

Impact of ICT Diffusion on Economic Growth: Exploring the Moderating Role of Financial Inclusion in E7 Countries

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Abstract

This research examines the effect of Information and Communication Technology (ICT) diffusion on economic growth with the moderating influence of financial inclusion. This research focuses on E7 countries, which are among the leading emerging economies, including China, India, Brazil, Mexico, Indonesia, Turkey, and Russia. This study adopts a quantitative method using secondary panel data spanning 2001 to 2023 from the World Development Indicators. The proposed frameworks have been tested using fixed- and random-effect techniques to examine the relationships among variables. ICT is measured by Individuals using the Internet (% of population), and economic growth is captured by the GDP per capita (constant 2015 US\$). Financial Inclusion is measured by the number of ATMs per 100,000 adults. This paper finds that ICT has a substantial positive impact on economic growth in E7 countries. Moreover, financial inclusion, as a moderator, also exhibits a strong effect. However, the interaction term between ICT and financial inclusion is significant and negative, indicating a weakening of the relationship. Moreover, control variables—namely, inflation, trade openness, and government expenditure—were included in this research to achieve robust results and ensure a substantial impact on the analysis. The findings are informative for policymakers in emerging economies seeking to improve economic performance through ICT and financial inclusion.

Keywords: ICT Diffusion; Financial Inclusion; Economic Growth; Panel Data Analysis.

Introduction

Reflecting on the contemporary digital age, the diffusion of Information and Communication Technology (ICT) has emerged as one of the central drivers of national economic growth and advancement (Horvey et al., 2025). ICT has been enhancing service provision, promoting innovation, giving access to global markets, and increasing productivity (Vu, 2011). According to extensive research, ICT improves economic activity by enabling better access to information, thereby increasing trade and innovation (Vu, 2011). Despite the theoretical framework predicting a positive effect of ICT on growth, empirical results are somewhat mixed (Sassi & Goaid, 2013).

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Over the past 20 years, ICT diffusion has rapidly penetrated the economic systems of both developed and developing countries. Numerous studies have emphasised the various ways that ICT, particularly a robust telecommunications infrastructure, can support economic growth. These include enhancing productivity, lowering transaction costs, boosting trade, attracting innovation and development, raising demands and employment, and fostering the growth of the financial sectors (Dewan & Kraemer, 2000; Ishida, 2015; Nasab & Aghaei, 2009; Pohjola, 2000; Yousefi, 2011). The integration of ICT into economics is becoming increasingly essential as the emerging and developing economies attempt to close the gap with developed nations. In particular, the E7 countries (China, India, Brazil, Mexico, Russia, Indonesia, and Turkey) account for rapidly growing economies with a range of monetary and tech systems. Hayford et al. (2023) examined the effects of ICT and clean cooking technologies on reducing environmental pollution in E7 economies. The report states that, by enhancing ecological awareness and promoting energy efficiency, increasing internet use and mobile subscriptions contribute to reducing carbon emissions.

With the increase of ICT, Financial Inclusion is exceptionally vital. It ensures that EG should include everyone and is sustainable in the long term globally (Shaukat et al., 2023). Financial Inclusion has been defined as adults having access to and effectively using appropriate financial services (Ahmad et al., 2025). Such services include transaction accounts, savings, and credit facilities. They should be provided responsibly and well-regulated to reflect the growing importance of access to financial markets (Demirgüç-Kunt et al., 2015). FI initiatives have been developed in over 60 countries to increase accessibility. For instance, India has used digital frameworks to enable millions of people to open bank accounts. The World Bank and the G20 are also collaborating to enhance financial access and consumer protection to build comprehensive, sustainable economies globally (World Bank, 2025).

ICT adoption is more effective in contexts where Financial Inclusion is pursued, as the availability of financial services drives the adoption of digital technologies. Furthermore, FI has increasingly been seen as a primary driver for greater economic performance and better equality. For instance, most studies have shown that FI has a positive impact on EG (Ozili et al., 2022).

