Special issue of The Scientific Journal of Business and Finance

https://caf.journals.ekb.eg

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Published online: **April 2024.**

To cite this article: Selim, Eman. **Panel Analysis of Relationship between Financial Inclusion and Sustainable Development in Two Groups of Emerging Countries,** Special issue of The Scientific Journal of Business and Finance, 44, (**Special issue**), 558:606

DOI: 10.21608/caf.2024.372962

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Panel Analysis of Relationship between Financial Inclusion and Sustainable Development in Two Groups of Emerging Countries

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Abstract:

The purpose of the paper is to empirically investigate the long-run, the short-run and the causal relationship between financial inclusion and sustainable development for two groups of emerging economies. The first group the top ten emerging countries; Argentina, Brazil, India, Indonesia. Mexico, Poland, South Africa, South Korea, Singapore, Russia, and Turkey. The second group includes the other major emerging countries; Egypt, Thailand, Chile, Hungary, Malaysia, Saudi Arabia, United Arab Emirates, and the Philippines. The paper uses the panel annual data of each group of emerging countries with 17 years of annual data from 2004 to 2021. The paper applies the panel unit root tests to determine the order of integration of the time series, the panel ARDL Bound test to test whether variables are cointegrated, the Panel VECM to examine the long-run and the short-run dynamics and to determine the speed of adjustment to long run equilibrium.

The paper used the Principal Components Analysis PCA to construct a financial inclusion composite index for each group of emerging countries.

Key words: Emerging Countries, Financial Inclusion, Sustainable Development, Panel Unit Root test, Panel ARDL, Panel VECM, The PCA.

JEL Code: Q56, G21, G34

تحليل للعلاقة بين الشمول المالي والتنمية المستدامة في مجموعتين من البلدان الناشئة

ايمان سليم[1]

ملخص البحث:

الغرض من هذه الورقة هو التحقيق التجريبي في العلاقة طويلة الأجل وقصيرة الأجل والسببية بين الشمول المالي والتنمية المستدامة لمجموعتين من الاقتصادات الناشئة. المجموعة الأولى البلدان الناشئة العشرة الأولى. الأرجنتين، إندونيسيا، البرازيل، الهند. المكسيك وبولندا وجنوب إفريقيا وكوريا الجنوبية، وسنغافورة وروسيا وتركيا. وتشمل المجموعة

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الثانية البلدان الناشئة الرئيسية الأخرى؛ مصر وتايلاند وتشيلي والمجر وماليزيا والمملكة العربية السعودية والإمارات العربية المتحدة والفلبين. تستخدم الورقة البيانات السنوية للجنة لكل مجموعة من البلدان الناشئة مع 17 عاما من البيانات السنوية من 2004 إلى 2021. تطبق الورقة اختبارات جذر وحدة اللوحة لتحديد ترتيب تكامل السلاسل الزمنية، واختبار ARDL لاختبار ما إذا كانت المتغيرات متكاملة ، ولوحة VECM لفحص ديناميكيات المدى الطويل والمدى القصير وتحديد سرعة التكيف مع التوازن على المدى الطويل.

1. Introduction

According to the World Bank[2] financial inclusion means that individuals and businesses have access to useful and affordable financial products and services that meet their needs – transactions, payments, savings, credit, and insurance – delivered in a responsible and sustainable way. Financial inclusion has been identified as an enabler for 8 of the 17 Sustainable Development Goals.

Sarma (2008) defines financial inclusion based on three dimensions of financial inclusion: accessibility, availability, and usage of the financial system and develops a composite index of financial inclusion based on Euclidean distance to measure the depth of financial inclusion across economies.

The Sustainable Development Goals are the channels to achieve a better and more sustainable future for all. They address the global challenges the world faces, including those related to poverty, inequality, climate change, environmental degradation, peace, and justice. The 17 Goals are all interconnected, and to leave no one behind, it is important that we achieve them all by 2030.[3]

Sustainable development has three broad dimensions, namely, the economic dimension, environmental dimension, and social dimension.

Financial inclusion is considered essentially as a conduit to other developmental goals in the 2030 Sustainable Development Goals, where it is featured as a target in eight of the seventeen goals.[4] These include SDG1, on eradicating poverty; SDG 2 on ending hunger, achieving food security, and promoting sustainable agriculture; SDG 3 on profiting health and well-being; SDG 5 on achieving gender equality and economic empowerment of women; SDG 8 on promoting economic growth and jobs; SDG 9 on supporting industry, innovation, and infrastructure; and SDG 10 on reducing inequality. Additionally, in SDG 17 on strengthening the means of implementation there

[2] https://www.worldbank.org/en/topic/financialinclusion/overview

[3] https://www.un.org/sustainabledevelopment/sustainable-development-goals/

[4] https://www.uncdf.org/financial-inclusion-and-the-sdgs?ref=hackernoon.com

is an implicit role for greater financial inclusion through greater savings mobilization for investment and consumption that can spur growth.

One of the early definitions by Leyshon and Thrift (1995) defines financial exclusion as referring to those processes that serve to prevent certain social groups and individuals from gaining access to the formal financial system. According to Sinclair (2001), financial exclusion means the inability to access necessary financial services in an appropriate form. Exclusion can come about because of problems with access,

The World Bank (2014) defines voluntary exclusion as a condition where the segment of the population or firms choose not to use financial services either because they have no need for them or due to cultural or religious reasons. In contrast, involuntary exclusion arises from insufficient income and high-risk profile or due to discrimination and market failures and imperfections. Policy and research initiatives must then focus on involuntary exclusion as it can be addressed by appropriate economic programs and policies which can be designed to increase income levels and correct market failures and imperfections.

Several studies concentrate on measuring a financial inclusion index such as Sarma (2008, 2012, 2015) measures financial inclusion based on three dimensions; penetration, availability, and usage. Similarly, Park and Mercado (2015, 2018) build a multidimensional financial inclusion index based on several aspects such as bank branches, ATMs, domestic credit to GDP, borrowers, and depositors. Ozili 2021 proposes measures for financial inclusion and financial exclusion.

Some studies cover the relationship between financial inclusion and the reduction of poverty and income inequality such as Park and Mercado 2015, Girma, A. G., & Huseynov, F. (2023), and Bayar AA. 2023. Honohan, P. 2008

This paper investigates the relationship between some indicators of financial inclusion and economic growth using data of two groups of emerging countries. The paper used the PCA to construct a financial inclusion index for each group of emerging countries,

The structure of this paper is as follows: The section that follows will review the literature on financial inclusion and the relationship between financial inclusion and sustainable development. The focus is on the empirical studies that used panel data of diverse groups of countries. Section 3 discusses the data, variables, and methodology used in the study. Section 4 describes the findings and implications of the study. The last section concludes the paper.

2. Literature Review

Sarma 2008, and 2012 acknowledged the absence of a comprehensive measurement in the literature for assessing the amount of financial inclusion across economies. To address this deficiency, Sarma proposed the Index of Financial Inclusion (IFI). The IFI is a comprehensive index that consolidates data on multiple facets of financial inclusion into a single digit ranging from 0 to 1. A value of 1 signifies full financial inclusion in an economy, while 0 represents total financial exclusion. The proposed index is comparable across nations and is simple to calculate.

Andrianaivo and Kpodar 2011 examined the influence of information and communication technology (ICT), specifically the widespread adoption of mobile phones, on the economic development of a selected group of African nations between 1988 and 2007. Additionally, they examine the potential impact of mobile phone development on economic growth by exploring the role of financial inclusion as a potential route. When assessing the influence of information and communication technology (ICT) on economic growth, a diverse set of ICT indicators is employed. These indicators encompass mobile and landline telephone penetration rates, as well as the cost of local calls. The Generalized Method of Moment (GMM) estimator is employed to mitigate endogeneity concerns. Variables that assess access to financial services, such as the quantity of deposits or loans per individual, have been utilized to measure financial inclusion. They used variables that Beck, Demirguc-Kunt, and Martinez Peria (2007) as well as the Consultative Group to Assist the Poor (CGAP, 2009). The findings validate that collected and ICT, encompassing the advancement of mobile phones, makes a substantial contribution to the economic expansion of African nations. One of the contributing factors to the favorable impact of mobile phone penetration on economic growth is the enhanced level of financial inclusion. Simultaneously, the advancement of mobile phones reinforces the influence of financial inclusion on economic expansion, particularly in nations where mobile financial services firmly establish themselves.

Park and Mercado (2015) contribute to the current body of knowledge on financial inclusion by specifically examining the context of developing Asian economies. A financial inclusion index is developed to evaluate the impact of several macroeconomic and country-specific factors on the level of financial inclusion in 37 chosen developing Asian nations. In addition, the researchers examine the effects of financial inclusion, in conjunction with several control factors, on poverty levels and income inequality. The findings of their study indicate that factors such as per capita income, rule of law, and demographic characteristics highly influence financial inclusion in developing Asian nations. Moreover, research indicates that financial inclusion has a substantial impact on poverty reduction, and there is also empirical support for its ability to decrease inequality in income. Their research indicates that implementing measures such as retirement pensions and enhancing the rule of law, which includes enforcing financial contracts and providing regulatory oversight, will expand financial inclusion. This, in turn, will lead to a reduction in poverty and a decrease in income inequality.

