

## Financial Inclusion, Economic Growth, And Asean Economies: Empirical Evidence From Panel Pooled Mean Group-Autoregressive Distributed Lag

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### Abstract

This empirical study examines the long-run and short-run relationship between financial inclusion and economic growth in seven Association of Southeast Asian Nations (ASEAN) countries including Indonesia, Malaysia, the Philippines, Thailand, Vietnam, Cambodia, and Lao PDR. Using Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL) model, the analysis regresses three financial inclusion determinants namely number of commercial bank branches, account ownership, and automated teller machines (ATM) against the GDP per capita, the proxy of economic growth, with a designated set of control variables. The panel data covers the period of 2000 to 2021. The findings contribute to the literature on the subject by providing empirical evidence of a positive and statistically significant long-run relationship between financial inclusion determinants and GDP per capita in the ASEAN region. The study's findings indicate that, in a long run, a 1% increase in commercial bank numbers corresponds to a 0.57 % increase in GDP growth, while a 1% increase in number of account ownership is linked to a 1.03 % increase in GDP growth. However, evident of the effects of numbers of ATM is less significant, although a 1% increase of this variable is associated with a 0.23 % rise in GDP growth. The short-run relationship between financial inclusion and economic growth is mixed and varies across different estimation lags, highlighting the complexity of the relationship. The study offers important policy implications for ASEAN economies and beyond, suggesting that policymakers in the region need to continue promoting financial inclusion for long-run positive effects on economic growth.

**Keywords:** financial inclusion; financial development; economic growth; developing economies, pooled mean group-ARDL; ASEAN.

**JEL Classifications:** B55, D60, O23, I15, I30, J10

## **1. Introduction**

In the aftermath of the COVID-19 pandemic, governments and policymakers worldwide have recognized an unprecedented need to prioritize financial inclusiveness more than ever before. Strengthening financial institutions and banking access across the board has become a pressing concern as countries work to address the economic challenges posed by the pandemic. After the wide-spread devastating Asian financial crisis of 1997, financial inclusion in the Association of Southeast Asian Nations (ASEAN) region has become a key policy priority in building more resilient and inclusive economies (World Bank, 2021). Although ASEAN countries have made significant progress in expanding access to financial services, significant disparities remain, particularly in rural areas and among lower-income households. These concerning disparities could pose serious consequences for economic resilience and recovery post-pandemics. Given these challenges, policy makers in the ASEAN region need to understand the developing relationship between financial inclusion and economic growth and to identify effective strategies for improving financial inclusion for long-run economic gains.

World Bank (2022) describes financial inclusion as the availability of affordable and useful financial products and services that cater to the needs of individuals and businesses. Given this definition, financial inclusion has been recognized as key enabler for the 2030 Sustainable Development Goals emphasized by the United Nations, which include the goal to achieve no poverty, zero hunger, good health and well-being, quality education, gender equity, decent work and economic growth, and reduced inequality. Other prominent international development organizations and initiatives such as G20 and International Monetary Funds (IMF) have also acknowledged the importance of financial inclusion and its wide-ranging positive effect on different aspects of economy that could lead to greater economic growth, stability, and inclusiveness (Barajas, Beck, Belhaj, & Ben Naceur, 2020).

The level of financial inclusion has been measured using access to financial services such as savings accounts, credit, insurance, and payment services to individuals and businesses who are excluded from the formal financial system (Demirguc-Kunt, Klapper, Singer, Ansar, & Hess,

2018). According to the World Bank's Global Findex database, reported by Demirgüç-Kunt et al.(2018, 2022), the percentage of adults worldwide with a bank account increased from 51% in 2011 to 62%, 69%, and 76% in 2014, 2017, and 2021, respectively. However, significant disparities remain across countries and regions. For instance, over 94% of adults in high-income economies have a bank account in comparing to only 63% of adults in developing economies own a bank account in 2017. In addition, women are disproportionately excluded from financial services, with 56% of women compared to 52% of men in developing economies lacking a bank account. In terms of the access to credit, an estimated 1.7 billion adults worldwide lack access to formal financial services, and an additional 200 million have only informal access to credit (Demirgüç-Kunt et al., 2018). This has led to a significant reliance on informal lenders, which can expose borrowers to high interest rates and other risks.