Based on such knowledge, the current study will investigate the moderating impact of Financial Inclusion on the relationship between ICT and EG in E7 nations. Although there are several studies on the individual effects of ICT on EG, and some on the role of FI in other developing countries, there is limited research on how FI could act to moderate the link between ICT diffusion and EG in E7 countries. Moreover, FI plays a critical moderating role and has a significant effect on economic drivers of growth in emerging markets (Mendoza, 2010).

The E7 countries are considered emerging economies, including Brazil, China, India, Indonesia, Mexico, Russia, and Turkey. These are some of the most rapidly growing economies in the world (Gulzar et al., 2024). They have been spending much money on digital infrastructure and deepening financial services. Still, they have also faced drawbacks such as inconsistent digital access and regional imbalances in FI. This existing literature is mainly focused on the analysis of developed economies or cross-country analyses at a broad level, failing to explore such dynamics specifically in the E7 context.

The primary purpose of this research is to analyse the impact of ICT on economic growth in E7 countries. Then, will investigate how Financial Inclusion strengthen the ICT and EG relationship. This can serve as a guide for policymakers in tapping these factors to propel more inclusive and sustainable growth in the economies and to better focus on their economic development. Moreover, the research will be able to contribute to the development of strategic choices, support overall growth, and bridge the current literature gap by concentrating on the E7 economies, an underexplored yet increasingly researched field.

Literature Review

ICT Diffusion and Economic Growth

ICT diffusion has been found crucial to promoting environmental sustainability worldwide, particularly in high- and middle-income countries, according to various studies. ICT is successfully used across multiple fields to increase energy efficiency and implement low-carbon technologies that help reduce greenhouse gas emissions (Probst et al., 2021; Sun et al., 2023; Watkins et al., 2022).

Numerous scholars and researchers have focused on the impact of ICT on economic development at the business, national, and international levels, given the technology's growing role and global transformation (Sarwar et al., 2024; Talha et al., 2025). Lee et al. (2012) employed a panel data set to examine how telecommunications affect economic growth in sub-Saharan Africa. Under their work, the development of the GDP of the region is highly affected by the growth of telecommunications, especially the mobility of mobile phones. Telecommunication infrastructure is an effective way to promote long-term EG in less developed countries, as demonstrated by a dynamic panel model that addresses endogeneity concerns. The study confirmed that ICT infrastructure plays a central role in economic development, especially in developing and emerging economies.

Using a data sample from 59 countries spanning 1995-2010, Niebel (2018) examined how ICT capital affected economic growth in developing, emerging, and established countries. According to the research, ICT investment has a statistically significant beneficial impact on EG across all country categories. Appiah-Otoo and Song (2021) point out that ICT contributes positively towards economic growth in both developed and developing nations, but the contribution is more significant in poorer economies.

Pradhan et al. (2018) used cross-country panel data to test the causal link between ICT infrastructure and economic growth. The authors found a two-way causal relationship between ICT and economic development, with ICT both feeding into and being fueled by economic growth. ICT infrastructure makes a greater contribution to economic growth in developing nations, according to research.

Albiman and Sulong (2016) investigated the ongoing impact of ICT on economic growth in SSA. They discovered that ICT proxies, including the Internet, mobile phones, and fixed phone lines, had a direct linear impact on economic development that is both positive and statistically significant.

Salahuddin and Gow (2016) examined developing economies and concluded that the use of ICT, particularly mobile and Internet services, significantly and positively influences long-run EG. This indicates that ICT infrastructure is a prerequisite for contemporary economic activities. Additionally, Bahrini and Qaffas (2019) examined the relationship between ICT and EG in several developing nations. They found that the employment of ICT tools has an evident and positive effect on economic performance. Using panel data from 95 nations and 8 MENA region countries between 1980 and 2001, Hassan (2005) demonstrated that ICT and growth were positively correlated across all countries except those in the MENA region. After recognising the beneficial impact of ICT applications beyond fixed telephones in driving growth in these two areas, a more recent study by Bahrini and Qaffas (2019) confirmed the MENA region's supremacy over SSA countries in Internet and broadband adoption.

Overall, past studies have found that ICT contributes to EG in developing nations by fostering better business practices, increased productivity, and new ideas. However, the general scope of how ICT affects economies in E7 countries is hardly researched. Therefore, further research is needed to understand better the connection between ICT and the economies of these countries.

