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Borsa İstanbul Review

Borsa İstanbul Review xxx (xxxx) xxx

http://www.elsevier.com/journals/borsa-istanbul-review/2214-8450

Financial inclusion and its impact on financial efficiency and sustainability: Empirical evidence from Asia

Thai-Ha Le [a,b,*], Anh Tu Chuc [c], Farhad Taghizadeh-Hesary [d]

[a] RMIT University, Viet Nam
[b] IPAG Business School, France
[c] Academy of Finance, Viet Nam
[d] Waseda University, Japan

Received 10 April 2019; revised 8 June 2019; accepted 11 July 2019
Available online ■ ■ ■

Abstract

This study examines the trend of financial inclusion in Asia and its impact on financial efficiency and financial sustainability. For this purpose, the study employs a sample of 31 Asian countries during the period spanning from 2004 to 2016. Composite indicators for the three financial dimensions are constructed using principal component analysis (PCA) based on normalized variables. We find that the trends are fluctuating across countries and there is no clear pattern in several cases. The findings are robust to different normalization techniques. Furthermore, the impact of financial inclusion on financial efficiency and sustainability is analysed using Feasible Generalized Least Squares (FGLS). The estimation results indicate that growing financial inclusion negatively affects financial efficiency while favourably influences financial sustainability. The findings hold for the whole sample as well as across the two subsamples of countries with different income levels. This implies that while there are policy synergies between growing financial inclusion and maintaining financial sustainability, proper attention needs to be paid to the side effect of financial inefficiency associated with increasing financial inclusion.

JEL classification: O16; O57; C38; C33

Keywords: Financial inclusion; Panel data analysis; Principal component analysis; Standardization; Asia

1. Introduction

Financial development is a critical and inextricable part of the growth process and has thus received considerable attention in recent years since the emergence of the endogenous growth theory. Financial inclusion, i.e. the use of formal financial services, is a feature of financial development which received a great deal of public attention and research interest in the early 2000s, originating from a research finding that attributed poverty to financial exclusion (Babajide, Adegboye, & Omankhanlen, 2015). At the G20 Summit held in Seoul, South Korea in November 2010, financial inclusion has been recognized as one of the nine key pillars of the global development agenda (GPFI, 2011).

Financial inclusion implies that all adult members of the society are granted access to a range of proper financial services, designed based on their needs and provided at affordable costs. Formal financial inclusion begins with having a deposit or transaction account, at a bank or other financial service provider, for the purpose of making and receiving payments as well as storing or saving money (Demirguc-Kunt, Klapper, & Singer, 2017). At a later stage, financial inclusion also involves access to appropriate credit from formal financial institutions, in addition to the use of insurance products that enable people to alleviate financial risks such as fire, flood or crop damage (Demirguc-Kunt et al., 2017). Furthermore, access to accounts through financial inclusion increased savings

* Corresponding author.
E-mail address: Ha.lethai@rmit.edu.vn (T.-H. Le).
Peer review under responsibility of Borsa İstanbul Anonim Şirketi.

https://doi.org/10.1016/j.bir.2019.07.002

among farmers, leading to greater agricultural output and household spending (Demirguc-Kunt et al., 2017). This particularly matters for those people who live in the poorest households in rural areas. In this regard, financial inclusion helps reduce poverty and inequality.

Financial inclusion is recognized as 'a process that marks improvement in quantity, quality, and efficiency of financial intermediary services' (Babajide et al., 2015), which helps improve lives, foster opportunities and strengthen economies. Local savings are promoted through financial inclusion, leading to increased productive investments in local businesses (Babajide et al., 2015).

This study examines the financial inclusion in Asia regarding two matters: (1) the trend of financial inclusion, and (2) the impact of financial inclusion on financial efficiency and sustainability. Being regarded as one of the most important dimensions of financial development, financial efficiency is defined as "the extent to which the financial system fulfills its functions" (Olgu, 2014). Efficient financial systems are believed to be less susceptible to banking crises (Olgu, 2014). Meanwhile, financial stability is considered as the ability of the financial system to "absorb shocks without causing a collapse of financial institutions, financial markets and payment systems" (Motelle & Biekpe, 2015; Nelson & Perli, 2007). Despite being important criteria to classify a sound financial system, financial efficiency and financial sustainability have been neglected in the financial development comparisons, partly due to the lack of required data for assessment.

Asia is regarded as the fastest growing region in terms of economy for decades to come, with GDP expected to increase by an average annual growth rate of 6.3% over the next two years (Bhardwaj, Hedrick-Wong, & Howard, 2018), mostly attributable to emerging economies in the region. However, while Asia is well positioned for robust growth, policymakers need to address the lack of access to financial services in order to ensure that this growth is equitable and inclusive. It is estimated that more than one billion people within the region are left without access to formal financial services, i.e., no formal employment, no bank account, no meaningful ability to engage in paid work activities online or offline (Bhardwaj et al., 2018). Furthermore, it is estimated that, within developing Asia, only 27% of adults have an account in a formal financial institution, while only 33% of firms reportedly have a loan or line of credit (Bhardwaj et al., 2018). In spite of many initiatives being taken to promote financial inclusion in Asia, fostering financial inclusion remains a critical challenge in the region. This is attributable to the fact that Asia is one of the most diverse regions in the world, with significant variation across countries in per capita GDP and population size, in addition to a dizzying array of cultural, ethnic, linguistic, and religious diversity (Bhardwaj et al., 2018). Consequently, a "magic bullet" approach to promote higher financial inclusion is highly unlikely to be a solution for Asia (Bhardwaj et al., 2018).

The rest of this study is organised as follows. Section 2 reviews the related literature on financial inclusion and the nexus between financial inclusion and economic growth, as well as other aspects of financial development. Section 3 describes data, model and methodology. Section 4 presents and discusses the empirical results. Section 5 concludes the study.

2. Literature review

The literature on financial inclusion could be divided into three parts, namely, (1) constructing indicators of financial inclusion, (2) examining determinants of financial inclusion and (3) investigating the nexus between financial inclusion and different dimensions of financial and economic development.