The same World Bank's Global Findex database report reveals that the percentage of adults with a bank account in ASEAN countries increased from 29.6% in 2011 to 43.7% in 2017 (Demirgüç-Kunt et al., 2018). A more recent report of the United Nations Capital Development Fund (UNCDF), reported by Naidoo and Loots (2022), reveals that there are still 265 million or 44% of adults in ASEAN who are still unbanked. This statistical number indicates that significant disparities remain within the region, with the highest levels of financial inclusion in countries such as Singapore (96.4%) and Brunei (64.4%), while countries such as Cambodia (22.9%) and Myanmar (26.4%) have much lower levels of financial inclusion. In addition, Naidoo and Loots (2022) reports that the access to credit in ASEAN remains a significant challenge for many individuals and small businesses in the region, with an estimated 45% of the adult population in ASEAN countries lacking access to formal credit.

Previous studies have found a positive correlation between financial inclusion and economic growth in ASEAN countries, suggesting that an increasing access to credit and other financial services, promoting entrepreneurship and innovation would enable the efficient allocation of resources. Among others, the empirical studies conducted by Malarvizhi, Zeynali, Mamun, & Ahmad, (2019), Suidarma, (2019), and Nguyen and Ha (2021) find that financial

inclusion has a significant positive impact on economic growth in ASEAN countries such as Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam. However, existing literature suggest that the relationship between financial inclusion and economic growth is complex and may vary depending on the specific context and economic conditions of a country such as institutions and the level of economic development (Beck, Demirgüç-Kunt, & Honohan, 2009; Cull, Demirgüç-Kunt, & Morduch, 2013; Kyophilavong and Shahbaz, 2016). While Timer & Raza (2022) and Chen, Zhu, Zhao, Cao, Cai (2022) have found that the relationship between financial inclusion and economic growth is non-linear, with financial inclusion having a diminishing marginal effect on economic growth at higher levels of inclusion, Sarma & Pais (2011) extrapolated that human development and financial inclusion in a country move closely with each other with significant evident in factors such as income, inequality, literacy, urbanisation.

This study seeks to further explore the relationship between financial inclusion and economic growth in ASEAN economies by expanding the empirical analysis to include countries such as Cambodia and Lao PDR, two of the least developed economies in the region. In comparing with other ASEAN member nations, the economies of Cambodia and of Lao PDR lack behind in level of financial inclusion due to less developed financial systems that leave a vast majority of their populations with limited access to financial services and remain unbanked (ADB, 2017; Loo, 2019). The findings from this study will contribute to the existing literature by providing additional evidence of relationship between financial inclusion and economic growth in the region. Specifically, for the economies of Cambodia and of the Lao PDR, as part of the ASEAN economic integration. Moreover, this study takes on a different analysis approach by applying a Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL) Analysis techniques. The use of PMG-ARDL in this study is appropriate given the panel data structure and the need to identify both short- and long-term effects of financial inclusion on economic growth. Additionally, this technique is well-suited to address issues of endogeneity and autocorrelation that may arise in the data.

## Literature Review

### **Financial Inclusion and Economic Growth in ASEAN**

Over the past two decades, financial inclusion in ASEAN has gained increasing attention due to its benefits in boosting economic growth and progress achieved in poverty reduction Barajas et al. (2020). To promote financial inclusion and economic growth, governments in ASEAN have implemented a number of policy measures. These include efforts to improve access to financial services, such as through the expansion of mobile banking and digital financial services, as well as regulatory reforms to improve the enabling environment for financial inclusion (Ayyagari & Beck, 2015; ADB, 2017). In addition, there have been efforts to increase financial literacy and education, which can help to increase the demand for financial services and support the development of financial products (Loukoianova et al., 2018; Lusardi, 2019; Naidoo and Loots, 2022).

Existing research on the relationship between financial inclusion and economic growth in ASEAN have found a positive correlation between financial inclusion and economic growth, with increased access to financial services leading to higher levels of economic activity and development. Malarvizh et al.(2019) examine relationship between financial sector development and economic growth in five ASEAN countries. The study uses data from 1980 to 2011 and finds that financial inclusion is associated with higher levels of gross domestic product (GDP) in Malaysia, Indonesia, Singapore, Thailand, and Philippines. A similar study conducted by Suidarma (2019) on the nexus between financial inclusion and economic growth in ASEAN reveals a positive effect of financial inclusion through the number of ATMs and commercial bank branches.

Empirical evidence from previous studies reveals that impacts of financial inclusion on economic growth in ASEAN countries have been observed through the improving access to credit, which allows unbanked and underbanked individuals access to financial system that facilitate investment and entrepreneurship (Demirgüç-Kunt & Singer, 2017). Ratnawati (2020) finds that the increase of financial inclusion encourages financial stability through the increase of the intermediating process between savings and investment. In addition, financial inclusion may also enable individuals and businesses to better manage risk, which can promote stability and support economic growth (Hannig &

Jansen, 2010; Sarma & Pais, 2011).

