

Please cite the Published Version

Banna, H and Alam, MR (2021) Impact of digital financial inclusion on ASEAN banking stability: implications for the post-Covid-19 era. *Studies in Economics and Finance*, 38 (2). pp. 504-523. ISSN 1086-7376

DOI: <https://doi.org/10.1108/SEF-09-2020-0388>

Publisher: Emerald

Version: Accepted Version

Downloaded from: <https://e-space.mmu.ac.uk/628901/>

Usage rights: © In Copyright

Additional Information: This is an author accepted manuscript of an article published in *Studies in Economics and Finance*.

Enquiries:

If you have questions about this document, contact openresearch@mmu.ac.uk. Please include the URL of the record in e-space. If you believe that your, or a third party's rights have been compromised through this document please see our Take Down policy (available from <https://www.mmu.ac.uk/library/using-the-library/policies-and-guidelines>)



Impact of digital financial inclusion on ASEAN banking stability: Implications for the post-Covid-19 era

Journal:	<i>Studies in Economics and Finance</i>
Manuscript ID	SEF-09-2020-0388.R3
Manuscript Type:	Research Paper
Keywords:	Covid-19, Digital financial inclusion index, banking stability, fintech, ASEAN

SCHOLARONE™
Manuscripts

Impact of digital financial inclusion on ASEAN banking stability: Implications for the post-Covid-19 era

Structured abstract

Purpose: This paper intends to investigate how digital financial inclusion can be a potential factor to maintain banking stability in ASEAN countries and whether the relationship could bring a possible implication for the post-Covid-19 pandemic era.

Design/methodology/approach: Using an unbalanced panel data of 213 banks of 4 ASEAN countries, the study has deployed principal component analysis (PCA), ordinary least square (OLS), two-step dynamic system generalised method of moments (GMM), and panel corrected standard errors (PCSE) techniques.

Findings: Our empirical study finds that the full-fledged application of DFI accelerates the ASEAN banking stability which not only decreases the default risk of the banks but also upturns the financial mobility in the region. The results also suggest that ASEAN banks are, with the implementation of DFI, likely to uphold the banking sector stability by reducing liquidity crisis and NPLs during and in the post-Covid-19 era. Therefore, accelerating digital finance in ASEAN countries is considered as one of the significant means for the banking sector stability that subsequently leads to economic and financial resilience even in the face of any crises.

Originality: Prevailing studies have mostly investigated the association between financial inclusion and banking stability in different contexts. However, this study is unique to empirically investigate the association between digital financial inclusion and the ASEAN banking stability.

Keywords: Covid-19; digital financial inclusion index; banking stability; fintech; ASEAN

I. INTRODUCTION

Does digital financial inclusion ensure the ASEAN banking stability? This simple question sheds light on a few issues. The Covid-19 pandemic, considered as one of the biggest global crises, has brought a drastic impact on the global financial sector (Narayan, 2020a; Phan and Narayan, 2020). The nationwide social distancing, quarantine, and lockdown measures have affected all the sectors and brought insurmountable social and economic consequences causing an unprecedented and multi-dimensional strain on stock markets, businesses, health sector, societies, and individuals as well (Narayan *et al.*, 2021; Yang and Deng, 2021; Arner *et al.*, 2020). However, the banking sector is more vulnerable in this pandemic (Wójcik and Ioannou, 2020) as majority of the economic activities of human civilization are directly or indirectly related to and carried out through this sector (Banna *et al.*, 2020a). Moreover, governments of many countries have announced different types of stimulus packages to reduce the economic needs of their people (Narayan *et al.*, 2020) that are being disbursed through the banking industry. This accelerates liquidity pressure on the global banking system which is, in turn, likely to create liquidity crisis (Li *et al.*, 2020). Besides, liquidity problems faced by the households, govt. institutions, and business sectors amidst this current crisis lead to the rise of non-performing loans in the banking sector that is a fatal hazard to the global financial sector (Wójcik and Ioannou, 2020). Nonetheless, to keep the economy stable, banks are required to carry out their daily operations by any means (McKibbin and Fernando, 2020). Thus, the proper execution of digital financial services (DFS) is necessary to carry out a smooth operation so that people can maintain their basic transactions without the fear of being affected by the virus and government can also check the spread of the disease. Though many banks have been practising DFS for many years, they, however, did not realise its importance as much as they realise in this crisis period. Hence, the efficient and full-fledged implementation of digital financial inclusion (henceforth DFI) is seen essential that is a blessing for the banking industry

the Covid-19 has brought through which banks can retain their stability (Wójcik and Ioannou, 2020).

DFI is the extension or the wider application of financial inclusion (henceforth FI) that aims to perform all the financial operations through a cashless manner (Banna and Alam, 2020) by which both the parties (service providers and service receivers) get benefited (Klapper, 2017). Studies show that wider inclusion of easily accessible financial services helps banks attain stability (Ahamed and Mallick, 2019) and increase banks' revenue by reducing costs (Van *et al.*, 2020). Since DFI is faster, efficient, time saving, and cheaper, many countries of the world, during this pandemic, have already started practising it in full swing (Ellis, 2020) to retain their financial and banking sector stability. Keeping pace with the world, the ASEAN banking sector is not lagging behind too. As noticed that, during this pandemic, the trend of opening bank accounts in ASEAN countries through online platform has visibly increased (Hoe, 2020). Thus, proper operation of DFI is prophesised to be a feasible solution to surmount the current crisis as in the post-GFC (global financial crisis) period, the execution of financial inclusion in the banking sector was seen as a timely measure to regain the damaged economy (Ahamed and Mallick, 2019; Banna *et al.*, 2020a).

However, besides its myriad positive sides, DFI, on the flip side, may also affect financial stability distressingly with excessive financial innovations (Mani, 2016). For instance, the rapid increase of DFI by both bank and non-bank financial institutions will disrupt the regulatory and supervisory activities by the regulatory authority, data privacy might be leaked by cyberattacks, money laundering and financing in terrorism may be increased. Moreover, other negative phases of DFI include the inability to avail a smartphone by all, lack of having smart/govt. issued identity card or birth certificate by all the individuals that are required for digital payments, and lack of digital literacy as well (Klapper, 2017). Therefore, both the negative and positive effects of DFI motivate us to undergo this study as they pose the

question of whether the proper and full-fledged implementation of DFI in the ASEAN banking sector, especially in the post-pandemic period, can be a probable solution for attaining banking stability or not. Thus, we form our hypothesis to empirically investigate the impact of DFI on ASEAN banking stability. Our hypothesis is motivated by the study of Ahamed and Mallick (2019) where they empirically investigated the impact of financial inclusion on bank stability and found a positive association. Since technological advancement has transformed FI to DFI, this study, therefore, aims to see how DFI can be a potential factor to maintain banking stability in ASEAN countries and whether the relationship could bring a possible implication for the post-Covid-19 pandemic era.

The study is expected to contribute to the existing literature in the following ways. Firstly, prevailing studies (e.g., Banna *et al.*, 2020a; Ozili, 2018; Van *et al.*, 2020; Ahamed and Mallick, 2019) mostly focus on various dimensions of FI including the importance and determinants of FI, its link with financial stability, and the theoretical perspective of DFI and Fintech as well. However, this study empirically investigates the relationship between DFI and bank stability (using bank-level data). Secondly, though the previous studies (e. g., Ahamed and Mallick, 2019; Van *et al.*, 2020) measure the FI index, the current study measures a comprehensive DFI index by considering both the demand-side and supply-side penetrations as well as both the demographic and geographic penetrations.