The literature on measuring financial inclusion is relatively new but growing rapidly (for instance, Honohan, 2008; Sarma, 2012; Demirguc-Kunt & Klapper, 2012, 2013; Sarma, 2015). Honohan (2008) measured financial inclusion by econometrically estimating the proportion of adult population/households (of an economy) that have a bank account. By so doing, the study provides a one-time measure of financial inclusion across countries for as many as 160 countries. These estimates might effectively quantify one aspect of financial inclusion, that is, financial penetration. Such a measure of financial inclusion, however, has many deficiencies since several crucial aspects of an inclusive financial system are ignored, including availability, affordability, quality and usage of the financial services that together form an inclusive financial system (Sarma, 2015). Furthermore, a number of studies have shown that merely having bank accounts may not be sufficient to imply financial inclusion if there are some barriers or limitations preventing people from adequately using the accounts, such as remoteness of bank branches, cost of transactions, psychological barriers (see, for instance, Kempson, 2006; Diniz, Birochi, & Pozzebon, 2012). Kempson et al. (2004) defined the notion of "underbanked" or "marginally banked" people as those who do not adequately utilize their bank accounts, in spite of having a bank account. In fact, in many countries, a significant portion of the so-called "banked population" was using informal non-bank financial services in lieu of the banking facilities. These households constitute a portion of so-called "underbanked" or "marginally banked" households, which has been regarded in the literature as equivalent to being financially excluded households (Sarma, 2012).

Demirguc-Kunt and Klapper (2012) is a recent attempt to build up the Global Findex database based on conducting surveys of 150,000 adults in 148 countries during 2011. The initiative provides interesting indicators of financial inclusion from a micro perspective, i.e. for adult individuals classified by income group, gender and education levels of the respondents. These indicators consist of share of adults who have an account with a formal financial institution, of adults who saved and borrowed using a formal account, of adults who used informal methods to save and borrow and shares of adults with credit/debit cards, with mortgage and with a health insurance. Since then, the database has been published every three years, by means of conducting nationally representative surveys of over 150,000 adults in more than 140 economies. The most recent Global Findex database published in 2017

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shows that financial inclusion is on a rising trend at the global level. Specifically, 1.2 billion adults have reportedly obtained a financial account since 2011, including 515 million since 2014. Between 2014 and 2017, the share of adults having an account with a financial institution or through a mobile money service sees an increase from 62% to 69% across the globe, and from 54% to 63% in the developing world. Nevertheless, the share of women having a bank account in developing economies remain 9 percentage points less than that of men (Demirguc-Kunt, Klapper, Singer, Ansar, & Hess, 2018).

The indicators of financial inclusion, either at the macro level or micro level, provide insight into the inclusiveness of a financial system (Sarma, 2012). However, when these indicators are used individually and separately, they provide only partial and thus incomplete information on the nature of inclusiveness of the financial system (Sarma, 2012). Using individual indicators might also result in a misleading interpretation of the extent of financial inclusion in an economy as shown by Sarma (2012).

The second strand of literature falls on examining the determinants of financial inclusion (for instance, Demirgüc,-Kunt, Klapper, & Singer, 2013; Kumar, 2013; Fungáčová & Weill, 2015; Allen, Demirgüc,-Kunt, Klapper, & Peria, 2016; Zins & Weill, 2016). For instance, based on the 2012 World Bank Global Findex Database on 98 developing countries, Demirgüc,-Kunt et al. (2013) finds that gender matters for financial inclusion. The study shows evidence on a significant gender gap existing in account ownership, formal saving and formal credit. The likelihood of being financially excluded increases with being a woman. Zins and Weill (2016) perform probit estimations on the World Bank's Global Findex database for 37 African countries. The empirical results indicate that being a man, richer, more educated, and older individuals, to a certain extent, are more likely to be financially included, with a higher influence of education and income. Basically mobile banking and traditional banking have the same determinants. On the other hand, the determinants of informal finance appear to be different from those of formal finance.

Allenet al. (2016) also utilised the 2012 World Bank Global Findex Database to explore the individual and country characteristics associated with financial inclusion on a global scale. They find that greater financial inclusion is related to lower banking costs, greater proximity to financial intermediaries, and better institutions such as stronger legal rights, and more politically stable environments. Furthermore, being richer, more educated, older, urban, employed, married or separated individuals are shown to favour financial inclusion in terms of having an account at a formal financial institution. The same individual characteristics also linked with the increased probability of saving formally. Finally, the probability of borrowing formally is higher for older, educated, richer and married men.

Fungáčová and Weill (2015) used data from the World Bank Global Findex database for 2011 to study financial inclusion in China, and compare it with other BRICS countries. The study finds that the likelihood of having formal accounts and formal credit in China is higher for richer, more educated, older men. With regard to barriers to financial inclusion, lack of money is more likely a concern to poorer people, in addition to the fact that another member of the family has a financial account. Meanwhile, more educated people care more about transaction cost and trust in the banking system. The likelihood of financial inclusion for women is less due to a lack of documentation or another member of the family owning an account. Furthermore, elderly adults are shown to be more concerned about lack of money, distance and religious reasons. Finally, the study also finds that income and education, but not gender, do influence the use of alternative sources of borrowing, that is, the choice between formal and informal credit. However, education does not result in better access to formal credit in China.

The third strand of literature is on the nexus between financial inclusion and different aspects of financial development (see, for example, De la Torre, Ize, & Schmukler, 2011; García & José, 2016; Mehrotra & Yetman, 2015; Neaime & Gaysset, 2018) and between financial inclusion and economic development (see, for instance, Estrada, Park, & Ramayandi, 2010; Sarma & Pais, 2011; Swamy, 2014; Babajide et al., 2015; Kim, 2016; Sharma, 2016; Kim, Yu, & Hassan, 2018).

Growing financial inclusion gives households easier access to saving and borrowing products due to consumption smoothing (Mehrotra & Yetman, 2015). It makes maintaining price stability an easier job for a central bank since output volatility is no longer a major problem. Furthermore, increasing financial inclusion means a higher proportion of economic activity that relies on interest rates, leading to the likely higher relevance of interest rates in monetary transmission (Mehrotra & Yetman, 2015). This tends to improve the effectiveness of monetary policy, implying more financial sustainability.

