TRAGEDIES of Regional Conflicts & PROMISES of Peacebuilding
Responding to Disruptors and Enablers of MENA Development Pathway
ERF 30th Annual Conference

www.erf.org.eg

Financial Inclusion and Threshold Effects in Carbon Emissions

Nidhaleddine Ben Cheikh
and Christophe Rault

ECONOMIC RESEARCH FORUM
منتدى البحوث الاقتصادية

2024

Financial Inclusion and Threshold Effects in Carbon Emissions

Nidhaleddine Ben Cheikh
ESSCA School of Management, France
E-mail address: nidhaleddine.bencheikh@essca.fr

Christophe Rault
LEO, University of Orléans (France), CESifo, and IZA (Germany),
Corresponding author: E-mail address: Christophe.rault@univ-orleans.fr
Website: http://chrault3.free.fr/

Abstract. While the financial inclusion would induce greater pollutant emissions through its impact of economic activity, the increased access to financial services may unleash investments in green technologies. This papier investigates whether the financial inclusion influences the dynamic of carbon dioxide (CO_2) emissions in a sample of 70 countries during the last decade. We implement panel threshold techniques to explore the possible regime shifts in the environmental quality. Our results reveal that an increased financial access impacts air pollution depending on the level of economic development. While financial inclusion would increase CO_2 emissions under lower-income regimes, the environment quality seems to be enhanced with more inclusiveness at later stages of development. Sounder environmental policies are needed for less developed countries to align financial inclusion initiatives with sustainable economic development.

Keywords: Financial inclusion, carbon emissions, panel threshold modelling.

JEL Classification Numbers: C23, O16, O44, Q53, Q56.

1. Introduction

The aim of this study is to investigate the dynamic relationship between the financial inclusion and greenhouse gas (GHG) emissions. The access to affordable financial products and services has witnessed a significant growth over the past decade, being a cornerstone of the 2030 Sustainable Development Goals (SDGs).[1] According to the World Bank's latest Global Findex data, the worldwide account ownership has increased from 51 percent to 76 percent between 2011 and 2021 (Demirgüç-Kunt, et al., 2022). In the recent years, there has been an increasing number of studies dealing with the role played by financial inclusion in the economic development and the growth process (see e.g., Emara et al., 2021; Kim et al., 2018; Cao and Zhang, 2020; Ozturk and Ullah, 2022, among others). Nevertheless, in their review of recent empirical evidence, Demirgüç-Kunt et al. (2017) claimed that linkage between financial inclusion and economic growth is still controversial, and there is relatively limited research on the topic.

It agreed that better financial access would exert a positive effect on economic growth, however the dynamic may be changing due to the existence of a turning point. For a sample of 44 Sub-Saharan African (SSA) countries, Amponsah et al. (2021) found that financial inclusion exhibits an inverted-U-shaped relationship with inclusive growth; that is, an increase in financial inclusion increases inclusive growth up to a threshold and thereafter declines. More recently, Abdul Karim et al. (2022) have investigated the presence of threshold in the nexus among financial inclusion and economic growth. For a panel of 60 emerging and less developed countries, the authors identify a certain threshold level beyond which the impact of an increased financial access on growth is declining. Also, using firm-level data, Nizam, et al. (2021) pointed out that the impact of financial inclusion on corporation growth is significantly negative after a certain threshold point is reached.[2]

As the increased access to affordable financial products and services would stimulate consumption and the economic activity, this would raise the question of its possible impact on the environmental quality. For a sample of 31 Asian countries, Le et al. (2020) found that GHG emissions are increasing with the improvement of access to banking facilities. In a similar vein, Zaidi et al. (2021) documented positive connections between financial inclusion, energy

[1] Financial inclusion has a prominent position that it features in 8 of the UN's 17 SDGs.
[2] More broadly, the presence of threshold effect in growth-financial development nexus has been also documented in the previous literature (see e.g., Arcand et al., 2015; Law & Singh, 2014; Beck et al., 2016).

consumption and carbon dioxide (CO_2) emissions for a panel of 23 OECD countries. Besides, it is worth noting that further financial inclusion may spur individuals and companies to seek green investments and environment-friendly technologies. Therefore, assuming a linear or monotonic relationship among the widening of financial access and pollutant emissions can be misleading. In a recent study, Shahbaz et al. (2022) found that the impact of financial inclusion on carbon emissions is asymmetric and varies geographically. There is a significant effect of financial inclusion on air quality in regions with low CO_2 emissions, however the impact is not significant in regions with higher emissions.

Moreover, Renzhi and Baek (2020) have tested the existence of environment Kuznets curve (EKC) between financial inclusion and CO_2 emissions in a large panel of 103 countries. The authors found that a greater financial access raises pollutant emissions in the early stages, but can be helpful for environmental preservation at a later stage. From an econometric point of view, Renzhi and Baek (2020) have introduced a quadratic term of financial inclusion in their empirical specification to capture the presence of an inverted U-shaped pattern. The estimated coefficient on financial inclusion is found to be positive, while the coefficient of its quadratic term is negative, which indicates the presence of a turning point. In our paper, we propose a new approach to explore the impact of financial inclusion on CO_2 emissions without imposing any prior shape on their relationship. We implement a panel threshold regression model where the possible existence of turning point is captured properly from the data (see e.g., Hansen, 1999; Kremer, et al., 2013; Seo and Shin, 2016). We investigate the presence of threshold effect by considering the moderating role of different factors, namely income level, institutional quality, and information and communication technology (ICT) infrastructure. Our study is conducted for a sample of 70 countries over the period 2010–2019. Principal component analysis (PCA) is used to construct a composite financial inclusion index from five indicators related to affordability of financial services.

The remainder of the paper is organized as follows: Section 2 reviews the related literature on financial inclusion and the possible presence of threshold effect. Section 3 describes the empirical approach and the data. Main empirical results are provided in Section 4. In Section 5, we give some concluding remarks.

2. Literature review

Although the large body of empirical literature on the relationship between economic activity and financial development, the presence of nonlinearity is still controversial and most of empirical evidence is inconclusive. For a sample of 87 developed and developing countries, Law and Singh (2014) has applied a dynamic panel threshold framework to capture the possible of existence of regime-switching behavior. The authors documented that the extent of financial development is not effective and even harmful for growth beyond a certain threshold value. However, the spread of financial services is only beneficial under the estimated threshold level. Law and Singh (2014) emphasized the fact that policymakers should seek for the optimal level of financial affordability to promote economic development. The idea that extending financial access would affect growth is time-varying and depending on the stage and level of economic development has been confirmed the previous studies (see e.g., Arcand et al., 2015; Deidda and Fattouh, 2002; Huang and Lin, 2009; Law et al., 2013, among others).

Nevertheless, it is worth noting that the extant literature has reported different patterns of the growth-finance nexus where the "bright" side of financial development is more prominent. While for low-income economies the relationship is not significant or weak, enhancing the access to financial services would boost the economic activity for high-income countries (see e.g., Cecchetti and Kharroubi, 2012; Hung (2009) Rioja and Valev, 2004). Given the inconclusiveness of the existing empirical studies, the use of an appropriate functional form and relevant econometric techniques is crucial to estimate properly the linkage among economic growth and the extant of financial development. Assuming linearity without testing for possible regime shift can be misleading. This would explain why a negative association is empirically found between financial sector and growth when a linear form is used.

While the adverse impact of financial access has been documented for higher levels economic growth, a different association has been found for financial innovation. Beck et al. (2016) suggested strong evidence that financial innovation is associated with higher levels of economic growth for a group of 32 countries. The authors put forth the role innovative activities of financial intermediation industry which help countries grow faster at high levels of income. Nevertheless, Beck et al. (2016) admitted that a higher level of financial innovation is associated with higher bank growth and higher fragility at the same time.

