-9.849*** (2.596)	11.263*** (2.363)	11.526*** (2.422)	8.908*** (2.382)	9.021*** (2.484)
MQ	1.470*** (0.511)	1.575*** (0.499)	-0.495 (0.709)	-0.536 (0.752)	-0.849* (0.446)	-0.985** (0.437)	0.585 (0.701)	0.677 (0.742)
RD	-0.002 (0.002)	-0.002 (0.001)	0.001 (0.002)	0.002 (0.002)	0.001 (0.001)	0.001 (0.001)	-0.001 (0.002)	-0.001 (0.002)
CAP	2.077*** (0.475)	1.669*** (0.463)	3.125*** (1.054)	3.190*** (1.051)	0.280 (0.377)	0.624* (0.379)	-0.198 (0.424)	-0.223 (0.427)
GDP	-0.070* (0.038)	-0.098* (0.054)	-0.117 (0.164)	-0.004 (0.111)	0.080** (0.038)	0.128** (0.055)	0.069 (0.168)	-0.042 (0.110)
GDP*DFI	0.020* (0.011)	0.028** (0.014)	0.034 (0.033)	0.008 (0.019)	-0.023** (0.011)	-0.035*** (0.014)	-0.032 (0.034)	-0.006 (0.018)
GG	0.253*** (0.080)	0.257*** (0.067)	0.192 (0.129)	0.209 (0.131)	-0.205*** (0.078)	-0.229*** (0.065)	-0.129 (0.117)	-0.161 (0.120)
year effect	yes	yes	Yes	yes	yes	yes	yes	Yes
country effect	yes	yes	Yes	yes	yes	yes	yes	Yes
Wald chi2	139.48***	196.17***	163.31***	163.73***	169.07***	214.30***	230.96***	222.82***
Obs.	683	683	320	320	703	703	327	327
R-squared	0.154	0.187	0.298	0.290	0.201	0.224	0.415	0.404

Notes: DFI = Digital Financial Inclusion, SIZE = Bank size based on total assets, LR = Loan ratio, LLP = Loan loss provision, MQ = Management Quality, RD = Revenue diversification, CAP = Capitalisation, GDP = Gross domestic products growth rate, GG = Good governance, Obs = Observations, ROAA = Return on Average assets, sd = Standard deviation. Standard errors are in parenthesis

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Number of mobile money agent outlets per 1,000 km² (model 1 & 5)

Number of mobile money agent outlets per 100k adults (model 2 & 6)

Number of mobile money accounts per 1,000 adults (model 3 & 7)

Number of mobile money and internet banking transactions (during the reference year) per 1,000 adults (model 4 & 8)

The findings (in Table 2) show that DFI has a positive relationship with Islamic banking stability (z-score) and a negative relationship with the volatility of ROAA. The result suggests that a higher level of DFI is significantly related to a higher level of banking stability (a high Z-score indicates greater stability, i.e., less risk taking, inclusive sustainable growth). Also, when DFI is enhanced in a country, the volatility of the ROAA is less and hence, more stability is obtained. Though the usage penetrations have an insignificant relationship, the financial outreach penetrations (both geographic and demographic) have a stronger association with bank stability. This suggests that DFI enriches the soundness of individual Islamic banks in the sample countries. These findings are similar with the previous studies (e.g., Ahamed & Mallick, 2019; Morgan & Pontines, 2014) that show a financial system with inclusive DFS tends to strengthen banking stability, and that the greater implementation of DFI reduces the excessive risk-taking tendency of a particular bank.

However, the insignificant effect of usage dimensions of DFI suggests that in the sample countries, banks and Fintech companies have provided sufficient access to finance but people lack the necessary knowledge to maximize utilization. This is due to the current early onset of digital finance in the sample nations and the “drive to maturity” (representative of the adoption rate and learning curve by the Stages of Economic Growth model of Rostow (1959)). In addition, there is not enough resources and education to teach citizens about contemporary finance (Morgan et al., 2019).