On the other hand, growing financial inclusion means a greater number of financial transactions covered by the same existing intermediaries. This higher intensity of participation in the financial markets can expand the social costs of individual institutional imperfections. Consequently, the occurrence of social and moral hazard will likely increase, and thus endanger financial stability (De la Torre et al., 2011). In this regard, it would be more desirable to have a greater number of financial intermediaries if it is accompanied by proper governance and an adequate structure of financial regulation and supervision (De la Torre et al., 2011). Otherwise, the increase number of local institutions, such as cooperatives or rural banks, presents higher risks in the financial markets, making them more vulnerable to natural disasters and recessions (García & José, 2016).

Financial inclusion is not only a result of economic growth but also its driver (Babajide et al., 2015). Babajide et al. (2015) used to annual data series from 1981 to 2012 to investigate the impact of financial inclusion on economic growth in Nigeria. The commercial bank deposit (CMBD), which reported 'the number of deposit account holders in commercial banks and other resident banks functioning as commercial banks that are resident nonfinancial corporations

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(public and private) and households', taken from the World Development Indicators (WDI) is used as the proxy for financial inclusion in the study. The empirical results indicate that financial inclusion is a crucial determinant of the total factor of production, and capital per worker, thus affecting the output level in the economy.

Sharma (2016) investigates the nexus between the vast dimensions of financial inclusion and economic growth in India, an emerging economy, for the period 2004−2013. Three core dimensions of financial inclusion are focused, namely, banking penetration, availability of banking services and use of banking services (deposits). The study finds a positive linkage between economic growth and several dimensions of financial inclusion. The empirical results based on Granger causality analysis show that there are a bi-directional causal relationship between geographic outreach and economic development as well as a unidirectional causality running from the number of deposits/loan accounts to GDP.

Kim et al. (2018) examines the linkage between financial inclusion and economic growth for Organization of Islamic Cooperation (OIC) countries. Five variables were employed to measure key factors of financial inclusion, namely: (1) automated teller machines per 100,000 adults, (2) bank branches per 100,000 adults, (3) deposit accounts with commercial banks per 1000 adults, (4) borrowers from commercial banks per 1000 adults, and (5) life insurance premium volume to GDP. Based on the results of dynamic panel estimations performed on a panel data for 55 OIC countries, the study finds that financial inclusion has a crucial role in promoting economic growth and there are mutual causalities between the two variables. While the study provides some interesting results, there are several limitations. First, major differences exist among OIC countries including the level of financial inclusion. These variations might be attributable to different religion level, gender inequality, illiteracy rate, interest rate, income level, and policies. Thus, it is necessary to consider the factors that may impact the level of financial inclusion in Islamic countries in modelling. Second, multiple financial inclusions are examined separately in different models instead of a composite index for financial inclusion.

In a nutshell, a number of studies have suggested that financial inclusion could affect financial stability in both positive and negative ways. However, very few empirical studies have been conducted on their relationship (see, Morgan & Pontines, 2014; Neaime & Gaysset, 2018). Meanwhile, there has been no empirical study examining the connection between financial inclusion and financial efficiency. This is partly attributable to the scarcity and relative newness of data on financial inclusion and financial efficiency.

This study thus contributes to the literature on this subject by measuring and identifying the trends of financial inclusion, financial efficiency and financial sustainability. Furthermore, the study also explores whether financial inclusion is associated with financial efficiency and sustainability. The purpose is to determine whether there are policy synergies between financial inclusion, financial efficiency and financial stability than conflicts. For this purpose, a sample of 31 Asian countries is employed for the empirical analysis.

3. Data and methodology

3.1. Data and variables

This study attempts to develop a composite Financial Inclusion Index for Asia, taking into account different aspects as suggested by the existing literature. Principal component analysis (PCA) is then performed to assess which selected indicators have largest individual effects on this Index for Asia as a whole and for individual countries in the study sample.

We collect data from the World Bank's Global Financial Development Database. In total, our country sample consists of 31 countries, belonging to different income country groups (Refer to Table 1).

This study investigates whether financial inclusion is related to financial efficiency and financial sustainability for 31 Asian countries. The list of selected variables for constructing our three composite financial indicators, namely, financial inclusion, financial efficiency and financial sustainability are presented in Table 2. Our choices of variables for the three composite financial indicators are based on classification by the World Bank's Global Financial Development Database and subject to data availability of our study sample for a significant investigation period. The statistical descriptions of the variables are summarized in Table 3.

3.2. Methodologies

Table 2 shows that the variables have different units and are on different scales. Furthermore, Table 3 indicates that some variables have a large variance while for some others, the variance is small. Since PCA attempts to maximize variance, it will load more heavily on the large variances. As such, the selected indicators need to be transformed to normalized variables. This transformation is a necessary step before the indicators can be aggregated to form a composite index. In this study, different methods of normalization, such as using z-score, min-max and softmax techniques are employed for robustness check and sensitivity analysis.

The z-transformation is a common standardization method to normalize the indicators where scaling is based on deviation from the mean. The use of this method enables cross-country

Table 1
List of countries in the study sample (31 countries).

High-income countries (10)
Brunei, Israel, Japan, South Korea, Kuwait, Macao, Qatar, Saudi Arabia, Singapore, United Arab Emirates
Upper-middle income countries (7)
Iraq, Jordan, Kazakhstan, Lebanon, Malaysia, Maldives, Thailand
Low and lower-middle income countries (14)
Afghanistan, Tajikistan, Yemen, Bangladesh, Bhutan, Cambodia, India, Indonesia, Kyrgyz Republic, Mongolia, Pakistan, Philippines, Sri Lanka, Vietnam

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Table 2
Asia's Financial Indicators considered in the study (2004−2016).