As higher economic growth is associated with more greenhouse gases (GHG) emissions, it is interesting to explore how enhanced financial access would impact the environmental quality. Using both the linear and nonlinear specifications within the cross-sectional augmented ARDL (CS-ARDL) of Chudik et al. (2016), Badeeb et al. (2023) has investigated the key drivers of the affordability of financial services. For a sample of OECD countries, they documented that the use of clean energy would foster financial inclusion, contrary to natural resources which have negative effects. We note that Badeeb et al. (2023) have introduced a square term to examine the nonlinear nexus between natural resources and financial inclusion. While the coefficients of square terms of natural resources are negative, they suggested that when the degree of natural resource dependence is less than the threshold value, the negative effect of natural resource on inclusive finance is significantly greater than that after the threshold value is surpassed. Using the same panel data technique, namely the CS-ARDL framework, Cai and Wei (2023) measured the impact of increased financial access on carbon emissions for a panel of 32 Countries of the Belt and Road Initiative (BRI). Unlike the development of renewable energy, improving the affordability of financial services is not effective to mitigate the environmental pollution.

At the same time, recent empirical studies have been conducted to test whether there is a possible turning point or a threshold effect in the dynamic of financial inclusion. For a large sample of 84 countries, Daud and Ahmad (2023) analyzed the connection among financial inclusion, digital technology and economic growth. Using dynamic panel data analysis, the authors reported that there is a threshold level for financial inclusion that needs to be achieved before it positively affects country growth. Daud and Ahmad (2023) recognized that improving digital technology infrastructure has a key role in accelerating financial inclusion.[3]

Besides, some studies have investigated the moderating effect in the nexus between air pollutants and financial inclusion. Using the method of moments quantile regression of Machado and Silva (2019) for 27 European countries, Fareed et al. (2022) underscore the importance of innovation activity in moderating the positive link between financial access and carbon emissions, appearing as an effective mitigation measure. It is worth highlighting that an interaction term, i.e., a multiplication of financial inclusion and innovation activity variables,

[3] The overall level of financial access remained stable and strong throughout the COVID-19 episode which is mainly due to the greater use of digital financial services that played a key role in supporting access to banking facilities during the health crisis (Financial Access Survey (FAS), 2023).

has been introduced in their empirical specification to capture the possible presence of moderation. To avoid the use of an arbitrary specification for the presence of moderating effect, we propose to use a nonlinear panel threshold model where the presence regime-switching behavior in financial can be captured properly form the data.[4]

3. Empirical strategy and data

The panel threshold regression model allows to identify any regime shift in the relationship among inclusiveness and emissions. The model can be written for a single threshold model (two regimes) as follows:

$$\Delta e_{it} = (1, x'_{it})\beta_1 \mathbb{1}\{q_{it} \leq \gamma\}\mu_i + (1, x'_{it})\beta_2 \mathbb{1}\{q_{it} > \gamma\} + \varepsilon_{it}, \quad (1)$$

where Δe_{it} is the dependent variable represented by the change in CO_2 emissions (measured in metric tons per capita).[5] $\mathbb{1}\{\cdot\}$ is an indicator function indicating the regime defined by the threshold variable q_{it}, and the threshold parameter γ. The latter allows to divide the equation into two different regimes with coefficients β_1 and β_2. x_{it} is a vector of time-varying explanatory variables that may influence the environment quality, including the composite index of financial inclusion. If the threshold variable q_{it} is below or above a certain value γ, then x_{it} has a different impact on pollutant emissions Δe_{it} represented by $\beta_1 \neq \beta_2$.[6]

In our applications, different threshold variables q_{it} are considered that may influence the nexus between financial inclusion and air pollutants, such as the income level gdp_{it}, the governance quality GOV_{it}, and ICT infrastructure ICT_{it}: $q_{it} = (gdp_{it}; ICT_{it}; GOV_{it})$.[7] Firstly, the moderating role of income level is considered here to test the presence an inverted U-shaped pattern in line with EKC assumption (see e.g., Renzhi and Baek, 2020). Secondly, the importance of governance quality in promoting financial development has been established in

[4] The implementation of panel threshold regression models has had notable success in the energy economics literature, see e.g. Ben Cheikh and Ben Zaied (2023), Ben Cheikh, et al. (2023), among others.
[5] Other proxies have been used in the literature, such as the extent of CO_2 intensity, which refers to the degree to which a country's economic outputs are associated with fossil fuels (Ben Cheikh and Ben Zaied, 2024, for a discussion).
[6] As discussed by Seo and Shin (2016), x_{it} may include the lagged dependent variable. Also, the threshold variable q_{it} could be an element of the explanatory variables or a variable external to the model.
[7] It is possible to consider other threshold variables to test their moderating effect, such as urbanization, industrialization, or renewable use. Unfortunately, when we perform threshold effect tests, the null hypothesis of no threshold cannot be rejected for this kind of variables.

the previous studies. In a recent paper, Zeqiraj et al. (2022) has pointed out the role institutions quality in improving access to financial services using dynamic-panel-GMM estimation.

Table 1. Summary of descriptive statistics

	Mean	SD	Min.	Q_1 (.25)	Median	Q_2 (.75)	Max.
CO_2 emissions	4.35	4.91	0.06	1.29	3.55	5.76	34.19
GDP per capita	13837.70	17647.30	479.88	2613.53	6147.29	15610.20	88413.19
Energy intensity	4.41	2.25	1.32	3.01	3.68	5.05	14.75
Trade openness (% of GDP)	90.74	55.12	22.49	55.12	79.84	107.83	379.10
FDI (% of GDP)	4.95	9.79	-40.08	1.31	2.69	4.98	102.31
Financial inclusion indicators							
ATMs	55.33	47.31	1.43	20.27	50.93	72.38	288.59
Bank branches	19.77	15.71	0.42	8.95	14.85	24.85	95.93
Bank accounts	1511.23	1277.35	71.67	635.68	1139.14	2079.99	7270.62
Deposits (% of GDP)	58.83	40.59	11.13	33.96	45.82	71.79	251.26
Loans (% of GDP)	54.77	34.31	5.95	28.91	47.97	74.72	167.85
ICT infrastructure							
Fixed telephone subscriptions	19.06	15.84	0.09	5.63	15.64	30.05	62.85
Mobile cellular subscriptions	112.35	30.61	30.70	93.97	113.20	132.09	212.64
Individuals using the Internet	50.38	27.07	3.00	25.65	52.95	73.13	99.65
Governance Indicators							
Government Effectiveness	0.23	0.81	-1.39	-0.43	0.12	0.87	2.24
Control of Corruption	0.07	0.91	-1.39	-0.60	-0.23	0.71	2.28
Political Stability	-0.03	0.85	-2.81	-0.59	0.01	0.67	1.62
Regulatory Quality	0.27	0.82	-1.73	-0.33	0.22	0.85	2.26
Rule of Law	0.12	0.85	-1.45	-0.56	-0.10	0.75	2.02
Voice and Accountability	0.15	0.80	-2.12	-0.42	0.11	0.79	1.69

Notes: Data are collected for 70 countries for the annual period 2010–2019. SD, min., max., Q_1 (.25), and Q_3 (.75) are the standard deviation, minimum, maximum, first quartile, and third quartile, respectively.

Moreover, for a sample of 85 countries, Law et al. (2013) documented that the impact of finance on growth is positive and significant only after a certain threshold level of institutional development has been attained. Finally, we consider ICT penetration as a threshold variable due to its possible impact on environmental performance (see e.g., Asongu et al., 2018; Ben Lahouel et al., 2021; Usman et al., 2021), but also for its complementarity with financial inclusion (see e.g., Chatterjee, 2020). Within our nonlinear panel data model, the above threshold variables are allowed to directly interact with the composite index of financial inclusion.

