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Financial inclusiveness and economic growth: new evidence using a threshold regression analysis

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ABSTRACT

This paper investigates the effect of financial inclusiveness on economic growth in selected developed and developing countries (63 countries) for the years of 2014 and 2017. The level of financial inclusiveness for each country is calculated using a new construction of the financial inclusion index. The role of financial inclusiveness on economic growth is subsequently estimated using a cross-sectional threshold regression technique. The main findings revealed that there is a threshold effect of the financial inclusiveness-growth nexus, which means that financial inclusiveness exhibits a non-monotonic positive relation with economic growth. The positive effect is more pronounced at a high level than in the low level of financial inclusion index. These new findings should motivate policymakers and the banking sector in each country to exert greater effort in raising the level of financial inclusion in stimulating sustainable economic growth.

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1. Introduction

Since the early 2000s, the concept of financial inclusiveness has become increasingly popular and crucial among researchers, politicians, policymakers and other financial stakeholders. It becomes the main issue of policy-making in socially excluded society and also the most important issue highlighted by central banks and the World Bank. The G20 and World Bank led the initiative for increased financial inclusion in developing countries to alleviate poverty levels and inclusive economic growth in emerging economies (Global Partnership for Financial Inclusion (GPFI), 2011). Financial inclusiveness, which means equal access to financial services, is among the pillars of inclusive and sustainable growth in addition to equal access to education and market participation.

In recent years, over two billion of the global population were financially excluded. Lower-income earners, the uneducated in rural areas and the financially disadvantaged should have access to affordable financial services (Chibba, 2009). Financial

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inclusiveness is one of the quality dimensions of financial development which affects economic condition in a country through household access to financial products and services. Numerous evidence from empirical studies has revealed the positive relationship between the level of financial inclusiveness and economic growth (e.g., Kim et al., 2018). Financial inclusion is a core target for many developing nations and many research findings have identified the importance of financial inclusion to the economy in reducing the poverty levels in households (Global Findex, 2012).

The importance of financial inclusiveness is theoretically acknowledged. Over the last two decades, the strong relationship between financial development and economic growth is well documented in some empirical studies (Abdul Bahri et al., 2018; Beck et al., 2005; Demirguc-Kunt et al., 2008; Demirguc-Kunt & Maksimovic, 1998; King & Levine, 1993a, 1993b; Law et al., 2018; Levine, 2005). Conversely, Honohan (2004) found that financial depth alone did not accurately measure financial development and the reverse causality problem disturbed the analysis. Financial development in itself is inadequate to provide clear insights into whether an economy is moving along a sustainable path or otherwise. Studies by Law and Singh (2014) have shown that there must be a limitation on how much financial development need to be generated. The contradiction between these findings on the linear and non-linear relationship between financial development and economic growth suggests the need to re-evaluate the relationship with other elements of financial development. Therefore, this study will assess and detail out the impact of financial inclusiveness, and its significance, on the economic growth of a country.

This present study contributes to a new measurement of the financial inclusion index, which is the combination of parametric and non-parametric methods in determined the weight of the indicators endogenously through Principle Component Analysis (PCA) by using the multidimensional formula, and also using the supply-side and demand-side indicators. The old measurement of the index contained several weaknesses. The non-parametric approach which measures the weight of the dimension of the index may lead to potential bias (Camara & Tuesta, 2014). Whereas, using only the supply-side indicator proved inadequate for gauging actual financial inclusiveness across various countries (Abd Rahman, 2016). This study, therefore, will use both sources of indicators, including the financial technology (fintech) dimension as a new demand-side indicator, in the construction of a new financial inclusion index.

In order to elucidate the relationship between financial inclusiveness and economic growth, Figure 1 presents plotted data of the new construction index of financial inclusion (IFI) and Gross Domestic Product Per Capita (GDPPC) across selected developed and developing countries for the current year of 2014 and 2017, wherein the new revolution in digital financial technology of financial inclusiveness occurred. The scatter plot shows a positive slope or positive correlation between the logarithm transformation of GDPPC and IFI for both years. Further study on threshold regression analysis of financial inclusiveness and economic growth is thus opportune to ensure whether the nexus remains positive or otherwise.

Studies on the non-monotonic relationship of financial inclusion level on economic growth have not been adequately addressed earlier. Recent studies by Kim et al. (2018) and Goel and Sharma (2017) showed that financial inclusion exerted a

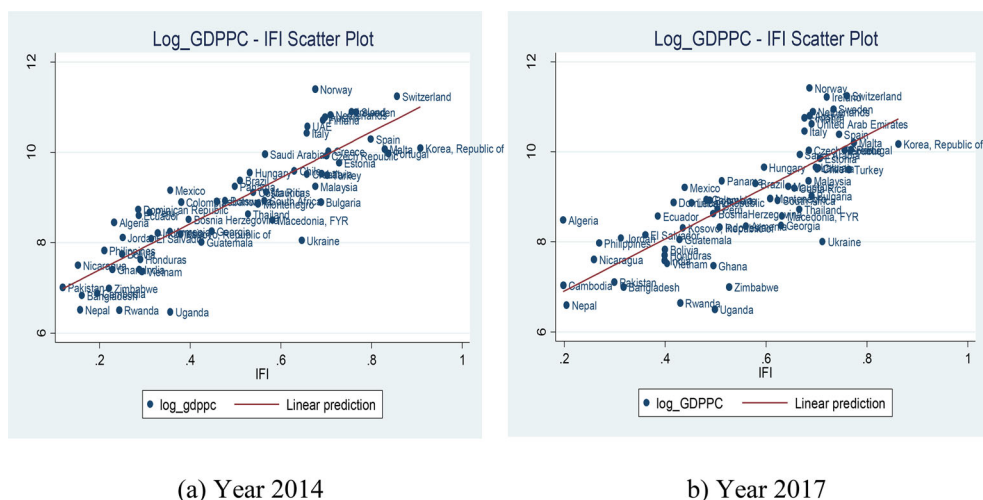


Figure 1. Scatter plot of GDP per capita and index of financial inclusion (IFI) for 2014 and 2017.
Source: Primary data, authors' estimation.