Williams *et al.*, (2017) examine the impact of financial inclusion on poverty reduction and economic growth in a developing economy. The researchers employ panel data analysis, ranging from 2006 to 2015, and utilize a log-linear model specification approach. The study's approach is derived from existing literature. Based on their regression analysis, the variables that showed the strongest predictive power for financial inclusion in reducing poverty in a developing country were the number of operating ATMs, bank branches, and government spending. They select these variables from three African nations. An increase of one percent in the ratio of active ATMs is associated with a corresponding increase of approximately 0.0082 percent in the gross domestic product and a reduction in poverty within the developing economy. However, it is important to note that this finding does not align precisely with the findings of Sarma (2008). A measure indicates that most ATMs in emerging economies are outdated and so necessitate a technology enhancement to have a substantial influence in rural regions. The coefficient of determination had a significantly high value. The findings indicate that around 92 percent of the overall fluctuations in the real growth rate of gross domestic product can be accounted for by the overall impact of all the independent variables included in the model. Therefore, they recommended that the Government should prioritize poverty reduction by directing its attention towards infrastructural development, with the aim of improving banking services.

Kim, Dai-Won *et al.*, (2018) investigated the correlation between financial inclusion and economic growth within the countries of the Organization of Islamic Cooperation (OIC). We have established panel data for 55 OIC countries to obtain multilateral results. We have conducted dynamic panel estimates, as well as panel VAR, IRFs, and panel Granger causality tests. The findings derived from the dynamic panel estimations indicate a positive correlation between financial inclusion and economic growth. The findings obtained from the panel VAR analysis indicate that financial inclusion has a favorable impact on economic growth. Furthermore, the panel Granger causality tests show a reciprocal relationship between financial inclusion and economic growth. Hence, they can infer that financial inclusion exerts a favorable impact on the economic growth of nations within the Organization of Islamic Cooperation (OIC).

Fouad, 2018 considers that the purpose of financial inclusion is to incorporate marginalized populations into the financial system, to alleviate poverty and foster economic prosperity. This study investigates the phenomenon of financial inclusion in 23 countries within the Middle East and North Africa region from 2004 to 2016. The analysis employs a multi-dimensional index that encompasses the dimensions of availability, usage, and access to banking services. The study employed a panel model to examine the effects of financial inclusion on both economic growth and poverty reduction. The analysis utilized a dataset specifically focused on financial inclusion. The study identified several factors that exhibited statistical significance, including the number of automated teller machines, the count of depositors, borrowers, and bank accounts, as well as the proportion of credit relative to GDP. This article shows the importance of governments implementing complementing policies aimed at promoting greater financial inclusion to stimulate economic growth and alleviate poverty.

Huang *et al.*, (2020) examines the influence of financial inclusion and trade openness on the economic development of the twenty-seven countries that are members within the European Union (EU). They categorize the nations included in the sample into low-income, high-income, old-EU, and new-EU members. This categorization enables us to offer policy implications that are more constructive and practical. The study employed panel econometric approaches and utilized annual data spanning from 1995 to 2015. The findings indicate that there is a notable positive correlation between economic growth and factors such as access, depth, efficiency, and the general development of financial institutions, as observed in both the complete sample and sub-samples. Additionally, their analysis reveals that capital, labor, energy consumption, and trade openness exert significant influence on the trajectory of economic growth within these panels. Furthermore, the influence of financial inclusion on economic productivity is more pronounced in low-income and newly-member countries of the European Union compared to high-income and long-standing member countries of the European Union. The conclusions presented in this study have comprehensive policy implications for both the European Union as a whole and its different sub-groups.

Omar, M.A., Inaba, K. 2020 argue that financial inclusion is a crucial component of social inclusion, playing a significant role in addressing poverty and income inequality by providing access to chances for progress that have been previously inaccessible to marginalized groups within society. They examine the influence of financial inclusion on the reduction of poverty and income inequality, as well as the factors that determine and the conditions under which this effect occurs, in 116 developing nations. The conducted research utilizes imbalanced annual panel data spanning the years 2004 to 2016. To achieve this objective, they develop an innovative measure of financial inclusion by utilizing a comprehensive range of metrics related to financial sector outreach. They reveal that per capita income is directly proportional to the level of internet access. The amount of financial inclusion in developing nations is significantly influenced by factors such as users, age dependency ratio, inflation, and income inequality. In addition, the findings offer substantial evidence supporting the notion that financial inclusion has a significant impact on poverty rates and income disparity in emerging nations. The results support the notion of enhancing the accessibility and utilization of formal financial services among marginalized populations, with the aim of optimizing the general well-being of society.

Adedokun *et al*., (2022), identified financial inclusion as an essential component of development policy and a fundamental driver of economic progress in underdeveloped nations. In essence, the majority of Sub-Saharan African (SSA) countries have seen volatile economic expansion throughout the past thirty years. Financial inclusivity plays a crucial role in fostering sustainable economic growth across all economies. This research examines the impact of financial inclusion on a sample of 41 Sub-Saharan African countries spanning the years 2004 to 2019. The study utilizes the generalized method of moments (GMM) approach and conducts a Granger causality analysis. The findings indicate a direct correlation between financial inclusion and economic growth. The results of the non-causation tests indicated the presence of bi-directional causality between the variables in both the overall region and the low-income and lower-middle-income countries. In upper-middle-income nations, there is a one-way causal relationship from financial inclusion to economic growth. The study determined that financial inclusion has a beneficial impact on the economic growth of Sub-Saharan Africa (SSA). It suggests that policies and interventions in the financial system should be reevaluated to attain consistent economic growth and long-term viability.

Chuka *et al*., (2022) investigate the influence of financial inclusion on economic growth by analyzing panel data from twenty-two sub-Saharan African (SSA) nations over the period from 2012 to 2018. The research utilizes the Generalized Method of Moments (GMM) simulation system. Through the utilization of a composite index of financial inclusion, alongside individual financial inclusion indicators, their findings indicate that the availability dimension of financial inclusion, penetration dimension of financial inclusion, and composite financial inclusion (which include all indicators) have a statistically significant and positive influence on economic growth. However, the usage dimension of financial inclusion does not demonstrate a significant improvement in economic growth. Additionally, it is worth noting that bank branches and automated teller machines (ATMs) exert a positive and substantial influence on economic growth. On the other hand, deposit accounts and outstanding loans contribute to economic growth, albeit not to a major extent, whilst outstanding deposits have a detrimental effect on economic growth. Furthermore, the analysis of mobile money indicators spanning the years 2012 to 2018 has demonstrated that mobile money agents have a detrimental impact on economic growth, whereas mobile money accounts and transactions have a positive effect.

Ozili 2022 examined the correlation between financial inclusion and sustainable development. Two datasets were utilized in this work, and the researchers employed the Pearson correlation analysis and Granger causality test to investigate the correlation and pairwise causation between financial inclusion and sustainable development. The results indicate a significant correlation between elevated levels of financial inclusion, as measured by the number of commercial bank branches per 100,000 adults, and increased electricity generation from renewable sources, enhanced industry productivity, higher adult literacy rates, and greater consumption of renewable electricity. Furthermore, there is a strong correlation between increased financial inclusion and reduced reliance on combustible renewable energy sources and waste. A one-way Granger causation exists between the worldwide interest in Internet information about sustainable development and the worldwide interest in Internet information regarding financial inclusion, namely during the period following the global fiscal crisis but prior to the COVID-19 pandemic.

Gharbi and Kammoun (2023) developed a multidimensional financial inclusion (FI) index. This index aims to evaluate the amount of FI in 91 countries across various income levels. The principal component analysis method was employed for this purpose. This approach effectively responds to the critique of the arbitrary allocation of weights and provides a comprehensive assessment of the level of financial inclusion. The data utilized in this study were sourced from the International Monetary Fund (IMF) Financial Access Survey (FAS), the World Development Indicators (World Bank), and the Global Findex Database. The data collection period spanned from 2004 to 2020. This study is the inaugural examination of a comprehensive set of indicators pertaining to financial inclusion, encompassing a total of 13 indicators. These indicators are categorized into three distinct dimensions of financial inclusion, thereby encompassing a wide range of aspects associated with this concept. Furthermore, in contrast to other research, this report examines both developing and developed nations, enabling the identification of distinctions between them. The proposed index possesses several benefits. The model exhibits robustness, allowing for comparability across different nations, and demonstrates strong predictive capabilities in monitoring household microeconomic indicators like as accounts and savings. There exists a strong correlation between this phenomenon and other macroeconomic indicators, including literacy rate, poverty levels, GINI index, real interest rate, and employment status. Furthermore, our findings unequivocally demonstrate a positive correlation between a nation's income level and its degree of financial inclusion.

Biswas 2023 acknowledged that financial inclusion plays a significant role in fostering national growth by facilitating the development of financial infrastructure. This, in turn, expedites economic operations and generates employment opportunities. The present study sought to investigate the impact of financial inclusion on the economic growth of four South Asian nations. Through the utilization of diverse panel data models and several indicators of financial inclusion, the present study aimed to elucidate the correlation between economic growth and financial inclusion. The study's findings validated that financial inclusion exerted a favorable influence on economic growth in those nations, but with varying degrees of impact across different indicators of financial inclusion. Hence, policymakers in these nations must implement requisite measures to expedite financial inclusion initiatives to attain resilient economic expansion.

Yap *et al.,* (2023), financial inclusion plays a crucial role in attaining the Sustainable Development Goals (SDGs). Hence, given the dearth of existing research establishing a connection between financial inclusion and the Sustainable Development Goals (SDGs), the current study employed a panel regression model to investigate the individual and collective impacts of financial inclusion on the SDGs in specific nations from 2017 to 2020. This study is the first to investigate the relationship between financial inclusion and finance-related Sustainable Development Goals (SDGs), which has not been explored in previous research. The results suggest that there is a positive relationship between financial inclusion and the 2nd, 5th, and 8th Sustainable Development Goals (SDGs), however this relationship is not statistically significant for the 1st, 3rd, 9th, and 10th SDGs. The study also revealed a noteworthy and favorable association between financial inclusion and sustainable development, as indicated by the finance-related SDG index. The present study is distinctive in that it focuses on seven finance-related components of the Sustainable Development Goals (SDGs), as delineated by the World Bank, even though financial inclusion may not have a direct impact on all SDGs. The results may motivate policymakers to intensify their efforts in expanding financial inclusion to improve the finance-related Sustainable Development Goals (SDGs).