As a key independent variable, we compute a composite financial inclusion index using PCA from different indicators which is common in this strand of literature (see e.g., Ahamed and Mallick, 2019; Badeeb et al., 2023; Kebede et al., 2021).[8] We consider five measures of financial inclusion: ATMs per 100,000 adults; bank branches per 100,000 adults; bank accounts per 1,000 adults; outstanding deposits from commercial banks, % of GDP; and outstanding loans from commercial banks, % of GDP (see e.g., Pradhan et al., 2021; Zeqiraj et al., 2022). Information on the extracted principal components are given in Appendix (Figure A1 and Figure A2).[9] The scree plot in Figure A1 indicates that the first principal component retains the largest proportion of information from the five financial inclusion measure (56.2% of the total variation). This is confirmed by the eigenvalue of the first principal component, which is larger than 1 as reported in Table 2. Figure A2 shows that outstanding loans and bank accounts have the highest contributions to the first component, 38.2% and 35.7%, respectively.

Table 2. Eigenvalues and proportion of variances using PCA

Component	Eigenvalue	% of variance	Cumulative % of variance
Financial inclusion Index			
1	2.84	56.20	56.87
2	0.92	18.50	75.37
3	0.69	14.30	89.25
4	0.33	7.00	95.92
5	0.20	4.00	100.00
ICT index			
1	2.18	72.80	72.80
2	0.58	19.65	92.46
3	0.22	7.53	100.00
Governance quality index			
1	4.93	82.26	82.26
2	0.43	7.31	89.57
3	0.38	6.38	95.95
4	0.13	2.25	98.21
5	0.06	1.08	99.29
6	0.04	0.70	100.00

Notes: The eigenvalues measure the amount of variation retained by each principal component. The percentage of variation explained by each eigenvalue is given in the second column. For example, 2.84 divided by 5 equals 56.87% of the variation is explained by this first eigenvalue. The cumulative percentage explained is obtained by adding the successive proportions of variation explained to obtain the running total.

Additional explanatory variables have been introduced as potential drivers of the air quality, namely, GDP per capita growth, energy intensity, trade openness, and FDI net inflows

[8] While the most two common approaches used in this context are PCA et Common Factor Analysis (CFA), the existing literature showed the preference for PCA as it is not necessary to draw additional assumptions about the raw data, such as selecting the underlying common factors.

[9] We have performed panel unit root tests using Breitung and Das (2005) test which is robust to cross-sectional dependence. The results confirm the stationarity of our key variables. Panel unit root tests are not reported here to save space but available upon request.

(see e.g., Ben Cheikh et al., 2021; Ozturk and Ullah, 2022; Zaidi et al., 2021). Also, in line the extant literature, we consider the quality of governance with its six different dimensions: control of corruption; government effectiveness; political stability; regulatory quality; rule of law; and voice and accountability (see Kaufmann et al., 2010). Finally, for the investments in ICT, three different measures are used here: fixed telephone subscriptions (per 100 people); mobile cellular subscriptions (per 100 people); individuals using the Internet (% of population). Composite indices were constructed from governance and ICT indicators using PCA.

Due to data availability, annual data have been collected for a panel of 70 countries spanning the period 2010–2019 to reach a strongly balanced panel. For financial inclusion indicators, data are obtained from Financial Access Survey of the International Monetary Fund (IMF). Governance indicators are sourced from World Governance Indicators (WGI), while ICT and macroeconomic variables are sourced from World Development Indicators (WDI). The summary statistics of the key variables is provided in Table 1. Full details of the definition and sources of the data are reported in Table A1 in Appendix.[10]

4. Empirical results

As a first step, we perform the threshold effect tests using Hansen (1999) procedure to identify the number thresholds in the panel structure. Table 3 displays F-statistics, F_1, F_2, and F_3, and their asymptotic bootstrap p-values to assess the null assumption of no, one, and two thresholds, respectively. When we test the presence of threshold effect with respect to (log) level of GDP per capita, $q_{it} = gdp_{it}$, the null of no threshold effect is strongly rejected according to the p-value of F_1. The test statistic for a double threshold, F_2, is also significant at the level of 1% with a bootstrap p-value of 0.008. Finally, F_3 indicates that the null assumption of at most two thresholds cannot be rejected. A panel threshold regression model with two thresholds is then more appropriate to describe the impact of financial inclusion on carbon emissions with respect to income level. We rewrite equation (1) for a double-threshold model (three regimes) as follows:

$$\Delta e_{it} = (1, x'_{it})\beta_1 \mathbb{I}\{gdp_{it} \leq \gamma_1\}\mu_i + (1, x'_{it})\beta_2 \mathbb{I}\{\gamma_1 \leq gdp_{it} \leq \gamma_2\} + (1, x'_{it})\beta_3 \mathbb{I}\{gdp_{it} > \gamma_2\} + \varepsilon_{it}, \qquad (2)$$

[10] The panel of 70 countries listed according to the World Bank region classification is provided in Table A2 in Appendix.

When we conduct threshold tests for ICT composite index, $q_{it} = ICT_{it}$, there is evidence of a single threshold at the 5% significance. However, the presence of threshold effect seems to be weak for the case governance index, $q_{it} = GOV_{it}$, as bootstrap p-value of F_1 is equal to 0.103. The estimation results using the selected threshold variables are reported in Table 4. Our threshold panel models have been estimated using the first-differenced generalized method of moments (FD-GMM) approach as in Seo and Shin (2016). This would allow to mitigate the bias due to the potential endogeneity issue in both regressors and threshold variables.[11] When considering the log-level of GDP per capita as a threshold variable, the estimated thresholds $(\hat{\gamma}_1; \hat{\gamma}_2) = (8.11; 9.61)$ allow the distinction of three regimes with respect to income level: a *low-income regime* when GDP per capita is lower than 3,340$ (8.11 in logarithms); a *high-income regime* when the income capita exceeds 15,033$ (9.61 in logarithms); and an intermediate *middle-income regime* between 3,340$ and 15,033$.

Table 3. Tests for threshold effects

Threshold variables (q_{it})	(1) gdp_{it}	(2) ICT_{it}	(3) GOV_{it}
Single-threshold effect test (H_0: no threshold)			
F_1	35.83	14.02	10.29
p-value	0.002	0.046	0.103
(5%, 1% critical value)	(23.510, 34.779)	(13.458, 16.961)	(12.744, 19.089)
Double-threshold effect test (H_0: at most one threshold)			
F_2	29.35	8.91	7.77
p-value	0.008	0.266	0.3433
(5%, 1% critical value)	(21.360, 27.828)	(16.204, 21.949)	(16.774, 23.908)
Triple-threshold effect test (H_0: at most two thresholds)			
F_3	11.40		
p-value	0.5900	-	-
(5%, 1% critical value)	(26.924, 36.528)		

Note: The table reports the test statistics F_1, F_2, and F_3 establishing the number of thresholds. The bootstrapped p-values are obtained from 1000 bootstrap replications.

The point estimates indicates that financial inclusion entails higher CO_2 emissions in the middle-income regimes, while the environmental damage seems to be non-significant under the lower regime. However, the improvement in financial access is found to be beneficial for the quality of environment when GDP per capita surpasses the threshold level of 15,033$. The increase in financial inclusion has significant negative impact on air pollutant emissions in the high-income regime. The 95% confidence intervals confirm the presence of regime-dependence

[11] See e.g., Ozturk and Ullah (2022) and Renzhia and Baek (2020) for a recent discussion.

in the linkage among financial inclusion and CO_2 emissions due to the level of economic development in line with EKC assumption.

