


# The Impact of Financial Development, Renewable Energy Consumption, and Information and Communication Technology-oriented Strategies on Inclusive Growth of Asian Economies

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## ABSTRACT

This study aims to accentuate the role of financial development, renewable energy consumption, and information and communication technology (ICT)-oriented strategies to achieve inclusive growth in 21 Asian economies from 1995-2019. The long-run findings of panel linear ARDL reveal positive but insignificant responses in inclusive growth to financial development. Whereas, the estimates of panel NARDL depict that financial development positive and negative movements boost inclusive growth significantly. Interestingly, both techniques provide significant but contradictory outcomes for the effects of renewable energy on inclusive growth. Moreover, the results confirm that the individual impact of financial development and ICT increases but their interaction decreases inclusive growth. It indicates that ICT fails to complement the financial sector in enhancing inclusive growth. Therefore, the study recommends improving ICT infrastructure through the appropriate investment so that it could complement the financial sector effectively to achieve inclusive growth. It implicates for the stakeholders to boost the efficiency of the financial intermediaries and equitable access to digital finance and clean energy to attain inclusive growth.

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## INTRODUCTION

Inclusive growth is creating opportunities for every citizen and sharing the prosperity benefits equally across society (Organisation for Economic Co-operation and Development, 2013). The concept of inclusive growth had special recognition in late 2000 because it was when most world economies were rising economically and experiencing inequality (Prasanna, 2016). Therefore, World Bank established a sustainable and inclusive growth paradigm by assimilating economic growth with poverty and inequality. Extensive theoretical and empirical literature proves that “economic growth is necessary but not a sufficient condition for development, because the growth has an inbuilt process of creative destruction which can create poverty” (Schumpeter, 1934). Economic growth is often seen as a positive thing because it provides health, education and employment opportunities to people and reduces poverty. However, economic growth alone is insufficient to ensure development due to the process of creative destruction. Creative destruction refers to the idea that innovations and new technologies often replace the older ones, leading to job loss and structural change in an economy. But at the same creates new jobs and employment opportunities for others by leaving some segments of society behind and creating poverty. Thus, economic growth may generate winners and losers. These facts provide the basis for a shift in policy debate from economic growth to inclusive growth (Asongu & Nwachukwu, 2016). Therefore, most economists believe that inclusive growth can better explain the economic development process than economic growth alone (Gyamfi et al., 2019). Inclusive growth ensures the equality of opportunities, contribution to the economic growth procedure and sharing of growth doles by all (United Nations Development Programme, 2015).

The SDGs highlighted financial development, clean energy and ICT as potential drivers for inclusive growth since 2015. Financial development means developing size, access, and efficiency of financial markets. If a sizeable financial sector lacks access to its services to the majority of the population then it remains unable to sustain economic growth and welfare. Financial development indirectly alleviates poverty by increasing the level of per capita income. Access to the financial system improves the incomes of marginalized people, reduces poverty, and guarantees inclusive growth. But the relationship between FD and economic growth is not straight. It means that FD has the ability to increase and decrease economic growth at different phases of development. This is the reason that previous studies either found a U-shaped or inverted U-shaped association between finance-growth linkages.

The provision of clean and affordable energy is crucial to attain sustainable growth and mitigate greenhouse gases. The SDGs integrate the provision

of financial services to developing countries to adopt clean energy and digitalization. But the situation related to energy availability and sustainability is relatively complicated in less and middle-income economies rather than in high-income economies. Apart from reducing pollution, renewable energy has many societal implications due to heavy investments. The developing economies have severe energy and finance shortage and serious concerns regarding energy infrastructure and technical skills (Murshed, 2018). As a result, it's challenging to make it a significant factor of inclusive growth.