The study has apprehended a positive (negative) association between economic growth (GDP) and Islamic banking stability (volatility of ROAA) as growth influences banking stability. However, the results show that GDP alone has a negative (positive) effect on Islamic banking stability (volatility of ROAA). But interestingly, the interaction effect of DFI with GDP is positively (negatively) and significantly related to Islamic banking stability (volatility of ROAA). The interaction effect of DFI with GDP growth is considered because this shows how DFI contributes to achieving inclusive sustainable growth by improving the stability of the banking sector. While talking about the real or inclusive economic growth of any country, GDP comes to appear as the main determinant (Banna & Alam, 2020) that is a pivotal factor for long term economic development of a country (Ben-David & Papell, 1995). As both inclusive digital finance and GDP promote the economic advancement of any country, the interaction effect of both is also thought to bring inclusive sustainable growth in a heightening manner.

The economic impact of the results, in particular, suggests that inclusive digital finance may help Islamic banks to enhance efficiency and productivity by minimising operational

cost through maintaining minimum paperwork, documentation and fewer physical bank branches (Manyika et al., 2016). DFI, as an instrument, helps financial and monetary system regulators to reduce the level of inflation in both poor and developing countries by restricting the circulation of the amount of physical cash. Besides, DFI plays a significant role in enhancing the welfare of individuals and business sectors through which individuals can easily access funds in their bank accounts to perform financial transactions (CGAP., 2015). Therefore, with an inclusive financial sector, Islamic banks enjoy greater financial stability that eventually promotes inclusive economic growth. Besides, SIZE, LR, LLP, RD, CAP and GG are also significant determinants of Islamic banking stability.

Robustness test: Instrumental variables

Though possible reverse causality (endogeneity) is a common identification issue in any banking study, this study might have less concern of endogeneity issue as it investigates the role of DFI (a country-level indicator) on Islamic banking stability (bank-level indicator). Nevertheless, we test for robustness following Kim et al. (2020)'s 2SLS-IV technique.

We searched recent empirical studies on banking stability and FI to choose instrumental variables (IVs) to address any potential endogeneity issue. Following Ahamed and Mallick (2019), this study considers the proportion of Mobile cellular subscriptions (per 100 people) in other countries in the same region as an IV for 2SLS-IV technique. We have categorised countries based on High-Income, South Asia, Europe & Central Asia, Sub-Saharan Africa, East Asia & Pacific, and the Middle East & North Africa regions. It is argued that the banking operational costs, as well as physical and financial infrastructural deficiencies can be reduced through good communication infrastructure (Beck et al., 2007) and excessive use of mobile phones (Allen et al., 2014). Hence, countries with a large number of mobile subscriptions help to facilitate unbanked people to be banked. In addition to that, we consider 'percentage of adults borrowing from friends and family' as an instrumental variable. It is found that the key source of borrowing money in developing countries is friends and family (Demirguc-Kunt & Klapper, 2012) and it is also evident that only 9% of adults borrowed from formal financial sectors and 29% of the adults borrowed from friends and family. The higher percentage of adults borrowing from friends and family may influence DFI without directly affecting bank stability (Ahamed & Mallick, 2019).