According to Nantharath *et al*., (2023), financial inclusion has been recognized as a crucial instrument for promoting sustainable development in the Sub-Saharan Africa (SSA) region. The limited extent of financial inclusion in Sub-Saharan Africa (SSA) has been ascribed to a multitude of issues, including but not limited to, low-income levels, high poverty rates, poor literacy rates, and insufficient infrastructure. This study examines the enduring and immediate connections between financial inclusion and sustainable development in Sub-Saharan Africa (SSA) through the utilization of a panel vector error correction model (VECM) regression technique. The research employs cross-sectional data encompassing 48 nations in Sub-Saharan Africa (SSA), spanning the time frame from 2000 to 2021. The model considers the bank branch count per 100,000 adults, the number of automated teller machines (ATMs) per 100,000 adults, and the number of borrowers from commercial banks per 100,000 adults as indicators of financial inclusion. The human development index (HDI) is used as a proxy for sustainable development. Furthermore, the model effectively manages the impact of GDP per capita and health expenditure. The findings of the regression analysis indicate a substantial and positive correlation between financial inclusion and the degree of sustainable development in the Sub-Saharan Africa (SSA) region. Over an extended period, there exists a positive correlation between a 1% rise in financial inclusion and a 0.62% increase in sustainable development. Additionally, the short-run Wald test reveals that the lagged values of all independent variables collectively contribute to changes in the Human Development Index (HDI), implying that financial inclusion variables play a role in predicting short-term deviations in HDI. The conclusions of this investigation are substantial.

3. Data and Methodology

We designed this study to examine the impact of financial inclusion on economic output in two groups of emerging countries by including key determinants of output (such as capital, labor, and exports). The selection of the empirical model is based on the theoretical and empirical literature, specifically the original Solow model.

$$Y(t) = f(A(t), K(t), L(t))$$

The Solow model focuses on four variables: the output y . capital K , Labor and Knowledge A . Time does not enter the the production function directly but through capital, labor and knowledge. That the output changes over time if the inputs change. We assume here that knowledge A is fixed. we augmented the production function by exports of goods and services and financial inclusion indicators according to the model version of , Mankiw et al. (1992), . The augmented version which have suggested that an augmented Solow growth model can account for most of the variation in output across countries due to different steady-state growth paths that result from differences in saving rates, education, and population growth.

For instance, several empirical studies document that the economic output of any country is primarily determined by capital, labor, exports and financial development Given this evidence, we frame the following empirical model:

$$GDP_{it} = f(GFCF_{it,}LF_{it}, Export_{it}, FI_{it})$$

$$GDP_{it} = \beta_0 + \beta_1 GFCF_{it} + \beta_2 LF_{it}, + \beta_3 Export_{it}, + \beta_4 FI_{it} + \varepsilon_{it}$$

where GDP, GFCF, LF, Export and FI represent gross domestic product (or GDP per capita) as a proxy for economic growth, gross fixed capital formation for capital stock, labor force, exports of goods and services to present the export led growth strategy followed by emerging countries and financial inclusion indicators. respectively.

Exports of goods and services is used instead of the usual trade openness defined as exports minus imports to put an emphasis of the export led growth strategy implemented by all emerging economies. Similarly, i and t refer to the cross-section and time, respectively, while we denote the error term by μ.

The second model

$$LGDPP_{i,t} = \beta_0 + \beta_1 FI_{i,t} + \beta_2 LGFCF_{i,t} + \beta_3 LPOP_{i,t} + \beta_4 LEXPORT_{i,t} + \varepsilon_{i,t}$$

- $LGDPP_{i,t} = \log gross\ domestic\ product\ per\ capita$
- $F_{i,t} = Financial\ inclusion\ index$
- $LGFCF_{i,t} = \log gross\ fixed\ capital\ formation$
- $LPOP_{i,t} = log\ total\ population$
- $LEXPORT_{i,t} = \log Exports$
- $\varepsilon_{i,t} = error\ term$

The First Step Normalizing the financial variables:

The aim of this step is to standardize the range of the continuous initial variables so that each one of them contributes equally to the analysis because PCA, is quite sensitive regarding the variances of the initial variables.

Mathematically, this can be done by subtracting the minimum value and dividing by the maximum value minus the minimum value for each value of each variable.

$$NV_{i,t} = \frac{V_{i,t} - Min_{i,t}}{Max_{i,t} - Min_{i,t}}$$

$$NV_{i,t} = normalized\ variable\ for\ domension\ i\ and\ period\ t$$

$$Min_{i,t} = Minimum\ value$$

$$Max_{i,t} = maximum\ value$$

The second step is to compute the covariance matrix to determine the correlation among the financial variables.

The third step is to compute the eigen vectors and the eigen values of the covariance matrix to identify the principal components.[5]

The study undertakes four panel unit root tests to investigate the stationary property issues in the selected variables. Specifically, we use Levin *et al*., (LLC) (2002) and Breitung (2000) tests under the assumption of 'common unit root process' while Im *et al*., (IPS) (2003) tests under 'individual unit root process'. Further, we also employ the cross-sectionally augmented panel unit root test (CIPS) proposed by Psarian (2007), which considers of cross-sectional dependence. The null hypothesis of unit root is tested against the alternative hypothesis of no unit root.

Finally, to estimate long-run relationship between the variables we used Pedroni (2000, 2001). This approach computes the average of individual cross-section. This method is more appropriate in the presence of heterogeneity as it offers more reliable estimates of the sample mean of the cointegrating vector as compared to pooled and weighted estimators.

We include two measures of the availability of financial services namely, 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. The first two measures pertain to availability of banking services as a dimension of financial inclusion, while the last three refers to the usage dimension of financial inclusion. All indicators are sourced from the World Bank's World Development Indicators, and each indicator for each economy belongs to the average value from 2004 to 2021.

A detailed description of variables and their sources is presented in Appendix A.

The study covers two groups of emerging countries. The first group of emerging countries includes 11 countries. The second group of the emerging countries includes 8 countries. We provide the definition of the two groups in appendix A. we present a detailed description of variables and their sources in Appendix A.

[5] the eigenvectors of the Covariance matrix are actually *the directions of the axes where there is the most variance* (most information) and that we call Principal Components. And eigenvalues are simply the coefficients attached to eigenvectors, which give the *amount of variance carried in each Principal Component*.

Table 1: Data description

	GDPP	GFCF	LF	TRADE	CBB	ATM
Mean	13767.44	2.30E+11	85417558	7.22E+09	16.68737	76.04323
Median	9499.975	2.28E+11	28783879	5.26E+08	14.72000	55.71500
Maximum	67175.86	8.44E+11	5.35E+08	1.35E+11	38.52000	288.5900
Minimum	892.3821	3.80E+10	2234837.	-1.31E+11	4.690000	1.870000
Std. Dev.	14012.42	1.62E+11	1.30E+08	5.22E+10	7.770327	68.86529
Skewness	2.075609	1.157378	2.511244	0.224711	1.026729	1.699980
Kurtosis	6.677439	4.682935	8.054947	3.195996	3.374753	5.224782
Jarque-Bera	253.7384	67.57049	418.9174	1.983250	35.94632	136.2024
Probability	0.000000	0.000000	0.000000	0.370973	0.000000	0.000000
Sum	2725952.	4.56E+13	1.69E+10	1.43E+12	3304.100	15056.56
Sum Sq. Dev.	3.87E+10	5.20E+24	3.34E+18	5.38E+23	11894.46	934258.3
Observations	198	198	198	198	198	198

Table 2 presents correlations of the variables for the first group of emerging countries. The gross domestic product a proxy for economic growth is positively correlated with all the variables, except for trade openness. The economic output is highly correlated with capital, labor force, and ATM financial inclusion indicator.

The correlation between GDP and population which sometimes used as a proxy for the labor force is as strong as its correlation with labor force. We favor the use of the labor force variable over the population variable. It is important to note that capital is not highly correlated with CBB financial inclusion indicator. Therefore, there is no severe multicollinearity among the selected variables. Based on these correlations, we argue that the economic output is positively correlated with basic inputs (capital, labor, and exports), and ATM financial indicators. However, as the correlations between economic output and trade openness is negative, we therefore used exports instead of trade openness to undertake rigorous empirical investigation to understand the nature of their relationship in the long term.

Table 2:data correlation

	GDP	GFCF	LF	POP	TRADE	EXPORT	IMP	CBB	ATM
GDP	1.000000	0.930560	0.634409	0.603974	-0.257164	0.445975	0.566261	0.197300	0.336567
GFCF	0.930560	1.000000	0.718547	0.696979	-0.279640	0.527631	0.661801	0.081704	0.326619
LF	0.634409	0.718547	1.000000	0.997028	-0.517486	0.152520	0.335742	-0.139936	-0.278398
POP	0.603974	0.696979	0.997028	1.000000	-0.528812	0.151436	0.338319	-0.165778	-0.293879
TRADE	-0.257164	-0.279640	-0.517486	-0.528812	1.000000	0.383297	0.082782	0.158199	0.488264
EXPORT	0.445975	0.527631	0.152520	0.151436	0.383297	1.000000	0.952185	0.055002	0.538354
IMP	0.566261	0.661801	0.335742	0.338319	0.082782	0.952185	1.000000	0.007016	0.419359
CBB	0.197300	0.081704	-0.139936	-0.165778	0.158199	0.055002	0.007016	1.000000	0.285828
ATM	0.336567	0.326619	-0.278398	-0.293879	0.488264	0.538354	0.419359	0.285828	1.000000

4. Empirical Results of the first Model

4.1 Empirical Results for the First Group of Emerging Countries

4.1.1 Panel Unit Root test

Panel unit root test is an econometric approach that tests whether the mean and variance change over time considering the autoregressive structure of the time series. A test for determining whether the mean, variance, and covariance are independent of time or not.