Information and communication technologies have become essential for economic and societal activities all over the globe for two decades. Therefore, ICT has become indispensable for the realization of inclusive growth (Habibi & Zabardast, 2020). ICT contributes to the growth process in developing economies by promoting greater demand and investment through efficient resource allocation, reducing communication and production costs in all sectors (Grimes et al., 2012; Lee et al., 2012; Pradhan et al., 2015). ICT affects inclusive growth by improving health, education, the standard of living, financial markets and institutions (Adeleye et al., 2020). Wider access to the internet and smartphones increases financial inclusion which is crucial for economic and sustainability (Shamim, 2007). ICT applications have facilitated the distance learning process, significantly contributing to all economic sectors. Therefore, ICT has a direct as well as indirect impact on inclusive growth. However, current literature on the joint influence of ICT and FD towards the attainment of inclusive growth also shows indefinite and mixed findings.

The prime purpose of current research is to liaise FD, REC, and ICT with inclusive growth to explore the accomplishment of sustainable development goal 8 and allied targets<sup>1</sup> in Asia. Asia's swift economic growth is accompanied by a significant decrease in poverty and an increase in inequality. Economic growth is not very much inclusive here due to uneven growth process, uneven demand of skilled and non-skilled labour and, unequal access to opportunities. The financial sector is still underdeveloped in Asia (Estrada et al., 2022). But Asia is still a potential market for renewable energy sources and ICT penetration. According to International Renewable Energy Agency (2018) report, in 2017, Asia had four-fifths of all renewable energy jobs. Policymakers and environmentalists are trying to promote financial, energy and ICT sectors to achieve inclusive development in Asia for the last two decades (Pradhan et al., 2015).

It contributes by discovering the major determinants and their relevance in inclusive growth from linear and nonlinear perspectives in Asia. Additionally, the complementary role of ICT for financial development to attain inclusive

<sup>1</sup> Goal 7: Provision of clean energy to everyone.

growth will also be analyzed. Previous research laid stress on exploring the effects of financial expansion on economic growth rather than inclusive growth by using variables measuring either financial access, efficiency, or depth individually. This study focuses on inclusive growth and uses the newest and comprehensive measures of the multidimensional inclusiveness index (MDI) and financial development index (FDI) for inclusive growth and financial development, respectively. ICT access and its impact on inclusive growth vary a lot across regions but the existing literature does not provide much information about finance-ICT-inclusive growth linkages in Asia. Therefore, it is needed to scrutinize the direct and indirect impact of ICT for financial development to achieve inclusive growth to fill the gaps in previous literature. Asia has been selected for this study due to its rapid economic growth in the last decade. It caters to more than 60% of the world's populace and Asian economies are trying hard to achieve SDGs.

## LITERATURE REVIEW

### Financial development and inclusive growth

A positive and crucial linkage could be established between financial development and economic growth through appropriate resource allocation and reduced asymmetric information (Schumpeter, 1934). Financial institutions cause economic growth through the mobility of funds towards profitable businesses, dissemination of knowledge, risk management, and the monitoring of investments (Kassi et al., 2020). The degree and direction of financial development on growth are based on the financial sector's inclusion, stability and efficiency of different countries (Gyamfi et al., 2019). Aoyagi and Ganelli (2015) focused on the importance of fiscal and monetary measures for economic, financial and inclusive growth in Asia. Sarabdeen et al. (2020) found that a large financial sector significantly reduces the inclusiveness in growth in the case of the Gulf region due to a lack of gender diversity in the labour force. They emphasized that female labour force participation is a prerequisite for adding inclusiveness to growth. The financial expansion and economic growth do not have cause-and-effect relation in the case of BRICS and emerging economies (Akbas, 2015; Guptha & Rao, 2018).

Many studies discovered a bi-directional causal association between the growth-finance nexus which elaborated that financial development nurtures economic growth through efficient capital allocation, promoting investment, and facilitating technological evolution (Al-Yousif, 2002; Calderón & Liu, 2003; Marques et al., 2013). At the same time, economic growth contributes to financial development by enhancing the demand for financial services and expanding the

size of financial institutions and markets. While [Odhiambo \(2008\)](#) confirmed one-way causality between the two in the case of Kenya. The findings showed that the efficient formal financial sector plays a significant role in boosting economic growth. [Adu et al. \(2013\)](#) highlighted the importance of the financial sector for economic growth, but they were unable to establish whether financial expansion is the cause or effect of economic growth. On the contrary, [Law and Singh \(2014\)](#) witnessed the negative impact of financial expansion on the growth process. Thus, the inconclusive finance-growth linkage in the past literature motivates the current research to focus on exploring the influence of financial development on inclusive growth rather than just economic growth.