Variable	Topic	Indicator	Unit
FI1	Access	Automated Teller Machines (ATMs) per 100,000 adults	
FI2	Access	Branches of commercial banks per 100,000 adults	
FI3	Access	Institutions of commercial banks	
FI4	Access	Outstanding deposits with commercial banks (% of GDP)	%
FI5	Access	Outstanding loans with commercial banks (% of GDP)	%
FE1	Efficiency	Bank net interest margin (%)	%
FE2	Efficiency	Bank return on assets (%, after tax)	%
FE3	Efficiency	Bank return on equity (%, after tax)	%
FS1	Stability	Bank Z-score	
FS2	Stability	Bank credit to bank deposits (%)	%
FS3	Stability	Liquid assets to deposits and short term funding (%)	%

Note: Data Source: World Bank's Global Financial Development Database 2018.

comparisons. However, two matters need to be paid attention to, including: (1) the size of the sample should be sufficiently large and (2) recalibration is required when new data points are added.

Standardization using z-score normalization is constructed as follows.

$$Zee = \frac{X_i - \overline{X}}{\sigma} \quad (1)$$

where,

$\overline{X}$ = group average.
σ = standard deviation.

In the min-max method, the maximum and minimum values observed are taken to form a scale. Following this scale, other values are placed with reference to these values. The method of this method is that performance could be assessed based on the best and worst performance. Meanwhile, a drawback of this method is similar to that of the z-score normalization, which is the need to recalibrate when adding additional data points.

Table 3
Summary on statistical descriptions of the selected variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
FI1	379	45.991	56.054	0.012	288.632
FI2	389	14.421	12.100	0.374	71.607
FI3	397	43.370	42.633	3	296
FI4	391	64.630	47.804	3.601	270.389
FI5	391	49.911	32.537	1.162	155.514
FE1	397	4.210	2.394	0.760	20.488
FE2	391	1.487	1.010	−1.447	5.579
FE3	393	14.093	9.001	−14.591	117.537
FS1	396	17.174	10.112	2.488	60.437
FS2	398	103.827	111.638	9.224	879.662
FS3	400	32.283	18.576	6.750	98.552

Source: Authors' calculations.

In the min-max normalization, normalize scores are computed using minimum and maximum observations, as follows.

$$mmx = \frac{X_i - X_{min}}{X_{max} - X_{min}} \quad (2)$$

where,

X_{min} = minimum data point.
X_{max} = maximum data point.

In the softmax normalization or normalized exponential function, the influence of extreme values or outliers in the data is reduced without removing them from the dataset. Because outliers are an important part of a dataset, they should be included in the dataset while we still preserve the significance of data within a standard deviation of the mean. The nonlinear transformation of the data is conducted using one of the sigmoidal functions.

Softmax normalization calculates normalized score using exponential function and mean and standard deviation, as follows.

$$softmax = \frac{1}{1 + exp^{-V}} \quad (3)$$

where,

$V = \frac{X_i - \overline{X}}{\sigma}$
σ = standard deviation.

In the next stage, normalized data were processed by means of PCA, which assesses the impact of changes in the values of selected variable on final result. PCA is a standard technique for simplifying a dataset by extracting data for hidden features and relationships, and removing data with excessive information. By so doing, PCA reduces the dimensionality of data for analysis. PCA basis vectors depend on the dataset and PCA does not have a fixed set of basis vectors, unlike other linear transformation methods. Furthermore, the additional advantage of PCA lies on its ability to identify the similarity and difference of the various models created (Yoshino & Taghizadeh-Hesary, 2015).

PCA is widely used for explanatory data analysis. As a method of projections, it reveals the structure of data and explains the variations (Jolliffe, 2011). In the existing literature, PCA has rarely been used in quantification of financial inclusion. However, the use of PCA in the analysis of the phenomena affected by a variety of financial variables has been acceptable (see Adu, Marbuah, & Mensah, 2013; Ang, 2010; Ang & McKibbin, 2007; Le, Kim, & Lee, 2016; Muhammad Adnan Hye, 2011). For instance, Ang and McKibbin (2007) used this method to construct the financial depth index and financial repression index for Malaysia. Ang (2010) constructed financial liberalization index by means of this technique to investigate the impact of research efforts and financial sector reforms on inventive activity in South Korea.

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Adu et al. (2013) employed PCA to construct several indexes of financial development for Ghana to examine the long-run growth effects of financial development in this country.

PCA assigns weights to each of input variables included in the construction of the index, and by so doing the outcome variable is determined. The first principal component is determined as the value of the newly established index since it is considered the best representative of values of the selected input variables (Radovanović, Filipović, & Golušin, 2018). The resulting weights indicate the degree of correlation between a given input variable and the outcome index (Radovanović et al., 2018). Based on this, we can determine which variables have an important role in explaining the outcome index. Due to standardization, all the principal components have zero mean while the standard deviation for each of the components is the square root of the eigenvalue (Radovanović et al., 2018).

Two tests, namely, Bartlett's test of sphericity and Kaiser-Meyer-Olkin (KMO) test, were performed at the beginning of the PCA in order to examine the suitability of these data for factor analysis. The Bartlett's test of sphericity examines whether the correlation matrix used in the PCA is an identity matrix. It should be significant ($p < 0.05$) for factor analysis to be suitable (Hair, Black, Babin, Anderson, & Tatham, 2006; Tabachnick, Fidell, & Ullman, 2007). Meanwhile, the Kaiser-Meyer-Olkin (KMO) test was conducted to measure the sampling adequacy. It indicates the proportion of common variance that might be caused by underlying factors (Yoshino & Taghizadeh-Hesary, 2015). The KMO index ranges from 0 to 1, with larger than 0.5 generally indicating that the factor analysis is suitable (Hair et al., 2006; Tabachnick et al., 2007). The results of performing these two tests are reported in Table 4. In most of the cases, the KMO values are greater than 0.5 (with three cases are 0.5). For the Bartlett's test of sphericity, the computed p values in all cases are lower than the significance level alpha = 0.01. This means that the null hypothesis, H0, result is rejected, confirming that the variables used in the PCA are correlated. As such, the results of both tests support the use of PCA in this study.