positive impact on economic growth in a linear or monotonic relationship. However, the relationship might also be non-linear but will nevertheless contribute to economic growth or otherwise following a certain level of financial inclusion. Numerous past studies have used proxies for financial development to measure the level of economic growth without focussing on the role of financial inclusion despite its importance in the inclusive and sustainable growth of a country (Chauvet & Jacolin, 2017; Levine, 1997). The relationship between financial development and economic growth has often become the subject of research and economic expertise. Researchers at the International Monetary Fund (IMF) such as Cecchetti and Kharroubi, (2012) have suggested that the level of financial development is good only up to a certain point, after which it becomes a drag on growth. This implies that there is a turning point in the effect of financial development. This relationship has however been questioned due to variation in research results. Thus, in this study financial inclusion is included as the other element or quality of financial development to measure the relationship, either monotonic or non-monotonic.

This paper contributes to policymaking and to existing growth empirics literature in the following aspects. First, to the policymakers, the threshold analysis is necessary to determine the optimal level or minimum turning point of financial inclusion that confers a favourable effect on economic growth. The existence of the threshold level presents important policy implications requiring policymakers to devise an effective strategy to raise the level of financial inclusiveness through strengthen the index and determine the optimum level of financial inclusion to foster economic development. Through knowing the contingent effect and the appropriate financial inclusion threshold level, policymakers are able to frame policies and focus on other growth-enhancing strategies.

Second, the study contributes to the literature on the measurement of financial inclusion index wherein the new weight through the PCA method and fintech dimensions (demand-side indicators) were introduced. Digital finance which known as fintech is financial services delivered through mobile phones, personal computers, the

internet or card linked to a reliable digital payment system. Fintech could lead to greater financial inclusion, expansion of financial services to non-financial sectors, and the expansion of basic financial services to individuals since approximately 50% of people in the developing world have access to a mobile phone (World Bank, 2014). Past literature such as Pradhan et al. (2016) and Kim et al. (2018), mostly recorded the use of a single indicator as a proxy of financial inclusion in the economy. This study will extend the literature to cover financial inclusion as a proxy for determinant economic growth.

This paper is organised as follows. Section 2 provides a discussion on past literature review on financial inclusion as related to growth. Section 3 describes the data, the empirical model, and the econometric method. Section 4 discusses the empirical findings and robustness of the study. Finally, Section 5 provides a summary and conclusions.

2. Literature review

The past literature had identified relationships between financial inclusiveness and other development indicators such as the Human Development Index (HDI), income gap, and per capita income. The initial study by Sarma (2008) compared financial inclusions with HDI using the financial inclusion index (IFI) value for 54 countries. They showed significant relationships in countries with high levels of human development. Financial inclusion has also been recognised globally as an important index in poverty reduction and in achieving inclusive economic growth (Global Findex, 2012). This was reported in several studies such as Kim et al. (2018), which showed that financial inclusiveness has a positive impact on economic growth in the 55 member countries of the Organization of Islamic Cooperation (OIC). King and Levine discovered that financial access increases economic growth, while a structural framework method by Dabla-Norris et al. (2015) showed that financial inclusion drives Gross Domestic Product (GDP) growth through access to credit, credit depth, as well as credit mediation efficiency among firms, in six countries, studied (Malaysia, Kenya, Uganda, Philippines, Mozambique, and Egypt).

Financial inclusion is now a common goal for most central banks in developing countries (Divya, 2014). According to Nwanko and Nwanko (2014), the traditional idea of inclusive finance is the provision of access and use of financial services that are diverse, easy and affordable. Goel and Sharma (2017) also stated that access and use of financial services is one of the key drivers of economic growth. Greater financial access will exert further impacts on the growth of the Gross Domestic Product (GDP). Inclusive finance means sustainable, relevant, cost-effective and meaningful financial services for people with less access and for the rural population. Financial inclusiveness refers to the whole initiative that makes the formal financial services available, accessible and affordable to all segments of the population (Triki & Faye, 2012).

There are several reasons why an increment of financial inclusiveness is said to support financial stability or economic growth. For instance, users who gain access to the formal financial system may increase their savings and diversify their bank

deposits. Hence, any increase in potential savings will help financial institutions to be resilient, given the stability of deposit funding, especially when supported by the effectiveness of the deposit insurance scheme (Hannig & Jansen, 2010). During a global financial crisis, total deposits will slide in an economy where financial inclusiveness is higher in terms of bank deposits, especially in middle-income countries (Han & Melecky, 2013). In Bangladesh, since its introduction in the mid-1970s, financial inclusiveness showed a positive impact in driving the country's economic growth, especially for the lower-income group, through poverty alleviation and improvement in their living standards. Access to inclusive finance is, therefore, necessary to ensure inclusive and stable economic growth (Ibor et al., 2017).

Gine and Townsend (2004), in their study on households in Thailand between 1976 and 1996 revealed that financial access flexibility led to increased access to credit services and rapid growth of per capita Gross Domestic Product (GDP) in the economy. Research by the Consultative Group to Assist the Poor (CGAP, 2012), showed that there are interrelated factors between financial inclusiveness, financial consumer integrity, financial consumer protection, and financial stability. Whether the relationship is successful or failure there is one dimension that will cause problems with other individuals. The literature is also less consensual on the manner and extent of the relationship between financial inclusions and economic growth.