Our results confirm a non-monotonic effect of financial inclusion on environmental quality. Without imposing an a priori restriction on the inclusiveness-emissions nexus, the implemented of nonlinear panel data framework enables us to capture the presence of threshold effect. A large amount of empirical literature reported that the extent of financial inclusion is statistically significantly and positively associated with air pollutant emissions. For a panel of 76 emerging and developing economies over the period 2011-2021, Khan et al. (2023) suggested that increased financial access is harmful for the environment. Besides, some studies showed that the effect of financial inclusion on GHG emissions could be different even within a given country. For a panel dataset of 284 cities in China covering 2011–2017, Wang et al. (2023) used a spatial econometric model which revealed that financial access positively influences air pollution of local cities, but negatively impacts neighboring cities. We note that the threshold effect is also confirmed for the income growth as the impact on emissions is found to be significantly negative in the upper regime which is consistent with the previous studies (see e.g., Arouri et al., 2012; Ben Cheikh and Ben Zaied, 2021; Bimonte and Stabile, 2017; Yang et al., 2015, among others).

When considering ICT index as a threshold variable, the impact of financial access seems to be different between lower and upper regimes. However, the 95 confidence intervals indicate that point estimates are not significantly different from a statistical point view. Although ICT can provide opportunities for greater access to financial services, unfortunately we cannot assert ICT can help to reduce the environmental impact of financial inclusion. Indeed, the previous literature has examined how the combination of financial inclusion and ICT would affect the economic activity. Andrianaivo and Kpodar (2011) documented that an improved access to financial services is one of the important channels through which ICT diffusion contributes to economic growth. For a sample of 44 African countries, the authors explained that the positive impact of mobile penetration on growth is more pronounced for countries with better access to financial services.

Table 4. Results from panel threshold models

	Dependent variable: Change in CO_2 emissions		
	(1)	(2)	(3)
Threshold variables (q_{it})	gdp_{it}	ICT_{it}	GOV_{it}
Threshold value ($\hat{\gamma}_1$)	8.114	0.344	0.1161
	{7.735; 8.491}	{0.236; 0.451}	{-0.217; 0.117}
Threshold value ($\hat{\gamma}_2$)	9.618	-	-
	{9.596; 9.620}		
Energy intensity	0.672***	0.5617***	0.671***
	(0.043)	(0.078)	(0.043)
Trade openness	-0.0003**	-0.0004**	-0.0004**
	(0.0001)	(0.0002)	(0.0002)
FDI inflows	0.0001	0.0000	0.0001
	(0.0002)	(0.0003)	(0.0002)
ICT	-0.039*	-0.0412***	-0.011*
	(0.0047)	(0.009)	(0.006)
Governance	-0.068	-0.034*	-0.086***
	(0.051)	(0.018)	(0.028)
Lower regime:			
Income growth	1.303***	1.073***	1.174***
	(0.134)	(0.116)	(0.114)
	{1.038; 1.568}	{0.843; 1.302}	{0.949; 1.400}
Financial Inclusion	0.023	0.029*	0.016***
	(0.016)	(0.015)	(0.007)
	{-.0095; .0555}	{-.0007; .0591}	{0.002; 0.029}
Intermediate regime:			
Income growth	0.944***		
	(0.164)	-	-
	{0.621; 1.266}		
Financial Inclusion	0.036***		
	(0.009)	-	-
	{0.016; 0.055}		
Upper regime:			
Income growth	-0.818***	0.697*	-0.459
	(0.234)	(0.414)	(0.534)
	{-1.278; -0.359}	{-0.116; 1.511}	{-1.509; 0.590}
Financial Inclusion	-0.024***	-0.018**	-0.011
	(0.009)	(0.008)	(0.006)
	{-.0436; -.0055}	{-0.035; -0.0015}	{-0.024; .0021}
Observations	630	630	630
Adjusted R-squared	0.663	0.652	0.684
J-test	18.564	18.345	18.448
	[0.187]	[0.172]	[0.186]

Note: The estimation results are obtained from a panel threshold models over the period 2010–2019. Standard errors are displayed in parentheses. 95% confidence intervals are reported between braces. J-test stands for the validity of the overidentifying moment conditions with p-values in square brackets. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

In a similar vein, Wang et al. (2023) have selected the most advanced African economies in terms of ICT infrastructure to assess their degree of growth inclusiveness. Using GMM estimator for linear dynamic panel data models, the authors introduced an interaction term to capture the combined effect of ICT penetration and financial inclusion. Their empirical findings confirmed that the interaction between financial access and ICT would foster inclusive growth, with a 1% increase in the interaction term increasing inclusiveness by 0.10%. Our empirical results do not show an important role of ICT in the nexus among carbon emissions and the degree of financial inclusion. In contrast to the above studies, which considered an interaction term, our study implements a panel threshold regression to properly account for the mediating effect of ICT development.

The quality of governance as a moderator variable does not seem to lead to a significantly different impact of financial inclusion on pollution. Although improved access to finance appears to be detrimental to environmental performance when institutional quality is low, point estimates are not statistically different from those estimated when institutional quality is high. Once again, our results contrast with some previous studies that have suggested a key role for institutional quality in the affordability of financial services. For a panel of 73 developing countries, Zeqiraj et al. (2022) reported that institutional quality is one of the main drivers of financial inclusion. Their point estimates suggested that a 1% increase in governance quality increases access to finance by 0.64%. Moreover, the quality of governance is found to be critical for the inclusive growth. Amponsah et al. (2021) highlighted the role of institutional quality in promoting inclusiveness in SSA countries provided that an index of financial inclusion is included in the empirical specification. Our empirical analysis differs from the aforementioned studies in that we consider a nonlinear panel framework, which allows for the interaction among institutional quality and financial inclusion. The failure to find a significant mediation effect has already been confirmed by the tests of threshold effects in Table 3.

Table 5. Sample split with respect to the estimated threshold level of GDP per capita

Countries in low-income regime:		**Countries in middle-income regime:**		**Countries in high-income regime:**
$GDP_{it} \leq 3{,}340\$$		$3{,}340\$ < GDP_{it} \leq 15{,}033\$$		$GDP_{it} > 15{,}033\$$
Bangladesh	Togo	Algeria	Mauritius	Austria
Bhutan	Uganda	Argentina	Mexico	Belgium
Bolivia	Ukraine	Armenia	Mongolia	Estonia
Cameroon	Uzbekistan	Bosnia	Montenegro	Greece
Gambia	Zambia	Bulgaria	Namibia	Ireland
Ghana		Chile	North Macedonia	Italy
Honduras		Colombia	Panama	Japan
India		Costa Rica	Paraguay	Korea, Rep.
Indonesia		Croatia	Peru	Malta
Kenya		Ecuador	Poland	Netherlands
Morocco		Egypt, Arab Rep.	South Africa	Portugal
Mozambique		El Salvador	Thailand	Qatar
Nicaragua		Georgia	Turkiye	Singapore
Pakistan		Hungary	Uruguay	Spain
Philippines		Latvia		Sweden
Rwanda		Lebanon		Switzerland
Senegal		Malaysia		United Arab Emirates
Total: 22 countries		**Total: 31 countries**		**Total: 17 countries**

Note: Our panel of 70 countries is classified with respect to their income level based on the estimated per capita GDP threshold values.