*H1: Financial development has a significant linear and nonlinear relationship with inclusive growth.*

### Renewable energy consumption and Inclusive growth

It is empirically proved that renewable energy use significantly raises the inclusive growth of developing economies by creating employment opportunities with heavy investment projects ([Kouton, 2021](#); [Schwerhoff & Sy, 2017](#)). Affordable and clean energy reduces the heavy import bills of developing nations thus improving the per capita income. [Liu et al. \(2020\)](#) also advocated the contribution of renewable energy consumption towards the real output of BRICS and emphasized that renewable energy is the best policy to promote sustainable economic growth and reduce pollution. On the contrary, clean energy adversely affects economic growth in Nigeria ([Maji, 2015](#)) while there are mixed results identified on the relationship between the two in the study of [Bhattacharya et al. \(2016\)](#). The insignificant impact of renewable energy on economic growth is found in those countries that do not use renewable energy sufficiently and effectively. Thus, it is needed to re-examine the effect of renewable energy on inclusive growth.

*H2: Renewable energy consumption is positively associated with inclusive growth.*

### ICT and Inclusive growth

Digitalization affects economic growth through direct as well as indirect channels but the existing literature is still inconclusive due to the mixed effects of different channels and forms of technology. [Asongu and Roux \(2017\)](#) established a positive effect of ICT in the form of smartphone penetration on inclusive development in the case of developing countries. The findings of [Appiah-Otoo and Song \(2021\)](#) revealed that digitization posits a significant and positive effect on the economic growth of rich and poor economies in the transitional

period from 2002 to 2017. Digital technologies promote economic and social development by reducing business costs and enhancing the proficiency and output of firms (Bon et al., 2016; Kurniawati, 2020). Salahuddin and Gow (2016), and Alam et al. (2019) also justified that reasonable investment in ICT infrastructure enhanced the level of economic growth. They gave much importance to the role of ICT as an enabler for economic and social development. Conversely, Adeleye et al. (2020) found mixed results of internet technology on inclusive growth in different economies. The reason behind these mixed results is the undeveloped level of ICT access and expertise.