A recent study by Bertram et al. (2016) identified that full or complete financial inclusions serve as a prerequisite for inclusive economic development in Nigeria. A descriptive questionnaire survey generated data on financial inclusions from stakeholders such as banks, insurance, regulators, and telecommunication firms that provide each household with access to a range of modern financial services. They discovered that financial inclusiveness has an impact on inclusive economic development. In consequence, they concluded that all initiatives that make formal financial services available, accessible and affordable to all segments of the population should be encouraged to achieve inclusive economic development. Park and Mercado (2016, 2018) pointed out that income per capita, legal regulation, and demographic characteristics are positively correlated with financial inclusion. Financial inclusions are significantly correlated with poverty reduction in both global samples and in those from developing Asian countries.

Based on the previous empirical literature, studies on the non-linear or non-monotonic relations are only conducted between financial development and economic growth, which does not consider other mechanisms of financial development, namely financial inclusion. For instance, Cecchetti and Kharroubi (2012) in their study of 50 developed and developing countries using panel data analysis for the period of 1980 to 2009, found that the financial sector development (proxy by private sector credit growth) has an inverted U-shaped effect on productivity growth. Arcand et al. (2012) state that over 100 developed and developing countries from 1960 to 2010 have shown that financial development has a negative effect on growth when credit to the private sector reaches 100% of GDP ratio, which is in line with the vanishing effect of financial development. A study by Law and Singh (2014) in 87 developed and developing countries from 1980 to 2010 also found that there was a non-linear effect on the relationship between financial development and economic growth. Whereas,

Samargandi et al. (2015) who used panel data analysis from 1980 to 2008 also found the consistent result of an inverted U-shaped relationship between financial development and economic growth.

Theoretically, financial development affects the growth only to a certain extent, the increase in financial development exceeds a certain threshold point, which will give a negative impact on economic growth. Furthermore, studies on the nonlinear relationship between financial development and growth were mostly conducted from 1980 to 2010, which is the period of several economic crises such as the third commodity crisis in 1985–1986, the Gulf war crisis in 1990–1991, the Asian financial crisis in 1997–1998, the dot.com bubble crisis in 2000–2001, and most recently the global financial crisis in 2007–2008. Therefore, the focal point of this present study is to consider the years after the global economic crisis (2014 and 2017) and financial development mechanism namely financial inclusion in examining the effects of the monotonic or non-monotonic relationship between financial inclusion upon economic growth.

Given this backdrop, this study fills the gaps in the existing literature in four ways. First, it attempts to examine the role of financial inclusion in its relationship with economic growth by using the new composite index as a measure of financial inclusion. Second, in the construction of the financial inclusion index, this study utilised the methods of multidimensional and Principle Component Analysis together with demand-side and supply-side indicators, including financial technology (fintech) indicator, in which the new adapted dimension on the demand-side. Third, this study focuses on the periods of 2014 and 2017, a period of a new revolution in digital financial technology related to financial inclusiveness and stability of the financial system (Ozili, 2018). Lastly, this study presents new evidence on the non-monotonic relationship between financial inclusion and economic growth.

3. Methodology and data

3.1. Data description

This study employs cross-country estimations and utilised macro data from 63 selected developed and developing countries (as listed in Appendix A) for the years 2014 and 2017. The selection of countries was primarily dictated by the availability and reliability of data. The dependent variable used in this study is the real GDP per capita as a proxy for economic growth. The real GDP per capita (GDPPC) is expressed in USD at constant 2010 prices, and data are in the logarithm form. This data was obtained from World Databank Indicators. Meanwhile, the financial inclusion index as an independent variable. This index is constructed based on four dimensions, using a combination of the approach of demand and supply-side dataset. The dataset of four dimensions which are banking penetration, availability of banking services, usage of financial services and digital financial technology (fintech) is obtained from the Financial Access Survey (FAS) database of the International Monetary Fund (IMF) and Global Findex database respectively.

Several macroeconomic factors were utilised for cross-section regression to control the possible factors that affect economic growth. These data were obtained from

World Databank Indicators. Thus, we set up four control macroeconomic variables by following Bjork (1999) and Mankiw (2012), which are inflation rate (INF), population growth rate (POP), unemployment rate (UNEMP), and trade openness (T.OPENNESS). Recent studies by Kim et al. (2018) have used these control variables in examining the links between financial inclusion and economic growth in OIC countries, and the main results indicated that these macroeconomic factors have intermittent statistical significance influencing economic growth in either positive or negative direction.

3.2. Constructing the financial inclusion index (IFI index)

Most of the researchers tend to construct a multidimensional financial inclusion index as a composite indicator because it contains various information on a single aggregate measure and it might be a yardstick for measuring the financial access performance of countries. A multidimensional index increases the comparability of the analysis and explores the trend and relative rankings of countries' financial inclusion levels.

The IFI Index is computed by considering a composite index of 4 dimensions and 7 indicators. There are three advantages of using this new index compared to another financial inclusion measure. First, this new index eliminates the potential bias, lack of scientific rigour and multicollinearity problems in weight assignment, where the Principle Component Analysis (PCA) is the most-used method to obtain weight endogenously have been used to obtain weight or parameter intrinsically. In comparison, Sarma (2012) has assigned weights based on the researcher's intuition. Thus, the selection of financial components and the weight is crucial for the appropriate measurement of the financial inclusion index because indexes are sensitive to subjective weighting, where small changes in weighting will dramatically change the value of the index (Lockwood, 2004). Therefore, this study applies a combination of parametric method (Principle Component Analysis (PCA) and non-parametric method (multidimensional) to generate financial inclusion index across countries. Second, the new index has combined the information from both supply and demand-side data sets, wherein the new fintech dimension (demand-side data) has been used in the calculation. This index contains the aggregate information of different dimensions of financial access for each country that allows researchers and policymakers to make substantial comparisons across economies. Third, this index allows studying the relationship between financial inclusion and other macroeconomic variables of interest.