Next, we perform the PCA in this study, which consists of two stages: identifying and interpreting the factors. At the first step, we identify the factors that have the lowest pairwise correlation and determine the total variance of the variable that they account for. The purpose is to identify and extract the factors that contribute the highest portion of the variation in the original variables. The first factor, or the first component, explains the largest percentage of the total variation. Afterwards, the second factor is extracted, which explains the largest share of the remaining unexplained variance but with no correlation to the first factor (Radovanović et al., 2018). This extraction process continues until the number of identified components equals the number of original variables. Thereafter, we can extract the components which account for a portion of variance above a certain threshold, expressed in terms of the amount of variance in the original variables explained by each component (or eigenvalue) (Radovanović et al., 2018). This threshold is usually set at one (Mundfrom, Shaw, & Ke, 2005).

4. Empirical results

Table 5 reports the estimated factors and their eigenvalues. Based on this, we decide to employ the first three factors for the PCA on Financial Inclusion, since taken together, they explain more than 80% of the total variance of the Financial Inclusion indicator. For Financial Efficiency and Financial Sustainability indicators, all the three factors are retained.

The estimated principal components are presented in Table 6, for three cases of normalized variables as presented in Section 3. For the **Financial Inclusion Index**, we include the first three principal components, which capture more than 80% of the variation. This is an acceptably large percentage. Magnitudes of the coefficients as presented in Table 6 give the contributions of each variable to that component. However, the magnitudes of the coefficients also depend on the variances of the corresponding variables. As mentioned in the previous section, all the principal components have zero mean, due to

Table 4
Results of Bartlett test of sphericity and Kaiser-Meyer-Olkin Measure of Sampling Adequacy.

	Bartlett test of sphericity			Kaiser-Meyer-Olkin Measure of Sampling Adequacy
	Chi-square	Degrees of freedom	p-value	
Financial Inclusion				
z-score normalization	389.530***	10	0.000	0.63
min-max normalization	319.902***	10	0.000	0.61
softmax normalization	393.807***	10	0.000	0.63
Financial Efficiency				
z-score normalization	570.033***	3	0.000	0.59
min-max normalization	455.770***	3	0.000	0.57
softmax normalization	550.172***	3	0.000	0.59
Financial Sustainability				
z-score normalization	12.125***	3	0.007	0.50
min-max normalization	14.965***	3	0.002	0.50
softmax normalization	13.798***	3	0.003	0.50

Source: Authors' calculations. Note: Bartlett test of sphericity: H0: variables are not intercorrelated. *** indicates statistical significance at 1% level.

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Table 5
Total variance explained.

	Component	Eigenvalues	% of Variance	Cumulative Variance %
Financial Inclusion Index				
Normalized variables	1	2.009	45.05	45.05
using standardized	2	0.898	20.14	65.19
Z-score	3	0.764	17.14	82.33
	4	0.510	11.44	93.77
	5	0.278	6.23	100
Normalized variables	1	0.236	41.10	41.10
using min-max	2	0.119	20.84	61.94
normalization	3	0.112	19.56	81.50
	4	0.068	11.82	93.32
	5	0.038	6.68	100
Normalized variables	1	0.096	45.65	45.65
using softmax	2	0.042	19.90	65.55
normalization	3	0.035	16.76	82.31
	4	0.024	11.35	93.66
	5	0.013	6.34	100
Financial Efficiency Index				
Normalized variables	1	1.94	70.65	70.65
using standardized	2	0.671	24.40	95.05
Z-score	3	0.136	4.95	100
Normalized variables	1	0.194	66.98	66.98
using min-max	2	0.077	26.60	93.57
normalization	3	0.0187	6.43	100
Normalized variables	1	0.085	70.35	70.35
using softmax	2	0.0297	24.43	94.78
normalization	3	0.0063	5.22	100
Financial Sustainability Index				
Normalized variables	1	1.094	39.18	39.18
using standardized	2	0.931	33.32	72.50
Z-score	3	0.768	27.50	100
Normalized variables	1	0.131	40.09	40.09
using min-max	2	0.108	32.94	73.03
normalization	3	0.088	26.97	100
Normalized variables	1	0.052	40.38	40.38
using softmax	2	0.041	32.03	72.42
normalization	3	0.035	27.58	100

Source: Authors' calculations.

standardization. It is also noted that there is zero correlation between the principal components themselves.

In order to interpret the principal components, we need to identify the variables that are most strongly correlated with each component, i.e., which of these numbers are large in magnitude, the farthest from zero in either direction. For this purpose, we propose that a correlation of 0.5 and above is deemed important. These large correlations are in boldface in Table 6. The next paragraphs will interpret the principal component results with respect to the value that we have determined to be significant.

We find that the first principal component is strongly and positively correlated with three normalized variables, namely, FI1, FI2 and FI3, suggesting that these three criteria vary together. The finding that these financial inclusion indicators tend to move in tandem could be explained due to the fact that their movements are associated with same key underlying factors, such as macroeconomic stability and economic growth. For instance, economies with higher expected GDP levels are more likely to experience an expansion of financial and credit services, including the number of Automated Teller Machines (ATMs), the number of branches of commercial banks and the number of loans (World Bank, 2010). Our results are consistent with the findings by Ageme, Anisiuba, Alio, Ezeaku, and Onwumere (2018) which also documented that financial accessibility variables in Nigeria, which are based on financial technological innovation and distinct bank-based channels for financial accessibility, move together in the long run.

Our results indicate that if FI1 increases, FI4 and FI5 tend to increase as well. This component can be viewed as a composite measure of number of Automated Teller Machines (ATMs) per 100,000 adults, outstanding deposits and loans with commercial banks. Furthermore, while the first principal component correlates most strongly with outstanding loans with commercial banks (FI5), the correlations of FI1, FI4 and FI5 with this principal component are not significantly different (i.e., 0.51, 0.53 and 0.54, respectively). The results are relatively robust to different normalization techniques including min-max and softmax standardization. The second principal component increases with FI2. This component can be viewed as a measure of branches of commercial banks per 100,000 adults. The third principal component increases with increasing FI3. This component can thus be viewed as a measure of institutions of commercial banks.

The plots of Financial Inclusion Index as measured by PCA are presented in Figure S1 (available online). As discussed in Section 3, the principal components are constructed based on normalised variables using three techniques: z-score, min-max and softmax standardization. For the purpose of comparison and robustness checks, three plots of principal component scores based on three types of normalised variables are presented on the same graph for each country.