Thirdly, this study mainly focuses on ASEAN countries as most of the countries of this region have set their motto to be a cashless society by the year 2022. Hence, this empirical evidence will provide insightful implications for the policymakers of this region. Fourthly, focusing on Asian markets in the phase of Covid-19, a few studies have been carried out. Those studies have mainly enlaced the impact of Covid-19 on oil price news and crude oil price (Narayan, 2020b; Gil-Alana and Monge, 2020), on Indian financial market (Mishra *et al.*, 2020), on Chinese stock prices (He *et al.*, 2020), on Chinese corporate performance (Shen *et*

1
2
3 *al.*, 2020), on commonality in volatility for five Asian booming economies (Sharma, 2020),
4
5 influence of Covid-19 on Turkish diesel consumption (Ertuğrul *et al.*, 2020), the role of Islamic
6
7 stock market to overcome any uncertainty (Salisu and Sikiru, 2020), and the impact of
8
9 intellectual capital investment on Malaysian energy firm performance during this pandemic
10
11 (Asif *et al.*, 2020). Moreover, other similar studies in the context of different Asian countries
12
13 show varied impacts of this pandemic on different phases like systematic risk of Chinese
14
15 commercial banks (Liu *et al.*, 2020), stock market returns of OECD countries (Yang and Deng,
16
17 2021), Chinese currency exchange rate (Fang and Zhang, 2021), domestic credit of Chinese
18
19 banks (Appiah-Otoo, 2020), and so on. However, most of these studies have contributed to the
20
21 energy sector literature, stock market, and other trades and commerce phases. Though few more
22
23 studies have attempted to scrutinise the impact of Covid-19 on banking industry, they are from
24
25 different perspectives. Hence, the current study is hoped to contribute to the banking and
26
27 finance literature by analysing the impact of DFI on ASEAN banking stability that is hoped to
28
29 have an implication for the post Covid-19 era and helps the concerned personnel decide the
30
31 application of DFI in the banking industry. In this regard, using the latest data of DFI of the
32
33 ASEAN banking industry and various econometric techniques to check the robustness of the
34
35 findings, this study shows how the proper application of DFI ensures ASEAN banking stability
36
37 at the time of any financial crisis like the Covid-19.
38
39
40
41
42
43

44
45 To inspect the impact of DFI on banking stability, the study has used the data of 253
46
47 banks of 4 ASEAN countries over the period 2011-2019. Data have been sourced from Orbis
48
49 bank-focus, world development indicators (WDI), Global Findex, countries' central banks, and
50
51 financial access survey (FAS) databases. The study has deployed ordinary least square (OLS),
52
53 panel corrected standard errors (PCSE), and two-step dynamic system generalised method of
54
55 moments (GMM) techniques. Our empirical study finds that greater implementation of DFI is
56
57 positively associated with ASEAN banking stability which does not only reduce the default
58
59
60

1
2
3 risk of the banks but also increases the financial mobility in the region. The results also suggest
4
5 that an integrated inclusion of digital finance in the ASEAN banking industry ensures
6
7 sustainable economic growth that is likely to help maintain financial sustainability in times of
8
9 any economic shocks like the Covid-19.
10
11

12 The remaining portion of the paper has been organised in the following order. Section
13
14 two highlights an account of literature review and hypothesis development while methodology
15
16 appears in Section three. Section four and Section five respectively illustrate the analysis and
17
18 conclusion with policy recommendations.
19
20
21

22 23 **II. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT**

24 25 *A. Review of existing studies*

26
27 The Covid-19 pandemic can be considered as a game changer for DFI through which the lower-
28
29 income households and small firms can have more advantages by using mobile money
30
31 transactions, Fintech services (Allmen *et al.*, 2020), and digital payments as well which were
32
33 never seen before (Arner *et al.*, 2020). In line with this, the global banking industry is in the
34
35 way of implementing DFI in full swing to face this pandemic. This section, therefore, reviews
36
37 the prevailing studies encompassed the impact of FI and DFI on banking stability.
38
39
40

41 DFI means “digital access to, and the use of, formal financial services by the excluded
42
43 and underserved population” (CGAP., 2015). It refers to those innovative and Fintech based
44
45 financial products/services that are enjoyed through electronic devices in a cashless manner
46
47 without much pain by which both the service providers and receivers get benefitted (Klapper,
48
49 2017). The full swing and proper application of DFI can accelerate economic thrift and stabilise
50
51 the banking sector. The study of Siddik and Kabiraj (2020) shows how the full-fledged
52
53 execution of DFI (e.g., Fintech-based financial services) can enhance the wider application of
54
55 FI that ultimately brings inclusive economic growth by eradicating poverty. Poverty
56
57 eradication could be possible when a country will experience a higher level of financial stability
58
59
60

and economic performance. Using time series data and deploying a multiple regression model the study of Kammoun *et al.* (2020) shows that Fintech, even in times of political instability, accelerates financial stability and economic performance in the MENA region. In this region Fintech sector is in a booming trend where dozens of new start-ups are appearing to operate every year. Hence, proper policies and regulations should be adopted to retain such prospective flow of economic thrift.

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) states that the prime concern of DFI is to ensure easy and affordable access of the poor, rural, and unprivileged people to formal financial services that subsequently brings financial growth and stability. Formal financial services help banks collect more deposits, maximise capital, reduce liquid fragility, and increase liquid assets which helped small and medium banks to perform better during the GFC of 2007-2008 (Phan *et al.*, 2021). Moreover, access to formal financial services by more people will have a long-run impact on banking performance that helps banks to be financially stable and consequently contributes to the national development of a country through generating higher tax revenue (Manyika *et al.*, 2016). Therefore, national development can be achieved by the application of both FI and DFI in a proper way.

To scan the impact of FI on banking stability, a good number of studies are evident. However, being an ongoing research topic, studies are very scarce except a few to empirically scrutinize the association of DFI with banking stability. As noted that analysing the data of 43 banks of Bangladesh, the study of Banna (2020) shows that DFI has a significantly positive impact on banking stability that ultimately helps attain the SDGs. The study has considered the number of active mobile money agents, number of active mobile money accounts and mobile money transactions per 1000 adults as DFI variables and finds that the number of mobile money agents is not greatly associated with bank stability, whereas the number of mobile money

accounts and transaction is highly associated with bank stability. Besides, 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) considering mainly the mobile phone penetration and internet usage 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. Their study, deploying a random effect model and then a system GMM, finds that the advent of digital technology in the financial sector has a significant contribution to financial inclusion and the integration of both mobile phone and internet usage can remove the obstructions of implementing financial inclusion in a full swing and hence will open the door of digital financial inclusion. However, the condition of FI is not same in all their sample countries since online transactions need a high-speed internet connection that is not equally available in all the countries. Moreover, DFI strengthens the functions of FI as stated that 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 latest technological innovation (Moufakkir and Mohammed, 2020). Apprehending the impact of DFI, people living in Sub-Saharan African region become more inclined to mobile money transactions at a rapid rate where 122 million active mobile money accounts exist till 2018 (Moufakkir and Mohammed, 2020).

Although there are a few theoretical and empirical studies pertaining to the role and impact of FI, DFI on banking stability and economic growth, we are unique to investigate the impact of DFI on ASEAN banking stability. Since it is evident from the existing literature that the integration of digitization along with 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 banking stability. Thus, the proposed study is expected to add value to the prompt implementation of inclusive digital finance in the ASEAN banking sector which will ultimately facilitate the achievement of banking stability.

B. Hypothesis development

From the prevailing studies, both the positive and negative impacts of FI and DFI are denoted. Timely and efficient application of DFI might spur the overall economic condition of a country through ensuring banking stability and firms’ financial steadiness. Besides, when most of the people are banked, their savings increase banks’ deposit and hence their liquidity rises high. On the contrary, higher level of digitalized financial services may lead to many other awkward situations like card hacking, card cloning, card jamming, and privacy insecurity that might result in unauthorized money transfer. Moreover, people need to have a smartphone and apt financial literacy that might not be possible by the people living under poverty line. However, the positive impact of DFI outperforms the negative impact. Hence, the current study tends to develop the following hypothesis:

Hypothesis 1: Digital financial inclusion has a positive impact on the ASEAN banking stability.

III. DATA AND METHODOLOGY

The main objective of this study is to see how DFI can be a potential factor to maintain banking stability in ASEAN countries and whether the relationship could bring a possible implication for the post-Covid-19 era. In this regard, we need to see the empirical relationship between banking stability and DFI using the available data. This section provides the data sources and the methodology of this research.

A. Data

Many countries are heading towards a cashless economy through implementing the innovative technology properly. Governments believe that technology can serve both the banked and unbanked population of any country by providing digital financial services. Thus, several technology-based financial institutions including the existing banking sector are rendering financial services. However, this study merely considers the data of the banking sector, more particularly the ASEAN banking sector. The reasons behind choosing this area are as follows:

a) Most of the ASEAN countries have set their motto to be a cashless society by the year 2022 (ASEAN, 2019). b) Despite the rapid intensification in technology-based financial activities, approximately 470 million adults do not have a bank account and/or a mobile money account in this region (Prentice, 2020). Hence, they have decided to emphasise on how to bank the unbanked population of this region by implementing DFS. As a result, many financial institutions of these countries have started to provide DFS. c) Finally, ASEAN is a region having the most diversities in the world in terms of per capita GDP, culture, language, religion, population size, and ethnicity that all pose a grave challenge to execute FI and DFI efficiently in a full swing in this region (Bhardwaj *et al.*, 2018).

The study considers 4 ASEAN countries namely, Indonesia, Malaysia, the Philippines, and Thailand. Initially, we choose 10 ASEAN countries. But later we restrict our sample size to four due to the data unavailability. However, these four countries along with Singapore hold more than 80%¹ of the total ASEAN banking industry's assets. We have excluded Singapore to maintain our sample homogeneous as Singapore is a developed country which might produce a bias influence on the overall sample.