Levin, Lin & Chu t, assuming common unit root process Im, Pesaran and Shin W-stat , ADF - Fisher Chi-square and PP - Fisher Chi-square assuming individual unit root process . The null hypothesis for all these tests is the non-stationarity.

We provide the Panel Root test results for the variables used we use for the first group of emerging countries in appendix B. The results shows that Log GDP, Log GFCF, Log LF, Log Export, Log CBB, and Log ATM are integrated of the first order I(1).

4.2 Panel Cointegration Test

Pedroni Residual Cointegration Test					
Series: LOG(GDP) LOG(GFCF) LOG(LF) LOG(EXPORT) LOG(CBB)					
Sample: 2004 2021					
Included observations: 198					
Cross-sections included: 11					
Null Hypothesis: No cointegration					
Trend assumption: Deterministic intercept and trend					
Automatic lag length selection based on SIC with a max lag of 2					
Newey-West automatic bandwidth selection and Bartlett kernel					
Alternative hypothesis: common AR coefs. (within-dimension)					
				Weighted	
		Statistic	Prob.	Statistic	Prob.
Panel v-Statistic		4.016914	0.0000	2.109768	0.0174
Panel rho-Statistic		2.286474	0.9889	2.552060	0.9946
Panel PP-Statistic		-1.323192	0.0929	-1.708594	0.0438
Panel ADF-Statistic		-1.603959	0.0544	-2.411342	0.0079
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		3.385622	0.9996		
Group PP-Statistic		-5.587412	0.0000		
Group ADF-Statistic		-2.789800	0.0026		
Cross section specific results					

Phillips-Peron results (non-parametric)					
Cross ID	AR(1)	Variance	HAC	Bandwidth	Obs
1	0.152	0.000457	0.000369	6.00	17
2	0.150	4.39E-05	4.09E-05	2.00	17
3	-0.069	5.00E-05	9.49E-06	7.00	17
4	-0.075	0.000182	0.000182	1.00	17
5	0.021	5.53E-05	4.21E-05	4.00	17
6	0.370	6.33E-05	4.96E-05	3.00	17
7	0.359	0.000134	0.000146	1.00	17
8	-0.173	4.29E-05	4.29E-05	0.00	17
9	-0.246	2.65E-05	3.18E-06	16.00	17
10	-0.114	9.16E-05	1.38E-05	14.00	17
11	-0.159	3.10E-05	3.09E-05	1.00	17
Augmented Dickey-Fuller results (parametric)					
Cross ID	AR(1)	Variance	Lag	Max lag	Obs
1	0.152	0.000457	0	2	17
2	0.150	4.39E-05	0	2	17
3	-0.069	5.00E-05	0	2	17
4	-0.075	0.000182	0	2	17
5	-0.189	4.60E-05	1	2	16
6	0.057	3.94E-05	1	2	16
7	0.359	0.000134	0	2	17
8	-0.173	4.29E-05	0	2	17
9	-0.899	2.11E-05	1	2	16
10	-0.558	7.73E-05	1	2	16
11	-0.159	3.10E-05	0	2	17

Most Statistics(6 out of eleven) have p-value less than 0.05 which allow to reject the null hypothesis of no cointegration.

4.3 Panel Auto regression distributed lag model Panel ARDL for the first group of emerging countries

Estimating Panel ARDL -VECM with PMG

$$\Delta Y_{it} = \sum_{k=1}^{\rho-1} \gamma^{*}{}_{ik} \Delta Y_{i,t-k} + \sum_{k=0}^{q-1} \delta'{}_{ik} \Delta X_{i.t-k} + \varphi_i (Y_{i.t-1} + \beta'{}_i X_{it} + \omega_i + \varepsilon_{it}$$

1. PMG
- Long run coefficients,β_i are the same across groups (i.e. cross-sections).
- Short-run coefficients $\delta'{}_{ik}$ and cointegrating term φ_i coefficients vary across groups.
2. Dynamic Fixed Effect DFE: $\beta_i, \gamma_{ik}, and\ \delta'{}_{ik}$ are the same across groups.

3. Mean Group MG: $\beta_i, \gamma_{ik}, and\ \delta'_{ik}$ vary across groups.

- Data:
- the target variable is log real gross domestic product per capita GDPP which is I(1)
- The regressors are log real gross fixed capital formation log GFCF , log labor for log LF, log real exports of goods and services , and log Commercial Banks Branches per 100,000 adults log CBB
- The data are annual data
- The sample period: 2004- 2021
- The number of panels: eleven countries
- The sample size n: 176

Table 3

5. Dependent Variable: DLOG(GDP)
Method: ARDL
Sample: 2006 2021
Included observations: 176
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LOG(GFCF) LOG(LF) LOG(EXPORT) LOG(CBB)
Fixed regressors: C
Number of models evaluated: 4
Selected Model: ARDL(1, 2, 2, 2, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
LOG(GFCF)	0.497774	0.018034	27.60137	0.0000
LOG(LF)	-0.359161	0.061555	-5.834777	0.0000
LOG(EXPORT)	0.359253	0.016495	21.77899	0.0000
LOG(CBB)	-0.220344	0.009244	-23.83663	0.0000
Short Run Equation				
COINTEQ01	-0.271782	0.104516	-2.600379	0.0110
DLOG(GFCF)	0.205061	0.077454	2.647527	0.0097
DLOG(GFCF(-1))	-0.009358	0.036219	-0.258379	0.7967
DLOG(LF)	0.505133	0.336838	1.499633	0.1375
DLOG(LF(-1))	-0.091844	0.233735	-0.392942	0.6954
DLOG(EXPORT)	0.034235	0.028503	1.201109	0.2331
DLOG(EXPORT(-1))	-0.027229	0.026731	-1.018654	0.3113
DLOG(CBB)	0.185700	0.083574	2.221969	0.0290
DLOG(CBB(-1))	-0.006031	0.116828	-0.051620	0.9590
C	3.101285	1.149693	2.697489	0.0084
Mean dependent var	0.032409	S.D. dependent var		0.038079
S.E. of regression	0.008506	Akaike info criterion		-5.982741
Sum squared resid	0.006078	Schwarz criterion		-4.089496
Log likelihood	706.2913	Hannan-Quinn critter.		-5.216418

*Note: p-values and any subsequent tests do not account for model selection.

- The selected model is ARDL (1,2,2,2,2) meaning that means 1 lag is included for the target variable the real gross domestic product per capital and 2 lags are included for each of the regressors.
- The gross fixed capital formation, and the exports of goods and services have positive and statistically long-run effects on Gross domestic product per capita.
- If gross fixed capital formation increases (falls) by 1 percent, gross domestic product is expected to increase by about 0.50 percent.
- If exports of goods and services rise (falls) by 1 percent, gross domestic product is expected to increase(falls) by about 0.36 percent.
- However, labor force, and Commercial banks branches per 100,000 adults have negative and significant impacts on gross domes product.
- If labor force rises (falls) by 1 percent, gross domestic product a fall (rises) by 0.36percent.
- If the number of Commercial Bank Branches per 100,000 adults increases by 1 percent, gross domestic product is expected to fall (increase) by 0.22 percent.
- The speed of adjustment is the coefficient of the cointegrating equation. The cointegrating equation is the error correction term:

$$ECT_i \; Y_{i,t-1} + \beta'_i X_{it}$$

- Estimated Coefficient, $\varphi = 0.271$
- This coefficient has the correct sign(negative) and is statistically significant at 0.05 level.
- The coefficient value of -0.271 means that about 0.271 percent of the departure from the long-run equilibrium is corrected in each period i.e. each year.
- The short run equation shows that current changes in log gross fixed capital formation are positive and significant at 0.05 level. A one percent changed in $\Delta logGFCF$ causes 0.20 percent$\Delta logGDP$.
- The short run equation also shows that changes in log CBB have positive and significant effects on changes in log GDP. A one percent changes in $\Delta \log CBB\ causes$ 0.185 percent changes in $\Delta logGDP$.

4.4 The Panel Cointegration Results with the Automated Machines

Pedroni Residual Cointegration Test				
Series: LOG(GDP) LOG(GFCF) LOG(LF) LOG(EXPORT) LOG(ATM)				
Sample: 2004 2021				
Included observations: 198				
Cross-sections included: 11				
Null Hypothesis: No cointegration				
Trend assumption: Deterministic intercept and trend				
Automatic lag length selection based on SIC with a max lag of 2				
Newey-West automatic bandwidth selection and Bartlett kernel				
Alternative hypothesis: common AR coefs. (within-dimension)				
			Weighted	
	Statistic	Prob.	Statistic	Prob.

Panel v-Statistic	3.491200	0.0002	1.187795	0.1175
Panel rho-Statistic	2.460671	0.9931	3.008286	0.9987
Panel PP-Statistic	-0.223792	0.4115	0.410564	0.6593
Panel ADF-Statistic	-0.604963	0.2726	-0.632158	0.2636
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	3.773229	0.9999		
Group PP-Statistic	-1.044592	0.1481		
Group ADF-Statistic	-0.965484	0.1672		

Cross section specific results

Phillips-Peron results (non-parametric)

Cross ID	AR(1)	Variance	HAC	Bandwidth	Obs
1	0.262	0.000163	0.000186	1.00	17
2	-0.304	2.34E-05	1.07E-05	7.00	17
3	-0.020	5.11E-05	2.14E-05	5.00	17
4	0.142	0.000459	0.000459	0.00	17
5	0.066	5.41E-05	3.39E-05	5.00	17
6	0.696	6.26E-05	8.55E-05	1.00	17
7	0.363	0.000131	0.000144	1.00	17
8	-0.065	5.05E-05	5.02E-05	1.00	17
9	0.134	4.05E-05	1.52E-05	7.00	17
10	0.236	0.000152	0.000141	2.00	17
11	0.160	2.99E-05	2.97E-05	1.00	17

Augmented Dickey-Fuller results (parametric)

Cross ID	AR(1)	Variance	Lag	Max lag	Obs
1	0.262	0.000163	0	2	17
2	-0.304	2.34E-05	0	2	17
3	-0.020	5.11E-05	0	2	17
4	0.142	0.000459	0	2	17
5	0.066	5.41E-05	0	2	17
6	0.533	4.75E-05	1	2	16
7	0.363	0.000131	0	2	17
8	-0.065	5.05E-05	0	2	17
9	-0.223	3.61E-05	1	2	16
10	0.236	0.000152	0	2	17
11	0.160	2.99E-05	0	2	17

Pedroni panel cointegration panel test do not reject null hypothesis of no cointegration since most p-values are greater than 0.05.