Overall, we find the trend of increasing financial inclusion in Bangladesh, Bhutan, Cambodia, India, Kyrgyz Republic, Mongolia, Philippines, Sri Lanka and Tajikistan for the group of low and lower-middle income countries. For the group of upper-middle and high-income countries, improved financial inclusion is also found in Japan, South Korea, Kuwait, Lebanon, Macao, Malaysia, Maldives, Qatar, Saudi Arabia, Singapore, Thailand and United Arab Emirates. Our findings are in line with Jahan, De, Jamaludin, Sodsriwiboon, and Sullivan (2019) who also documented significant progress in financial inclusion in Singapore, Japan, South Korea, Thailand, Malaysia, India, Philippines and Cambodia.

On the other hand, the trend of financial inclusion was mostly unclear for the rest of the countries. However, for Indonesia, Pakistan, Vietnam, Iraq, Jordan, the results indicate some progress in the recent years. This finding could be attributable to the genuine political will and actions taken by the government in these countries over the past decade to enhance financial inclusion. For instance, Vietnamese government has shown strong interest in promoting financial inclusion in the country in its "2011−2020 Socio-Economic Development Strategy" and its "Microfinance Development Strategy: 2011−2020". With the commitment to "build and

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Table 6
Impact assessment of selected indicators on the principal components of the composite Financial Indexes in 31 Asian countries (2004−2016).

	Normalized variables using standardized Z-score			Normalized variables using min-max normalization			Normalized variables using softmax normalization		
Financial Inclusion Index									
Variable	Principal component (82%)			Principal component (81%)			Principal component (82%)		
	1	2	3	1	2	3	1	2	3
FI1	0.514	0.175	−0.065	0.539	0.115	0.186	0.521	0.190	0.005
FI2	0.233	0.899	−0.041	0.290	0.209	0.834	0.244	0.886	0.070
FI3	0.325	−0.090	0.934	0.333	0.804	−0.432	0.321	−0.229	0.905
FI4	0.529	−0.366	−0.287	0.492	−0.383	−0.250	0.525	−0.332	−0.343
FI5	0.544	−0.140	−0.199	0.522	−0.387	−0.144	0.539	−0.125	−0.242
Financial Efficiency Index									
Variable	Principal component (71%)			Principal component (67%)			Principal component (70%)		
	1	2	3	1	2	3	1	2	3
FE1	0.446	0.895	0.032	0.417	0.908	0.044	0.432	0.901	0.033
FE2	0.640	−0.294	−0.710	0.647	−0.262	−0.716	0.645	−0.283	−0.710
FE3	0.626	−0.337	0.704	0.639	−0.327	0.696	0.630	−0.328	0.704
Financial Sustainability Index									
Variable	Principal component (40%)			Principal component (40%)			Principal component (40%)		
	1	2	3	1	2	3	1	2	3
FS1	0.166	0.976	0.142	0.321	0.819	0.475	0.063	0.972	0.226
FS2	0.691	−0.218	0.689	0.628	−0.560	0.540	0.733	−0.199	0.650
FS3	−0.704	0.016	0.710	−0.709	−0.125	0.695	−0.677	−0.124	0.725

Source: Authors' calculations.

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develop a safe and sustainable microfinance system to serve the poor, low income and micro and small enterprises", the State Bank of Vietnam (SBV), partnering with the World Bank, has led the design and implementation of a national financial inclusion strategy (Segre, 2018).

For the **Financial Efficiency Index**, the first three principal components are included, which capture about 70% of the variation. This is an acceptable percentage. Table 6 also presents the magnitudes of the coefficients giving the contributions of each variable to that component. The magnitudes of the coefficients also vary upon the variances of the corresponding variables. Similar to the Financial Inclusion Index, standardization leads to all the principal components having zero mean. Furthermore, there is no correlation between the principal components.

Next, we identify the variables that are most strongly correlated with each principal component in order to interpret the principal components. Again, a correlation of 0.5 and above is deemed important. These large correlations are in boldface in Table 6.

We find that the first principal component is strongly and positively correlated with two normalized variables, namely, FE2 and FE3, suggesting that these two criteria vary together. For instance, if FE2 (bank return on assets (ROA), in %) increases, FE3 (bank return on equity (ROE), in %) will likely increase as well. These two indicators permit measuring the bank performance in term of profitability, and are thus expected to have interactions with banking performance, solvency risk and macroeconomic indicators in the same manner (Aisen & Franken, 2010). For instance, annual GDP growth rate represents the growth of economic activity, which is often viewed as macroeconomic determinant of bank profitability and thus a positive relationship is theoretically expected between GDP growth rate and bank's profitability (Bhattarai, 2017). GDP growth has a positive effect on banks profitability, possibly due to increase in lending rates (Athanasoglou, Brissimis, & Delis, 2008; Demirguc-Kunt & Huzinga, 1999). This is supported by the majority of empirical literature, for instance, the results from Rachdi (2013), Ali, Akhtar, and Ahmed (2011) and Zeitun (2012) reveal that GDP growth significantly and positively affects both ROA and ROE. However, Combey and Togbenou (2017), Khrawish (2011) and Saeed (2014) found that the impacts of real GDP growth on banks' ROA and ROE are both statistically significant and negative.

Furthermore, while the first principal component correlates most strongly with bank return on assets (FE2), the correlations of FE2 and FE3 with this principal component are relatively similar (i.e., 0.64 and 0.63, respectively). The results are also robust to different normalization techniques including min-max and softmax standardization. The second principal component increases with FE1, which is a measure of bank net interest margin. Meanwhile, the third principal component increases with decreasing FE2 and increasing FE3.

The plots of Financial Efficiency Index are presented in Figure S2 (available online). Similarly, the principal components are constructed based on normalised variables using three techniques: z-score, min-max and softmax standardization. Again, for the purpose of comparison and robustness checks, three plots of principal component scores based on three types of normalised variables are put on the same graph for each country.