Other studies of financial inclusion in ASEAN have found mixed results with some suggesting that the relationship between financial inclusion and economic growth is complex and may depend on a range of factors such as the level of economic development, the quality of institutions, and the regulatory environment (Beck et. al, 2009; Cull et.al, 2013). While Ma'ruf & Aryani (2019) find significant effect of financial inclusion on achieving sustainable development goals in ASEAN countries, including Indonesia, Malaysia, the Philippines, Thailand, Brunei Darussalam, Cambodia, Singapore, and Myanmar, Nizam, Karim, Sarmidi, & Rahman (2020) conduct a threshold regression on ASEAN countries, namely Malaysia, Thailand, Philippines, Indonesia, and Vietnam and find a negative correlation between financial inclusion and economic growth at the firm level. Dabla-Norris, Townsend, & Unsal (2015), develop a micro-founded general equilibrium model to identify the constraints financial inclusion and their impact on GDP and find that financial inclusion promotes GDP growth by providing access to credit, enhancing credit depth, and improving credit mediation efficiency for firms in Malaysian and the Philippines. There is limited research on the relationship between financial inclusion and economic growth in Lao PDR and Cambodia. However, a study by Kyophilavong and Shahbaz (2016) on the nexus between financial development and economic growth of Lao PDR finds that financial inclusion promotes economic growth with increased access to financial services leading to higher levels of economic activity and development.

Overall, the evidence suggests that financial inclusion can play a role in promoting economic growth in the ASEAN region, but the magnitude and direction of the effect may vary depending on the specific context.

### **Theoretical Framework and Financial Determinants**

The theoretical framework for financial inclusion and economic growth is based on the view that financial inclusion promotes economic growth by improving the efficiency of resources allocation, increasing investment and economic activity, and enhancing human capital development (Demirgüç-Kunt & Klapper, 2012; Sahay, Cihak, N'Diaye, Barajas, Mitra, Kyobe, & Yousefi, 2015). While the ultimate objective of financial inclusion is to

facilitate and increase the access of individuals and businesses to financial services, including savings, credit, insurance, and payment systems (World Bank, 2022), the inaugural development of this concept may be traced back to the early exploration of the relationship between financial development and economic growth in early 1900s. In an inquiry into profits, capital, credit, interest, and the business cycle, Schumpeter (1911) argues that credit is necessary to fund entrepreneurial activity and investment in new products and methods of production, which leads to economic growth. Goldsmith (1969) emphasizes that the expansion of financial institutions, markets, and instruments is essential for promoting economic growth by facilitating savings mobilization and investment allocation. Shaw (1973) hypothesizes financial deepening and postulates that the expansion of financial intermediaries and markets leads to greater efficiency in resource allocation, thereby increasing economic growth. Roubini & Sala-i-Martin (1992) focus on the importance of financial repression and how it hinders economic growth and argue that financial development can have a positive impact on economic growth by increasing the availability of credit and reducing the cost of capital. Banerjee and Newman (1993) put forward the exploration in this field by introducing the theoretical model to study the role of credit access on the occupational choices that leads to different level of economic development. The findings of their study further suggests that occupational choices of individuals in developing countries are greatly impacted by limited access to credit, education, and technology.

Since the emergence of the endogenous growth theory, more recent exploration of the relationship between financial development and economic growth has been emphasized on the empirical evidence resulted from the increase in the level of financial inclusion, particularly from the developing economies worldwide. Khan & Senhadji (2000) use a large cross-sectional sample of countries to examine the relationship between financial development and economic growth and find that positive effects vary with different indicators of financial development and functional form of the relationship. Among others, Beck, Demirgüç-Kunt, Levine (2007) and Hasan, Sanchez, & Yu (2011) conduct extensive panel data analyses and find that financial inclusion is positively associated with economic

growth, especially in low-income countries. Moreover, Hasan et al.(2011) stress that a well-functioning financial system play a significant role but not sufficient condition to sustain economic growth in developing countries. Allen, Caretti, Cull, Qian, Senbet, & Valenzuela, (2014) findd positive relationship in developing economies when comparing to a more developed counterpart due to factors such limited financial infrastructure, lack of access to credit, and weaker regulatory frameworks.