Primarily, the annual data of 256 commercial banks from 4 ASEAN countries have been considered. However, some banks have been excluded from the sample due to the data unavailability and missing values. Our final sample consists of 253 commercial banks with an

¹ Based on the data of S&P global database for the year 2018.

unbalanced panel data over the period 2011-2019 as DFI is available from 2011 onwards. Table 1 shows the proportion of our sample size in which Indonesia conveys the highest proportion (45%) followed by the Philippines (26%), Malaysia (19%) and Thailand (10%). The data have been taken from various sources: i) Orbis Bank-Focus database for bank-specific data; ii) Financial Access Survey (FAS), Global Findex databases and individual country's central bank's report for DFI data; iii) World Development Indicators (WDI), World Bank database for macroeconomic factors; and iv) previous literature for instrumental variables' data.

INSERT TABLE 1

B. Methodology

Banking stability

This study, following Kim *et al.* (2020), Banna (2020) and Ahamed and Mallick (2019), uses two proxies for banking stability measures: a) *Z-score*, the widely used in the banking and finance literature, an unbiased parameter of bank riskiness and distance-to-default; and b) the volatility of return of average assets (*sd(ROAA)*). The *Z-score* has been calculated in the following way:

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

Where $ROAA_{it}$, EQT_{it} and $\sigma(ROAA)_{it}$ refer to the return on average assets, the equity to assets ratio, and standard deviation (SD) of *ROAA* of bank *i* in year *t*, respectively. This study uses the 3-year rolling window to calculate SD of *ROAA*. Higher (lower) *Z-score* refers to less (more) asset's riskiness of the bank and less (more) default risk, thus more (less) stability and a bank with less (more) volatility of *ROAA* has displayed more (less) stability. As the *Z-score* is highly skewed, therefore, to minimise the potential skewness, by following Ahamed and Mallick (2019) and Kim *et al.* (2020), this study uses the natural logarithm of *Z-score* and the natural logarithm of the volatility of *ROAA* [$\ln(sd(ROAA))$] as a proxy for banking stability.

Digital financial inclusion index

To find the relationship between banking stability and *DFI*, we need to measure proxies for *DFI*. Due to the data unavailability, it is quite difficult to measure proxies and/or index for *DFI*. However, based on the available data on FAS and Global Findex databases, we have taken variables which are solely related to digital financial activities including mobile and internet-based financial services that can be enjoyed through electronic devices in a cashless manner. Following the previous studies (e.g., Ahamed and Mallick, 2019; Banna *et al.*, 2020a; Banna and Alam, 2020) on financial inclusion with banking performance, we also consider both the access (supply side) and usage (demand side) penetrations for our digital financial inclusion index. Previous studies have taken the number of ATMs, bank branches, and bank accounts as financial inclusion proxies; whereas, this study considers the number of mobile money agent outlets, mobile money accounts, and mobile and internet banking transactions (Siddik and Kabiraj, 2020) to measure a comprehensive digital financial inclusion index.

For the supply side (both geographic and demographic outreach - access to digital finance penetration) - *Mobile money agent outlets per 100,000 adults*, as well as *per 1,000 km²* have been considered. For the demand side (usage of digital finance penetration) - *Number of mobile money accounts per 1,000 adults*, *Number of mobile and internet banking transaction (during reference year) per 1,000 adults*, and *Value of mobile and internet banking transaction (during reference year) (% of GDP)* have been taken. We endorse mobile money, a digitalised technology, which allows people to retrieve, save, and spend money using a mobile device (Subramaniam, 2020). The rapid pace of mobile money (*DFI*) broadens the room and spectrum of financial services to reach the poorest and most remote parts of the society. These were the biggest obstacles for FI since these poor and rural people are away from formal banking facility. This is because, some of them often cannot afford the minimum balance to open a bank account and some remain aloof due to conservative religious outlook. The mobile and internet banking,

on one hand, have banked the unbanked and, on the other hand, have enhanced banking stability through minimising operational costs and maximising efficiency and productivity.

Since the proxies used in building the *DFI* index are highly correlated with each other, this study develops an inclusive index of *DFI* to capture the common variation among the proxies using principal components analysis (henceforth PCA²). This index will sufficiently deal with the setback of multicollinearity and over-parameterisation as a single measure of *DFI* (Ahamed and Mallick, 2019). We have measured both the supply side (*access*) index and the demand side (*usage*) index separately using the PCA. Finally, we combine these two indices to create a comprehensive digital financial index using the PCA. All these three indices have been normalised using minimum-maximum normalisation technique to avoid the unnecessary negative value.

Bank-specific and macro-economic variables

This study controls both the bank-specific and macroeconomic variables. Following Fang *et al.* (2014), ratio of total loans over total assets (Loan ratio - *LR*) has been used to account for liquidity risk of individual banks. To control potential size effect and the loan portfolio risk of an individual bank, this study uses the logarithm of total assets (Bank size – *SIZE*) and the ratio of loan loss provision to total loans (*Loan loss provision ratio* - *LLPR*) respectively. The ratio of non-interest income to total operating income (Revenue diversification - *IND*) has been considered to control the ambiguous effect of off-balance sheet activities. Since the better management quality can reduce excessive risk-taking tendency, the ratio of total earning assets to total assets (Management quality - *MQ*) has, therefore, been taken into consideration. The equity ratio (Capitalisation - *CAP*) has been used to control the capital risk as well-capitalised banks are assumed to take less risks. The Herfindahl-Hirschman Index (*HHI*) has been taken for controlling market concentration. The specialisation (*SPECIAL* - whether Islamic or

² For the brevity, we did not provide the results of PCA, but the results are available upon reasonable request.

conventional bank) has also been controlled. This paper uses several macroeconomic variables such as, annual *GDP* growth rate (*GDPG*), inflation (*INFL*), good governance (*GG*) to control economic growth, business cycle and institutional effect. *GG* index is constructed using standardised approach of Kaufmann *et al.* (2010)'s governance indicators which is 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 investigate the impact of *DFI* on ASEAN bank stability, the following baseline regression analysis has been used in this study.

$$Y_{ijt} = \alpha + \beta DFI_{jt} + \gamma B_{ijt} + \varphi M_{jt} + \varepsilon_{ijt} \quad (2)$$

Where, $Y_{ijt} = \ln (Z\text{-score})$ and $\ln(sd(ROAA))$ as dependent variables which are the proxies for the bank stability of bank *i* of country *j* in year *t*. DFI_{jt} = Digital Financial Inclusion index of country *j* in year *t*. B_{ijt} = Bank-specific factors of bank *i* of country *j* in year *t* (*such as SIZE, LR, LLPR, IND, MQ, CAP, HHI and SPECIAL*). M_{jt} = Macroeconomic factors of country *j* in year *t* (*such as INF, GDPG and GG*). β, γ, φ = Coefficients of the variables and ε_{ijt} = Error term.

We, primarily, use the ordinary least square (OLS) method to find the fundamental relationship between banking stability and *DFI*. After that, we use the two-step system dynamic generalized method of moments (GMM) panel regression model of Blundell and Bond (1998) to minimise the potential endogeneity issues and mitigate the unobserved time-invariant bank-specific heterogeneity effect based on the study of Ahamed and Mallick (2019). This study also uses panel-corrected standard errors (PCSE) method of Beck and Katz (1995) by following

Alfadli and Rjoub (2020) to see the additional robustness of the relationship between the variables.

IV. RESULTS AND ANALYSIS

This section contains three subsections. The first subsection provides the descriptive statistics of the research, followed by main findings and discussions of the study in the second subsection. The final sub-section discusses the robustness checks of the results.

A. Descriptive statistics

Table 2 contains the descriptive statistics of the variables. Few observations are noteworthy in the table. First, the $\ln(Z\text{-score})$ has an average value of 4.19 with a standard deviation (SD) of 1.23, indicating that to minimise bank equity, $ROAA$ would have to drop by an average of 4.19 times of their SD. Moreover, the mean value of the ASEAN bank size and SD are 7.62 and 2.13 respectively which shows high yearly variation among the banks. The sample countries, on average, have achieved so far 5.18% growth in their GDP over the year 2011 to 2019. However, due to the Covid-19 pandemic, the IMF predicted the overall growth of ASEAN countries will be less than 2.9% in 2020 (ASEAN, 2020). In the first quarter of 2020, Indonesia observes a growth of 3%, whereas, Malaysia and the Philippines observe 0.7% and -0.2% respectively (ASEAN, 2020). This shows a fatal impact of the Covid-19 on ASEAN economic growth which subsequently affects the entire ASEAN banking sector. Furthermore, the decomposition of DFI index shows that the existing mobile money account and bank account holders of this region are vastly comfortable with the use of mobile and internet banking facilities. In addition to that, Figure 1 shows the DFI indices of the sample countries where Thailand holds the higher index score in terms of comprehensive DFI index as well as DFI access index, whereas Malaysia contains the higher index score in terms of DFI usage index. On the other hand, Indonesia, Malaysia, and the Philippines have the lowest score of overall DFI , DFI access, and DFI usage indices respectively over the period 2011-2019. Our index

score is allied with Prentice (2020), who reported that 74% of the internet users in Thailand have access to banking services through their mobile devices.