We could not find a clear trend of improved financial efficiency in any country of our study sample over the investigation period (2004−2016). The pattern is mostly fluctuating with some ups and downs for most of the countries. The declining trend of financial efficiency is, however, found in many countries including: India, Indonesia, Mongolia, Tajikistan, Vietnam, and Yemen for the group of low and lower-middle income countries; and in Iraq, Kuwait, Qatar, Saudi Arabia and Singapore for the group of upper-middle and high income countries. On the other hand, the trend has been relatively stable for several countries such as Sri Lanka, Philippines, Israel, Thailand and United Arab Emirates.

For the **Financial Sustainability Index**, the first three principal components are included, capturing approximately 40% of the variation. Table 6 reports the magnitudes of the coefficients, which indicate the contributions of each variable to that component. Similar to the two other Financial Indexes, standardization makes all the principal components having zero mean, and there is no correlation among the principal components.

Next, the variables that are strongly correlated with each principal component are identified based on the benchmark correlation of 0.5 and above. These large correlations are in boldface in Table 6. The results reveal that the first principal component of Financial Sustainability Index is strongly and positively correlated with FS2 while significantly and negatively correlated with FS3. This finding indicates that these two criteria vary together in the opposite direction. For instance, if FS2 (bank credit to bank deposits, in %) increases, FE3 (liquid assets to deposits and short-term funding, in %) will likely fall. This negative movement between the two variables is expected in theory since the bank credit to bank deposits ratio represents the liquidity risks, i.e., the mounting bank credit to bank deposit ratio is believed to drive the banking system vulnerabilities; meanwhile, an increase in liquid assets relative to deposits and short-term funding indicates that a bank has greater liquidity and is thus less vulnerable to a bank run (Shen & Chen, 2014). The results are also robust to different normalization techniques including min-max and softmax standardization. The second principal component increases with FS1, which is the bank Z-score. On the other hand, the third principal component increases with increases in both FS2 and FS3.

Figure S3 (available online) presents the plots of Financial Sustainability Index. Similar to the other two Financial Indexes, we construct the principal components based on normalised variables using three techniques: z-score, min-max and softmax standardization. Again, we put three plots of principal component scores based on three types of normalised variables on the same graph for each country for the purpose of comparison and robustness checks.

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Overall, we find the trend of improved financial sustainability in Bhutan, Cambodia, Indonesia, Kyrgyz Republic, and Vietnam for the group of low and lower-middle income countries; and in Lebanon, Qatar and Singapore for the group of upper-middle and high income countries. On the other hand, the declining trend of financial sustainability is observed in Afghanistan, Brunei, Japan, and Maldives. For the rest of the investigated countries, the trend has been fluctuating over the investigation period.

Based on our findings on the three Financial Indexes considered in this study, we may propose that there seems to be no connection between financial inclusion and financial efficiency within our countries. This is because no clear trend of improved financial efficiency is found for any country in our study sample while increased level of financial inclusion is observed in a number of countries. On the other hand, there might be some significant relationship between financial inclusion and financial sustainability in a number of countries in which improvements in both indexed is found. Alternatively, the relationship might be significant but not readily observable due to fluctuating patterns of the indexes during the investigation period. In a nutshell, what we proposed is merely based on preliminary observations of the plots, which might be misleading. In order to justify our proposed relationships, we first employed the Granger non-causality test by Dumitrescu and Hurlin (2012). We found the evidence of causality running from financial inclusion to financial efficiency and financial sustainability in all cases at 5% significance level. However, in order to conduct this Granger non-causality test, we replaced missing values in the normalised variables since this test since it is only applicable for strongly balanced panels and without gaps (no missing values), which is not the case of this study. As such, our results might not be reliable. Furthermore, the causality analysis was unable to reveal the sign of causal relationship between the variables.

As such, we employ Feasible Generalized Least Squares (FGLS) to examine whether there is a significant relationship between the three variables measuring three financial indicators. FGLS originally proposed by Parks (1967) fits panel-data linear models by using feasible generalized least squares and yields unbiased and consistent parameter estimates in the presence of correlated and heteroskedastic error terms across the panels (Rosenfeld & Fornango, 2007). This allows estimation in the presence of AR (1) autocorrelation within panels and cross-sectional correlation and group-wise heteroskedasticity across panels. The FGLS estimator in this study is both consistent and efficient under the null hypothesis of the Hausman test, i.e., random effect estimation.[1] As presented in Equations (4) and (5), the baseline model consists of the three financial indexes considered in our study. Furthermore, GDP per capita taken in natural logarithm is also included as a control variable in our baseline model since this variable might impact the relationship between different financial indicators (Kim et al., 2018; Sharma, 2016).

$$\begin{aligned} Financial\ Efficiency_{it} = {} & \alpha_{10} + \delta_{11} Financial\ Inclusion_{it} \\ & + \delta_{12} Financial\ Sustainability_{it} \\ & + \delta_{13} GDP\ per\ capita_{it} + \varepsilon_{1it} \end{aligned} \tag{4}$$

$$\begin{aligned} Financial\ Sustainability_{it} = {} & \alpha_{20} + \delta_{21} Financial\ Inclusion_{it} \\ & + \delta_{22} Financial\ Efficiency_{it} \\ & + \delta_{23} GDP\ per\ capita_{it} + \varepsilon_{2it} \end{aligned} \tag{5}$$

in which: i, t is country i in year t. α are the constant terms and δ are the estimated coefficients; ε are error terms. The estimation is conducted for the whole panel as well as for the two subsamples of countries at different income levels. The results are reported in Table 7 in a concise format.

In contrast to the preliminary observations, the estimation results indicate that financial inclusion significantly and negatively impacts the level of financial efficiency in the whole sample as well as the two subsamples of countries at different income levels. On the other hand, financial inclusion is found to significantly and positively affect the level of financial sustainability in the whole sample. The same finding also applies to the two subsamples of countries at different income levels.

Our findings on the negative linkage between financial inclusion and financial efficiency are in line with García and José (2016) who opined that growing financial inclusion due to intensive participation in the financial system by low-income clients may lead to high transaction and information costs. This increases the information asymmetries that characterise financial systems − a fundamental source of inefficiencies that are difficult to resolve (for instance, due to lack of collateral or credit history).