Extant literature suggests several determinants of financial inclusion. However, the most common factors used to identify the determinant of financial inclusion encompass accessibility, affordability, availability, depth, efficiency, and overall development of financial institutions. In the cross-country variation in household access to financial services study, Honohan (2008) measure financial inclusion through availability and accessibility of formal financial services such as bank accounts, credit facilities, insurance products, and payment systems, while considering the proportion of the adult population with access to formal financial intermediaries as an indicator of the degree to which financial services are available and accessible in an economy. Park and Mercado (2015) use five measures in constructing financial inclusion indicators, which include automated teller machines (ATM) per 100,000 adults, commercial bank branches per 100,000 adults, borrowers from commercial banks per 1,000 adults, depositors with commercial banks per 1,000 adults, and domestic credit to GDP ratio. Kim and Hassan (2018) extend on this methodology and incorporate the value of life insurance to GDP ratio to measure financial inclusion in the context of the Organization for Islamic Cooperation (OIC). Using principal component analysis (PCA), Park and Mercado (2018) construct a new index for financial inclusion across 151 economies by weighting indicators of access, availability, and usage of financial services. Nguyen (2021) extends on a similar approach to construct a comprehensive multidimensional financial inclusion index. Other studies have also measured financial inclusion using variable identified in the World Bank's Global Findex database including saving, borrowing, payment, and risk management (Demirgüç-Kunt & Klapper, 2012; Ahamed and Mallick,2019); Lyons and Kass-Hanna, 2021).

### Econometric Model and Data

This study employs panel data analysis technique to examine the relationship between financial inclusion and economic growth in seven ASEAN economies namely Indonesia, Malaysia, the Philippines, Thailand, Vietnam, Cambodia, and Lao PDR. More specifically, the objective is to understand how the dependent variable, which in this case is GDP per capita, is affected by the independent and control variables over time. Based on the financial inclusion's definition that refers to the extent to which individuals and businesses have access to and use of formal financial services including savings, credit, insurance, and payment systems (World Bank, 2021, 2022), combined with the methodologies proposed by Sarma (2008) and Park and Mercado (2015, 2018), this study proxies the financial inclusiveness using the followings variables: bank branches per 100,000 adults, account ownership at a financial institution or with a mobile-money-service provider (% of population ages 15+), and automated teller machines (ATMs) (per 100,000 adults). Due to the limitation of data of the interested economies, other significant financial determinants suggested by existing literature such as borrowers from commercial banks (per 100,000 adults) and income share held by lowest 20% are excluded. To account for macroeconomic factors, a set of control variables such as inflation rate and population (ages 15-64 in % of total population) are included in the model. The dependent variable representing the economic growth is proxied by GDP per capita.

**Table 1: Description and Calculation of Variables**

| Variable    | Description       | Calculation                                                                 | Data Sources                              |
|-------------|-------------------|-----------------------------------------------------------------------------|-------------------------------------------|
| <b>GDPP</b> | GDP per capita    | GDP per capita (current US\$)                                               | World Development Indicators (World Bank) |
| <b>INFL</b> | Inflation         | Inflation rate                                                              | World Development Indicators (World Bank) |
| <b>POPU</b> | Population        | Population ages 15-64 (% of total population)                               | World Development Indicators (World Bank) |
| <b>BKBN</b> | Bank branches     | Bank branches per 100,000 adults                                            | World Development Indicators (World Bank) |
| <b>ACCT</b> | Account ownership | Account ownership at a financial institution or with a mobile-money-service | World Development Indicators (World Bank) |

|             |                                        |                                                          |                                              |
|-------------|----------------------------------------|----------------------------------------------------------|----------------------------------------------|
|             | provider (% of population<br>ages 15+) |                                                          |                                              |
| <b>ATMS</b> | Automated<br>teller machines           | Automated teller machines<br>(ATMs) (per 100,000 adults) | World Development Indicators<br>(World Bank) |

### Panel autoregressive distributed lag (ARDL) Model

The panel Autoregressive Distributed Lag or ARDL model is an extension of the time series ARDL that allows for dynamic or panel data analysis (Cho, Greenwood-Nimmo, & Shin 2023), which involves both time series and cross-sectional dimensions. The model allows for the estimation of both short-run and long-run relationships between non-stationary variables with different orders of integration, i.e., mixed of I(0) and I(1). It also accounts for cross-sectional dependence and heterogeneity among the units in the panel (Pesaran, Shin, and Smith, 2001).