*H3: ICT- oriented strategies enhance inclusive growth.*

### Financial development, ICT and Inclusive growth

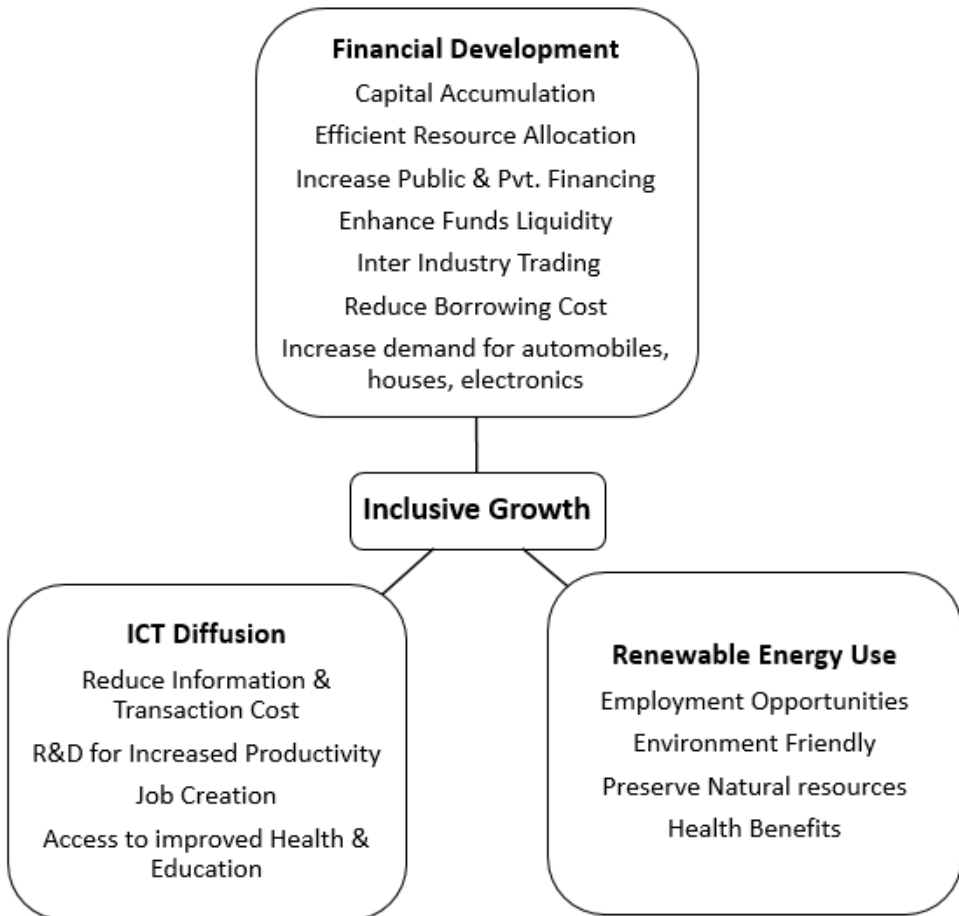
Sufficient literature has established a new wave of theoretical and empirical research on the pervasive role-played by ICT, particularly for financial intermediaries, output and productivity growth. The latest trends of digitization may exert upward pressure on inclusive growth by reducing income and non-income inequalities. Sassi and Goaid (2013) established a negative association of financial up gradation with growth while a positive impact of ICT on economic growth in MENA countries. But the estimated combined impact of finance-ICT on economic growth remained positive. Financial development reduces inequality and poverty but the combined effect of ICT and financial development is not favourable to attaining inclusive growth in developed countries (Alimi & Adediran, 2020; Chatterjee, 2020; Evangelista et al., 2014). On the contrary, ICT adoption upgraded the financial sector and opened new avenues of inclusive development for developing economies (Jin & Zedtwitz, 2008; Mishra & Bisht, 2013). The comparative study of Habibi and Zabardast (2020) confirmed that ICT-led financial and economic well-being proved beneficial for obtaining economic growth in both high and low-income economies.

The adoption of ICT in the form of internet access, fixed landline and smart technology does not play any significant role in financial development in achieving inclusive growth due to the non-availability issues (Abeka et al., 2021; Cao et al., 2021; Ejemeyowwi & Osabuohien, 2018). Das et al. (2016) found a positively significant joint impact of finance-ICT on the growth of poor countries while it is insignificant for high-income countries. It does not imply that ICT is unimportant for high-income nations. The insignificance on the part of ICT to complement the financial sector refers to the phenomena of saturation effect or ICT maturity. The ICT maturity or saturation effect suggests that rich countries already have higher ICT adoption rates and modern infrastructure. The additional use of ICT may result in diminishing marginal return in terms of

economic growth. Thus, the complementary effect of ICT for financial expansion to achieve inclusive growth is still debatable.

*H4: Internet technology complements FD positively and significantly to attain inclusive growth.*

Based on the literature review, the conceptual model of the study is constructed based on possible channels through which finance-renewable energy-ICT may affect inclusive growth Figure 1.



**Figure 1:** *Conceptual model*

## METHODOLOGY

The empirical investigation is performed by using the annual panel data for 21 Asian countries<sup>2</sup> over the period 1995 to 2019. The countries and time span are based on the availability of data. All the selected variables are transformed into the natural log form. The description of variables and their proxies are described as follows:

IG is the dependent variable of the study and is measured through a novel and comprehensive multidimensional inclusiveness index (MDI). MDI covers the sub-indices of development equity<sup>3</sup> and development achievements<sup>4</sup>. The data for MDI is obtained from the work of [Dörffel and Schuhmann \(2022\)](#). Financial development (FD) is the first explanatory variable of the study for which the newest financial development index of the International monetary fund (IMF database, 2021) is used as a proxy by pursuing the work of [Odugbesan et al. \(2021\)](#); [Ofori and Asongu \(2021\)](#); [Svirydzenka \(2016\)](#). This index covers the overall development of financial intermediaries in a single digit with respect to their depth, access and efficiency by using twenty sub-indices. The second explanatory variable of the study includes renewable energy consumption (REC) which is a percentage of total final energy consumption. The third explanatory variable of the study is ICT for which internet subscribers (percentage of population) are used as a proxy ([Abeka et al., 2021](#)). An interaction term FDxICT is included in the model to explore the complementary role of ICT for financial development to achieve inclusive growth ([Cao et al., 2021](#); [Cheng et al., 2021](#); [Kumari & Singh, 2022](#)). The internet has played a crucial role in complementing financial development by increasing access, efficiency, transparency, and security in financial transactions and services. Labour force participation (LAB) and trade openness (TO) are the control variables of the study. LAB and TO are measured through the percentage of the total population ages between 15-64 and exports and imports, as a percentage of GDP, respectively. The data is obtained from the World Bank database's World Development Indicators ([The World Bank, 2021](#)).

The dynamic linkages among FD, REC, ICT and IG will be explored through an augmented neo-classical equation<sup>5</sup> ([Chatterjee, 2020](#); [Das et al., 2016](#))

<sup>2</sup>Armenia, Bangladesh, Bhutan, China, Hong Kong, India, Indonesia, Iran, Israel, Japan, Korea, Malaysia, Nepal, Philippines, Pakistan, Saudi Arabia, Singapore, Sri Lanka, Thailand, United Arab Emirates and Vietnam.

<sup>3</sup>GINI income is used to measure development inequality.

<sup>4</sup>Per capita GDP, savings, life expectancy and human capital are used to measure development achievements.

<sup>5</sup>The impact of labour, capital and technological innovation (renewable energy and ICT) will be analyzed for inclusive growth.



$$IG_{i,t} = \alpha_{i,t} + \beta_1 FD_{i,t} + \beta_2 REC_{i,t} + \beta_3 ICT_{i,t} + \beta_4 FD \times ICT_{i,t} + \beta_5 LAB_{i,t} + \beta_6 TO_{i,t} + \varepsilon_{i,t} \quad (1)$$

### Panel ARDL Model

Following [Qamruzzaman and Jianguo \(2020\)](#); [Sarabdeen et al. \(2020\)](#), the linear impact of selected independent variables on dependent variables will be explored by applying the panel ARDL approach ([Pesaran et al., 1999](#)).

Linear ARDL is an efficient econometric technique in case of endogeneity, serial correlation, and variable's mixed order of integration. After inserting the short-run dynamics and lagged error correction term, Equation (1) can be written as follows:

$$\begin{aligned} \Delta IG_{it} = & \alpha_0 + \sum_{m=1}^n \phi_{1m} \Delta IG_{it-m} + \sum_{m=0}^n \phi_{2m} \Delta FD_{t-m} + \sum_{m=0}^n \phi_{3m} \Delta REC_{t-m} \\ & + \sum_{m=0}^n \phi_{4m} \Delta ICT_{t-m} + \sum_{m=0}^n \phi_{5m} \Delta FD \times ICT_{t-m} + \sum_{m=0}^n \phi_{6m} \Delta LAB_{t-m} \\ & + \sum_{m=0}^n \phi_{7m} \Delta TO_{t-m} + \beta_1 IG_{i,t-1} + \beta_2 FD_{i,t-1} + \beta_3 REC_{i,t-1} + \beta_4 ICT_{i,t-1} + \\ & \beta_5 FD \times ICT_{i,t} \\ & + \beta_6 LAB_{i,t-1} + \beta_7 TO_{i,t-1} + \theta ECT_{i,t-1} + \varepsilon_{i,t} \end{aligned} \quad (2)$$

In Equation (2),  $\Delta$  denotes variables at their first difference,  $\phi_s$  and  $\beta_s$  show short and long-run coefficients respectively while  $\varepsilon$  is a linear disturbance term.  $\theta$  reflects the coefficient of lagged error correction term which must be negative and statistically significant because it is the proof of long-term co-integration between the selected variables.