Table 6. Estimation by group of countries with respect to income level

	Dependent variable: Change in CO_2 emissions		
	(1)	(2)	(3)
	Low-income countries	Middle-income countries	High-income countries
	$GDP_{it} \leq 3{,}340\$$	$3{,}340\$ < GDP_{it} \leq 15{,}033\$$	$GDP_{it} > 15{,}033\$$
Income growth	1.135	0.890***	-0.756***
	(0.320)	(0.232)	(0.540)
Financial Inclusion	0.013*	0.040**	-0.029***
	(0.008)	(0.018)	(0.013)
Energy use	0.859***	0.727***	0.592***
	(0.157)	(0.051)	(0.074)
Trade openness	-0.0001	-0.0005**	-0.0017**
	(0.0004)	(0.000)	(0.0007)
FDI inflows	0.0014	-0.0005	0.0003
	(0.0023)	(0.0007)	(0.0004)
ICT	-0.012	-0.013*	-0.048**
	(0.021)	(0.007)	(0.023)
Governance	0.016	-0.046*	-0.023**
	(0.027)	(0.026)	(0.012)
Observations	198	279	153
Adjusted R-squared	0.627	0.668	0.680
J-test	16.676	17.065	17.978
	[0.148]	[0.175]	[0.181]

Note: Column (1) represents estimation results for the group of countries with $GDP_{it} \leq 3{,}340\$$; Column (2) for the group with $3{,}340\$ < GDP_{it} \leq 15{,}033\$$; and Column (3) for the group with $GDP_{it} > 15{,}033$. Standard errors are displayed in parentheses. . J-test stands for the validity of the overidentifying moment conditions with p-values in square brackets. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Finally, we check the robustness of the moderating role of income level in the inclusiveness-emissions nexus using a split-sample approach. As a robustness check, Abdul Karim et al. (2022) proposed to divide their sample of 60 countries into two categories, less developed and emerging economies, to ensure the positive effect of financial inclusion on economic growth. The authors confirmed that the relationship varies across the group of countries, e.g. the effect on economic growth is more pronounced for countries with lower levels of access to finance. In our empirical exercise, we proceed by splitting our panel of 70 countries into three different groups with respect to the identified income threshold levels: $(\hat{\gamma}_1; \hat{\gamma}_2) = (8.11; 9.61)$. Then, low, middle, and high-income groups are defined as consisting of countries having more than half of the observations of their GDP per capita less than 3,340$, between 3,340$ and 15,033$ and more than 15,033$, respectively.[12] We reestimated the impact

[12] It is possible to rather classify countries with respect to the average of their annual GDP per capita over 2010-2019. This does not alter the outcome that financial inclusion impacts differently CO2 emissions depending on the level of income.

of financial inclusion separately for each identified cohort. The classification of countries with respect to their income level is given in Table 5.

It is worth noting that for high-income group threshold-based classification is slightly different from the World Bank region classification. For instance, Croatia, Hungary, and Latvia are listed as a middle-income instead of a high-income country. Regarding the estimation results, Table 6 confirms that the existence of threshold effect with respect to income level is still robust. Contrary to low- and middle-income groups, widening financial coverage contributes to mitigate GHG emissions in high-income countries. For lower-income countries, individuals are more concerned with improving their standard of living, so any improvement in access to financial services will lead to more consumption and greater pollutant emissions. However, beyond a certain level of income, financial inclusion can help individual to shift towards more eco-friendly consumption habits. Sounder environmental policies are needed for less developed countries to align financial inclusion initiatives with sustainable economic development. Despite the current global financial flows to support mitigation and adaptation actions, including from public and private finance sources, are insufficient especially in less developed countries (IPCC, 2023).[13] Environmental degradation, in turn, can damage economic growth and reduce the availability of affordable financial products, further exacerbating the financial constraints on supporting climate action. Accelerating financial support to developing countries is critical to the adoption of low-carbon energy sources and to tackling climate change.

5. Conclusion

In this paper, we have explored whether promoting financial inclusion would impact CO_2 emissions in a sample of 70 countries over the period 2010-2019. Panel threshold techniques have been applied to capture the possible regime shift in the relationship between financial access and environmental quality. Threshold effect tests indicate that the level of income has a significant moderating role which is more apparent compared to other factors, such as ICT and governance quality. Our results reveal that the financial inclusion impacts air pollution depending on the level of economic development in line with the environmental Kuznets curve. While the financial inclusion would increase CO_2 emissions in lower-income regimes, the

[13] Mobilised financial flows from developed to developing countries fell short of the Paris Agreement's target of USD 100 billion per year.

environment quality seems to be enhanced with more inclusiveness at later stages of development.

For lower-income countries, individuals are more concerned with improving their standard of living, so any improvement in access to financial services will lead to more consumption and greater pollutant emissions. However, beyond a certain level of income, financial inclusion can help individual to shift towards more eco-friendly consumption habits. Also, with the improvement of living standards, financial inclusion would allow for access to new investment opportunities, such as environmentally responsible ones. Sounder environmental policies are needed for less developed countries to align financial inclusion initiatives with sustainable economic development. However, despite increased awareness of climate risk, current financial support falls short of what is needed for climate adaptation and to meet mitigation targets. The energy transition is lagging behind in most developing countries, as public and private financial flows for fossil fuels are still higher than for renewables. Greater international financial cooperation and coordinated multilateral action are needed to accelerate the transition to renewable energy and reduce GHG emissions. Improved access to adequate financial resources, especially for vulnerable developing regions, is critical to achieving sustainable and climate-resilient development.

References

Abdul Karim, Z., Nizam, R., Law, S.H., Hassan, M.K. (2022). Does Financial Inclusiveness Affect Economic Growth? New Evidence Using a Dynamic Panel Threshold Regression. Finance Research Letters 46, 102364.

Ahamed, M.M., Mallick, S.K., 2019. Is financial inclusion good for bank stability? International evidence. J. Econ. Behav. Organ. 157, Pages 403-427.

Amponsah, M., F. W. Agbola, A. Mahmood. (2021). The impact of informality on inclusive growth in Sub-Saharan Africa: Does financial inclusion matter? Journal of Policy Modeling. DOI: 10.1016/j.jpolmod.2021.03.009.

Andrianaivo, M. and Kpodar, K. 2011. ICT, Financial Inclusion, and Growth: Evidence from African Countries. IMF Working Paper No. 2011/073 (Washington: International Monetary Fund).

Arcand, J. L. E. Berkes and U. Panizza (2015), Too much finance. Journal of Economic Growth 20, 105–148.

Arouri, M.H., Ben Youssef, A., M'henni, H., Rault, C., (2012). Energy consumption, economic growth and CO_2 emissions in Middle East and North African countries. Energy Policy. 45, 342–349.

Asongu, S., Le Roux, S., Biekpe, N. (2018). Enhancing ICT for environmental sustainability in sub-Saharan Africa, Technological Forecasting and Social Change 127, 209-216.

Badeeb, R. A., Wang, B., Zhao, J., Khan, Z., Uktamov, K. F., Zhang, C. 2023. Natural resources extraction and financial inclusion: Linear and non-linear effect of natural resources on financial sector, Resources Policy, Volume 85, Part A, 103826.

Beck, T., Tao, C., Chen, L., & Frank, M. S. (2016). Financial innovation: The bright and the dark sides. Journal of Banking & Finance, 72(11), 28–51.

Ben Lahouel, B., Taleb, L., Ben Zaied, Y., Managi, S. (2021). Does ICT change the relationship between total factor productivity and CO2 emissions? Evidence based on a nonlinear model, Energy Economics 101, 2021, 105406.

Ben Cheikh, N., Ben Zaied, Y., Chevallier, J. (2021) On the nonlinear relationship between energy use and CO_2 emissions within an EKC framework: Evidence from panel smooth transition regression in the MENA region. Res Int Bus Finance 55, January 2021, 101331.

Ben Cheikh, N., Ben Zaied, Y. (2021). A new look at carbon dioxide emissions in MENA countries. Climatic Change 166, 27.