Hence, constructing the new IFI Index consist of four dimensions. The first dimension is banking penetration (d_{i1}), which measured based on the number of deposit bank account per 1000 adult population. The second dimension is the availability of banking services (d_{i2}), where it was measured based on the number of ATM per 100,000 people and the number of bank outlets per 100,000 populations. The third dimension is the usage of financial services (d_{i3}) that was measured by two basic services of a banking system which are credit and deposit from a commercial bank (% of GDP) in a country. Datasets of a commercial bank are chosen because 85% of data on financial inclusion are taken from commercial banks and it is

sufficient for comparison across the nation. The last dimension is digital financial technology or Fintech (d_{i4}). It was measured based on three indicators which are used the internet to pay bills or to buy something online in the past year (% age 15+), paid utility bills using a mobile phone (% age 15+) and made or received digital payments in the past year (% age 15+).

The calculation of IFI Index begins with computing a dimension index for each of these dimensions by the following formula,

$$d_i = w_i \frac{A_i - m_i}{M_i - m_i} \quad (1)$$

where,

w_i = weight attached to the indicator i , $0 < w_i < 1$

A_i = actual value of indicator i

m_i = minimum value of indicator i , fixed by pre-specified rule as followed by Sarma (2012).

M_i = maximum value of indicator i , fixed by pre-specified rule as followed by Sarma (2012).

The dimension index (d_i) measures the country's achievement in the i dimension of financial inclusion. After calculating the dimension indexes, the weight (w_i) for each dimension of financial inclusion is determined endogenously through PCA analysis and attached to the dimension i indicating the relative importance of the dimension i . The two-stage PCA procedure as suggested by Nagar and Besu (2002) is used to minimise the problem of biased towards the weights of indicators that are highly correlated with each other. The first stage is the estimation of parameters or weights of four index dimensions which are banking penetration, availability, usage, and fintech, while the second-stage involves the estimation on dimension weights and the overall financial inclusion index are using the dimensions as explanatory variables. The latent variable of financial inclusion (FI) is linearly determined as follows:

$$FI_i = w_1 Y_i^p + w_2 Y_i^a + w_3 Y_i^u + w_4 Y_i^f + e_i$$

where, i = country

Y_i^p, Y_i^a, Y_i^u dan Y_i^f = banking penetration, availability, usage, and fintech dimension

e_i = total variation in financial inclusion is presented by two orthogonal parts which are variation due to causal variables and due to error.

After the weights w_i is determined intrinsically (z) through PCA method, the index of financial inclusion is calculated based on four dimensions, thus the final formula for constructing IFI index for a country is then calculated as below:

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

where p_k, a_k, u_k and f_k denote respectively the weighted dimension indexes for the dimensions penetration, availability, usage, and fintech.

3.3. Model specification and empirical strategy

The empirical model is based on King and Levine (1993a, 1993b), and Kim et al. (2018) in which the empirical linkages between financial inclusion and growth can be written as following growth equation:

$$RGDPPC_i = \alpha_0 + \beta_1 IFI_{(fintech)i} + \beta_2 X_i + \varepsilon_i \quad (3)$$

where,

$RGDPPC$ = logarithm of real gross domestic product (GDP) per capita

$IFI_{(fintech)i}$ = index of financial inclusion

X_i = vector of control variables that affect real GDP per capita

i = country, $i = 1, 2, \dots, n$

ε = error term

The threshold effect hypothesis or nonlinearity in this study is as follows:

$$H_0 : \beta_1 = \beta_2$$

$$H_1 : \beta_1 \neq \beta_2$$

where β_s are vectors of the parameter. The null hypothesis is linear regression and the alternative hypothesis is nonlinear regression. If the null hypothesis is rejected, then we have a two-regime, nonlinear threshold regression.

The following Equation (4) is particularly well suited to test the hypothesis outlined and to capture the presence of contingency effects between financial inclusion and economic growth. The model based on threshold regression takes the following form:

$$RGDPPC_i = \begin{cases} \beta_0^1 + \beta_1^1 IFI_{(fintech)i} + \beta_2^1 X_i + e_i, & IFI_{(fintech)i} \leq \gamma \\ \beta_0^2 + \beta_1^2 IFI_{(fintech)i} + \beta_2^2 X_i + e_i, & IFI_{(fintech)i} > \gamma \end{cases} \quad (4)$$

where, IFI_i (level of financial inclusion) is the threshold variable used to split the sample into regimes or groups, and γ is the unknown threshold parameter. This type of modelling strategy allows the role of financial inclusion to differ depending on whether the countries are below or above some unknown level of γ . In this equation, the index of financial inclusion act as a sample-splitting or threshold variable. The impact of financial inclusion on real GDP per capita will be β_1^1 and β_1^2 for countries with a low or high regime, respectively. On the other hand, under the hypothesis $\beta_1 = \beta_2$, the model becomes linear and reduces to (3).

Equation (4) can be re-written in a general form as:

$$y_i = \beta_1' x_i I(q_i < \gamma) + \beta_2' x_i I(q_i \geq \gamma) + e_i = \beta_1' x_i(\gamma) + e_i \quad (5)$$

where $I(\cdot)$ is an indicator function, $\beta = (\beta_1', \beta_2')$ and $x_i(\gamma) = \begin{bmatrix} x_i I(q_i < \gamma) \\ x_i I(q_i \geq \gamma) \end{bmatrix}$

3.4. Cross section threshold regression

This study applied the cross-section threshold regression method to shed light on the non-monotonic effect of financial inclusiveness on economic growth. Financial

inclusiveness and economic growth issues are dynamic by nature and to understand the adjustment, this method could be used. Allowing for dynamics in the underlying process may be crucial for recovering consistent estimates of other parameters.

The first step of the estimation is to test the null hypothesis of linearity $H_0 : \beta_1 = \beta_2$ against the threshold model in Equation (4). If the null hypothesis is rejected, then statistically, there is evidence of threshold level regression with two regimes and the model is non-linear. When a threshold value exists, the sample is estimated to be $IFI_{(fintech)i} \leq \gamma$ referring to the first regime and $IFI_{(fintech)i} > \gamma$ referring to the second regime. Statistically, both regimes give different decisions in estimation.