The general form of ARDL model for  $t = 1, 2, 3, \dots, T$ , period and  $i = 1, 2, \dots, N$ , groups can be written as follows:

*ARDL* ( $p, q, q, \dots q$ ):

$$Y_t = \sum_{k=1}^p \lambda_{ik} Y_{i,t-k} + \sum_{k=0}^q \delta'_{ik} X_{i,t-k} + \omega_i + \varepsilon_{it}$$

Where:

$X_{it}$  = (k x1) vector of explanatory variables for group 1, maybe I(0) or I(1),

$\lambda_{ik}$  = Coefficients of lagged dependent variable (scalers)

$\delta'_{ik}$  = (kx1) coefficient vectors

$\omega_i$  = Group-specific fixed effects error term

$\varepsilon_{it}$  = Error term

Reparametrizing the ARDL to the Vector-Error Correction Model (VECM):

Panel ARDL ( $p, q, q, \dots q$ ) with Error Correction Model:

$$\Delta Y_t = \sum_{k=1}^{p-1} \lambda_{ik}^* \Delta y_{i,t-k} + \sum_{k=0}^{q-1} \delta_{ik}^{*'} \Delta X_{i,t-k} + \varphi_i (y_{i,t-1} + \beta_i' X_{it}) + \omega_i + \varepsilon_{it}$$

{Representing short-run term}      {Representing long-run term}

Incorporating proxies for economic growth variables and financial variables identified in table1, dependent variable, Y, and independent variables, X, and consist of the followings:

Y = [GDP per capital] or a matrix of [GGDP]

X = [inflation, population, urbanization, bank branches, Automated teller machines, account ownership, borrow accounts, and income share] or a matrix of [ INFL, POPU, BKBN, ATMS, ACCT]

Where:

$\lambda_{ik}^*, \delta_{ik}^{*'} =$  short-run coefficients

$\varphi_i =$  Group-specific error-correction coefficients

$\beta_i' =$  Vector of long-run coefficients

In this model, the dependent variable (GDP per capita) and the independent variables (inflation, population, bank branches, number automated teller machines, and number account ownership) are assumed to be stationary or integrated of order 1, I(1) or a mixed set of I(0) and I(1). If any variable is found to be non-stationary or integrated of order 2 or higher (I(2), I(3), etc.), then the variables need to be first differenced or transformed before including them in the model. Additionally, the model assumes that the variables are not cointegrated, i.e., there is no long-run relationship between the variables. However, in the present of cointegration, then the model needs to be specified as an error correction model (ECM).

The ARDL model incorporates the lagged dependent variable as part of the regressors. The lagged dependent variable captures the effect of the dependent variable on itself from the previous time period (Nantharath and Eungoo, 2019). The inclusion of the lagged dependent variable in the model allows for the examination of the short-term and long-term dynamics of the relationship between the dependent variable and the other regressors (Pesaran, Shin, and Smith, 1998).

The coefficients for each independent variable capture

the effect of each independent variable on the dependent variable while controlling for the effects of the other independent and control variables. The error term represents the unobserved factors that may influence the dependent variable but are not captured by the other variables included in the model. The error term is assumed to be normally distributed with a mean of zero and constant variance across individuals and over time.

In general, the regression of panel can be estimated using techniques such as dynamic pooled OLS, fixed effects (FE), random effects (RE), mean group (MG), or pooled mean group (PMG) framework. While pooled and MG estimations face limitation in their assumption of parameter homogeneity and making use of homogeneity restriction, PMG estimate ARDL model under assumption of long-run homogeneity (Cho et al.(2023). Therefore, employing PMG framework introduced by Pesaran, Shin, and Smith (1999) offers a more suitable and robust estimation for this study.

According to Pesaran, Shin, and Smith (1999), the PMG ARDL model assumes common long-run relationship among variables across individual units in the panel, but the short-term dynamics can differ across units. The model allows for cross-sectional dependence among units and the estimation approach involves estimating a pooled mean group model, where the coefficients of the individual units are assumed to be different but have a common mean. This mean group approach allows for separate estimation of both the long-run and short-run coefficients for each unit, while taking into account the heterogeneity across units. Although unit root test is not required for ARDL cointegration technique, Nkoro and Uko (2016) suggested that pre-testing for unit roots helps confirming whether chosen model is a good fit for the regression.

To allow for lag maximization and robust regression, four specifications of model are constructed with one independent variable added at a time. Note that model D is considered the main model for this study, and it includes all independent variables as show in table 2.