That means the I(1) variables are not cointegrated. With this outcome we can run panel Vector Auto Regression Model VAR, not Vector Error Correction Model.

- Specification of The VAR Model

$$Y_{it} = \sum_{j=1}^{\rho} \gamma_{ij}\, Y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}\, X_{i,t-j} + \mu_i + \varepsilon_{it}$$

$$Y_{it} = dependent\ variable\ for\ group\ i$$

$$X_{it} = K * 1\ vector\ of\ explanatory\ variables\ for\ group\ i$$

$$\gamma_{ij}\ and\ \delta_{ij}\ \ are\ K * 1\ coefficients\ vector, groups\ are\ denoted\ by\ i = 1,2,3, \ldots and\ time\ is\ denoted\ by\ t = 1,2, \ldots .T$$

$\mu_i = Fixed\ Effects\ unobserved\ group\ dependnet\ error\ term(hetrogenity)$

ε_{it}= iid error term

We begin by determining the optimal lags to use in the VAR model estimation.

Then we first estimate the Fixed Effects FE model and second we estimate the random effects model RE model.

We perform Hausman test to choose between FE and RE

The Hausman test hypotheses are:

$$H_0:\ Random\ Effects\ model\ is\ the\ appropriate\ model$$

$$H_a: Fixed\ Effexts\ model\ is\ the\ appropriate\ model$$

4.5 Hausman Test results

Correlated Random Effects - Hausman Test				
Equation: Untitled				
Test cross-section random effects				
Test Summary		Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random		11.776769	4	0.0191
Cross-section random effects test comparisons:				
Variable	Fixed	Random	Var(Diff.)	Prob.
LOG(GFCF)	0.425170	0.432243	0.000013	0.0491
LOG(LF)	0.376626	0.286314	0.001932	0.0399
LOG(EXPORT)	0.256776	0.271688	0.000125	0.1824

LOG(ATM)	0.023924	0.025675	0.000001	0.0280
Cross-section random effects test equation:				
Dependent Variable: LOG(GDP)				
Method: Panel Least Squares				
Date: 03/29/24 Time: 16:44				
Sample: 2004 2021				
Periods included: 18				
Cross-sections included: 11				
Total panel (balanced) observations: 198				

We do not reject the null hypothesis $H_0: Random\ Effects\ model\ ia\ appropriate$ for the alternative hypothesis $H_a: Fixed\ Effexts\ model\ is\ appropriate.$

4.6. Panel VAR

Dependent Variable: LOG(GDP)				
Method: Panel EGLS (Cross-section random effects)				
Sample: 2004 2021				
Periods included: 18				
Cross-sections included: 11				
Total panel (balanced) observations: 198				
Swamy and Arora estimator of component variances				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.978469	0.558999	7.117136	0.0000
LOG(GFCF)	0.432243	0.029010	14.89998	0.0000
LOG(LF)	0.286314	0.041544	6.891826	0.0000
LOG(EXPORT)	0.271688	0.023042	11.79081	0.0000
LOG(ATM)	0.025675	0.007077	3.627713	0.0004
	Effects Specification			
			S.D.	Rho
Cross-section random			0.215571	0.9663
Idiosyncratic random			0.040262	0.0337
	Weighted Statistics			
R-squared	0.956968	Mean dependent var		1.204247
Adjusted R-squared	0.956077	S.D. dependent var		0.195939
S.E. of regression	0.041065	Sum squared resid		0.325458
F-statistic	1073.020	Durbin-Watson stat		0.372425
Prob(F-statistic)	0.000000			
	Unweighted Statistics			

the results of the Random Effects model show that the coefficient of Log ATM is positive and statistically insignificant but is small effect which means that the number of automated Bank machines does have an impact on real gross domestic product per capita. Increase in the number of Automated Machines per 10,00 adults would increase GDP by 0.0256 percent.

5 Empirical Results for the Second Group Of Emerging Countries

5.4 Panel Unit Root Test

We provide results of the panel Unit root tests for the variables we include in the model for the second group of emerging countries in Appendix B. Results show there is a mix of results some variables are integrated of the first order. I(1) and some variables are stationary at level.

5.5 Panel cointegration Test with ATM

Kao Residual Cointegration Test

Series: LOG(GDPP) LOG(GFCF) LOG(LF) LOG(EXPORT) LOG(ATM)

Sample: 2004 2021

Included observations: 144

Null Hypothesis: No cointegration

Trend assumption: No deterministic trend

Automatic lag length selection based on SIC with a max lag of 3

Newey-West automatic bandwidth selection and Bartlett kernel

	t-Statistic	Prob.
ADF	-2.113181	0.0173
Residual variance	0.001296	
HAC variance	0.002001	

Kao Panel cointegration test confirm the cointegration relationship between the variables. However the Pedroni do not reject the null hypothesis of no cointegration. Since the panel unit root tests show that some variables are I(1) and others are I(0) we undertake the Panel ARDL model was a

5.6 Panel ARDL Model with ATM

Dependent Variable: DLOG(GDPP)
Method: ARDL
Sample: 2006 2021
Included observations: 128
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LOG(GFCF) LOG(LF) LOG(EXPORT) LOG(ATM)
Fixed regressors: C
Number of models evalulated: 4
Selected Model: ARDL(2, 2, 2, 2, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
LOG(GFCF)	0.941119	0.320729	2.934312	0.0050
LOG(LF)	-1.188425	0.650181	-1.827839	0.0733
LOG(EXPORT)	0.022382	0.115957	0.193020	0.8477
LOG(ATM)	0.168127	0.109396	1.536872	0.1304
Short Run Equation				
COINTEQ01	-0.089695	0.044027	-2.037244	0.0467
DLOG(GDPP(-1))	-0.359295	0.193446	-1.857341	0.0689
DLOG(GFCF)	0.110136	0.036502	3.017224	0.0039
DLOG(GFCF(-1))	0.106598	0.033298	3.201383	0.0023
DLOG(LF)	-0.238377	0.454912	-0.524007	0.6025
DLOG(LF(-1))	-0.348979	0.368735	-0.946423	0.3483
DLOG(EXPORT)	0.166184	0.079958	2.078389	0.0426
DLOG(EXPORT(-1))	0.056216	0.063737	0.882000	0.3818
DLOG(ATM)	0.003552	0.028211	0.125893	0.9003
DLOG(ATM(-1))	-0.075431	0.061012	-1.236328	0.2219
C	0.400335	0.192846	2.075935	0.0429

Mean dependent var	0.014991	S.D. dependent var	0.043500
S.E. of regression	0.015756	Akaike info criterion	-4.792122
Sum squared resid	0.012910	Schwarz criterion	-2.894742
Log likelihood	437.0328	Hannan-Quinn criter.	-4.021134

*Note: p-values and any subsequent tests do not account for model selection.

- The selected model is ARDL (2,2,2,2,2) meaning that means 2 lag are included for the target variable the real gross domestic product per capital and for each of the regressors.
- The gross foxed capital formation has positive and statistically significant long-run effects on Gross domestic product per capita.

- If gross fixed capital formation increases (falls) by 1 percent, gross domestic product is expected to increase by 0.941 percent.
- Exports of goods and services has positive but insignificant impact on real gross domestic product per capita in the long run.
- However, labor force, has negative and statistically long run effect on GDPP at the 10 percent level of significance.
- If labor force increases (falls) by 1 percent, real GDPP rises (falls) by 1.88 percent.
- and ATM have positive and statistically insignificant impacts on gross domes product per capita.
- The speed of adjustment is the coefficient of the cointegrating equation. The cointegrating equation is the error correction term:

$$ECT_i: Y_{i,t-1} + \beta'_i X_{it}$$

- Estimated Coefficient, $\varphi = 0.089$
- This coefficient has the correct sign(negative) and is statistically significant at 0.05 level.
- The coefficient value of -0.089 means that about 0.089 percent of the departure from the long-run equilibrium is corrected in each period i.e. each year.
- The short run equation shows that the first difference of current value of log ATM and the one period lagged value of log ATM do not have significant impact on real GDPP.