This study follows Hansen (1996, 2000) who suggests a heteroscedasticity-consistent Lagrange Multiplier (LM) bootstrap procedure to test the null hypothesis of a linear formulation against a threshold regression alternative. Since the threshold parameter γ is not identified under the null hypothesis of the no-threshold effect, the p values are computed by a fixed bootstrap method. Hansen (2000) shows that this procedure yields asymptotically correct p values. If the hypothesis of $\beta_1 = \beta_2$ is rejected and a threshold level is identified, then we should test again the threshold regression model against a linear specification after dividing the original sample according to the threshold identified. This procedure is carried out until the null of $\beta_1 = \beta_2$ can no longer be rejected.

4. Empirical results

Based on the value of financial inclusion index, $IFI \text{ index} = 0$; denotes complete financial exclusion, while $IFI \text{ index} = 1$; indicates complete financial inclusion. The higher value of the financial inclusion index, the more inclusive of financial services in a particular country. The level of Financial Inclusion Index (IFI) is presented in appendix A in the appendices. Based on the observation in appendix A, different countries have a different level of financial inclusion. Among the 63 countries for which IFI has been computed, in the year 2014, Korea ranked the highest IFI with a value of 0.9079, while Pakistan ranked the lowest IFI with a value of 0.1192. Meanwhile, in the year 2017, Korea also ranked the highest IFI with a value of 0.8623, and Algeria ranked the lowest IFI with a value of 0.1979.

4.1. Hansen (2000) threshold regression

Table 1 presents descriptive statistics of the variables employed in the analysis. Statistics pertaining to each variable reported are unit of measurement, mean, standard deviation, minimum (Min), and maximum (Max). It shows that all level data are extremely skewed from the fact that the mean and median values of all variables have differed.

The impact of financial inclusion on GDP growth has been estimated using Equation (4) to each model for the years 2014 and 2017 respectively. As mentioned previously, we employed a splitting of the sample threshold method proposed by

Table 1. Descriptive statistics of data 63 selected developed and developing countries for 2014 and 2017.

	Unit of measurement	Mean	Std. Dev	Min	Max
Economic growth	Log GDP per capita US\$ 2010 constant price	8.919	1.257	6.466	11.421
Financial inclusion	Scaled from 0 to 1	0.523	0.194	0.119	0.908
Inflation	Annual % Consumer Price Index (CPI)	3.074	2.969	1.418	15.489
Population growth	%	0.989	1.093	1.306	6.016
Unemployment	%	8.351	7.256	0.18	35.15
Trade openness	Ratio of import plus export value to GDP	0.959	0.491	0.229	2.839

Notes: N = 63 cross-country. T = 2014 and 2017.

Source: Primary data, authors' estimation.

Table 2. Threshold estimates of financial inclusion index (IFI) for 2014.

	First sample split	Second sample split
LM test for no threshold	14.236	7.700
Bootstrap <i>p</i> -value	0.036**	0.643
Threshold estimate	0.550	0.689
95% confidence interval	[0.244, 0.630]	[0.550, 0.908]

Notes: *** denote significant at 5% level.

Source: Primary data, authors' estimation.

Hansen (1996, 2000) to investigate the threshold effect of financial inclusion upon economic growth.

The result of each model for years 2014 and 2017 are presented in Tables 2–5. The findings reveal several interesting observations. First, Tables 2 and 3 have tested the hypotheses null of no threshold against the alternative of threshold allowing heteroskedastic errors (White corrected). It shows that the *p*-value of the hypothesis of no threshold effects as computed by the bootstrap method with 5000 replications and 15% trimming percentage are rejected at a highly significant level for both years. These findings clearly indicate that the relationship between economic growth and financial inclusiveness is non-linear, and therefore the imposition of a priori monotonic restriction on the relationship also could be ambiguous. The finding provides a better explanation for a dynamic relationship between financial inclusion and economic growth, where financial inclusion could effectively contribute to economic growth only at a certain level of the index or any of its interaction terms. We also tested whether the high IFI group could be split further into sub-regimes. The bootstrap *p*-values were insignificant for the second sample split, thus it suggests that only the single threshold is adequate for the model of the year 2014 and 2017.

The presence of the threshold level also indicates that the sample can be split into two regimes depending on the level of financial inclusion in the country. This study has used the first sample split in measuring the turning point. The country is said or considered as low-level of financial inclusiveness if the index of financial inclusion (IFI) is below the threshold level, while the country with the IFI index greater than the threshold level is considered as the high level of financial inclusiveness. The behaviour of the relationship between financial inclusion and economic growth are different for low and high IFI countries. Tables 4 and 5 depicts that the hypothesis of IFI-led growth is rejected.

Based on threshold model specifications in Table 4 for the year 2014, it shows that the coefficients estimate for IFI is significant and positive in both levels either below

Table 3. Threshold estimates of financial inclusion index (IFI) for 2017.

	First sample split	Second sample split
LM test for no threshold	13.853	7.670
Bootstrap p-value	0.038**	0.751
Threshold estimate	0.667	0.691
95% confidence interval	[0.496, 0.687]	[0.691, 0.691]

** denote significant at 5% level.

Source: Primary data, authors' estimation.

Table 4. Regression results using the financial inclusion index (IFI) as a threshold variable. Dependent variable: GDP per capita (2014).