Financial Inclusion as a Moderator

The term financial inclusion describes the responsible and sustainable delivery of reasonably priced financial services, such as credit, insurance, savings, and payments, to both consumers and enterprises. By improving access to financing, FI empowers women, promotes economic growth, reduces poverty, and fosters strong small businesses. Additionally, it strengthens defences against threats such as financial crises and climate change (World Bank, 2025).

The literature on financial inclusion in emerging and developing countries has been comprehensively reviewed (Sarwar et al., 2023). However, despite years of study, there is still debate about how FI affects other economic factors. Emara and El Said (2021) examined the Middle East and some MENA nations and found that FI has contributed to economic growth. Their research indicates that effective governance mechanisms strengthen FI's positive contribution to promoting EG, whereas poor governance weakens this role. Van et al. (2021) investigate the relationship between FI and EG in emerging markets, using indicators of FI and EG's GDP per capita. Their findings show a positive relationship between FI and EG, with the effect stronger in low-income countries and in countries with low FI levels. In Nigeria, Nkwede (2015) examined the relationship between FI and EG. The study concludes that FI significantly hinders Nigeria's economic expansion.

FI eases financial constraints for businesses and individuals, enabling investment in ICT devices and infrastructure. Users who have access to financial products can buy cellphones, internet connections, and other digital devices required for the spread of ICT (Demirgüç-Kunt et al., 2018). According to Lenka and Sharma (2017), FI is a key driver of India's economic growth. They found that financial services contribute to long-term economic development. Their report underscores the need to strengthen banking networks and increase access to basic financial instruments to boost EG. Financial development and ICT penetration have a significantly positive relationship,

Moreover, Maune (2018) investigated the moderating effect of FI on the relationship between trade openness and EG using time-series data from Zimbabwe. Multiple regression analysis was used to examine whether FI and TO, individually and together, influence economic growth. Interestingly, even though both FI and TO had an adverse direct effect on EG, when combined or complementary, their effect was found to be strongly positive. This suggests that FI is a good moderator and can increase the efficiency of TO in promoting EG when combined. Moreover, Chatterjee (2020) examined 41 nations to identify the impacts of ICT and financial inclusion on EG. Her findings indicate that when citizens have greater access to ICT, such as telephones, the internet, and telephone lines, they tend to use formal financial services. This suggests that ICT contributes to higher FI. She also discovered that when FI increases, economic growth is higher. Above all, her research indicates that FI can strengthen the effect of ICT on EG.

In E7 nations, financial inclusion as a moderator is increasingly in the spotlight. Numerous studies have examined the relationship between ICT and EG, and some have also examined the influence of FI on EG. However, few studies have examined all three variables in conjunction, and as a whole, this topic remains under-researched, particularly in E7 countries where digital and financial infrastructures are still maturing. Some studies reveal that financial inclusion tends to be an effective moderator for various economic relationships. Asongu and Odhiambo (2024) had studied the moderating effect of financial inclusion on the relationship between energy poverty and entrepreneurship in Ghana. His study found that financial inclusion had a significant impact on the relationship between energy poverty and entrepreneurship, showing how it was able to impact socio-economic dynamics.

This validates the belief that FI can amplify ICT's impact on economic development by enabling more individuals to access digital services. The reviewed studies also confirm that ICT and FI are both essential for economic growth. ICT improves access and efficiency, while