The Panel Cointegration Test results with CBB for the second group of emerging countries

Pedroni Residual Cointegration Test
Series: LOG(GDP) LOG(GFCF) LOG(LF) LOG(EXPORT) LOG(CBB)
Date: 03/29/24 Time: 20:09
Sample: 2004 2021
Included observations: 144
Cross-sections included: 8
Null Hypothesis: No cointegration
Trend assumption: Deterministic intercept and trend
Automatic lag length selection based on SIC with a max lag of 2
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	2.821368	0.0024	0.897743	0.1847
Panel rho-Statistic	2.191770	0.9858	2.363136	0.9909
Panel PP-Statistic	0.386655	0.6505	0.882951	0.8114
Panel ADF-Statistic	-0.668000	0.2521	0.346729	0.6356

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	3.163783	0.9992
Group PP-Statistic	0.625708	0.7342
Group ADF-Statistic	-0.071096	0.4717

Cross section specific results

Phillips-Peron results (non-parametric)

Cross ID	AR(1)	Variance	HAC	Bandwidth	Obs
1	0.245	6.47E-05	6.78E-05	2.00	17
2	-0.002	0.000239	0.000174	3.00	17
3	0.398	0.000229	0.000242	1.00	17
4	0.284	0.000199	0.000195	2.00	17
5	0.618	0.000310	0.000457	2.00	17
6	0.345	0.000255	0.000257	1.00	17
7	0.053	0.000505	0.000482	1.00	17
8	-0.133	7.24E-05	6.52E-05	2.00	17

Augmented Dickey-Fuller results (parametric)

Cross ID	AR(1)	Variance	Lag	Max lag	Obs
1	0.245	6.47E-05	0	2	17
2	-0.002	0.000239	0	2	17
3	0.398	0.000229	0	2	17
4	0.284	0.000199	0	2	17
5	0.239	0.000173	2	2	15
6	0.345	0.000255	0	2	17
7	0.053	0.000505	0	2	17
8	-0.133	7.24E-05	0	2	17

Ten out of eleven Pedroni Cointegration do not reject the null hypothesis of no cointegration(most p-values are greater than 0.05.

The Panel VAR Model for the Second Group of Emerging Countries :With The CBB

The Hausman test

The Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	7.776418	4	0.1001

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
LOG(GFCF)	0.446429	0.480599	0.000214	0.0195
LOG(LF)	-0.612286	-0.734170	0.002468	0.0141
LOG(EXPORT)	-0.042680	0.003131	0.001633	0.2569
LOG(CBB)	-0.094273	-0.147337	0.000719	0.0479

Cross-section random effects test equation:
Dependent Variable: LOG(GDPP)
Method: Panel Least Squares
Sample: 2004 2021
Periods included: 18
Cross-sections included: 8
Total panel (balanced) observations: 144

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.097631	0.924075	9.845124	0.0000
LOG(GFCF)	0.446429	0.038919	11.47064	0.0000
LOG(LF)	-0.612286	0.092832	-6.595641	0.0000
LOG(EXPORT)	-0.042680	0.041948	-1.017445	0.3108
LOG(CBB)	-0.094273	0.074373	-1.267572	0.2072

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.990328	Mean dependent var	9.130982
Adjusted R-squared	0.989522	S.D. dependent var	0.878785
S.E. of regression	0.089953	Akaike info criterion	-1.899404
Sum squared resid	1.068083	Schwarz criterion	-1.651920
Log likelihood	148.7571	Hannan-Quinn criter.	-1.798841
F-statistic	1228.731	Durbin-Watson stat	0.298829
Prob(F-statistic)	0.000000		

The Hausman Test reveals that we reject the null hypothesis that Random Effects model is the appropriate model, the p-value is greater than 0.05 and we choose the alternative hypothesis that the Fixed Effects model is the appropriate model:

The Fixed Effect Model

Dependent Variable: LOG(GDP)

Method: Panel Least Squares

Sample: 2004 2021

Periods included: 18

Cross-sections included: 8

Total panel (balanced) observations: 144

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.097631	0.924075	9.845124	0.0000
LOG(GFCF)	0.446429	0.038919	11.47064	0.0000
LOG(LF)	-0.612286	0.092832	-6.595641	0.0000
LOG(EXPORT)	-0.042680	0.041948	-1.017445	0.3108
LOG(CBB)	-0.094273	0.074373	-1.267572	0.2072

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.990328	Mean dependent var	9.130982
Adjusted R-squared	0.989522	S.D. dependent var	0.878785
S.E. of regression	0.089953	Akaike info criterion	-1.899404
Sum squared resid	1.068083	Schwarz criterion	-1.651920
Log likelihood	148.7571	Hannan-Quinn criter.	-1.798841
F-statistic	1228.731	Durbin-Watson stat	0.298829
Prob(F-statistic)	0.000000		

The Fixed Effects model results show that the coefficient if the Commercial Banks Branches per 100,000 adults is negative and statistically insignificant. That means the financial inclusion indicator here does not have short run impact on real gross domestic product per capita for the second group of emerging countries and the panel cointegration test previously shows that it does not have a long run relationship either.

The Panel ARDL for the combined group emerging countries[6] with Domestic Credit to private sector

Dependent Variable: DLOG(GDP)
Method: ARDL
Sample: 2006 2022
Included observations: 238
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LOG(GFCF) LOG(LF)
LOG(EXPORT) LOG(DCP)
Fixed regressors: C
Number of models evalulated: 4
Selected Model: ARDL(2, 2, 2, 2, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
LOG(GFCF)	0.543318	0.028998	18.73659	0.0000
LOG(LF)	0.300445	0.080939	3.712008	0.0003
LOG(EXPORT)	0.367009	0.047626	7.706060	0.0000
LOG(DCP)	-0.176574	0.033374	-5.290849	0.0000
Short Run Equation				
COINTEQ01	-0.174274	0.048302	-3.607979	0.0005
DLOG(GDP(-1))	-0.130116	0.099736	-1.304611	0.1948
DLOG(GFCF)	0.193867	0.043174	4.490353	0.0000
DLOG(GFCF(-1))	0.046456	0.034977	1.328189	0.1869
DLOG(LF)	0.279838	0.172939	1.618134	0.1086
DLOG(LF(-1))	-0.433309	0.196812	-2.201641	0.0298
DLOG(EXPORT)	0.097679	0.048043	2.033162	0.0445
DLOG(EXPORT(-1))	0.049252	0.036022	1.367276	0.1744
DLOG(DCP)	-0.073761	0.029238	-2.522748	0.0131
DLOG(DCP(-1))	0.015786	0.042857	0.368348	0.7133
C	-0.126362	0.041086	-3.075533	0.0027

Mean dependent var	0.035031	S.D. dependent var	0.034201
S.E. of regression	0.009901	Akaike info criterion	-5.540071
Sum squared resid	0.010587	Schwarz criterion	-3.411528
Log likelihood	894.8294	Hannan-Quinn criter.	-4.684952

*Note: p-values and any subsequent tests do not account for model selection.

[6] 14 emerging countries: Egypt, Thailand, Chile, Colombia, Hungary, Malaysia, Mexico, Brazil, India, Indonesia, Poland, Singapore, South Africa, and Türkiye.

- The selected model is ARDL (2,2,2,2,2) meaning that means 2 lag are included for the target variable the real gross domestic product per capital and for each of the regressors.
- The gross foxed capital formation, the labor force and the export have positive and statistically significant long-run effects on Gross domestic product.
- If gross fixed capital formation increases (falls) by 1 percent, gross domestic product is expected to increase by 0.54 percent.
- If log Exports of goods and services increases (falls) by 1 percent, log GDP would increase (fall) by 0.30 percent.
- If labor force rises(falls) by 1 percent log GDP rises (falls) by 0.37 percent level of significance.
- and DCP has negative and statistically insignificant impacts on gross domes product per capita. If log DCP rises (falls) by 1 percent, log GDP falls (rises) by percent.
- The speed of adjustment is the coefficient of the cointegrating equation. The cointegrating equation is the error correction term:

$$ECT_i: Y_{i,t-1} + \beta'_i X_{it}$$

- Estimated Coefficient, $\varphi = 0.1742$
- This coefficient has the correct sign(negative) and is statistically significant at 0.05 level.
- The coefficient value of -0.1742 means that about 0.1742 percent of the departure from the long-run equilibrium is corrected in each period i.e. each year.
- The short run equation shows that the first difference of current value of log DCP value of log DCP has negative and significant impact on changes in log real GDPP.

6 Empirical Results of the Second Model

Table Principale Components Analyses : Eigen values

Eigenvalues: (Sum = 5, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	2.618501	1.335809	0.5237	2.618501	0.5237
2	1.282691	0.523851	0.2565	3.901192	0.7802
3	0.758840	0.521218	0.1518	4.660033	0.9320
4	0.237622	0.135277	0.0475	4.897655	0.9795
5	0.102345	---	0.0205	5.000000	1.0000

The table above shows that the first two principal components explains the most variance about 78% with eigen values above one. Therefore, they are used to estimate the financial inclusion composite index.

Table Eigenvectors Loading

Variable	PC 1	PC 2	PC 3	PC 4	PC 5
NDCPGDP	0.333413	-0.612551	0.474538	0.448623	0.295242
NATM	0.451489	0.417209	-0.427688	0.661625	0.037812
NCBB	0.097802	0.654764	0.748247	0.001607	0.042933
NODGDP	0.586054	-0.137323	0.087894	-0.212810	-0.764637
NOLGDP	0.576167	0.056075	-0.155877	-0.561871	0.569991

Based on the results of the above table , the first two components are used to construct the financial inclusion index for the first group of emerging economies.

The equation below is used to construct the composite financial inclusion index.