Variable	Linear model OLS without threshold	Regime 1 IFI < 0.55	Regime 2 IFI > 0.55
Constant/Intercept	6.776*** (0.359)	6.362*** (0.384)	9.028*** (1.042)
IFI	5.051*** (0.447)	5.205*** (0.708)	2.849** (1.335)
Inflation	−0.057* (0.034)	−0.000 (0.027)	−0.155*** (0.022)
Population growth	0.048 (0.065)	−0.010 (0.069)	0.297*** (0.098)
Unemployment	−0.011 (0.010)	0.010 (0.012)	−0.041*** (0.015)
Trade openness	−0.170 (0.184)	−0.096 (0.221)	−0.470** (0.222)
R-square	0.758	0.580	0.589
Heteroscedasticity test (p-value)	0.479	—	—
No. of observation	63	36	27
Degrees of freedom	57	30	21

Notes: Number in parentheses are standard errors.

***, **, and * denote significant at 1%, 5% and 10% levels, respectively.

Table 5. Regression results using the financial inclusion index (IFI) as a threshold variable. Dependent variable: GDP per capita (2017).

Variable	Linear model OLS without threshold	Regime 1 IFI < 0.667	Regime 2 IFI > 0.667
Constant/Intercept	6.404*** (0.378)	7.520*** (0.595)	11.550*** (1.405)
IFI	5.418*** (0.648)	3.042*** (0.966)	−0.955 (1.506)
Inflation	−0.134*** (0.028)	−0.076 (0.047)	−0.173*** (0.016)
Population growth	−0.007 (0.143)	−0.256 (0.204)	0.461*** (0.115)
Unemployment	−0.006 (0.011)	0.007 (0.011)	−0.004 (0.021)
Trade openness	0.022 (0.177)	−0.177* (0.189)	−0.337 (0.289)
R-square	0.676	0.471	0.680
Heteroscedasticity test (p-value)	0.014	—	—
No. of observation	63	40	23
Degrees of freedom	57	34	17

Notes: Number in parentheses are standard errors.

*** and * denote significant at 1% and 10% levels respectively.

Source: Primary data, authors' estimation.

or above the inclusion threshold. Thus, a one-unit increase in IFI will raise the economic growth by 5.205 percent and 2.849 percent in a low and high regime of financial inclusion respectively. Above the threshold level of financial inclusion (IFI >

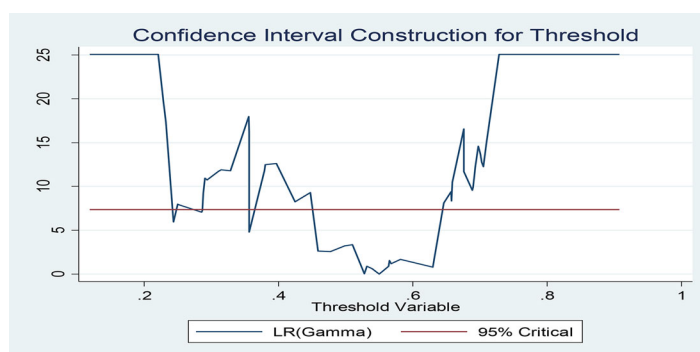
0.55), all the estimated coefficient of control variables (inflation, population growth, unemployment, and trade openness) are significant at 1 percent and 5 percent significance level respectively. However, the coefficient of inflation, unemployment, and population growth are constant with economic theory while trade openness is inconsistent regardless of whether below or above the IFI threshold. It shows that a one percent increase in inflation and unemployment will decrease economic growth by 0.155 and 0.041 percent, respectively. Meanwhile, a one percent increase in population growth, economic growth will increase by 0.297 percent. In contrast, below the threshold level ($IFI \leq 0.55$), all the estimated coefficient on inflation, population growth, unemployment, and trade openness are statistically insignificant in influencing economic growth.

Table 5 reports the threshold model specifications for the year 2017. It shows that above the threshold level ($IFI > 0.667$), the coefficient of IFI is insignificant as a determinant of economic growth but the coefficient is positive and significant in influencing growth below the threshold level ($IFI \leq 0.667$). Hence, below the threshold level, 1 unit increase in IFI, economic growth will increase by 3.042 percent. This finding suggests that financial inclusion could replicate a nonlinear relationship between financial inclusion and growth. Above the threshold level, the estimated coefficient of inflation and population growth are significant at 1 percent level. Inflation negatively associated with economic growth, meanwhile, population growth positively associated with economic growth. Below the threshold level, only trade openness has a significant estimated coefficient, however, the relationship is inconsistent with the theory. Other control variables have an insignificant coefficient in either below or above the threshold level.

Figures 2 and 3 displays a graph of the normalised likelihood ratio sequence $LR_n^*(\gamma)$ as a function of the threshold in output. Based on Figures 2 and 3, the LS estimate of γ is the value that minimises the graph, which occurs at $\hat{\gamma} = 0.550$ for 2014 and $\hat{\gamma} = 0.667$ for 2017. The 95% critical value also plotted as the dotted line, thus we can read off the asymptotic 95% confidence set of the interval from the graphs from where $LR_n^*(\gamma)$ crosses the dotted line. These results show that there is reasonable evidence for two regime specifications. Figures 2 and 3 shows that this confidence interval contains 36 and 40 out of 63 countries in the subsample respectively. Among 63 countries with initial output above 0.550 and 0.667, further sample split these two subsamples based on financial inclusion index result to none of the bootstrap test statistics were significant at the 1% or 10% level.

The regression's result from Equation (4) has provided a new intuitive understanding of the role of IFI on the economic growth of the country. As evidenced by the results of both the years 2014 and 2017, the findings demonstrate that the effect of financial inclusion on economic growth is different when considering yearly differences. The effect is much stronger in the year 2014 compared to 2017, where financial inclusion is a highly significant determinant of growth.