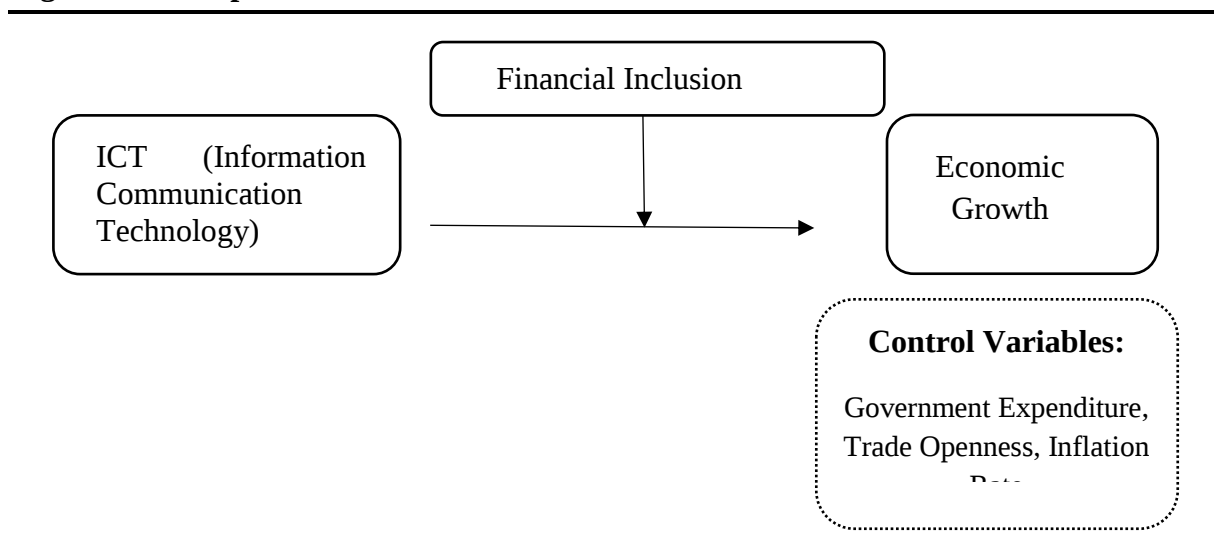
financial inclusion makes sure that the benefits of technology reach more people (Haris et al., 2025; Sarwar et al., 2025). Together, they help create a more equal and growing economy. However, the role of FI in shaping the ICT–growth nexus remains under-researched in E7 nations. This research will attempt to bridge that gap by analysing how ICT and FI jointly influence economic growth in these emerging economies.

Control Variables

This study includes four control variables as potential determinants of economic growth. Firstly, according to Alam and Sumon (2020), there is a favourable correlation between TO and EG. TO and EG are causally related in both directions, according to the vector model for error correction (VECM). Secondly, Bittencourt et al. (2015) studied the effect of Inflation on EG by using data from 15 Southern African countries between 1980 and 2009. Their findings show that higher inflation slows down economic growth. Thirdly, Many empirical studies support this relationship, especially in developed countries, where increased government spending corresponds with economic development (Peacock & Scott, 2000). Few studies have examined the relationship between Malaysian EG and government expenditure, although they primarily focus on the impact of total GEXP.

Theoretical Framework and Hypothesis Development

Figure 1: Conceptual Framework



This study is based on three main theories: the endogenous growth theory, the neo-schumpeterian growth theory, and the financial intermediation theory. According to the endogenous growth idea, continuous innovation and knowledge development can support economic growth. ICT directly contributes to this since it increases productivity, encourages innovation, and opens up global markets, all of which help an economy develop and share its knowledge and skills. Romer (1990) argues that technology has a direct impact on economic growth and if right policies and investments are made, every country can increase growth through its technology. ICT helps to drive economic growth through increased productivity in labor and capital.

According to endogenous growth theory that internal innovations and technology are the main sources of growth. Lucas Jr (1988) argued that a country's economy develop more rapidly if people's skills and knowledge continue to increase. Several empirical studies have validated the ICT-EG nexus in accordance with the endogenous growth theory Vu (2011) analyzed data from 102 countries and found that ICT investment is boosting growth in

developing countries. In E7 countries where digital infrastructure is improving rapidly, ICT investments are playing an important role in accelerating growth. If government policies in these countries promote ICT adoption, such as digital education, broadband access, and online business support, then long-term economic benefits can be obtained. And neo-schumpeterian theory suggests that innovation replaces old things with new ideas and technology, which is called "creative destruction". This process creates new business and market opportunities. Neoclassical theory views ICT as a form of capital that increases the productivity of labor and capital. Research studies such as Quah (2002) and Aghaei and Rezagholizadeh (2017) have also shown a positive relationship between ICT and economic growth, especially in developing countries.