FI=ndcpgdp*0.333413+natm*0.451489+ncbb*0.097802+nodgdp*0.586054+nolgdp*0.576167+ndcpgdp*-0.612551+natm*0.417209+ncbb*0.654764+nodgdp*-0.137323+nolgdp*0.056075

Where the variables are defined as in the following table

Financial Inclusion Variables	Variable Abbreviation	Dimension
Domestic credit to private sector by banks (% of GDP)	DCPGDP	Access
Number of ATMs per 100,000 adults	ATM	Availability
Number of commercial bank branches per 100,000 adults	CBB	Availability
Outstanding deposits with commercial banks (% of GDP)	ODGDP	Usage
Outstanding loans from commercial banks (% of GDP)	OLGDP	Usage

This data can be found here: https://databank.worldbank.org/source/global-financial-inclusion (and https://databank.worldbank.org/source/world-development-indicators

Panel ARDL Cointegration Test for the first Group of Emerging Economies

Dependent Variable: DLOG(GDPP)
Method: ARDL
Sample: 2006 2020
Included observations: 143
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): FI LOG(GFCF) LOG(POP) LOG(EXPORT)
Fixed regressors: C
Number of models evalulated: 4
Selected Model: ARDL(2, 2, 2, 2, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
FI	-0.466662	0.117908	-3.957847	0.0002
LOG(GFCF)	0.579595	0.058242	9.951448	0.0000
LOG(POP)	-2.786924	0.234787	-11.87002	0.0000
LOG(EXPORT)	0.675967	0.063697	10.61217	0.0000
Short Run Equation				
COINTEQ01	-0.163395	0.068542	-2.383844	0.0204
DLOG(GDPP(-1))	-0.196718	0.302408	-0.650505	0.5179
D(FI)	-0.172845	0.094588	-1.827350	0.0728
D(FI(-1))	0.007102	0.058950	0.120468	0.9045
DLOG(GFCF)	0.138234	0.056493	2.446907	0.0175
DLOG(GFCF(-1))	0.021502	0.051715	0.415772	0.6791
DLOG(POP)	0.337702	0.274774	1.229018	0.2240
DLOG(POP(-1))	3.795847	2.199888	1.725473	0.0898
DLOG(EXPORT)	0.099307	0.052169	1.903557	0.0619
DLOG(EXPORT(-1))	-0.016258	0.031300	-0.519421	0.6054
C	4.616966	1.934673	2.386432	0.0203

Mean dependent var	0.022479	S.D. dependent var	0.037070
S.E. of regression	0.009475	Akaike info criterion	-5.627277
Sum squared resid	0.005207	Schwarz criterion	-3.655944
Log likelihood	555.9958	Hannan-Quinn criter.	-4.826836

*Note: p-values and any subsequent tests do not account for model selection.

The results show that financial inclusion has a significant but negative impact on economic growth in the short-run and the long-run. The reason for the negative relationship between financial inclusion and economic growth may be due to the existence of high income inequality in emerging economies, the low level of domestic saving, and the high dependency on foreign debt, Economists suggest that low level of financial inclusion and high level of income inequality would lead to more financial crises than to more economic growth.

The Panel Causality Test results

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	127.3464	(2, 59)	0.0000
Chi-square	254.6928	2	0.0000

Null Hypothesis: C(3)=C(4)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(3)	-1.332478	0.149095
C(4)	0.798928	0.055632

Restrictions are linear in coefficients.

Pairwise Granger Causality Tests

Sample: 2004 2021

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG(GDPP) does not Granger Cause FI	144	8.62655	0.0003
FI does not Granger Cause LOG(GDPP)		3.39256	0.0364

the causality analysis results above show that the financial inclusion Granger causes economic growth at 5 percent level of significance, indicating the existence of causality running from the financial inclusion to economic growth. Also, the null hypothesis that economic growth does not Granger cause financial inclusion is rejected at 5 percent level of significance showing the existence of causality running from economic growth to financial inclusion. The above results indicate the existence of bi-directional causality between financial inclusion and economic growth.

Empirical Results of the Second Model for the Second Group of Emerging Countries:

The principal Components Analysis : The Eigen Values

Eigenvalues: (Sum = 5, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	3.040312	1.540719	0.6081	3.040312	0.6081
2	1.499594	1.150519	0.2999	4.539906	0.9080
3	0.349075	0.271428	0.0698	4.888981	0.9778
4	0.077647	0.044274	0.0155	4.966627	0.9933
5	0.033373	---	0.0067	5.000000	1.0000

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4	PC 5
NATM	0.518629	-0.228065	0.461962	-0.566210	-0.380798
NCBB	0.434270	-0.493756	0.293531	0.579926	0.380972
NDCPGDP	0.527429	0.187765	-0.479337	-0.365817	0.568311
NODGDP	0.093177	0.751062	0.598024	0.109261	0.240110
NOLGDP	0.505540	0.323793	-0.336205	0.444220	-0.573779

The Eigen Values table above shows that the first two principal components explains the most variance about 90% with eigen values above one. Therefore, they are used to estimate the financial inclusion composite index.
Based on the results of the above Eigen Vectors table, the first two components are used to construct the financial inclusion index for the first group of emerging economies.

The equation below is used to construct the composite financial inclusion index.

FI=0.518629*natm+0.434270*ncbb+0.527429*ndcpgdp+0.093177*nodgdp+0.505540*olgdp+(-0.228065*natm)+(-0.493756*ncbb)+0.187765*ndcpgdp+0.751062*nodgdp+0.323793

Panel ARDL Test for the second Group of Emerging Economies

Dependent Variable: DLOG(GDPP)
Method: ARDL
Sample: 2005 2022
Included observations: 90
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): FI LOG(GFCF) LOG(POP)
LOG(EXPORT)
Fixed regressors: C
Number of models evalulated: 1
Selected Model: ARDL(1, 1, 1, 1, 1)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Long Run Equation		
FI	-0.002203	0.001033	-2.131945	0.0370
LOG(GFCF)	0.353518	0.033132	10.66987	0.0000
LOG(POP)	-0.583514	0.179082	-3.258366	0.0018
LOG(EXPORT)	0.192349	0.028112	6.842322	0.0000
		Short Run Equation		
COINTEQ01	-0.309103	0.166111	-1.860826	0.0676
D(FI)	-0.001382	0.001364	-1.013375	0.3149
DLOG(GFCF)	0.113539	0.057846	1.962769	0.0542
DLOG(POP)	-7.013855	3.751625	-1.869551	0.0663
DLOG(EXPORT)	0.067264	0.042766	1.572858	0.1209
C	1.755178	0.914786	1.918677	0.0597

Mean dependent var	0.024274	S.D. dependent var	0.031039
S.E. of regression	0.014645	Akaike info criterion	-5.231335
Sum squared resid	0.013083	Schwarz criterion	-4.317316
Log likelihood	282.4884	Hannan-Quinn criter.	-4.862002

*Note: p-values and any subsequent tests do not account for model selection.

The results show that financial inclusion has a significant but negative impact on economic growth in the long run. The financial inclusion has negative and significant influence on economic growth in the short run.

The reason for the negative relationship between financial inclusion and economic growth may be as we have previously mentioned due to the existence of high income inequality in emerging economies, the low level of domestic saving, and the high dependency on foreign debt, Economists suggest that low level of financial inclusion and high level of income inequality would lead to more financial crises than to more economic growth.

7 Conclusion

The paper examines the relationship between financial inclusion and economic growth as one of the global sustainable development goals for two groups of emerging countries. The first group of countries which are considered as the major emerging economies includes eleven countries with the exclusion of China due to lack of data. The second group of emerging countries includes eight countries.

The paper used two financial inclusion indicators: the number of commercial banks branches per 100,000 adults and the number of Automated machines per 100,000 adults with annual time series over the period 2004-2021. The paper applied Panel root tests, panel cointegration tests, Panel Vector Error Correction and Vector models with fixed and random effects. For the first group of emerging countries, preliminary empirical results found that the number of commercial banks branches had a negative significant impact on real GDP in the long - run and positive significant on changes in log real GDP in the short run. The results also show that ATM does not exert any long run impact of real GDP and has positive significant impact on changes in real GDP in the short run. For the second group of emerging countries, neither the long run relationship between ATM and real GDP nor the short run relation are significant. The number of commercial banks branches does have a long run relationship with real GDP for the second group of emerging countries and has insignificant short run relationship.

The empirical results from the combined group which includes fourteen emerging countries from the first group and the second group, shows that the long run and short run relationships between domestic credit to private sector as an indicator for financial inclusion and real GDP are significant but negative.

The paper concludes that needed to explore more financial inclusion indicators especially those that measure the cost of getting the formal financial services.

The paper used the Principal Components Analysis to construct a financial inclusion index for each group of emerging economies to capture the impact of all financial indicators together.

The empirical results indicate that the financial inclusion index for the first group of emerging economies has significant but negative impact on economic growth in both the short run and the long run. The results also indicated the existence of bi-directional causality between financial inclusion and economic growth.

However, financial inclusion composite index has insignificant impact on economic growth in both the short run and the long run. The paper suggests considering the relationship between financial inclusion and other macroeconomic variables that may intervene in the relationship between financial inclusion and economic growth such as income and social inequality and to analyze the relationships for each country individually and to include cost indicators .

Appendix A

Table A.1 Data Definition

Variable	Definition	Source
GDPP	GDP per capita (constant 2015 US$)[7]	World Bank Development Indicators data base of World Bank
GFCF	Gross fixed capital formation (constant 2015 US$)[8]	World Bank Development Indicators data base of World Bank
LF	Labor force, total[9]	World Bank Development Indicators data base of World Bank
Trade	Exports of goods and services (constant 2015 US$) minus Imports of goods and services (constant 2015 US$)	World Bank Development Indicators data base of World Bank
CBB	Commercial bank branches (per 100,000 adults)	World Bank Development Indicators data base of World Bank
ATM	Automated teller machines (ATMs) (per 100,000 adults)	World Bank Development Indicators data base of World Bank
DWCB	Depositors with commercial banks (per 1,000 adults)	World Bank Development Indicators data base of World Bank
BFCB	Borrowers from commercial banks (per 1,000 adults)	World Bank Development Indicators data base of World Bank
DCPP	Domestic credit to private sector by banks (% of GDP)	
LE	Life expectancy at birth, total (years)	

[7]GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2015 U.S. dollars.

[8] Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. According to the 1993 SNA, net acquisitions of valuables are also considered capital formation.

[9] Labor force comprises people ages 15 and older who supply labor to produce goods and services during a specified period. It includes people who are currently employed and people who are unemployed but seeking work as well as first-time jobseekers. Not everyone who works is included, however. Unpaid workers, family workers, and students are often omitted, and some countries do not count members of the armed forces. Labor force size tends to vary during the year as seasonal workers enter and leave.