In the year 2014, the coefficient for inflation and unemployment is negative which reinforces the role of these variables in reducing the economic growth after a certain level of financial inclusion, while population growth and trade openness is positively associated with economic growth when the value of financial inclusion index is above the turning point or minimum value. All the estimated coefficient is mostly consistent with the economic theory in high regimes of a threshold effect. Meanwhile, in the

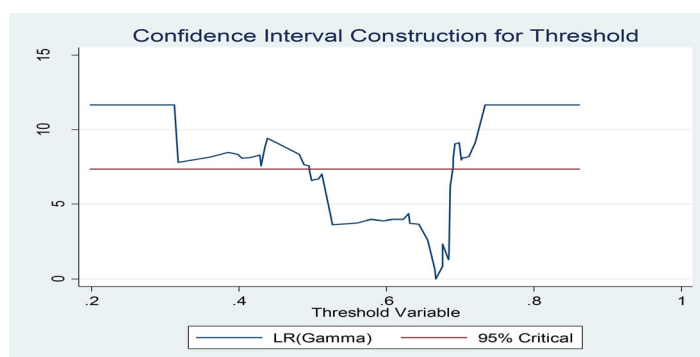


Notes: Threshold variable: Index of financial inclusion (IFI)

Figure 2. First sample split (2014): Confidence interval construction for threshold.

Notes: Threshold variable: Index of financial inclusion (IFI).

Source: Primary data, authors' estimation.



Notes: Threshold variable: Index of financial inclusion (IFI)

Figure 3. First sample split (2017): Confidence interval construction for threshold.

Notes: Threshold variable: Index of financial inclusion (IFI).

Source: Primary data, authors' estimation.

year 2017, only the coefficient of inflation is negative in determining economic growth after a certain level of IFI, while population growth is positively associated with economic growth. This is common to understand that population or labour force and economic growth is positively related (Kim et al., 2018). Only the value of the coefficient of trade openness is significant in low regimes of a threshold effect, however, the relationship is inconsistent with the economic theory. Our empirical findings highlight that, financial inclusiveness is a positive determinant of economic growth, further expanding of financial inclusion would not harm the economic growth as shown by the result of the threshold level exceeding the optimal point in the year 2017, the correlation remains insignificant.

4.2. Robustness checking

A robustness checking has applied to verify the sensitivity of the estimated threshold value and to strengthening the empirical findings. Thus, this study reestimates the

baseline model by considering the outliers test, take the two years average of the data set, and estimating the model using quantile regression.

To detect outliers, a DFITS statistical test was conducted. According to this test, DFITS measures the scale of the difference between the expected value of observations in the sample and out of the sample. DFITS evaluates the appropriate results for the regression model. The DFITS statistical test conducted in this study aimed at identifying outliers for the countries. There are 3 steps in the DFITS statistics test. First, calculate DFITS in the regression model of financial inclusion. Second, compute the DFITS statistics calculated in descending order. The third step computes the cut-off value proposed as a variable by assuming the DFITS value for each cut-off = 1. Subsequently, a list of countries detected as outliers will be shown. There were 4 countries (Malta, Dominican Republic, Nepal, and Finland) detected as outliers. Thus the remaining 59 countries out of 63 were selected for this robustness checking.

The empirical results for the two years' average after outlier's process are summarised in Table 6. There is a threshold effect when the test of null of no threshold against the alternative of threshold allowing heteroskedastic errors (White corrected), show that the p-value of the hypothesis of no threshold effects as computed by the bootstrap method with 5000 replications and 15% trimming percentage is significant at 1% level. Thus, we performed the analysis and presents the findings for two years average after outliers for robustness checking. It shows that result favour for a single threshold model and the hypothesis of a no-threshold model was rejected. The empirical findings reveal that in countries with (high levels of financial inclusion) in the second regime, there is a significantly positive relationship between financial inclusion index and economic growth, while in the first regime (low financial inclusion), the coefficient is positive but insignificant. Thus, the nexus between financial inclusion and growth is the only significant and positive coefficient in the high financial inclusion regime, in which the non-linear relationship between financial inclusive-growth nexus is held.

This study also applied the quantile regression method as robustness checking. Quantile regression is the extension of linear regression and could be used when the conditions of linear regression are not applicable. Quantile regression produces a distinct set of parameter estimates and predictions for each quantile level (Robert & Yonggang, 2017). In relative to the ordinary least squares regression, the quantile regression estimates are more robust against outliers in the response measurements. Thus, we performed the quantile approach for the dataset of two years average without outliers.

The empirical results for the quantile regression approach are summarised in Table 7. As for 0.25 quantile of economic growth, it showed that for countries with lower economic growth, the coefficient of financial inclusiveness (IFI) is significantly positive at 7.546, which is lower than average IFI in OLS regression. Meanwhile, as for 0.75 quantiles of economic growth, it showed that for countries with higher economic growth, the coefficient of financial inclusiveness (IFI) is significantly positive at 3.727, which is lower than average IFI in OLS estimation as well. Thus, the magnitude decreases along quantile, which means that less strong effect of financial inclusiveness on economic growth for those countries with higher growth.

Table 6. Robustness check using two years' average (2014 and 2017) dataset.

Variable	Linear model OLS without threshold	Regime 1 IFI < 0. 564	Regime 2 IFI > 0.564
Constant/ Intercept	24.468*** (0.904)	26.215*** (1.210)	18.982*** (2.773)
IFI	5.460*** (0.941)	2.467 (2.468)	11.695*** (3.238)
Inflation	0.017 (0.054)	0.075 (0.099)	−0.016 (0.050)
Population Growth	0.073 (0.195)	−0.450* (0.244)	0.943*** (0.176)
Unemployment	−0.081*** (0.022)	−0.095*** (0.025)	−0.026 (0.035)
Trade Openness	−1.379*** (0.517)	−1.375** (0.679)	−1.099** (0.525)
R-square	0.354	0.305	0.587
Heteroscedasticity test (p-value)	0.216	−	−
No. of observation	59	31	28
Degrees of freedom	53	25	22

Notes: Number in parentheses are standard errors.

***, **, and * denote significant at 1%, 5% and 10% levels, respectively.

Source: Primary data, authors' estimation.