McKinnon (1973) and Shaw (1973) initially developed the financial intermediation theory, which describes how financial institutions act as intermediaries between borrowers and savers. McKinnon (1973) stressed that in less-developed economies, people tend to self-finance because they do not have access to formal financial systems. He put forward the "complementarity hypotheses", which states that investment efficiency is increased by having access to financial intermediaries. On the other hand Shaw (1973) presented the idea of "financial deepening", in which financial services and instruments are deepened to facilitate improved capital accumulation and expansion. When people get easy access to financial services like bank accounts, loans, insurance then they can take better decisions for their small businesses or needs. This is financial inclusion, which means giving everyone an equal opportunity to be a part of the financial system. ICT tools like mobile and internet make this process easier. But if people do not have financial access, it becomes difficult to reap the benefits of technology. Therefore, financial inclusion plays an important role—it forms the bridge between ICT and economic growth. In countries where the financial system is inclusive, the impact of ICT is greater. People can earn, save and invest money using technology. Therefore, this theory supports that financial inclusion acts as a strong moderator between ICT and EG.

H1: ICT Diffusion has positive impact on economic growth.

H2: Financial Inclusion has positive effect on economic growth.

H3: Financial inclusion moderates the relationship between ICT diffusion and economic growth.

Data and Methodology

In this article analysis uses panel data of the E7 nations (China, India, Brazil, Mexico, Russia, Indonesia, and Turkey) on a yearly basis from 2001 to 2023. The E7 economies are taken into account as they embody the most dynamic emerging markets with an increasing contribution to global production and commerce. As Coopers-PwC (2017) reports, the E7 are set to overtake the G7 economies on GDP at purchasing power parity (PPP) by 2050, with their combined proportion of global GDP potentially reaching about 50%, as against a falling proportion of nearly 20% for the G7. This underlines the growing significance of the E7 group within the world economy. The 2001–2023 period is selected since it captures the time of strong ICT growth and financial sector reforms in these nations, which is a proper setting to evaluate the moderating effect of financial inclusion in the ICT–economic growth nexus.

Estimation Strategy

This research utilizes panel data methodology through the implementation of both fixed effects (FE) and random effects (RE) models, commonly utilized in finance and empirical growth literature (Baltagi, 2021; Hsiao, 2014). The FE estimator adjusts for country-specific properties that are not time-varying and could be related to explanatory variables, whereas the RE estimator postulates country-specific effects to be random and not correlated with

regressors, hence more efficient under its assumption (Wooldridge, 2016). The Hausman specification test is used to select between the two models, which determines the more reliable estimator for the data. All data have been obtained from World Development Indicators (WDI). The variable description, however is as follows;

Information Communication Technology Diffusion (ICT)

ICT in this research serves as the independent variable, which is measured by Individuals using the Internet (% of population). According to Niebel (2018), internet usage is an appropriate indicator of ICT since it is a direct reflection of how ICT infrastructure is adopted and utilized by the people. Likewise, Salahuddin and Gow (2016) highlight that increased internet penetration increases access to information and services, potentially contributing to economic growth. Hence, Individuals using the Internet (% of population) is widely used in empirical analysis as a good proxy for ICT development.

Economic Growth (EG)

In this study, economic growth is used as the dependent variable and is measured by GDP per capita (constant 2015 US\$). It measures the average income of people within a nation and facilitates comparison of standards of living between countries (World Bank, 2022).

Financial Inclusion (FI)

FI acts as moderator in this study and it is measured by ATMs per 100,000 adults which represent the access dimension of financial services. Many scholars indicate that FI has three main key dimensions: Access: this dimension explores how much the financial services are accessible to the population. It includes the number of bank accounts. Availability: it concerned to the accessibility of financial services to the population. It includes the quantity of offices and bank workers. Usage: it concerned to the usage of the financial services by the population through deposits and credits (Demirgüç-Kunt et al., 2015; Sarma, 2008). Initially, the usage and access dimensions were measured using proxies based on bank deposits (as a percentage of GDP) and the number of bank branches per 100,000 adults, respectively. However, these proxies were excluded due to the lack of complete and consistent data for all selected E7 countries for the study period 2001 to 2023. Thus, ATMs per 100,000 adults is employed as the single proxy, adopting the methodology of past research like (Lenka & Sharma, 2017; Park & Mercado, 2021; Sarma, 2008) which used ATMs to quantify FI in developing as well as emerging economies.