Ben Cheikh, N., Ben Zaied, Y. 2023. Renewable energy deployment and geopolitical conflicts, Journal of Environmental Management, Volume 344, 118561.

Ben Cheikh, N., Ben Zaied, Y. 2024. Does geopolitical uncertainty matter for the diffusion of clean energy? Energy Economics, Volume 132, 107453.

Ben Cheikh, N., Ben Zaied, Y., Nguyen, D. K. 2023. Understanding energy poverty drivers in Europe, Energy Policy, Volume 183, 113818.

Bimonte. S., Stabile, A., 2017. Land consumption and income in Italy: a case of inverted EKC. Ecological Economics. 131, 36–43.

Breitung, J., and S. Das. 2005. Panel unit root tests under cross-sectional dependence. Statistica Neerlandica 59: 414–433.

Cai, X. Wei, C. 2023. Does financial inclusion and renewable energy impede environmental quality: Empirical evidence from BRI countries, Renewable Energy, Volume 209, Pages 481-490.

Cao, G-H., J. Zhang 2020. The entrepreneurial ecosystem of inclusive finance and entrepreneurship: A theoretical and empirical test in China. International Journal of Finance & Economics. DOI: 10.1002/ijfe.2230.

Cecchetti, S.G., Kharroubi, E., 2012. Reassessing the impact of finance on growth. Bank of International Settlements Working Paper No. 381.

Chatterjee, A. 2020. Financial inclusion, information and communication technology diffusion, and economic growth: a panel data analysis. Information Technology for Development, 26:3, 607-635.

Chudik, A., K. Mohaddes, M. H. Pesaran, and M. Raissi. 2016. Long-Run Effects in Large Heterogeneous Panel Data Models with Cross-Sectionally Correlated Errors Essays in Honor of Aman Ullah. 85-135.

Daud, S. T. M., Ahmad, A. H. 2023. Financial inclusion, economic growth and the role of digital technology, Finance Research Letters, Volume 53, 103602.

Deidda, L., Fattouh, B., 2002. Non-linearity between finance and growth. Economics Letters 74 (3), 339–345

Demirgüç-Kunt, A., Leora, K., & Dorothe, S. (2017). Financial inclusion and inclusive growth. A review of recent empirical evidence. World Bank Group Policy Research Working Paper, no. WPS8040.

Demirgüç-Kunt, A., Klapper, L., Singer, D., Ansar, S.. 2022. The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19. Washington, DC: World Bank.

Emara, N., A. El Said, (2021). Financial inclusion and economic growth: The role of governance in selected MENA countries. International Review of Economics and Finance 75: 34–54.

Fareed, Z., Rehman, M. A., Adebayo, T. S., Wang, Y., Ahmad, M., Shahzad, F. 2022. Financial inclusion and the environmental deterioration in Eurozone: The moderating role of innovation activity, Technology in Society, Volume 69, 101961.

Financial Access Survey. 2023. Trends and Developments. IMF's Statistics Department, Washington, DC.

Hansen BE (1999) Threshold effects in non-dynamic panels: Estimation, testing, and inference. J Econom 93:345–368.

Huang, H.C., Lin, S.C., 2009. Non-linear finance-growth nexus. Economics of Transition 17 (3), 439–466.

Hung, F.S., 2009. Explaining the nonlinear effects of financial development on economic growth. Journal of Economics 97 (1), 41–65.

IPCC, 2023. Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 1-34, doi: 10.59327/IPCC/AR6-9789291691647.001

Kaufmann, D. Kraay, A., Mastruzzi, M., (2010). The Worldwide Governance Indicators : Methodology and Analytical Issues. Policy Research working paper ; no. WPS 5430. World Bank.

Kebede, J., Naranpanawa, A., Selvanathan, S., 2021. Financial inclusion: measures and applications to Africa. Econ. Anal. Pol. 70, 365–379.

Khan, K., Luo, T., Ullah, S., Rasheed, H. M. W., Li, P-H. 2023. Does digital financial inclusion affect CO2 emissions? Evidence from 76 emerging markets and developing economies (EMDE's), Journal of Cleaner Production, Volume 420, 138313.

Kim, D.W., Yu, J.S., Hassan, M.K., 2018. Financial inclusion and economic growth in OIC countries. Research in International Business and Finance 43, 1–14.

Kremer, S., Bick, A., Nautz D. 2013. Inflation and Growth: New Evidence from a Dynamic Panel Threshold Analysis, Empirical Economics 44, 861-878.

Law, S.H., Azman-Saini, W.N.W., Ibrahim, M.H., 2013. Institutional quality thresholds and the finance - Growth nexus. Journal of Banking and Finance 37 (12), 5373–5381.

Law, S. H., & Singh, N. (2014). Does too much finance harm economic growth? Journal of Banking & Finance, 41(4),36–44.

Le, T.H., Le, H.C., Farhad, T.H., 2020. Does financial inclusion impact CO2 emissions? Evidence from Asia. Finance Research Letters 34, May 2020, 101451.

Machado, J., Silva, S. (2019). Quantiles via moments, Journal of Econometrics, Volume 213, Issue 1, 2019, Pages 145-173.

Nizam, R., Abdul Karim, Z., Sarmidi, T., Abdul Rahman, A. (2021). Financial inclusion and firm growth in asean-5 countries: a new evidence using threshold regression. Finance Research Letters 41 (2021) 101861.

Ozturk, I., Ullah, S., 2022. Does digital financial inclusion matter for economic growth and environmental sustainability in OBRI economies? An empirical analysis. Resources, Conservation and Recycling 185, 106489.

Pradhan, R., Arvin, M., Nair, M., Hall, J. Bennett, S. (2021). Sustainable economic development in India: The dynamics between financial inclusion, ICT development, and economic growth. Technological Forecasting & Social Change 169, 120758.

Renzhia, N., Baek. Y-J. (2020). Can financial inclusion be an effective mitigation measure? evidence from panel data analysis of the environmental Kuznets curve. Finance Research Letters 37, November 2020, 101725.

Rioja, F., Valev, N. 2004. Finance and the sources of growth at various stages of economic development. Economic Inquiry 42, 127–140.

Seo, M. H., and Y. Shin. 2016. Dynamic panels with threshold effect and endogeneity. Journal of Econometrics 195: 169–186.

Shahbaz, M., Li, J., Dong, X., Dong, K. (2022). How financial inclusion affects the collaborative reduction of pollutant and carbon emissions: The case of China. Energy Economics 107, March 2022, 105847.

Usman, A., Ozturk, I., Ullah, S., Hassan, A. (2021). Does ICT have symmetric or asymmetric effects on CO2 emissions? Evidence from selected Asian economies, Technology in Society 67, 2021,101692.

Wang, X., Wang, X., Ren, X., Wen, F. 2022. Can digital financial inclusion affect CO2 emissions of China at the prefecture level? Evidence from a spatial econometric approach, Energy Economics, Volume 109, 105966.

Wang, W., Ning, Z., Shu, Y., Riti, M-K. J., Riti, J. S. 2023. ICT interaction with trade, FDI and financial inclusion on inclusive growth in top African nations ranked by ICT development, Telecommunications Policy, Volume 47, Issue 4, 102490.

Yang, H., He, J., Chen, S., 2015. The fragility of the Environmental Kuznets Curve: Revisiting the hypothesis with Chinese data via an "Extreme Bound Analysis". Ecological Economics. 109, 41–58.

Zaidi, S.A., Hussain, M., Zaman, Q.U. (2021). Dynamic linkages between financial inclusion and carbon emissions: Evidence from selected OECD countries. Resources, Environment and Sustainability 4, June 2021, 100022.