Table 7. Robustness check using quantile regression approach (quantile regression coefficient at different quantiles).

Variable	OLS regression	Quantile regression at 0.25 quantile (lower quantile)	Quantile regression at 0.75 quantile (higher quantile)
Intercept	19.860*	22.299*	25.746*
IFI	8.507*	7.546*	3.727*
Inflation	0.107	0.028	0.021
Population Growth	0.549	0.241	0.096
Unemployment	−0.012	−0.038	−0.062
Trade Openness	−0.477	−2.072	−0.958

*denote significantly different quantile regression coefficient from zero at the 5% significant level.

Source: Primary data, authors' estimation.

5. Summary and conclusions

This study provides new evidence of the nonlinear impact of financial inclusiveness on economic growth through the threshold level of financial inclusion index for 63 countries for the years 2014 and 2017. The cross-section model based on the concept of threshold effect proposed by Hansen (2000) was used to capture the relationship between financial inclusion index (IFI) and economic growth across countries. The threshold point tests the different effects of financial inclusion on economic growth with a comparison between low-level IFI countries and the high-level ones. These findings, therefore, underline the importance of policymakers to focus on the turning point and aspects of financial inclusion to ensure the greater performance of the economy.

The main findings can be summarised in three aspects. First, there is a threshold effect on the relationship between financial inclusiveness and economic growth. A priori monotonic restriction on the analysis of financial inclusion on economic growth in the past literature, such as Dixit and Ghosh (2013), Karpowicz (2016), and Kim et al. (2018), could lead to a premature conclusion. However, this study provides a new conclusion on the positive non-monotonic or non-linear relationships between

financial inclusion and economic growth. Second, financial inclusion is positive and significant in affecting economic growth particularly in the high regime threshold level (IFI), and the effect of financial inclusiveness on economic growth is much stronger for those countries with lower growth rather than between countries with higher growth. Third, we presented new evidence on the role of a new financial inclusion index as a measure of financial inclusiveness in selected developed and developing countries.

In terms of policy implication of this study suggests that policy formulation in the context of financial inclusiveness is based on improvements in the financial inclusion index. This new index measures could be applied and used as a basis for gauging actual financial inclusiveness across various economic aggregates. Policymakers in any country need to expand the use of fintech in financial access since it is an important element in financial inclusiveness. Fintech and financial inclusion have several benefits to financial service users, fintech providers, government and the economy such as increasing access to finance among poor individuals and increasing aggregate expenditure for governments. In addition, policymakers in each country also need to prioritise their efforts to raise the level of financial inclusiveness in lieu of its positive growth-enhancing effect. Developed countries like Korea, normally have a high level of financial inclusiveness where the index value exceeds the optimal level. Less developed and developing countries, therefore, need to achieve the optimal level of financial inclusion index and become more inclusive to boost economic growth. There are several developing countries that have achieved the optimal level of financial inclusion index which include Malaysia, Norway, Thailand, and Macedonia.

This study presents a number of possibilities for future research. First, other relevant indicators based on several dimensions could be included in the calculation of the financial inclusion index to enhance the efficiency of its measurement. Second, due to the limitation of data availability in this study, future researchers should ensure access to large panel datasets in order to capture the broader perspectives on the effect of financial inclusion on economic growth.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix A. Country list and the levels of financial inclusion

Country	Index of financial inclusion (IFI)	
	2014	2017
Algeria	0.2326	0.1980
Armenia	0.3558	0.5605
Austria	0.6977	0.6866
Bangladesh	0.1618	0.3176
Bolivia	0.2503	0.3998
Bosnia Herzegovina	0.3972	0.4955
Botswana	0.4775	0.4883
Brazil	0.5105	0.5790
Bulgaria	0.6887	0.6907
Cambodia	0.1951	0.1982
Chile	0.6301	0.7016
Colombia	0.3804	0.4822
Costa Rica	0.5395	0.6564
Croatia	0.6580	0.7036
Czech Republic	0.7008	0.6849
Dominican Republic	0.2858	0.4167
Ecuador	0.2868	0.3856
El Salvador	0.3145	0.3609
Estonia	0.7287	0.7067
Finland	0.6935	0.6764
Georgia	0.4475	0.6300
Ghana	0.2284	0.4958
Greece	0.7053	0.7559
Guatemala	0.4249	0.4285
Honduras	0.2904	0.3993
Hungary	0.5320	0.5960
India	0.2879	0.3993
Indonesia	0.3284	0.5082
Ireland	0.7564	0.7207
Italy	0.6571	0.6761
Jordan	0.2514	0.3129
Korea, Republic of	0.9079	0.8623
Kosovo, Republic of	0.3794	0.4356
Latvia	0.6904	0.6986
Lebanon	0.4591	0.4527
Macedonia, FYR	0.5821	0.6320
Malaysia	0.6764	0.6846
Malta	0.8293	0.7741
Mauritius	0.5680	0.6438
Mexico	0.3565	0.4391
Montenegro	0.5505	0.6082
Nepal	0.1577	0.2049
Netherlands	0.7099	0.6929
Nicaragua	0.1529	0.2591
Norway	0.6759	0.6864
Pakistan	0.1192	0.2996
Panama	0.4988	0.5129
Peru	0.3112	0.5042
Philippines	0.2108	0.2691
Portugal	0.8375	0.7693
Rwanda	0.2437	0.4302
Saudi Arabia	0.5653	0.6670
South Africa	0.5643	0.6234
Spain	0.7986	0.7447
Sweden	0.7663	0.7338
Switzerland	0.8568	0.7610
Thailand	0.5280	0.6660
Turkey	0.7025	0.7646
Uganda	0.3567	0.4986
Ukraine	0.6462	0.7122
UAE	0.6589	0.6905
Vietnam	0.2941	0.4043
Zimbabwe	0.2213	0.5272