Control Variables

In this study, government expenditure is captured through the proxy of general government final consumption expenditure as a percentage of GDP (Li et al., 2024) and trade openness use as a control variable and it is measure by trade (% of GDP).(Li et al., 2024; Verma et al., 2023) And inflation is measured in terms of the inflation, consumer prices (annual %) proxy, and it is the overall increase in prices over a period (Verma et al., 2023) .

In line with the finance and development literature, we will analyze the impact of ICT on EG using a basic econometric model (Asongu & Nwachukwu, 2019).

$$\ln EG_{it} = \alpha_i + \beta_1 \ln ICT_{it} + \beta_2 \ln TO_{it} + \beta_3 \ln INF_{it} + \beta_4 \ln GEXP_{it} + e_{it}$$

The moderating impact of FI rate on the effect of ICT on GE, we have added the interaction term between my independent variable i.e., ICT and FI in the model as follows:

$$\ln EG_{it} = \alpha_i + \beta_1 \ln ICT_{it} + \beta_2 \ln FI_{it} + \beta_3 (\ln ICT_{it} \times \ln FI_{it}) + \beta_4 \ln TO_{it} + \beta_5 \ln INF_{it} + \beta_6 \ln GEXP_{it} + e_{it}$$

Wherein:

FI: Financial Inclusion

$\ln ICT_{it} \times \ln FI_{it}$ = interaction term among ICT and FI rate.

Empirical Results

In this research, data analyzed using Stata software, which is widely applied to handle panel data, which is commonly used for the analysis of panel data in finance and economics studies. Outcome of the empirical research are discussed below:

The overall descriptive statistics of the main variables considered in the present study for different panels based on original data are shown in Table 1. However, the descriptive statistics represent variables' abbreviations, mean, median, minimum, maximum values.

Table 1: Descriptive Statistics

Variable	Observation	Mean	Std. Dev.	Min	Max
GDPPC	121	7062.883	3368.767	947.732	13449.930
INT	121	39.291	23.800	2.388	84.994
ATM	121	62.510	44.572	2.290	185.410
TO	121	47.932	13.101	22.105	83.069
INF	121	6.213	3.519	-0.728	19.596
GEXP	121	13.974	3.739	8.109	20.786

Table 2: Correlation Analysis

Variables	GDPPC	INT	ATM	TO	INF	GEXP
GDPPC	1.0000					
INT	0.7286***	1.0000				
	0.0000					
ATM	0.6415***	0.7748***	1.0000			
	0.0000	0.0000				
TO	0.1130	-0.0423	-0.3652***	1.0000		
	0.2173	0.6454	0.0000			
INF	0.0868	-0.0708	-0.0184	0.2394**	1.0000	
	0.3436	0.4401	0.8411	0.0082		
GEXP	0.5619***	0.5673***	0.7537***	-0.4787***	0.0453	1.0000
	0.0000	0.0000	0.0000	0.0000	0.6219	

Note: Correlation having 1%, 5% and 10% level of significance are represented by * ** *respectively.

Regression analysis and correlation analysis are utilized in inferential statistical analysis to determine the relationship strength, direction, and effect between variables.

Results of ICT-Economic Growth Nexus

Firstly, using data from 2001 to 2023, we run the models to examine the direct relationship between ICT and economic growth in the case of E7 countries.

Table 3: Fixed Effect Model

GDPPC	Coefficient	Standard Error	t-value	P>t
INT	51.096	4.350	11.74	0.000***
TO	-64.081	10.825	-5.92	0.000***
INF	167.538	29.819	5.62	0.000***
GEXP	-45.773	110.081	-0.42	0.678
_cons	7725.515	1596.287	4.84	0.000

R-sq: within = 0.6671, between = 0.2644, overall = 0.2891, F statistics = 55.10 and Prob > F = 0.0000, Number of observations =121. Variables having 1%, 5% and 10% level of significance are represented by ***, **, *

The F test result for fixed effects is 55.10, which is significant, indicating that the examined model fits the data well. Fixed effects have lower overall R², between R² than random effect. But R² is greater than random effect.