Zeqiraj, V., Sohag, K., Hammoudeh, S. (2022). Financial inclusion in developing countries: Do quality institutions matter? J. Int. Financ. Markets Inst. Money 81 (2022) 101677.

Appendix

Table A1. Data description

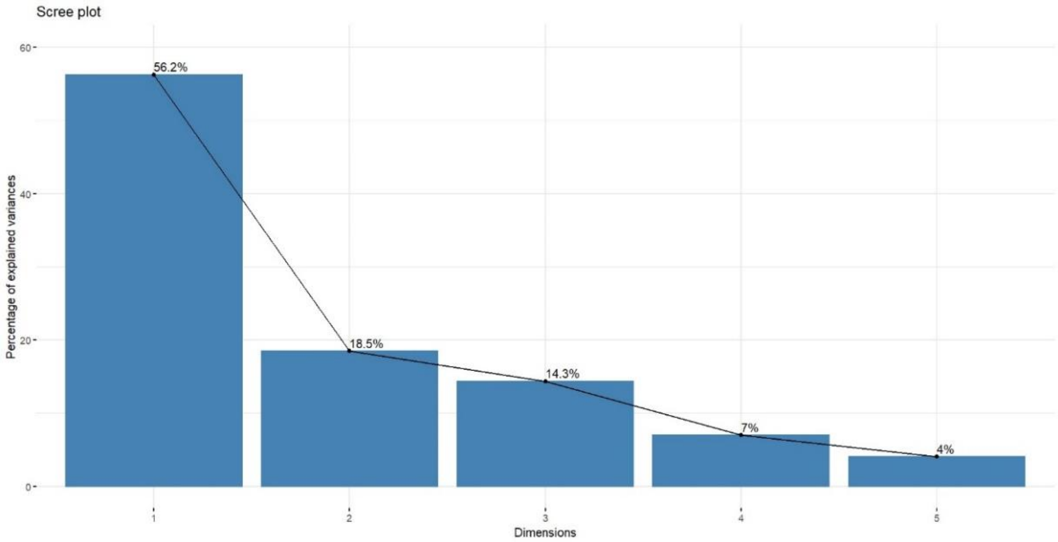
Variable	Measurement	Source
CO_2 emissions	CO_2 emissions (metric tons per capita)	International Energy Agency (IEA) Statistics.
Financial inclusion	ATMs per 100,000 adults	Financial Access Survey (FAS), International Monetary Fund (IMF)
	Bank accounts per 1,000 adults	Financial Access Survey (FAS), International Monetary Fund (IMF)
	Bank branches per 100,000 adults	Financial Access Survey (FAS), International Monetary Fund (IMF)
	Outstanding deposits with commercial banks (% of GDP)	Financial Access Survey (FAS), International Monetary Fund (IMF)
	Outstanding loans from commercial banks (% of GDP)	Financial Access Survey (FAS), International Monetary Fund (IMF)
Real GDP per capita	GDP per capita (constant 2015 US$)	World Development Indicators (WDI), The World Bank.
Energy intensity	Ratio of energy supply to GDP (MJ/$2017 PPP GDP)	International Energy Agency (IEA) Statistics.
Trade openness	Sum of exports and imports (% of GDP)	World Development Indicators (WDI), The World Bank.
FDI	Foreign direct investment, net inflows (% of GDP)	International Financial Statistics, International Monetary Fund.
ICT infrastructure	Individuals using the Internet (% of population)	The World Telecommunication/ICT Indicators Database
	Fixed telephone subscriptions (per 100 people)	The World Telecommunication/ICT Indicators Database
	Mobile cellular subscriptions (per 100 people)	The World Telecommunication/ICT Indicators Database
Governance	Government Effectiveness	Worldwide Governance Indicators (WGI), The World Bank.
	Control of Corruption	Worldwide Governance Indicators (WGI), The World Bank.
	Political Stability and Absence of Violence/Terrorism	Worldwide Governance Indicators (WGI), The World Bank.
	Regulatory Quality	Worldwide Governance Indicators (WGI), The World Bank.
	Rule of Law	Worldwide Governance Indicators (WGI), The World Bank.
	Voice and Accountability	Worldwide Governance Indicators (WGI), The World Bank.

Table A2. The sample of 70 countries based on the World Bank region classification.

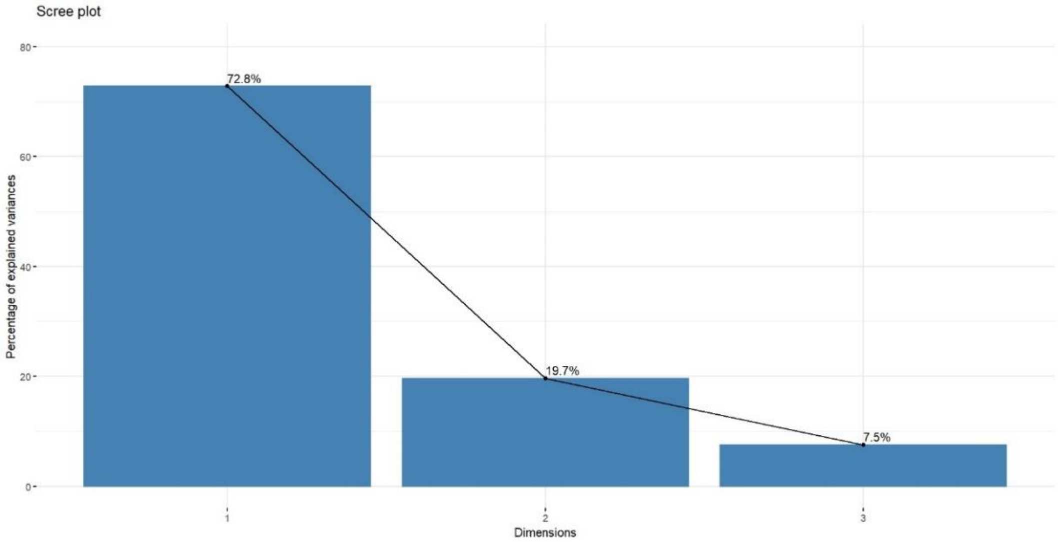
Geographic region	Country	Geographic region	Country	Geographic region	Country	Geographic region	Country
East Asia and Pacific	Indonesia	*High income (continued)*	Greece	*Latin America and the Caribbean*	Argentina	*South Asia*	Bangladesh
	Malaysia		Hungary		Bolivia		Bhutan
	Mongolia		Ireland		Chile		India
	Philippines		Italy		Colombia		Pakistan
	Thailand		Japan		Costa Rica	*Sub-Saharan Africa*	Cameroon
	Armenia		Korea, Rep.		El Salvador		Gambia
Europe and Central Asia	Bosnia		Latvia		Honduras		Ghana
	Bulgaria		Malta		Mexico		Kenya
	Georgia		Netherlands		Nicaragua		Mauritius
	Montenegro		Poland		Panama		Mozambique
	North Macedonia		Portugal		Paraguay		Namibia
	Turkiye		Qatar		Peru		Rwanda
	Ukraine		Saudi Arabia	*Middle East and North Africa*	Algeria		Senegal
	Uzbekistan		Singapore		Egypt, Arab Rep.		South Africa
High income	Austria		Spain		Jordan		Togo
	Belgium		Sweden		Lebanon		Uganda
	Croatia		Switzerland		Morocco		Zambia
	Estonia		United Arab Emirates				

Note: The country classification here is based on regions, except for the "high-income" group, which includes rich countries from different regions.