Table 3. Instrumental variables and 2SLS regression - Robustness

	Ln(Z-score)				ln(sd(ROAA))			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DFI	1.206*** (0.384)	2.322** (0.940)	0.149 (0.885)	0.006 (0.298)	-1.007*** (0.307)	-1.592** (0.687)	-0.059 (0.791)	-0.208 (0.277)
SIZE	0.449*** (0.106)	0.466*** (0.133)	0.549*** (0.124)	0.549*** (0.113)	-0.415*** (0.078)	-0.382*** (0.085)	-0.533*** (0.085)	-0.542*** (0.081)
LR	-0.365 (0.823)	-1.425 (1.095)	0.849 (0.945)	-0.813 (0.932)	-0.448 (0.692)	0.328 (0.878)	-1.923** (0.804)	-1.706** (0.809)
LLP	-7.763*** (2.436)	-7.445** (2.945)	-8.415*** (2.173)	-8.368*** (2.205)	-7.263*** (2.201)	-6.941*** (2.440)	-7.207*** (2.050)	-7.086*** (2.100)
MQ	0.654 (0.943)	0.644 (1.090)	0.677 (1.226)	0.705 (1.176)	0.066 (0.824)	-0.044 (0.891)	-0.095 (1.134)	-0.329 (1.075)
RD	-0.001 (0.001)	-0.001 (0.002)	-0.002 (0.002)	-0.001 (0.002)	-0.001 (0.001)	-0.001 (0.001)	0.001 (0.002)	0.001 (0.002)
CAP	4.964*** (0.969)	6.935*** (1.784)	4.058*** (1.374)	3.868*** (1.214)	-1.326** (0.607)	-2.147** (0.986)	-0.445 (0.734)	-0.391 (0.679)
GDP	-0.218*** (0.082)	-0.367** (0.168)	-0.263 (0.946)	-0.003 (0.354)	0.187** (0.073)	0.254* (0.137)	0.082 (0.841)	0.202 (0.328)
GDP*DFI	0.083*** (0.031)	0.113** (0.051)	0.049 (0.182)	0.002 (0.061)	-0.075*** (0.027)	-0.081* (0.042)	-0.009 (0.163)	-0.043 (0.057)
GG	-0.796** (0.324)	-0.614* (0.343)	-0.085 (0.212)	0.021 (0.202)	0.634** (0.254)	0.359 (0.241)	0.052 (0.183)	-0.071 (0.172)
year effect	yes	yes	Yes	yes	yes	yes	yes	Yes
country effect	yes	yes	Yes	yes	yes	yes	yes	Yes
Wald chi2	49.81***	35.82***	72.07***	71.78***	68.02***	55.95***	116.67***	120.07***
Obs.	547	547	251	251	566	566	257	257
R ²	0.0096	0.0033	0.2805	0.2792	0.0395	0.0064	0.4358	0.4211

Notes: DFI = Digital Financial Inclusion, SIZE = Bank size based on total assets, LR = Loan ratio, LLP = Loan loss provision, MQ = Management Quality, RD = Revenue diversification, CAP = Capitalisation, GDP = Gross domestic products growth rate, GG = Good governance, Obs = Observations, ROAA = Return on Average assets, sd = Standard deviation. Standard errors are in parenthesis *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Number of mobile money agent outlets per 1,000 km² (model 1 & 5)

Number of mobile money agent outlets per 100k adults (model 2 & 6)

Number of mobile money accounts per 1,000 adults (model 3 & 7)

Number of mobile money and internet banking transactions (during the reference year) per 1,000 adults (model 4 & 8)

The 2SLS-IV regression model does not change any result of the above analysis rather it shows a stronger relationship between DFI and Islamic banking stability by providing a higher coefficient (in Table 3). These findings show the robustness of the PCSE regression results and suggest that an inclusive digital financial system has a strong positive impact on Islamic banking stability in the sample countries. The interaction effect of DFI with GDP also denotes the robustness of the above results which suggests that accelerating digital finance in the sample countries through Islamic banks is considered as one of the significant means for the banking sector stability that subsequently leads to sustainable economic growth.

Robustness test: Alternative DFI proxy

We also consider ‘the percentage of adults who made or received digital payments in the past year’ (DigiPay) as an alternative proxy of DFI from the Global Findex database. The results, using an alternative proxy (in Table 4), assert the robustness of the previous results. Therefore, it is evident that with an inclusive digital financial sector, Islamic banks enjoy greater financial stability and overall, the country promotes sustainable economic growth.