Table 2: Model specifications

| General form of Model Specification |                                                                               |
|-------------------------------------|-------------------------------------------------------------------------------|
| Model A                             | $GDPP = \beta_0 + \beta_1 INFL + \beta_2 POPU + \beta_3 BKBN + \varepsilon_t$ |

|         |                                                                                                             |
|---------|-------------------------------------------------------------------------------------------------------------|
| Model B | $GDPP = \beta_0 + \beta_1 INFL + \beta_2 POPU + \beta_3 ACCT + \varepsilon_t$                               |
| Model C | $GDPP = \beta_0 + \beta_1 INFL + \beta_2 POPU + 3ATMS + \varepsilon_t$                                      |
| Model D | $GDPP = \beta_0 + \beta_1 INFL + \beta_2 POPU + \beta_3 BKBN + \beta_4 ACCT + \beta_5 ATMS + \varepsilon_t$ |

### Results

The empirical process of the penal PMG ARDL conducted in this study includes the (1) panel unit root test, using augmented Dickey-Fuller unit root test, to confirm no variable is greater or equals to I(2), (2) specify panel ARDL cointegration model, (3) estimate model with pooled mean group (PMG), and (4) interpret result for cointegration-joint causality, error correction term (ECT)-speed of adjustment, long-run causality, and short-run causality.

### ADF Unit Root Test

The results from Dickey-Fuller unit root test indicate that some variables are stationary, and some are not stationary at level. When tested at the first difference, the results show that all variables are stationary. Hence, it is concluded that the panel data used in this study consists of I(0) and I(1) variables. Therefore, the panel PMG ADRL model regression is ideal for this study.

**Table 3: ADF Unit Root Test (t-statistics, p-value)**

| Variable | At Level, I(0) |         | At First Difference, I(1) |           |
|----------|----------------|---------|---------------------------|-----------|
|          | ADF Statistic  | p-value | ADF Statistic             | p-value   |
| GDPP     | -2.5877        | 0.0956  | -11.167198                | 2.70E-20* |
| INFL     | -4.0978        | 0.0010* | -13.236514                | 9.35E-25* |
| POPU     | -2.5400        | 0.1060  | -11.210106                | 2.14E-20* |
| BKBN     | -3.0795        | 0.0281* | -6.1722582                | 6.76E-08* |
| ACCT     | -3.1890        | 0.0206* | -15.386975                | 3.35E-28* |
| ATMS     | -3.8470        | 0.0025* | -10.462453                | 1.35E-18* |
| Ln_GDPP  | -2.8069        | 0.0573  | -10.582272                | 6.86E-19* |
| Ln_INFL  | -1.92809       | 0.0269* | -11.707802                | 1.51E-21* |
| Ln_POPU  | -2.6056        | 0.0919  | -11.249105                | 1.73E-20* |
| Ln_BKBN  | -3.1454        | 0.0234* | -10.26062                 | 4.25E-18* |
| Ln_ACCT  | -4.9909        | 0.0000* | -17.23328                 | 6.17E-30* |
| Ln_ATMS  | -4.0537        | 0.0012* | -15.716962                | 1.34E-28* |

\*Indicating p-value rejected the Null Hypothesis

### Panel Pooled Mean Group ARDL

The panel pooled mean group ARDL regression of each model aims to investigate the long-run and short-run

relationship between the dependent variable Ln\_GDP and independent variables Ln\_INFL, Ln\_POPU, Ln\_BKBN, Ln\_ATMS, and Ln\_ACCT. After adjustment, the data covers the period from 2002 to 2021, with 140 observations. The model consists of both long-run and the short-run equations as depicted in the reparametrized ARDL model. The long-run equation represents the relationship between the dependent variable and the fixed regressors, while the short-run equation reveals the relationship between the dependent variable and the dynamic regressors.

The fixed regressors of model A include independent variables, namely Ln\_INFL, Ln\_POPU, and Ln\_BKBN, of model B include Ln\_INFL, Ln\_POPU, and Ln\_ACCT, of model C include Ln\_INFL, Ln\_POPU, and Ln\_ATMS, and of model D include Ln\_INFL, Ln\_POPU, Ln\_BKBN, Ln\_ACCT, and Ln\_ATMS. The dynamic regressors of all models include both the lagged dependent variable and lagged independent variables, as presented in table 2.

The long-run equations of model A and of model C show that all four independent variables (Ln\_INFL, Ln\_POPU, Ln\_BKBN, and Ln\_ATMS) have a statistically significant effect on the dependent variable (Ln\_GDP). However, the long-run equation of model B does not show a statistically significant effect of independent variable Ln\_INFL and Ln\_ACCT on the dependent variable.