INSERT TABLE 2

INSERT FIGURE 1

B. Banking stability and digital financial inclusion

This subsection provides the main findings of our analysis. The variance inflation factor (VIF) and the pairwise correlation suggest that none of the independent variables are highly correlated to violate the multicollinearity issue³. The Breusch-Pagan / Cook-Weisberg test⁴ for heteroskedasticity suggests an existence of heteroskedasticity issue in the model. As a result, we use OLS regression with heteroscedastic-corrected robust standard errors to find the baseline relationship of the ASEAN banking stability and digital financial inclusion. Initially (in Table 3), we control only the bank-specific variables such as *SIZE*, *LR*, *LLP*, *MQ*, *CAP*, *IND*, *HHI* and *SPECIAL* and after that, we also control macroeconomic factors such as *GDPG*, *INFL* and *GG* along with other bank-specific factors (in Table 4). We divide our analysis based on two dimensions: a) two proxies of banking stability – $\ln(Z\text{-score})$ (model 1-3) and $\ln(sd(ROAA))$ (model 4-6), b) three indices of *DFI*—*DFI index comprehensive* (model 1 & 4), *DFI index access* (model 2 & 5) and *DFI index usage* (model 3 & 6) by using the PCA.

INSERT TABLE 3

The findings (in Table 3) show that *overall DFI* has a significant positive relationship with ASEAN banking stability (*Z-score*) and a significant negative relationship with the volatility of *ROAA* at 5% level of significance while controlling the bank-specific factors. 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). Also, when *DFI* is

³ Results are available upon reasonable request

⁴ Results are available upon reasonable request

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

enhanced in a country, the volatility of the *ROAA* is less and hence, more stability is obtained. Though the *DFI usage* has a significant relationship with both the banking stability proxies, the *DFI access*, however, has an insignificant relationship (even it has an insignificant positive relationship with the volatility of *ROAA*). The findings suggest that people of the sample countries have lack of access to digital financial services as banks fail to provide enough mobile banking facilities and/or agent outlets services in this area specially in the remote areas of this region. Hence, they neither open an account nor do their basic transactions. However, those who have access, can utilise such services properly.

INSERT TABLE 4

In Table 4, we control both the bank-specific and the macroeconomic factors. However, the results remain unchanged except the significant level. We interpret the coefficient of *DFI* as semi-elasticity as our *Z-score* value is based on the natural logarithm and *DFI* is an index. Hence, we can construe the results in Table 5 that a one standard deviation increases in the *overall index of DFI*, which equals to 0.164, is associated with an increase in the *Z-score* (banking stability) of 13.40% (0.817×0.164). The economic value of the findings (in Table 4 and Table 5) suggests that *overall DFI* has a significant impact on ASEAN banking stability which means *DFI* enriches the soundness of individual ASEAN banks in the sample countries. These findings are in line with the previous studies (e.g., Banna, 2020; Morgan and Pontines, 2018; Ahamed and Mallick, 2019; Banna *et al.*, 2020b) that show a financial system with inclusive DFS inclines to boost banking stability, and that the greater implementation of *DFI* moderates the excessive risk-taking drift of a particular bank. The results also indicate that conventional banks are in a better position as compared to Islamic banks in terms of banking stability and *DFI* relationship in ASEAN region. Even while running the regression⁵ based on

⁵ Results are available upon request

bank specialisation, the relationship between banking stability and *DFI* is insignificant for Islamic banks regardless of indices.

Therefore, the insignificant results of Islamic banking stability – *DFI* and *DFI* access with overall banking stability advise that banking sector in this region needs to expand their agent networks and other access points as well as improve the design of their existing DFS products (Aviles and Trujillo, 2019) by implementing artificial intelligence to fascinate people of all economic classes. The advancement of digital finance products enjoyed through electronic devices can reduce the tendency of face-to-face interactions but keep the usual flow of people's financial transactions/activities unabated. As seen, in-person transactions fuel the spread of Covid-19, whereas contactless or digital transactions help break the chain of the virus. So, the proper and full swing execution of *DFI* in the banking sector will help the government to prevent the spread of the Covid-19. Consequently, *DFI* not only aids to bank the unbanked/disadvantaged people, but also may benefit banks to collect low-priced retail deposits from a colossal clientele base (Ahamed and Mallick, 2019) which can minimise the liquidity crisis of the bank in times of any crises (e.g., the current Covid-19 pandemic) and ultimately improves banking stability. Moreover, *DFI* can also help banks to lend money to their vast clientele including the SMEs and the other vulnerable groups which eventually improves the financial stability by achieving lower NPLs and default risk (Morgan and Pontines, 2018). Hence, the mobility restrictions to contain the uncertain Covid-19 pandemic have signalled the banking sector to implement DFS at a rapid pace. Though the proper implementation of *DFI* has been on the radar of global leaders and policymakers since long⁶ before the Covid-19 crisis, the Covid-19 pandemic has put forward questions on how *DFI* can be a feasible solution to react to the crisis and how the crisis would, in turn, accelerate *DFI*.

⁶ In 2018, the Annual Meeting of IMF and World bank launched the Bali fintech agenda to layout the proper development of digital financial services/fintech in the financial inclusion.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

Additionally, the economic impact of the results, in particular, suggests that inclusive digital finance may help ASEAN banks to enhance stability by minimising operational cost through maintaining minimum paperwork, documentation, and a fewer physical bank branches (Manyika *et al.*, 2016). Furthermore, *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 (Danisman and Tarazi, 2020). 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). As a result, during any pandemic like the Covid-19, *DFI* can help governments to reach out to those in the informal sector and without having access to formal bank accounts to provide quick and secure financial support as an emergency response (Allmen *et al.*, 2020). With an inclusive digitalised financial sector, ASEAN banks are likely to enjoy greater financial stability in times of economic shocks (e.g., during and the post Covid-19 pandemic era). Besides, *SIZE*, *LR*, *LLPR*, *CAP* and *INFL*, *GG* are also significant determinants of ASEAN banking stability.

37 38 39

C. Robustness test

40
41
42
43
44
45
46
47
48

In this subsection, this study provides various robustness checks of the results. In this regard, we first consider the two-step system GMM to mitigate possible endogeneity issues and to see the dynamic relation. Then we choose the PCSE model to correct panel standard errors. Finally, we take an alternative proxy for *DFI*.

49 50

Two-step dynamic system GMM model

51
52
53
54
55
56
57
58
59
60

To check the robustness of the OLS results and to see the dynamic relationship between ASEAN banking stability and *DF*, we now consider two-step system dynamic GMM panel regression. This study uses the Sargan over-identifying restrictions test in which the insignificant statistic suggests the validity of the utilised instruments. This paper also uses

Arellano-Bond AR(1) and AR(2) tests to see whether first-order and second-order autocorrelation exist in the model to justify the GMM dynamic model (Ahamed and Mallick, 2019). The significant AR(1) and the insignificant AR(2) statistics indicate that there is a first-order autocorrelation and no second-order autocorrelation respectively in the model.

INSERT TABLE 5

Table 5 reports the results of system GMM. The diagnostic tests [Sargan, AR(1) and AR(2) tests] justify the validity of the dynamic GMM model for this study. The results suggest that, after considering time-series variation, the relationship remain unchanged which confirms a robust positive relationship between ASEAN banking stability and *DFI index*.

PCSE regression model

To check the additional robustness of the OLS results, we run the panel-corrected standard errors (PCSE) regression model. The findings in the PCSE regression model⁷ remain mostly unchanged but improve the relationship coefficient between banking stability and DFI. Thus, the findings show the robustness of the OLS regression results and suggest that DFI has a significant impact on ASEAN banking stability. This suggests that ASEAN banks, with the proper implementation of *DFI*, expected to maintain financial stability in times of the Covid-19 crisis.

Alternative DFI proxy

We also consider *the percentage of adults made or received digital payments in the past year (MORDIGPAY)* as an alternative proxy for *DFI* from the Global Findex database. The results, using an alternative proxy, assert the robustness of the previous results. Thus, it is evident that with an inclusive digitalised financial sector, ASEAN banks enjoy greater financial stability. Consequently, ASEAN banks are, with the proper implementation of *DFI*, likely to uphold the banking sector stability by reducing liquidity crisis and NPLs. Furthermore, *DFI*

⁷ Results are available upon reasonable request.

can help governments, in times of economic shocks, to provide the vulnerable groups with quick and secure emergency financial supports based on their needs. Therefore, accelerating digital finance in ASEAN countries is considered as one of the significant means for the banking sector stability that subsequently leads to economic and financial resilience even in the face of any crises (e.g., GFC, Covid-19).