### Panel NARDL model

NARDL is considered a more intense estimation method compared to linear ARDL because it decomposes the positive and negative movements in the explanatory variables. Therefore, NARDL provides the direction and degree of change in the explained variable due to upward and downward movements in the explanatory variables more efficiently.

Following and extending the work of [Thampanya et al. \(2021\)](#), NARDL is used to explore the responses in inclusive growth due to the increase and decrease in financial development in Asia which is also a robustness check. The NARDL model specifications are as follows:

$$\begin{aligned}
 IG_{i,t} = & \alpha_{i,t} + \beta_1 FD_{i,t}^+ + \beta_2 FD_{i,t}^- + \beta_3 REC_{i,t} + \beta_4 ICT_{i,t} + \\
 & \beta_5 FD \times ICT_{i,t} + \beta_6 LAB_{i,t} + \beta_7 TO_{i,t} + \varepsilon_{i,t}
 \end{aligned}
 \tag{3}$$

In Equation (3), all the definitions are the same as before. Financial development, which is represented as  $FD_{i,t}$ , is decomposed into positive and negative partial sums as follows:

$$FD_0 = FD_t^+ + FD_t^- \tag{4}$$

$$FD_t^+ = \sum_{i=1}^t \Delta FD_i^+ = \sum_{i=1}^t \max(\Delta FD_i, 0) \tag{5}$$

$$FD_t^- = \sum_{i=1}^t \Delta FD_i^- = \sum_{i=1}^t \min(\Delta FD_i, 0) \tag{6}$$

Here,  $FD_t^+$  and  $FD_t^-$  represent the positive and negative changes in financial development, respectively.  $\Delta$  is used for the difference operator,  $\Delta FD_i = FD_t - FD_{t-1}$ . Now, Equation (2) is restructured to insert the decomposed financial development and written as follows:

$$\begin{aligned}
 \Delta IG_{t-j} = & \beta_0 + \sum_{j=1}^k \omega_{1j} \Delta IG_{t-j} + \sum_{j=1}^k \left( \gamma_{2j}^+ \Delta FD_{t-j}^+ + \gamma_{2j}^- \Delta FD_{t-j}^- \right) + \\
 & \sum_{j=1}^k \delta_{3j} \Delta REC_{t-j} \\
 & + \sum_{j=1}^k \psi_{4j} \Delta ICT_{t-j} + \sum_{j=1}^k \varphi_{5j} \Delta FD \times ICT_{t-j} + \sum_{j=1}^k \eta_{6j} \Delta LAB_{t-j} + \\
 & \sum_{j=1}^k \tau_{7j} \Delta TO_{t-j} \\
 & + \beta_1 FD_{i,t}^+ + \beta_2 FD_{i,t}^- + \beta_3 REC_{i,t} + \beta_4 ICT_{i,t} + \beta_5 FD \times ICT_{i,t} + \\
 & \beta_6 LAB_{i,t} + \beta_7 TO_{i,t} \\
 & + \sigma ECT_{i,t-1} + \varepsilon_{i,t}
 \end{aligned}
 \tag{7}$$

Here,  $k$  and  $\sigma$  display the optimal lag length and coefficient of error correction term respectively. The coefficient of  $ECT (-1)$  displays the time to restore the long-term equilibrium due to short-term shock.

## RESULTS

**Table 1.**

CD test

Test	Statistics	Probability
Breusch-Pagan LM	1571.940*	0.000
Pesaran Scaled LM	66.455*	0.000
Pesaran CD	18.083*	0.000

Note: \* denotes significance at 1% level.

Source: Author's calculations.

**Table 2.**

Panel unit root test

Tests	CIPS		CADF	
	I(0)	I(1)	I(0)	I(1)
Variables				
IG	-1.057	-2.568*	1.817	2.162**
FD	-2.539*	—	2.334*	—
REC	-0.891	-4.758*	0.926	3.202*
ICT	-2.572*	—	3.454*	—
LAB	-0.591	-3.320*	1.309	2.696*
TO	-1.680	-3.993*	1.785	3.207*

Note: \* and \*\* denote significance at 1%, and 5% levels respectively.