Table 4. Alternative DFI proxy regression - Robustness

	(1)	(2)	(3)	(4)
	Ln(Z-score)	ln(sd(ROAA))	Ln(Z-score)	ln(sd(ROAA))
DFI	0.027*** (0.003)	-0.025*** (0.003)	0.016* (0.009)	-0.024*** (0.007)
GDP	-0.031 (0.037)	0.040 (0.038)	-0.015 (0.035)	0.029 (0.033)
GDP*DFI	0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)	-0.001 (0.001)
Obs.	643	663	643	663
R ²	0.2556	0.2862	0.2347	0.2852
Wald chi2	251.364***	293.389***	93.021***	163.478***
control	Yes	yes	yes	yes
year effect	Yes	yes	yes	yes
country effect	Yes	yes	yes	yes

Notes: DFI = Digital Financial Inclusion, GDP = Gross domestic products growth rate, Obs = Observations, ROAA = Return on Average assets, sd = Standard deviation. Standard errors are in parenthesis

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

4.2. Impact, prospect and challenges of DFI

The impact and prospect of DFI is no longer an abstract notion, rather time demands its proper execution. The Executive Director of the Alliance for Financial Inclusion (AFI) Hannig (2017) says, “The adoption of digital finance will have a significant impact not only on financial inclusion but also inclusive economic growth.”. Highlighting the importance of DFI in their report, Manyika et al. (2016) draw some important notes based on the findings of field visits to seven countries and more than 150 expert interviews. They report (as shown in Figure 2), “Digital finance has the potential to provide access to financial services for 1.6 billion people in emerging economies, more than half of them women. Widespread adoption and use of digital finance could increase the GDP of all emerging economies by 6 per cent, or USD 3.7 trillion, by 2025,” which is equivalent to the economy of Germany. Moreover, 95 million new job scopes would be created in all sectors across the world through this additional GDP. Since GDP is seen as a key developmental index of an economy, the implementation of DFI in the Islamic banking sector will contribute to enhancing the GDP that will help to alleviate poverty and ultimately lead to inclusive economic growth to achieve the SDGs.

Figure 2. The impact and prospect of DFI. Source: McKinsey Global Institute (2016)

However, apart from a number of positive sides DFI has some threats and constraints too. Firstly, most of the people of lower income countries cannot afford to have a smart mobile phone to enjoy DFI. High speed internet is required for the smooth operation of DFI and is still unavailable in many countries (Ozili, 2018). Account hacking and ATM or SIM card cloning by the hackers are considered as acute threats to DFI (Wyman, 2017). Uninterrupted electricity is required for DFI and lack thereof causes card jamming in ATM-booths. Adeoti (2011) states several threats of ATMs in the context of Nigeria such as fake cards, card jamming, duplicate ATMs, and card swapping. Lack of digital literacy hinders the advancement of DFI that many countries still cannot ensure in a full pledge because of their financial constraints (Obiano, 2009). Loss of hand phone and cyber security problems are also threats to the proper execution of DFI.

5. Conclusion and policy recommendations

This study provides empirical evidence that greater DFI is positively associated with Islamic banking stability which suggests that DFI leads to sustainable economic growth and financial stability within banks. Governments, policymakers, and regulatory bodies can see DFI as a changing agent that can bring a revolutionary development in the overall financial sector of the Islamic banking industry, especially in the post Covid-19 era. In this regard, the implementation of the following policies can be taken into consideration.

First, people should be provided with digital financial literacy and the necessary infrastructure. Internet buffers can deter users from using DFI due to service interruptions. Financial literacy is also necessary (Klapper & Lusardi, 2019) as our findings also show that many countries have sufficient access to DFS, but their people lack knowledge to use it properly. Islamic banks and organizations need to hold workshops as well as maintenance and educational services for this. Time tested and time demanding DFS (e.g. Fintech using

artificial intelligence and machine learning) should be launched that will enhance banking stability and efficiency which will spur inclusive economic growth of the country.

In addition, the Islamic economy in conjunction with Islamic banks can enjoy the blessing of DFI by launching Zakat App since Zakat is the main source of revenue of any Islamic economy. Through this Zakat App, Zakat collection and distribution will be smoother and safer. Moreover, Islamic banks, in order to tackle hacking, cloning of ATM cards, debit cards, credit cards, and other technological threats, should implement updated software and databases so that hackers cannot breach the data. A proficient and unbiased regulatory body should be formed who can supervise all the activities in terms of DFI to minimise risks (Ketterer, 2017) and adopt innovative and time-tested policies to make it a successful journey.