V. CONCLUDING REMARKS

This paper examines the relationship between banking stability and *DFI* using a sample of 253 banks of four ASEAN countries from the year 2011 to 2019. The empirical evidence advises that greater implementation of *DFI* is positively associated with ASEAN banking stability which does not only reduce the default risk of the banks but also increases the financial mobility in the region. Consequently, an integrated inclusion of digital finance in the ASEAN banking industry ensures sustainable economic growth that is likely to help maintain financial sustainability in times of crisis like the Covid-19 pandemic. Our results are robust in various robustness checks.

Some of the countries, based on our findings, show lower *DFI* scores in various indices. Therefore, the following policies can be taken into consideration to improve the *DFI* scores. First, as our results find that there is a lack of digital financial access in the ASEAN region, the banking sector, therefore, needs to expand its agent networks and other access points as well as improve the design of its existing DFS products by implementing artificial intelligence and machine learning (e.g., online bank account opening, QR/NFC- mobile linked based ATMs) to fascinate people of all economic classes. This will not only reduce the liquidity problem faced by the banks in times of crises by increasing retail deposits from a vast clientele base but also ease financing constraints of individuals and SMEs. Second, since our index suggests that people in this region specially in the Philippines, Indonesia and Thailand have lack of financial and digital literacy, governments and policymakers should, therefore, provide people with

appropriate digital financial literacy specially to the middle aged and older people. Finally, the positive relationship between *DFI* and banking stability suggests that *DFI*, as a progressive mechanism, can bring a ground-breaking development in the ASEAN banking industry even in times of any economic shock. Hence, the government, policymakers, and standard setters should take immediate steps to implement the full-fledged DFS in the ASEAN banking sector by adopting innovative, technology-friendly, and regulatory-based policies as well so that they can efficiently tackle the aftermath of any adverse situation like the current Covid-19 pandemic.

Our study has some limitations such as, we could not consider all ASEAN countries in the analysis due to the data unavailability. We also could not accommodate all the banks of the said countries due to missing values. Despite some limitations pertinent to data unavailability, our findings can help future researchers to carry out the similar studies in the context of other regions like SAARC, MENA, LACs.

REFERENCES

- Ahamed, M. M. & Mallick, S. K. 2019, "Is financial inclusion good for bank stability? International evidence", *Journal of Economic Behavior & Organization*, Vol. 157 No. C, pp.403-427. doi: 10.1016/j.jebo.2017.07.027
- Alfadli, A. & Rjoub, H. 2020, "The impacts of bank-specific, industry-specific and macroeconomic variables on commercial bank financial performance: evidence from the Gulf cooperation council countries", *Applied Economics Letters*, Vol. 27 No. 15, pp.1284-1288. doi:10.1080/13504851.2019.1676870
- Allmen, U. E., Khera, P., Ogawa, S. & Sahay, R. 2020. Digital Financial Inclusion in the Times of COVID-19. Available from: <https://blogs.imf.org/2020/07/01/digital-financial-inclusion-in-the-times-of-covid-19/>.
- Appiah-Otoo, I. 2020, "Does COVID-19 Affect Domestic Credit? Aggregate and Bank Level Evidence From China", *Asian Economics Letters*, Vol. 1 No. 3. doi:10.46557/001c.18074
- Arner, D. W., Buckley, R. P., Zetsche, D. A. & Didenko, A. 2020, "After Libra, Digital Yuan and COVID-19: Central Bank Digital Currencies and the New World of Money and Payment Systems", *European Banking Institute Working Paper Series*, Vol. 65/2020. doi:10.2139/ssrn.3622311
- ASEAN 2019. "Investing in ASEAN". The Association of Southeast Asian Nations (ASEAN). Available at <https://asean.org/storage/2019/11/ASEAN-integration-report-2019.pdf>
- ASEAN 2020. "Economic Impact of COVID-19 Outbreak on ASEAN". The Association of Southeast Asian Nations (ASEAN). Available at https://asean.org/storage/2020/04/ASEAN-Policy-Brief-April-2020_FINAL.pdf
- Asif, J., Ting, I. W. K. & Kweh, Q. L. 2020, "Intellectual Capital Investment and Firm Performance of the Malaysian Energy Sector: A New Perspective From a Nonlinearity Test", *Energy Research Letters*, Vol. 1 No. 3, pp.13622. doi: 10.46557/001c.13622
- Aviles, A. M. & Trujillo, V. 2019. Advancing digital financial inclusion in ASEAN. Available from: <https://blogs.worldbank.org/psd/advancing-digital-financial-inclusion-asean>.
- Banna, H. 2020, "The role of digital financial inclusion on promoting sustainable economic growth through banking stability: Evidence from Bangladesh", *Development Review*, Vol. 29 No. 2020, pp.19-36. Available at http://research.napd.ac.bd/?page=journal-publication-details&journal_id=35

- 1
- 2
- 3 Banna, H. & Alam, M. R. 2020, "Islamic Banking Efficiency and Inclusive Sustainable Growth: The Role of
- 4 Financial Inclusion", *Journal of Islamic Monetary Economics and Finance*, Vol. 6 No. 1. doi:
- 5 10.21098/jimf.v6i1.1089
- 6 Banna, H., Alam, M. R., Ahmad, R. & Sari, N. M. 2020a, "Does financial inclusion drive the Islamic banking
- 7 efficiency? A post-financial crisis analysis", *The Singapore Economic Review*.
- 8 doi:10.1142/s0217590819420050
- 9 Banna, H., Hassan, M. K. & Alam, M. R. 2020b, "Digital Financial Inclusion, Islamic Banking Stability and
- 10 Sustainable Economic Growth", In: Saraç, M. & Hassan, M. K. (eds.) *Islamic Perspective for*
- 11 *Sustainable Financial System*. Istanbul University Press, Istanbul, pp.131-152. doi:
- 12 10.26650/B/SS10.2020.017.07
- 13 Beck, N. & Katz, J. N. 1995, "What to do (and not to do) with time-series cross-section data", *American*
- 14 *political science review*, Vol. 89 No. 3, pp.634-647. doi: 10.2307/2082979
- 15 Beck, T., Senbet, L. & Simbanegavi, W. 2014, "Financial inclusion and innovation in Africa: An overview",
- 16 *Journal of African Economies*, Vol. 24 No. suppl_1, pp.i3-i11. doi: 10.1093/jae/eju031
- 17 Bhardwaj, M., Hedrick-Wong, Y. & Thomas, H. 2018. Financial inclusion for Asia's unbanked. Available from:
- 18 <https://blogs.worldbank.org/allaboutfinance/financial-inclusion-asias-unbanked>.
- 19 Blundell, R. & Bond, S. 1998, "Initial conditions and moment restrictions in dynamic panel data models",
- 20 *Journal of econometrics*, Vol. 87 No. 1, pp.115-143. doi: 10.1016/S0304-4076(98)00009-8
- 21 CGAP. 2015. "What is Digital Financial Inclusion and Why Does it Matter?". Available at
- 22 <https://www.cgap.org/blog/what-digital-financial-inclusion-and-why-does-it-matter>
- 23 Danisman, G. O. & Tarazi, A. 2020, "Financial inclusion and bank stability: evidence from Europe", *The*
- 24 *European Journal of Finance*, Vol. 26 No. 18 pp.1842-1855. doi:10.1080/1351847X.2020.1782958
- 25 Ellis, M. 2020. How Digital Banking Saved the Day During the COVID-19 Pandemic. Available from:
- 26 [https://thefinancialbrand.com/96448/covid-19-coronavirus-how-digital-banking-saved-the-day-during-](https://thefinancialbrand.com/96448/covid-19-coronavirus-how-digital-banking-saved-the-day-during-the-covid-19-pandemic/)
- 27 [the-covid-19-pandemic/](https://thefinancialbrand.com/96448/covid-19-coronavirus-how-digital-banking-saved-the-day-during-the-covid-19-pandemic/).
- 28 Ertuğrul, H. M., Güngör, B. O. & Soytas, U. 2020, "The effect of the COVID-19 outbreak on the Turkish diesel
- 29 consumption volatility dynamics", *Energy Research Letters*, Vol. 1 No. 3, pp.17496. doi:
- 30 10.46557/001c.17496
- 31 Fang, X. & Zhang, Y. 2021, "An Analysis of the Dynamic Asymmetric Impact of the COVID-19 Pandemic on
- 32 the RMB Exchange Rate", *Asian Economics Letters*, Vol. 1 No. 4, pp.18644. doi:
- 33 10.1016/j.jbankfin.2013.11.003
- 34 Fang, Y., Hasan, I. & Marton, K. 2014, "Institutional development and bank stability: Evidence from transition
- 35 countries", *Journal of Banking & Finance*, Vol. 39 No. February 2014, pp.160-176.
- 36 doi:10.1016/j.jbankfin.2013.11.003
- 37 Gil-Alana, L. A. & Monge, M. 2020, "Crude oil prices and COVID-19: Persistence of the shock", *Energy*
- 38 *Research Letters*, Vol. 1 No. 1, pp.13200. doi: 10.46557/001c.13200
- 39 He, P., Sun, Y., Zhang, Y. & Li, T. 2020, "COVID-19's Impact on Stock Prices Across Different Sectors—An
- 40 Event Study Based on the Chinese Stock Market", *Emerging Markets Finance and Trade*, Vol. 56 No.
- 41 10, pp.2198-2212. doi:10.1080/1540496X.2020.1785865
- 42 Hoe, L. K. 2020. COVID-19: Opportunities and Challenges for Digital Banks. Available from:
- 43 [https://www.pwc.com/my/en/perspective/digital/200408-pwc-blog-covid-19-opportunities-challenges-](https://www.pwc.com/my/en/perspective/digital/200408-pwc-blog-covid-19-opportunities-challenges-digital-banks.html)
- 44 [digital-banks.html](https://www.pwc.com/my/en/perspective/digital/200408-pwc-blog-covid-19-opportunities-challenges-digital-banks.html).
- 45 Kammoun, S., Loukil, S. & Loukil, Y. B. R. 2020, "The Impact of FinTech on Economic Performance and
- 46 Financial Stability in MENA Zone", *Impact of Financial Technology (FinTech) on Islamic Finance*
- 47 *and Financial Stability*. IGI Global, pp.253-277. doi: 10.4018/978-1-7998-0039-2.ch013
- 48 Kaufmann, D., Kraay, A. & Mastruzzi, M. 2010, "The worldwide governance indicators: A summary of
- 49 methodology", *Data and Analytical Issues, World Bank Policy Research Working Paper*, Vol.
- 50 5430. doi: 10.1017/S1876404511200046
- 51 Kim, H., Batten, J. A. & Ryu, D. 2020, "Financial crisis, bank diversification, and financial stability: OECD
- 52 countries", *International Review of Economics & Finance*, Vol. 65 No. pp.94-104. doi:
- 53 10.1016/j.iref.2019.08.009
- 54 Klapper, L. 2017, "How digital payments can benefit entrepreneurs", *IZA World of Labor*. Available at
- 55 <http://hdl.handle.net/10986/31654>
- 56 Li, L., Strahan, P. E. & Zhang, S. 2020, "Banks as Lenders of First Resort: Evidence from the COVID-19
- 57 Crisis", *The Review of Corporate Finance Studies*, Vol.9 No.3 doi:10.1093/rcfs/cfaa009
- 58 Liu, S., Xu, Q. & Jiang, C. 2020, "Systemic risk of China's commercial banks during financial turmoil in 2010-
- 59 2020: A MIDAS-QR based CoVaR approach", *Applied Economics Letters*, pp.1-10. doi:
- 60 10.1080/13504851.2020.1839629
- Mani, M. 2016, "Financial Inclusion in South Asia—Relative Standing, Challenges and Initiatives", *South Asian*
- Survey*, Vol. 23 No. 2, pp.158-179. doi: 10.1177/0971523118783353