The short-run equation is cointegration equation represented by error correction term ( $y_{i,t-1} + \beta'_i X_{it}$ ) with a speed of adjustment coefficient  $\widehat{\phi}_1$ . The correction terms of model A and model C as shown in table 5 are negative and statistically significant at 5 percent level, which means that all variables are cointegrated and the regressor Ln\_INFL, Ln\_POPU, Ln\_BKBN, and Ln\_ATMS jointly Granger-cause Ln\_GDP in the long-run. The error correction term of model B is negative but not statistically significant.

The regression results of model D are used to validate the statistical evidence from model A, B, and C. The long-run equation of model D shows that, except the control variable, Ln\_INFL, all regressor variables have a statistically significant effect on the dependent variable (Ln\_GDP), at 5 percent level. The coefficient of error correction term of model D is also negative and statistically significant at 5 percent level. This means that there exists a cointegration of all variable and all regressors jointly Granger-cause long-run effect on Ln\_GDP.

A further observation is conducted on the result from model B using a cross-section short-run coefficients analysis. The results reveal that, among seven countries and except Vietnam, there exists statistically significant at 5 percent level evident of the effects of Ln\_INFL, Ln\_POPU, and Ln\_ACCT on Ln\_GDP. However, the short-run effect of Ln\_ACCT on Ln\_GDP is statistically significant at 15% level (p-value of 0.1598).

### Long-Run Estimation

**Table 4: Long-run estimation (coefficient, t-statistics, p-value)**

| Variables | Model A                            | Model B                            | Model C                            | Model D                          |
|-----------|------------------------------------|------------------------------------|------------------------------------|----------------------------------|
| Ln_INFL   | -0.024525<br>-4.995497<br>0.0000** | 0.053574<br>1.143250<br>0.2563     | 0.077962<br>1.929903<br>0.0572**   | -0.097036<br>-0.863132<br>0.3912 |
| Ln_POPU   | -0.517948<br>-8.153895<br>0.0000** | -10.44998<br>-1.967498<br>0.0526** | -3.542565<br>-6.669432<br>0.0000** | 1.339867<br>3.807552<br>0.0003** |
| Ln_BKBN   | 0.115832<br>10.12517<br>0.0000**   | -                                  | -                                  | 0.568057<br>2.044745<br>0.0449** |
| Ln_ACCT   | -                                  | 0.184371<br>0.680656<br>0.4981     | -                                  | 1.026470<br>2.639423<br>0.0104** |
| Ln_ATMS   | -                                  | -                                  | -0.381664<br>-3.458772<br>0.0009** | 0.226480<br>1.723073<br>0.0896*  |

\*Indicating p-value statistically significant at 10 % level

\*\*Indicating p-value statistically significant at 5 % level

### Short-Run Estimation

**Table 5: Short-run estimation (coefficient, t-statistics)**

| Variable         | model A                | model B                | model C                  | model D                |
|------------------|------------------------|------------------------|--------------------------|------------------------|
| Error Correction | -0.628498              | -0.125267              | 0.182742                 | -0.080461              |
| Coefficient      | -2.291826**            | -1.176274*             | -1.626747**              | -2.07562**             |
| D(Ln_INFL)       | 0.010864<br>0.256269   | 0.019358<br>2.086844** | 0.000958<br>0.045016     | 0.031795<br>2.210899** |
| D(Ln_POPU)       | -11.51979<br>-0.198162 | -17.61030<br>-0.391710 | -2.373911**<br>-0.045527 | -0.957556<br>-0.043831 |
| D(Ln_BKBN)       | -0.006571<br>-0.030391 | -                      | -                        | 0.281985<br>1.059943*  |

|                |           |           |           |            |
|----------------|-----------|-----------|-----------|------------|
| D(Ln_ACCT)     | -         | 0.031431  | -         | -0.096956  |
|                |           | 1.091164* |           | -1.646866* |
| D(Ln_ATMS)     | -         | -         | 0.048312  | 0.120343   |
|                |           |           | 0.887310  | 0.656339   |
| D(Ln_GDP)(-1)  | 0.265206  | -0.021787 | -0.049741 | -0.08447   |
|                | 1.252290  | -0.210939 | -0.337008 | -0.775946  |
| D(Ln_INFL)(-1) | -0.009238 | 0.000900  | -0.016536 | -0.009155  |
|                | -0.266546 | 0.091490  | -0.690827 | -0.451433  |
| D(Ln_POPU)(-1) | 190.9973  | 18.73831  | 22.83086  | 0.339299   |
|                | 1.265923* | 0.451570  | 0.477529  | 0.015394   |
| D(Ln_BKBN)(-1) | -0.303471 | -         | -         | 0.016216   |
|                | -1.312393 |           |           | 0.027598   |
| D(Ln_ACCT)(-1) | -         | 0.031431  | -         | -0.024787  |
|                |           | 1.091164* |           | -1.494475* |
| D(Ln_ATMS)(-1) | -         | -         | 0.057106  | -0.134517  |
|                |           |           | 0.883417  | -1.215320* |