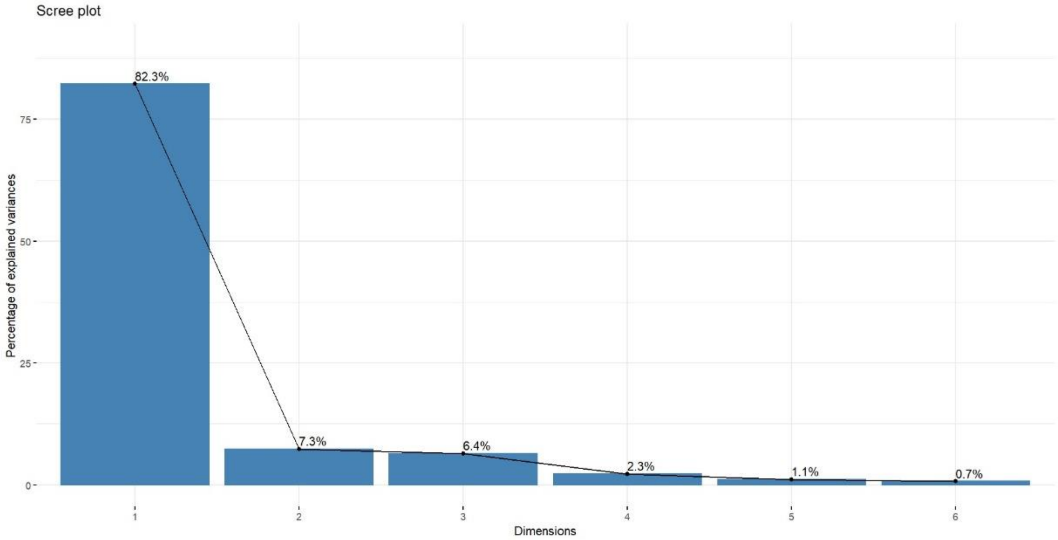
Figure A1. The scree plot for the extracted principal components



(a) Financial inclusion indicators



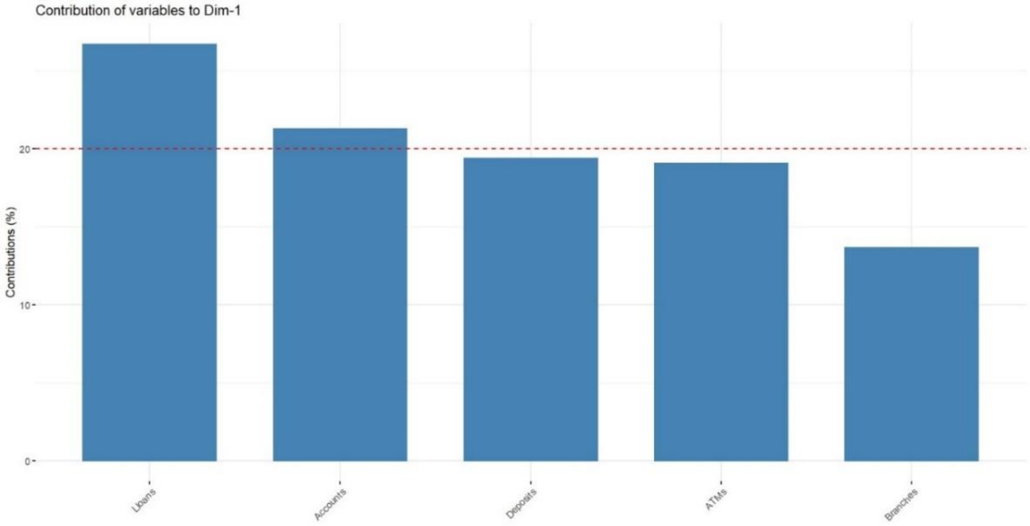
(b) ICT indicators



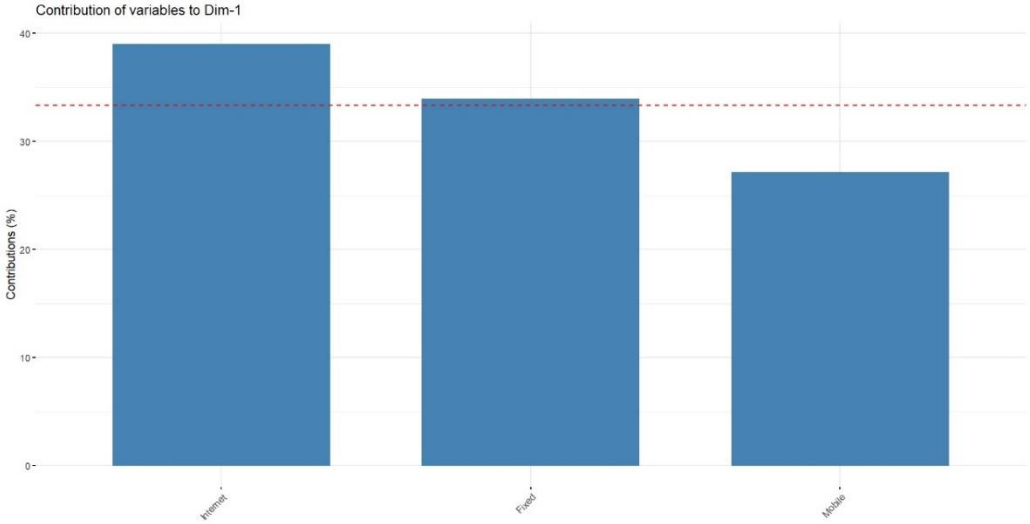
(c) Governance indicators

Notes: The scree plot above shows the proportion of variances (i.e., information) retained by each principal component.

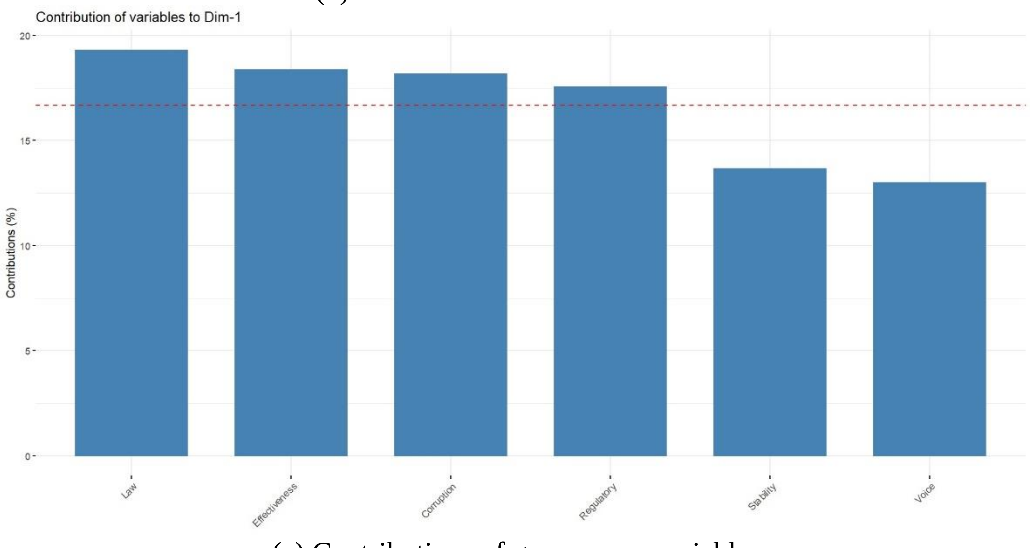
Figure A2. Bar plot for variable contributions in the first principal component



(a) Contributions of financial inclusion variables



(b) Contributions of ICT variables



(c) Contributions of governance variables

Note: The contributions of variables in accounting for the variability in a given principal component are expressed in percentage. The red dashed line on the graph above indicates the expected average contribution. For a given component, a variable with a contribution larger than this cutoff could be considered as important in contributing to the component.