Source: Author's calculations.

**Table 3.**

Westerlund's co-integration test

Panel	Statistic	Probability
Whole Asia	3.093	0.001

Source: Author's calculations.

## CD Test

The first step in panel data analysis requires identifying whether the cross-sections are independent or dependent on each other. Cross section dependence (CD) test is also essential to choose the suitable unit root test (Akbar et al., 2018; Pesaran, 2004). This research uses three panel CD tests having the same null hypothesis that “cross-sections are independent”. The significant p-values allow us to reject the null hypothesis and conclude that all cross-sections are dependent on each other as shown in Table 1.

## Unit root test

As the cross-sections are dependent on each other, the order of integration of each variable is explored by applying second-generation unit root tests, CIPS and CADF. These tests can handle heterogeneity and cross-sectional dependence more efficiently than the first-generation unit root tests (Pesaran, 2021). The null hypothesis of CIPS and CADF panel unit root tests is that “data series is non-stationary”. Table 2 contains the findings of both tests showing that all the examined variables have a mixed order of integration.

## Co-integration test

In the case of dependence among countries, the conventional co-integration tests provide misleading results. Therefore, this study uses a second-generation panel co-integration test as presented in Table 3 (Westerlund, 2005). The test’s null hypothesis is “no co-integration” between selected variables. The statistically significant probability value allows us to discard the null hypothesis and determine that long-run co-integration exists between the selected variables.

**Table 4.** Linear ARDL and non-linear ARDL estimates for short-run and long-run

Variables	Linear ARDL			Non-linear ARDL		
	Coefficients	Std. Error	t-stats	Coefficients	Std. Error	t-stats
Long run equations: Dependent variable=IG						
FD	0.0010	0.0166	0.0624	-	-	-
FD_Positive	-	-	-	0.0742*	0.0114	6.4742
FD_Negative	-	-	-	-0.3794*	0.0371	-10.217
REC	0.0430*	0.0099	4.3213	-0.1109*	0.0094	-11.768
ICT	0.0165*	0.0031	5.2600	0.0285*	0.0041	6.814
FD x ICT	-0.0035*	0.0004	-8.2582	-0.0005*	0.0002	-2.811
LAB	-0.1599***	0.0878	-1.8199	1.0110*	0.0728	13.883
TO	-0.1101*	0.0194	-5.6593	0.0650*	0.0089	7.245
Short run equations						
IG(-1)	0.3256*	0.0796	4.0868	0.1722**	0.0866	1.9871
ΔFD	-0.0008	0.0072	-0.1132	-	-	-
ΔFD_Positive	-	-	-	0.0106	0.0222	0.4783
ΔFD_Negative	-	-	-	0.0161	0.0301	0.5360
ΔREC	0.0120	0.0138	0.8668	0.0296	0.0218	1.3582
ΔICT	0.0009	0.0034	0.2605	0.0118**	0.0052	2.2567
Δ(FDxICT)	0.0008	0.0006	1.1888	-0.0008	0.0008	-1.0046
ΔLAB	0.2982	0.2251	1.3248	0.0323	0.1748	0.1849
ΔTO	0.0100*	0.0045	2.1850	-0.0085	0.0069	-1.2157
C	0.5358*	0.1418	3.7761	-0.1549**	0.0748	-2.0701
T	0.0014**	0.0007	1.9334	0.0003	0.0003	0.9672
EC <sub>t-1</sub>	-0.1257*	0.0331	-3.7982	-0.1457**	0.0619	-2.3507

Source: Author's calculations.

Note: \*, \*\* and \*\*\* show 1%, 5% and 10% significance levels, respectively.