\*Indicating p-value statistically significant at 10 % level

\*\*Indicating p-value statistically significant at 5 % level

**Table 6: Model B Cross-sectional short-run coefficient**

|                   | Cambodia | Indonesia | Laos    | Malaysia | Philippines | Thailand | Vietnam |
|-------------------|----------|-----------|---------|----------|-------------|----------|---------|
| <b>Error</b>      | 0.04243  | -0.21116  | -       | -0.73088 | -0.00839    | 0.06858  | -       |
| <b>Correction</b> |          |           | 0.01120 |          |             |          | 0.02624 |
| t-statistics      | 75.2753  | -54.0771  | -       | -29.4782 | -15.5750    | 28.0278  | -       |
|                   |          |           | 245.433 |          |             |          | 1.86041 |
| p-value           | 0.0000** | 0.0000**  | 0.000** | 0.0001** | 0.0006**    | 0.0001** | 0.1598* |

\*Indicating p-value statistically significant at 10 % level

\*\*Indicating p-value statistically significant at 5 % level

**Discussion**

Although the cointegration equations represented by error correction terms of all models indicate that there exists statistically significant evident of Granger causality between number of commercial bank branches (per 100,000 adult), number of account ownership (% of population ages 15+), and number of automated teller machines (per 100,000 adult) on GDP per capital in a long-run, the evident of short-run relationship between each independent variable on GDP per capital is mixed and different between lags in regression as shown in table 6. According to model D, the error correction coefficient of -0.08046 infers that about 8 percent of speed adjustment of departures from long-run equilibrium is corrected each period.

The results from model D also reveals that the

relationship of the abovementioned financial inclusion determinants with economic growth is positive and statistically significant, at 5 percent level for bank branches and account ownership and at 10% significant for automated teller machines, in a long run. It can be concluded that 1% increase in the commercial bank numbers is associated with a 0.568057% increase in GDP growth in the long run, holding other factors constant, while a 1% increase in the number of account ownership is associated with a 1.026470% increase in GDP growth in the long run, holding other factors constant. The effect of number of automated teller machines is significant at the 10% level ( $p\text{-value} = 0.089$ ) infers that a 1% increase in the number of automated teller machines per capita is associated with a 0.226480% increase in GDP growth in the long run, holding other factors constant.

The findings suggest that financial inclusion determinants, such as the bank branches per 100,000 adults, account ownership at a financial institution or with a mobile-money-service provider (% of population ages 15+), and automated teller machines (ATMs) (per 100,000 adults) have a positive and statistically significant long-run relationship with GDP per capita. Particularly, a higher number of commercial bank branches and account ownership are associated with higher GDP growth, while the relationship between automated teller machines and GDP growth is less certain. These findings are consistent with the studies of (Kyophilavong and Shabaz, 2016; Malarvizhi, et al., 2018; Suidarma, 2019; Nizam et.al, 2020) on the analysis of the effects on financial inclusion on economic growth of ASEAN countries. On the global level, the findings are also consistent with the study conducted by a mong other, Lenka and Sharma (2017), Kim et al.(2018), and Makina and Walle (2019).

However, the short-run relationship between these financial inclusion determinants and GDP per capita is mixed and varies across different lags. This suggests that the impact of financial inclusion on economic growth may be more complex and may depend on various other factors in the short run, such as macroeconomic conditions, policies, and other unobserved factors.

The policy implications of these findings are that increasing financial inclusion through measures such as expanding the number of commercial bank branches and

promoting access to bank account ownership can have a positive impact on long-run economic growth. However, policymakers need to be cautious in interpreting the short-run relationship between financial inclusion and economic growth and consider other factors that may influence the relationship in the short run.

Most importantly, the findings suggest that financial inclusion is an important factor for long-run economic growth, and policymakers in ASEAN countries should continue to promote financial inclusion to achieve sustainable economic growth.

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