Our results on the positive connection between financial inclusion and financial sustainability could be explained due to favourable effects that financial inclusion bring to the financial system, including: diversifying bank assets, and thus reducing their riskiness; increasing the stability of their deposit base, reducing liquidity risks; and improving the transmission of monetary policy (Morgan & Pontines, 2014). The findings are similar to Morgan and Pontines (2014) who showed that financial inclusion and financial sustainability are complementary rather than there being a trade-off between them and Neaime and Gaysset (2018) who find that financial inclusion contributes positively to financial stability for eight MENA (Middle East and North Africa) countries over the period from 2002 to 2015. Our findings are also supported by Mehrotra and Yetman (2015) who proposed that growing financial inclusion increases the proportion of economic activity from households and businesses that depends on interest rates and thus strengthens the role of interest rate in monetary transmission. As such, the effectiveness of monetary policy is improved, which contributes to maintaining financial sustainability.

[1] The results of standard Hausman tests accept the null hypothesis of no fixed-effects and suggest that FGLS (random effect estimation) is likely to produce consistent coefficient estimates for all the regression models. The results are not presented here to conserve space but they are available upon request.

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Table 7
Feasible generalized least squares (FGLS) estimation results.

Dep.var: Financial Efficiency	(1) Whole sample	(2) Low and lower-middle income countries	(3) Upper-middle and high income countries	Dep.var: Financial Sustainability	(4) Whole sample	(5) Low and lower-middle income countries	(6) Upper-middle and high income countries
Explanatory var:				Explanatory var:			
Financial Inclusion	−0.332***	−0.341***	−0.370***	Financial Inclusion	0.269***	0.165***	0.352***
	[0.052]	[0.067]	[0.080]		[0.038]	[0.053]	[0.050]
Financial Sustainability	0.077	−0.162*	0.399***	Financial Efficiency	0.041	−0.096*	0.183***
	[0.072]	[0.091]	[0.114]		[0.039]	[0.054]	[0.052]
GDP per capita	−0.012	0.023	−0.070	GDP per capita	−0.015	−0.025	0.152
	[0.044]	[0.093]	[0.183]		[0.032]	[0.071]	[0.124]
Constant	0.104	−0.253	0.502	Constant	0.203	0.280	−0.993
	[0.390]	[0.919]	[1.322]		[0.285]	[0.710]	[0.893]
N	355	200	155	N	355	200	155
Wald χ^2	42.19***	36.67***	24.41***	Wald χ^2	52.73***	19.50***	56.65***
Countries	31	17	14	Countries	31	17	14

Source: Authors' calculations. Note: Normalized variables using standardized Z-score are used for generating the three Financial Indexes using principal component analysis. Standard errors are in []. *, **, *** denote statistical significance at 10%, 5%, 1% levels, respectively.

However, our findings are somewhat opposite to Čihák, Mare, and Melecky (2016) who documented that, on average, there are trade-offs between financial inclusion and financial stability for their study sample. According to the study, greater financial inclusion is particularly associated with extensive borrowing by individuals, and thus may increase the risk of extreme events, unexpected losses of the financial system, and subsequently leading to more frequent banking crises (Čihák et al., 2016). However, Čihák et al. (2016) also proposed that synergies between financial inclusion and financial sustainability can occur with almost equally high probability as compared to trade-offs, particularly during the non-crisis periods. In this regard, they opined that greater financial inclusion is associated with greater stability and may help alleviate expected losses of the financial sector (Čihák et al., 2016). More specifically, the depth of credit information systems would generate synergies between financial inclusion and financial sustainability by improving screening of creditworthy customers, including new users of credit, and aids stability by, for instance, improving the accuracy of estimations of expected losses (Čihák et al., 2016). Similar to Căpraru and Ihnatov (2014), Smaoui and Ben Salah (2012), and Thiagarajan (2018), we found no significant impacts of GDP growth on financial efficiency and financial sustainability in all cases.

5. Concluding remarks

This study attempts to measure and identify the trends of financial inclusion, financial efficiency and financial sustainability in a sample of 31 Asian countries. The study also examines whether financial inclusion is associated with financial efficiency and sustainability that could give rise to either policy conflicts or synergies, and outlines questions for future research. PCA is conducted on different sets of normalized variables in order to construct the three financial indicators. Overall, we find that the trends are fluctuating among our study sample. The estimation results from FGLS indicate financial inclusion significantly and negatively impact financial efficiency while significantly and positively affect financial sustainability in the study sample countries during the investigation period from 2004 to 2016. These findings hold for the whole sample and the subsamples of countries at different income levels.

Our empirical evidence indicates that financial stability and financial inclusion are mutually reinforcing and thus a balance between these two objectives can be achieved. That is, policymakers can obtain the objectives of including a growing number of users of financial services while maintaining systemic stability. Indeed, it is opined that the recent policy reforms that promote financial inclusion in Asia have supported an accessible and stable financial sector environment (Hannig & Jansen, 2010).

On the contrary, our findings suggest that policy measures to increase financial inclusion might have the side effect of reducing financial efficiency. This is attributable to the higher intensity of participation in the financial markets that lead to the

expansion social costs of individual institutional imperfections. Consequently, social and moral will likely increase (De la Torre et al., 2011). Furthermore, growing financial inclusion due to intensive participation in the financial system by low-income clients may lead to high transaction and information costs. This increases the lack of collateral or credit history, which contributes to information asymmetries – a fundamental source of inefficiencies. In order to resolve this problem, a greater number of financial intermediaries accompanied by proper governance and an adequate structure of financial regulation and supervision are essential (De la Torre et al., 2011).

Conflict of interest

The authors declare no conflict of interest.

Acknowledgement

This work was part of the project "Solutions for Promoting Financial Inclusion in Vietnam", supported by The Office of National S&T research Programs (ONARP) of Vietnam, grant number KX.01.30/16-20.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bir.2019.07.002.

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Please cite this article as: Le, T.-H et al., Financial inclusion and its impact on financial efficiency and sustainability: Empirical evidence from Asia, Borsa İstanbul Review, https://doi.org/10.1016/j.bir.2019.07.002