- Manyika, J., Lund, S., Singer, M., White, O. & Berry, C. 2016, "Digital finance for all: Powering inclusive growth in emerging economies", *McKinsey Global Institute*. Available at <https://www.mckinsey.com/~media/McKinsey/Featured%20Insights/Employment%20and%20Growth/How%20digital%20finance%20could%20boost%20growth%20in%20emerging%20economies/MG-Digital-Finance-For-All-Full-report-September-2016.pdf>
- McKibbin, W. J. & Fernando, R. 2020, "The global macroeconomic impacts of COVID-19: Seven scenarios", *CAMA Working Paper* Vol. 19/2020. doi: 10.2139/ssrn.3547729
- Mishra, A. K., Rath, B. N. & Dash, A. K. 2020, "Does the Indian Financial Market Nosedive because of the COVID-19 Outbreak, in Comparison to after Demonetisation and the GST?", *Emerging Markets Finance and Trade*, Vol. 56 No. 10, pp.2162-2180. doi:10.1080/1540496X.2020.1785425
- Morgan, P. J. & Pontines, V. 2018, "Financial stability and financial inclusion: The case of SME lending", *The Singapore Economic Review*, Vol. 63 No. 01, pp.111-124. doi: 10.1142/S0217590818410035
- Moufakkir, M. & Mohammed, Q. 2020, "The Nexus Between FinTech Adoption and Financial Inclusion", *Impact of Financial Technology (FinTech) on Islamic Finance and Financial Stability*. IGI Global, pp.193-209. Doi: 10.4018/978-1-7998-0039-2.ch010
- Narayan, P. K. 2020a, "Has COVID-19 changed exchange rate resistance to shocks", *Asian Economics Letters*, Vol. 1 No. 1, pp.17389. doi: 10.46557/001c.17389
- Narayan, P. K. 2020b, "Oil price news and COVID-19—Is there any connection?", *Energy Research Letters*, Vol. 1 No. 1, pp.13176. doi: 10.46557/001c.13176
- Narayan, P. K., Gong, Q. & aliahmed, H. J. 2021, "Is there a pattern in how COVID-19 has affected Australia's stock returns?", *Applied Economics Letters*, Vol. No. pp.1-4. doi:10.1080/13504851.2020.1861190
- Narayan, P. K., Phan, D. H. B. & Liu, G. 2020, "COVID-19 lockdowns, stimulus packages, travel bans, and stock returns", *Finance Research Letters*, Vol. 38 No. January 2021. doi:10.1016/j.frl.2020.101732
- Neaime, S. & Gaysset, I. 2018, "Financial inclusion and stability in MENA: Evidence from poverty and inequality", *Finance Research Letters*, Vol. 24 No. march 2018 pp.230-237. doi: 10.1016/j.frl.2017.09.007
- Ozili, P. K. 2018, "Impact of digital finance on financial inclusion and stability", *Borsa Istanbul Review*, Vol. 18 No. 4, pp.329-340. doi: 10.1016/j.bir.2017.12.003
- Phan, D. H. B. & Narayan, P. K. 2020, "Country responses and the reaction of the stock market to COVID-19—A preliminary exposition", *Emerging Markets Finance and Trade*, Vol. 56 No. 10, pp.2138-2150. doi: 10.1080/1540496X.2020.1784719
- Phan, H. M., Pham, H. V. D., Nguyen, H. T. & Nguyen, L. T. 2021, "Bank performance during the credit crisis: evidence from Asia-Pacific countries", *Applied Economics Letters*, Vol. No. pp.1-14. doi: 10.1080/13504851.2020.1869160
- Prentice, G. 2020. "ASEAN needs smart regulation to boost financial inclusion", *Nikkei Asian Review*. Available at <https://asia.nikkei.com/Opinion/ASEAN-needs-smart-regulation-to-boost-financial-inclusion>
- Salisu, A. A. & Sikiru, A. A. 2020, "Pandemics and the Asia-Pacific Islamic Stocks", *Asian Economics Letters*, Vol. 1 No. 1, pp.17413. doi:10.46557/001c.17413
- Senou, M. M., Ouattara, W. & Acclassato Houensou, D. 2019, "Financial inclusion dynamics in WAEMU: Was digital technology the missing piece?", *Cogent Economics & Finance*, Vol. 7 No. 1, pp.1665432. doi: 10.1080/23322039.2019.1665432
- Sharma, S. S. 2020, "A Note on the Asian Market Volatility During the COVID-19 Pandemic", *Asian Economics Letters*, Vol. 1 No. 2, pp.17661. doi:10.46557/001c.17661
- Shen, H., Fu, M., Pan, H., Yu, Z. & Chen, Y. 2020, "The Impact of the COVID-19 Pandemic on Firm Performance", *Emerging Markets Finance and Trade*, Vol. 56 No. 10, pp.2213-2230. doi:10.1080/1540496X.2020.1785863
- Siddik, M. N. A. & Kabiraj, S. 2020, "Digital Finance for Financial Inclusion and Inclusive Growth", *Digital Transformation in Business and Society*. Springer, pp.155-168. doi: 10.1007/978-3-030-08277-2_10
- Subramaniam, P. 2020, "Banking: Digital initiatives aimed at financial inclusion". *The Edge Malaysia*. Available at <https://www.theedgemarkets.com/article/banking-digital-initiatives-aimed-financial-inclusion>
- Van, L. T.-H., Nguyen, N. T. & Vo, D. H. 2020, "Financial Inclusion and Stability in the Asian Region Using Bank-Level Data", *Borsa Istanbul Review*. doi: 10.1016/j.bir.2020.06.003
- Wójcik, D. & Ioannou, S. 2020, "COVID-19 and Finance: Market Developments So Far and Potential Impacts on the Financial Sector and Centres", *Tijdschrift voor economische en sociale geografie*, Vol. 111 No. 3, pp.387-400. doi:10.1111/tesg.12434
- Yang, H. & Deng, P. 2021, "The Impact of COVID-19 and Government Intervention on Stock Markets of OECD Countries", *Asian Economics Letters*, Vol. 1 No. 4, pp.18646. doi: 10.46557/001c.18646

Tables

Table 1. The list of countries and number of banks

Country-Name	Number of Banks	Observations	Sample %
INDONESIA	113	795	45
MALAYSIA	48	346	19
PHILIPPINES	66	348	26
THAILAND	26	201	10
Total	253	1690	100

This table reports the proportion of the sample size used in this study. The number of banks is based on the Orbis Bank-focus database. Only Four of Ten ASEAN countries have been considered for this study due to the unavailability of the digital financial inclusion data.