Table A. 2 : List of the First Group of Emerging Economies

Number	Country
1	Argentina
2	Brazil
3	Russa
4	India
5	Indonesia
6	Mexico
7	Poland
8	South Africa
9	South Korea
10	Singapore
11	Turkey

Table A.3 : List of the Second Group of the Emerging Countries

Number	Country
1	Egypt
2	Thailand
3	Chile
4	Hungary
5	Malaysia
6	Saudi Arabia
7	United Arab Emirates
8	The Philippines

Appendix B:

Tables for the First Group of the Emerging Countries

Table B.1.

Panel unit root test: Summary
Series: LOG(GDP)
Sample: 2004 2021
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.14525	0.0160	11	182
Breitung t-stat	-2.76604	0.0028	11	171
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.11951	0.8685	11	182
ADF - Fisher Chi-square	17.0597	0.7601	11	182
PP - Fisher Chi-square	26.5623	0.2283	11	187

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.2.

Panel unit root test: Summary
Series: D(LOG(GDP))
Sample: 2004 2021
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-8.12107	0.0000	11	171
Breitung t-stat	-1.13332	0.1285	11	160
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.34407	0.0000	11	171
ADF - Fisher Chi-square	74.0461	0.0000	11	171
PP - Fisher Chi-square	118.030	0.0000	11	176

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.3.
Panel unit root test: Summary
Series: LOG(GFCF)
Sample: 2004 2021
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-0.33864	0.3674	11	182
Breitung t-stat	-1.82337	0.0341	11	171
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.37317	0.9151	11	182
ADF - Fisher Chi-square	23.0919	0.3966	11	182
PP - Fisher Chi-square	40.2842	0.0100	11	187

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.4.

Panel unit root test: Summary
Series: D(LOG(GFCF))
Sample: 2004 2021
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.26139	0.0000	11	167
Breitung t-stat	-3.87626	0.0001	11	156
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-5.26762	0.0000	11	167
ADF - Fisher Chi-square	64.3213	0.0000	11	167
PP - Fisher Chi-square	101.757	0.0000	11	176

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table. B.5.
Panel unit root test: Summary
Series: LOG(LF)
Sample: 2004 2021
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-1.66474	0.0480	11	181
Breitung t-stat	-5.77567	0.0000	11	170
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-0.91366	0.1804	11	181
ADF - Fisher Chi-square	34.7556	0.0411	11	181
PP - Fisher Chi-square	36.2823	0.0283	11	187

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.6.

Panel unit root test: Summary
Series: LOG(EXPORT)
Sample: 2004 2021
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-5.04313	0.0000	11	184
Breitung t-stat	-0.66363	0.2535	11	173
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.28204	0.0005	11	184
ADF - Fisher Chi-square	45.3365	0.0024	11	184
PP - Fisher Chi-square	70.9415	0.0000	11	187

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.7.

Panel unit root test: Summary
Series: LOG(CBB)
Sample: 2004 2021
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	0.41766	0.6619	11	178
Breitung t-stat	4.75460	1.0000	11	167
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	3.30477	0.9995	11	178
ADF - Fisher Chi-square	5.32800	0.9999	11	178
PP - Fisher Chi-square	13.1080	0.9301	11	187

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.8

Panel unit root test: Summary
Series: LOG(ATM)
Sample: 2004 2021
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.50297	0.9336	11	182
Breitung t-stat	7.17373	1.0000	11	171
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	5.95732	1.0000	11	182
ADF - Fisher Chi-square	4.10343	1.0000	11	182
PP - Fisher Chi-square	14.7619	0.8723	11	187

** Probabilities for Fisher tests are computed using an asymptotic Chi
-square distribution. All other tests assume asymptotic normality.

Table B.10.

Panel unit root test: Summary
Series: D(LOG(ATM))
Sample: 2004 2021
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.95787	0.0000	11	170
Breitung t-stat	-2.64810	0.0040	11	159
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-4.76420	0.0000	11	170
ADF - Fisher Chi-square	58.0770	0.0000	11	170
PP - Fisher Chi-square	59.7754	0.0000	11	176

** Probabilities for Fisher tests are computed using an asymptotic Chi
-square distribution. All other tests assume asymptotic normality.

Table B.11

Panel unit root test: Summary
Series: D(LOG(CBB))
Sample: 2004 2021
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.45562	0.0000	11	169
Breitung t-stat	-1.09649	0.1364	11	158
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-4.43903	0.0000	11	169
ADF - Fisher Chi-square	57.8278	0.0000	11	169
PP - Fisher Chi-square	83.5094	0.0000	11	176

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.12

Panel unit root test: Summary
Series: LOG(GDP)
Date: 03/29/24 Time: 19:35
Sample: 2004 2021
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.81705	0.0024	8	128
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.73040	0.7674	8	128
ADF - Fisher Chi-square	10.0970	0.8615	8	128
PP - Fisher Chi-square	18.2176	0.3113	8	136

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.13

Panel unit root test: Summary
Series: D(LOG(GDP))
Date: 03/29/24 Time: 19:36
Sample: 2004 2021
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.07318	0.0191	8	120
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-2.04351	0.0205	8	120
ADF - Fisher Chi-square	26.5536	0.0467	8	120
PP - Fisher Chi-square	61.4689	0.0000	8	128

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.14

Panel unit root test: Summary
Series: LOG(GCF)
Sample: 2004 2021
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.26438	0.0005	8	128
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.47242	0.0705	8	128
ADF - Fisher Chi-square	26.4530	0.0480	8	128
PP - Fisher Chi-square	117.469	0.0000	8	136

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.15

Null Hypothesis: Stationarity
Series: LOG(GCF)
Sample: 2004 2021
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 144
Cross-sections included: 8

Method	Statistic	Prob.**
Hadri Z-stat	6.14821	0.0000
Heteroscedastic Consistent Z-stat	5.80206	0.0000

* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.
** Probabilities are computed assuming asympotic normality

Intermediate results on LOG(GCF)

Cross section	LM	Variance HAC	Bandwidth	Obs
1	0.3964	0.143353	2.0	18
2	0.5568	0.051489	3.0	18
3	0.4972	0.154499	3.0	18
4	0.3686	0.090963	3.0	18
5	0.5008	0.242210	3.0	18
6	0.4898	0.265824	3.0	18
7	0.4426	0.088357	2.0	18
8	0.5275	0.605371	3.0	18

Table B 15
Panel unit root test: Summary
Series: D(LOG(GCF))
Sample: 2004 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.32078	0.0000	8	125
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-5.59968	0.0000	8	125
ADF - Fisher Chi-square	58.9793	0.0000	8	125
PP - Fisher Chi-square	68.3757	0.0000	8	128

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.16
Panel unit root test: Summary
Series: LOG(LF)
Date: 03/29/24 Time: 19:53
Sample: 2004 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.94137	0.0000	8	128
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.42199	0.0003	8	128
ADF - Fisher Chi-square	45.9975	0.0001	8	128
PP - Fisher Chi-square	79.4631	0.0000	8	136

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B 17
Null Hypothesis: Stationarity
Series: LOG(LF)
Sample: 2004 2021
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 144
Cross-sections included: 8

Method	Statistic	Prob.**
Hadri Z-stat	6.63102	0.0000
Heteroscedastic Consistent Z-stat	6.76727	0.0000

* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.
** Probabilities are computed assuming asympotic normality

Intermediate results on LOG(LF)

Cross section	LM	Variance HAC	Bandwidth	Obs
1	0.4967	0.025490	3.0	18
2	0.4607	0.001175	2.0	18
3	0.5527	0.029865	3.0	18
4	0.5376	0.006914	3.0	18
5	0.5597	0.078013	3.0	18
6	0.5650	0.141735	3.0	18
7	0.4747	0.283454	3.0	18
8	0.5396	0.032166	3.0	18

Table B.18
Panel unit root test: Summary
Series: LOG(EXPORT)
Sample: 2004 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.09204	0.0000	8	136
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-2.07916	0.0188	8	136
ADF - Fisher Chi-square	28.4404	0.0280	8	136
PP - Fisher Chi-square	41.3068	0.0005	8	136

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.19
Panel unit root test: Summary
Series: D(LOG(EXPORT))
Sample: 2004 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.64438	0.0000	8	125
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-4.60438	0.0000	8	125
ADF - Fisher Chi-square	49.8903	0.0000	8	125
PP - Fisher Chi-square	52.0274	0.0000	8	128

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B 20

Panel unit root test: Summary
Series: LOG(CBB)
Sample: 2004 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.80010	0.9641	8	131
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	2.67836	0.9963	8	131
ADF - Fisher Chi-square	7.74424	0.9561	8	131
PP - Fisher Chi-square	7.61786	0.9594	8	136

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B.21

Panel unit root test: Summary
Series: D(LOG(CBB))
Sample: 2004 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-1.58779	0.0562	8	125
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.64366	0.0501	8	125
ADF - Fisher Chi-square	32.4975	0.0086	8	125
PP - Fisher Chi-square	32.7842	0.0079	8	128

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B 22
Panel unit root test: Summary
Series: LOG(ATM)
Sample: 2004 2021
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-9.00460	0.0000	8	132
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.95440	0.0000	8	132
ADF - Fisher Chi-square	105.224	0.0000	8	132
PP - Fisher Chi-square	136.530	0.0000	8	136

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table B. 23
Panel unit root test: Summary
Series: LOG(DCP)
Sample: 2004 2022
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.67409	0.0000	14	238
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-2.14341	0.0160	14	238
ADF - Fisher Chi-square	44.2311	0.0264	14	238
PP - Fisher Chi-square	55.1097	0.0016	14	252

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

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