Finally, our study has some limitations. We did not compare our findings with conventional banks and due to data unavailability, we had to exclude many Islamic banks of different countries which in turn provides scope for future studies.

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Appendix A1: List of countries and number of banks

Country-Name	Number of Banks	Observations
BANGLADESH	9	72
EGYPT	3	24
INDONESIA	11	88
IRAQ	16	128
IRAN	29	232
JORDAN	5	40
KENYA	3	24
KUWAIT	12	96
LEBANON	3	24
MALAYSIA	19	152
MAURITANIA	4	32
OMAN	3	24
PAKISTAN	9	72
PALESTINIAN	2	16
QATAR	5	40
SAUDI ARABIA	4	32
SUDAN	19	152
TUNISIA	2	16
TURKEY	5	40
UAE	10	80
UK	7	56
YEMEN	3	24
Total	183	1464

Appendix A2: Pairwise correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) ln(Z-score)	1.000																
(2) ln(sd(roaa))	-0.854*	1.000															
(3) DFI1	0.033	-0.059	1.000														
(4) DFI2	0.147*	-0.008	0.839*	1.000													
(5) DFI3	0.190*	-0.193*	0.412*	0.571*	1.000												
(6) DFI4	0.100*	-0.099*	0.549*	0.618*	0.690*	1.000											
(7) DigiPay	0.093*	-0.005	0.375*	0.481*	-0.159*	-0.070	1.000										
(8) Bank-size	0.124*	-0.390*	-0.081*	-0.174*	0.210*	0.201*	-0.503*	1.000									
(9) Loan-ratio	0.104*	-0.228*	-0.346*	-0.392*	-0.013	-0.099*	-0.100*	0.196*	1.000								
(10) Loan-loss-provision	-0.161*	0.228*	-0.044	-0.044	-0.115*	-0.109*	-0.001	-0.153*	0.101*	1.000							
(11) Management-quality	0.172*	-0.262*	-0.395*	-0.399*	0.084*	-0.083*	-0.174*	0.264*	0.690*	0.024	1.000						
(12) Revenue-diversification	-0.077*	0.072*	0.226*	0.209*	0.061	0.055	-0.007	-0.051	-0.283*	-0.040	-0.201*	1.000					
(13) Capitalisation	0.126*	0.215*	0.232*	0.340*	0.033	0.071	0.126*	-0.506*	-0.346*	0.019	-0.213*	0.124*	1.000				
(14) GDP	-0.019	-0.042	-0.110*	-0.056*	-0.106*	-0.094*	0.036	0.032	0.214*	0.048	0.200*	-0.032	-0.087*	1.000			
(15) Good-governance	0.159*	-0.164*	-0.503*	-0.414*	0.199*	0.127*	-0.586*	0.225*	0.224*	-0.006	0.430*	-0.134*	-0.006	0.096*	1.000		
(16) Mobile-Share	0.040	0.094*	0.156*	-0.029	-0.089*	0.166*	-0.210*	-0.006	-0.206*	-0.043	-0.145*	-0.035	0.209*	-0.217*	0.225*	1.000	
(17) Borrowed from fnf	-0.184*	0.162*	0.519*	0.332*	-0.482*	-0.216*	0.069*	0.048	-0.167*	0.030	-0.345*	0.233*	0.025	-0.056*	-0.634*	-0.119*	1.000

* shows significance at the .05 level

Mobile money agent-outlets per 1k km2 (DFI1)

Mobile money agent-outlets per 100k adults (DFI2)

Mobile money accounts per 1k adults (DFI3)

Mobile money and internet banking transactions per 1k adults (DFI4)

Made-or-received digital-payments in the past year (% age 15+) (DigiPay)