## DISCUSSION

Table 4 presents the findings of linear and non-linear ARDL. The long-run results of linear ARDL show that FD is positively associated with IG but its impact is insignificant which does not prove H1 (linear association), it is in line with previous researches (Khan et al., 2020; Ofori & Asongu, 2021; Owolabi et al., 2021). Unlike the linear ARDL, findings of non-linear ARDL depict that a one per cent increase in FD significantly increases the inclusive growth by 0.0742 per cent. While the negative shock of FD is negatively related to inclusive growth. It means that a one per cent decrease in financial development escalates inclusive growth significantly. However, the coefficient of a negative shock (-0.3794) is greater than a positive shock. It shows that financial development is efficiently monitoring investments, channelizing savings, managing risks, and creating employment opportunities and thus aiding the inclusive growth process. In this way, the financial sector reduces income and non-income inequalities and enables the marginalized community to become a part of the economic growth process. The movements in financial development exert positive and negative signs of coefficients implying that there exists a non-linear relationship (H1) between financial development and inclusive growth. Meanwhile, the effects of renewable energy consumption are found positive and significant through linear ARDL (H2), it is similar to the studies of Majeed et al. (2021); Shahbaz et al. (2020); Wei et al. (2022); Yikun et al. (2021). Renewable energy consumption aids physical and human capital through huge investments and creating employment opportunities which in turn supports the sustainable growth process. Contrarily, the outcomes of non-linear ARDL reveal that renewable energy consumption is significantly reducing inclusive growth (H2 not proved). It depicts that developing and emerging economies are still unable to reap the optimal benefits of renewable energy due to a shortage of financing, heavy project costs, long payback periods, and lack of government support. Further, the insufficient infrastructure, knowledge, potential suppliers, and financiers also prevent access to renewable energy. The outcomes of linear and non-linear ARDL show that ICT is augmenting inclusive growth significantly (H3), which is in line with the research of Adeleye et al. (2020); Cheng et al. (2021); Grimes et al. (2012); Kumari and Singh (2022); Lee et al. (2012); Pradhan et al. (2015). It implies that ICT promotes demand, investment, and employment by reducing communication, transaction, and production costs in all sectors smoothing the way of inclusive growth. The findings of both techniques demonstrate that the collaboration of financial development and ICT reduces inclusive growth significantly (Abeka et al., 2021; Cao et al., 2021; Kumari & Singh, 2022). Interestingly, the individual impacts of financial development and ICT are positive but their combination spurs negative effects which opposes H4. This result concludes that ICT is unable to reduce the negative effects of financial development like misallocation

of funds and asymmetric information in Asian economies. Labour force participation and trade openness are reducing inclusive growth in linear ARDL modelling (Batool et al., 2020; Bist, 2018). Whereas, the NARDL model displays that the labour force increases while trade openness decreases inclusive growth significantly. The short-run findings of both techniques reveal that the previous period's inclusive growth is significantly increasing the current period's inclusive growth. The coefficients of trade openness and ICT are found positive and significant. Both techniques present the negative and significant error correction term.

## CONCLUSION

The current research scrutinizes the association of financial development, renewable energy consumption and ICT-related strategies to achieve inclusive growth in Asia. Keeping in view the above outcomes, the study concludes that the governments of Asian countries should create a favourable atmosphere for the collaboration of the financial and the ICT sectors creating a comprehensive system for the development of online banking, encouraging financial institutions and markets to introduce new products and provide services at lower costs. Thus, if the stakeholders provide the infrastructure and expertise in the financial and ICT sectors, sustainable and inclusive growth would be guaranteed in this region.

## RECOMMENDATIONS

Huge investments are needed for improving financial and technological literacy and infrastructure. This can help people make better financial decisions and improve their understanding of financial products and services. Moreover, the provision of duty-free and subsidized renewable energy sources is a must to condense the reliance on fossil fuels and attain sustainable economic growth in Asia.

Regional cooperation should be fostered in the finance, energy and ICT sectors by promoting the sharing of best practices, encouraging cross-border investments, and harmonizing regulations across countries. This can help to improve the effectiveness of finance-renewable energy-ICT linkages for reducing income and non-income inequalities and leading Asian economies on the path of inclusive growth.

## IMPLICATIONS

This study has important theoretical implications based on empirical analysis to enhance internet diffusion and promote greater assimilation of electronic finance policies so that the progress of the financial, energy and technological sectors could be converted into inclusive growth.

## CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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