Table 2. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Banking stability					
<i>Ln(Z-score) using return on average assets (ROAA) (LZS)</i>	1303	4.190	1.225	-1.243	7.997
<i>Volatility of ROAA (SDROAA)</i>	1303	0.486	0.940	0.004	9.969
Digital Financial Inclusion proxies and indices					
<i>Number of mobile money agent outlets per 1,000 km² (MAGTKM)</i>	1690	78.897	54.153	15.907	273.049
<i>Number of mobile money agent outlets per 100k adults (MAGTAD)</i>	1690	62.244	32.422	16.488	242.06
<i>Number of mobile money accounts per 1,000 adults (MACTAD)</i>	1690	260.674	240.742	0.393	855.869
<i>Number of mobile and internet money transactions (during the reference year) per 1,000 adults (NMITAAD)</i>	1690	52673.81	88573.98	1876.87	400000
<i>Value of mobile and internet banking transaction (during reference year) (% of GDP) (VMITAAD)</i>	1690	204.874	127.409	74.407	571.605
<i>Comprehensive digital financial inclusion index using PCA (DFI)</i>	1690	0.284	0.164	0	1
<i>Digital financial inclusion (access – supply side) index using PCA (DFI – Access)</i>	1690	0.22	0.16	0	1
<i>Digital financial inclusion (usage – demand side) index using PCA (DFI – Usage)</i>	1690	0.256	0.245	0	1
<i>Made or received digital payments in the past year (% age 15+) (MORDIGPAY)</i>	1690	35.949	15.992	19.51	70.42
Bank-specific variables					
<i>Bank size (SIZE)</i>	1690	7.624	2.129	0.557	12.225
<i>Loan ratio (LR)</i>	1682	0.611	0.166	0	1.129
<i>Loan loss provision ratio (LLPR)</i>	1360	0.007	0.017	-0.079	0.268

<i>Management quality (MQ)</i>	1689	0.822	0.125	0.006	0.997
<i>Capitalisation (CAP)</i>	1690	0.17	0.154	-0.272	0.997
<i>Revenue diversification (IND)</i>	1524	33.111	36.609	-127.231	553.863
<i>Herfindahl-Hirschman index (HHI)</i>	1690	0.092	0.023	0.067	0.179

Macroeconomic variables

<i>Gross domestic product growth rate (GDPG)</i>	1690	5.178	1.147	0.84	7.243
<i>Inflation (CPI) (INFL)</i>	1690	3.379	1.821	-0.9	6.41
<i>Good governance index (GG)</i>	1690	0.508	0.127	0.353	0.801

This table provides the definition of all variables used in this study and their descriptive statistics. The volatility of ROAA is calculated based on three-years rolling periods. Bank size (SIZE) is the natural logarithm of the total assets, Loan ratio (LR) is ratio of total loans over total assets, Loan loss provision ratio (LLPR) is the ratio of loan loss provision to total loans, Management quality (MQ) is the ratio of total earning assets to total assets, Revenue diversification (IND) is the ratio of non-interest income to total operating income, Capitalisation (CAP) is the equity ratio, Herfindahl-Hirschman Index (HHI) index is the sum of the squares of the market shares of each bank, and Good governance index (GG) is constructed using standardised approach of Kaufmann et al. (2010)'s governance indicators which is 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. Source: Orbis Bank-focus, World Development Indicators (WDI), Financial Access Survey (FAS), Findex.

Table 3: ASEAN Bank stability and digital financial inclusion (OLS regression - Bank-level variables)

	<i>Ln (Z-score)</i>			<i>Ln (sd (ROAA))</i>		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>DFI</i>	0.722**			-0.919***		
	(0.354)			(0.308)		
<i>DFI - Access</i>		0.232			0.311	
		(0.257)			(0.223)	
<i>DFI - Usage</i>			0.733***			-0.949***
			(0.183)			(0.183)
<i>SIZE</i>	0.182***	0.192***	0.169***	-0.203***	-0.215***	-0.185***
	(0.022)	(0.022)	(0.023)	(0.020)	(0.020)	(0.021)
<i>LR</i>	1.050***	1.044***	1.143***	-0.744**	-0.737**	-0.865***
	(0.306)	(0.305)	(0.303)	(0.289)	(0.289)	(0.287)
<i>LLPR</i>	-23.272***	-23.234***	-22.471***	20.140***	20.082***	19.101***
	(3.784)	(3.824)	(3.668)	(3.287)	(3.324)	(3.108)
<i>MQ</i>	0.397	0.656	0.509	-0.333	-0.668	-0.473
	(0.507)	(0.505)	(0.462)	(0.449)	(0.451)	(0.416)
<i>CAP</i>	2.931***	3.015***	2.915***	0.853**	0.745**	0.876**
	(0.405)	(0.407)	(0.401)	(0.358)	(0.361)	(0.350)
<i>IND</i>	-0.005***	-0.004***	-0.005***	0.004***	0.004**	0.004***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
<i>HHI</i>	1.626	5.463***	4.735***	-0.681	-5.655***	-4.650***
	(1.845)	(1.978)	(1.642)	(1.788)	(1.915)	(1.549)
<i>SPECIAL</i>	0.549***	0.522***	0.460**	-0.737***	-0.701***	-0.621***
	(0.186)	(0.191)	(0.186)	(0.174)	(0.176)	(0.173)
Obs.	1162	1162	1162	1162	1162	1162
R-squared	0.252	0.249	0.258	0.305	0.301	0.315

This table displays the results of the relationship between ASEAN bank stability and digital financial inclusion while controlling the bank-specific variables using the ordinary least square (OLS) regression model. In this table, *DFI*, *SIZE*, *LR*, *LLPR*, *MQ*, *CAP*, *IND*, *HHI*, *SPECIAL*, Obs refer to Digital financial inclusion index, Bank size, Loan ratio, Loan loss provision, Management quality, Capitalisation, Revenue diversification, Herfindahl-Hirschman index, Commercial bank – 1 & Islamic bank – 0, and Observations respectively. Finally, *, **, and ***

denote statistical significance at the 10%, 5%, and 1% levels, respectively and robust standard errors are in parenthesis. Source: Orbis Bank-focus, WDI, FAS, Findex.

Table 4. ASEAN Bank stability and digital financial inclusion (OLS regression – Bank and Macro level variables)

	<i>Ln (Z-score)</i>			<i>Ln (sd (ROAA))</i>		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>DFI</i>	0.817** (0.375)			-0.921*** (0.334)		
<i>DFI - Access</i>		0.474 (0.300)			-0.577** (0.267)	
<i>DFI - Usage</i>			1.099** (0.520)			-1.060** (0.507)
<i>SIZE</i>	0.170*** (0.023)	0.172*** (0.023)	0.173*** (0.023)	-0.186*** (0.021)	-0.187*** (0.021)	-0.189*** (0.021)
<i>LR</i>	1.151*** (0.303)	1.155*** (0.303)	1.123*** (0.306)	-0.876*** (0.287)	-0.883*** (0.287)	-0.849*** (0.291)
<i>LLPR</i>	-22.567*** (3.667)	-22.659*** (3.694)	-22.343*** (3.656)	19.217*** (3.112)	19.324*** (3.140)	19.011*** (3.104)
<i>MQ</i>	0.565 (0.525)	0.596 (0.526)	0.610 (0.512)	-0.518 (0.457)	-0.547 (0.459)	-0.575 (0.449)
<i>CAP</i>	2.938*** (0.407)	2.956*** (0.406)	2.940*** (0.411)	0.854** (0.349)	0.836** (0.348)	0.846** (0.355)
<i>IND</i>	-0.005*** (0.002)	-0.005*** (0.002)	-0.005*** (0.002)	0.004*** (0.002)	0.004** (0.002)	0.004*** (0.002)
<i>HHI</i>	4.055* (2.346)	5.018** (2.326)	5.633** (2.291)	-4.461* (2.316)	-5.376** (2.291)	-6.452*** (2.237)
<i>SPECIAL</i>	0.464** (0.193)	0.460** (0.193)	0.453** (0.190)	-0.622*** (0.178)	-0.619*** (0.178)	-0.610*** (0.176)
<i>GDPG</i>	0.026 (0.038)	0.007 (0.037)	0.030 (0.041)	-0.013 (0.036)	0.007 (0.035)	-0.011 (0.038)
<i>INFL</i>	0.048* (0.028)	0.052* (0.029)	0.022 (0.029)	-0.063** (0.028)	-0.069** (0.028)	-0.037 (0.028)
<i>GG</i>	0.987*** (0.307)	1.482*** (0.374)	-0.477 (0.805)	-1.380*** (0.301)	-1.968*** (0.363)	0.005 (0.782)
Obs.	1162	1162	1162	1162	1162	1162
R-squared	0.259	0.258	0.259	0.317	0.316	0.316

This table reports the results of the relationship between ASEAN bank stability and digital financial inclusion while controlling both the bank-specific and macroeconomic variables using the ordinary least square (OLS) regression model. In this table, *DFI*, *SIZE*, *LR*, *LLPR*, *MQ*, *CAP*, *IND*, *HHI*, *SPECIAL*, *GDPG*, *INFL*, *GG*, and Obs refer to Digital financial inclusion index, Bank size, Loan ratio, Loan loss provision, Management quality, Capitalisation, Revenue diversification, Herfindahl-Hirschman index, Commercial bank – 1 & Islamic bank – 0, GDP growth, Inflation, Good governance index, and Observations respectively. Finally, *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively and robust standard errors are in parenthesis. Source: Orbis Bank-focus, WDI, FAS, Findex.

Table 5. ASEAN Bank stability and digital financial inclusion (Two-step system GMM)

	<i>Ln (Z-score)</i>			<i>Ln (sd (ROAA))</i>		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>L. DEP. VARIABLE</i>	0.564*** (0.045)	0.556*** (0.045)	0.555*** (0.045)	0.544*** (0.053)	0.540*** (0.050)	0.558*** (0.053)
<i>DFI</i>	0.562** (0.217)			-0.502** (0.217)		
<i>DFI - Access</i>		0.401 (0.251)			-0.428 (0.266)	
<i>DFI - Usage</i>			0.426** (0.190)			-0.359** (0.175)
<i>SIZE</i>	0.136** (0.054)	0.123* (0.063)	0.191*** (0.058)	-0.141*** (0.052)	-0.112** (0.056)	-0.171*** (0.053)
<i>LR</i>	1.304* (0.666)	1.506** (0.715)	1.868** (0.777)	-1.116* (0.610)	-1.421** (0.687)	-1.607** (0.760)
<i>LLPR</i>	-7.733*** (2.418)	-7.138*** (2.444)	-6.966*** (2.320)	7.311*** (2.159)	6.901*** (2.185)	6.939*** (2.113)
<i>MQ</i>	-1.026 (0.960)	-0.675 (0.877)	-0.763 (0.891)	0.627 (0.848)	0.379 (0.858)	0.572 (0.907)
<i>CAP</i>	1.530** (0.694)	1.538** (0.654)	1.954*** (0.641)	0.315 (0.517)	0.385 (0.533)	0.085 (0.529)
<i>IND</i>	0.000 (0.001)	0.000 (0.001)	0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.002* (0.001)
<i>HHI</i>	-2.488 (2.596)	-2.048 (2.923)	-3.565 (2.744)	0.986 (2.596)	-0.267 (2.853)	1.871 (2.814)
<i>SPECIAL</i>	0.274 (0.291)	0.277 (0.294)	0.173 (0.286)	-0.274 (0.289)	-0.301 (0.304)	-0.165 (0.297)
<i>GDPG</i>	0.077* (0.041)	0.082* (0.042)	0.149*** (0.053)	-0.077* (0.039)	-0.084* (0.043)	-0.136** (0.053)
<i>INFL</i>	-0.088*** (0.031)	-0.088*** (0.027)	-0.100*** (0.026)	0.072** (0.028)	0.068*** (0.026)	0.087*** (0.024)
<i>GG</i>	-0.335 (0.384)	0.287 (0.445)	-0.935* (0.523)	0.147 (0.362)	-0.512 (0.428)	0.613 (0.488)
Obs.	979	979	979	979	979	979
AR(1) p value	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) p value	0.144	0.154	0.138	0.139	0.167	0.137
Sargan test p value	0.218	0.190	0.296	0.428	0.216	0.458
Number of groups	197	197	197	197	197	197
Number of instruments	155	155	155	155	155	155

This table reports the results of the relationship between ASEAN bank stability and digital financial inclusion using the Two-step system GMM regression method, following Ahamed and Mallick (2019), for the robustness of the results. In this table, *DFI*, *SIZE*, *LR*, *LLPR*, *MQ*, *CAP*, *IND*, *HHI*, *SPECIAL*, *GDPG*, *INFL*, *GG*, Obs, and AR refer to Digital financial inclusion index, Bank size, Loan ratio, Loan loss provision, Management quality, Capitalisation, Revenue diversification, Herfindahl-Hirschman index, Commercial bank – 1 & Islamic bank – 0, GDP growth, Inflation, Good governance index, Observations, and Arellano-Bond respectively. Finally, *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively and robust standard errors are in parenthesis. Source: Orbis Bank-focus, WDI, FAS, Findex.

Figures

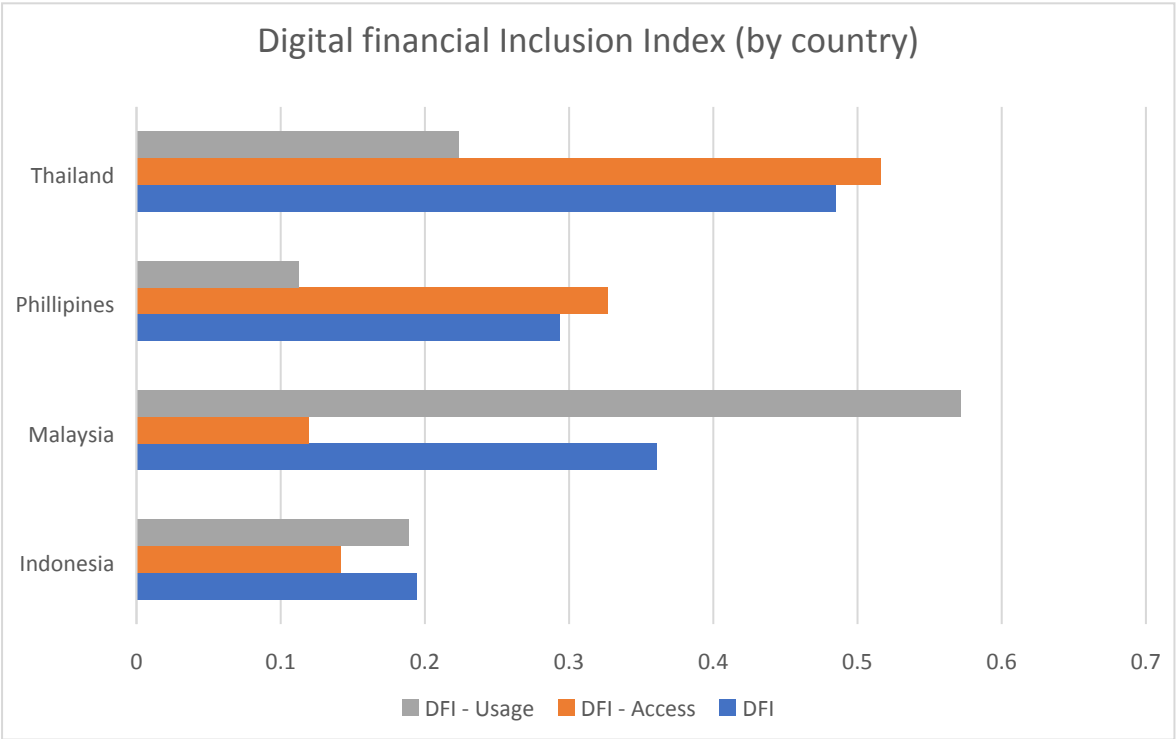


Figure 1: Digital Financial Inclusion Index among sample countries. Source: Author’s calculation using PCA.