Table 4: Random Effect Model

GDPPC	Coefficient	Standard Error	t	P>t
INT	49.777	4.673	10.65	0.000***
TO	-53.771	11.919	-4.51	0.000***
INF	156.020	33.027	4.72	0.000***
GE	76.661	96.964	0.79	0.429
_cons	5587.437	1548.177	3.61	0.000

R-sq: within = 0.6611, between = 0.3510, overall = 0.3688, Wald chi² =185.26 and Prob > F = 0.0000, Number of observations =121. Variables having 1%, 5% and 10% level of significance are represented by ***, **, * respectively.

Random effects have high between and overall R² values, whereas only the R² value is bit smaller than the fixed effects values. Since the Wald chi² value of 185.26 and the F value from the previous model are both significant, the models are well-fitted in this instance.

Table 5: Hausman Test

Variables	Fixed	Random	Difference
INT	51.09627	49.77756	1.318707
TO	-64.08114	-53.77173	-10.30941
INF	167.5385	156.0206	11.51789
GEXP	-45.77309	76.66138	122.4345

Chi²=27.49, and Prob > chi²=0.0000

We used the Hausman test to determine which model was best, and the fixed effect model is the most appropriate one based on the chi² value, which in this instance is 27.49 and purely significant. As a result, no further BPLM testing is necessary.

Result of Moderating Effect of Financial Inclusion in ICT-Economic Growth Nexus

In order to further establish statistical significance and determine the objective of the study, the researcher analyzed the moderator's interaction i.e., FI with the dependent variable (economic growth) and the independent variable (ICT).

Table 6: Fixed Effect Statistics of Moderate Model

GDPPC	Coefficient	Standard Error	t	P>t
INT	49.31737	7.783859	6.34	0.000***
ATM	19.83503	6.251299	3.17	0.002**
INTERACTION (ICT× FI)	-0.1664131	0.0874237	-1.90	0.006***
TO	-47.40987	11.54254	-4.11	0.000***
INF	163.5967	28.72043	5.70	0.000***
GEXP	-74.38556	108.0871	-0.69	0.493
_cons	6725.103	1569.444	4.29	0.000

R-sq: within = 0.6982, between = 0.3939, overall = 0.3866, F statistics = 41.64 and Prob > F = 0.0000, Number of observations =121. Variables having 1%, 5% and 10% level of significance are represented by ***, **, * respectively

The interaction term in our fixed effects model, which has a p-value of 0.006, indicates a significant but negative moderating impact of inflation on the relationship between ICT and economic growth. In this case, separately financial inclusion and ICT both have a significant impact on economic growth.

The model is well-fit with a strong F value of 41.64 and highly significant. Fixed effects inside R2 are larger than random effects, while fixed effect between R2 and overall R2 are smaller.

Table 7: Random Effect Statistics of Moderate Model

GDPPC	Coefficient	Standard Error	t-value	P>t
INT	104.2831	13.51751	7.71	0.000***
ATM	83.98931	11.59998	7.24	0.000***
INTERACTION (ICT×FI)	-1.163785	0.1582334	-7.35	0.000***
TO	116.5691	15.79298	7.38	0.000***
INF	39.08609	46.90057	0.83	0.405
GEXP	282.2727	67.8648	4.16	0.000***
_cons	-8252.559	1244.716	-6.63	0.000

R-sq: within = 0.3729, between = 0.9547, overall = 0.7694, Wald chi² = 380.43 and Prob > F = 0.0000, Number of observations = 121. Variables having 1%, 5% and 10% level of significance are represented by ***, **, * respectively.

The results of the random effect model for the financial inclusion-moderating effect similarly show a negative but significant relationship ICT and economic growth. As a result, the model fits well and matches the F values in the prior model are both significant in this case. Within R2 is lower in a random effects model, while between and total R2 are higher.

Table 8: Hausman Test

Variables	Fixed	Random	Difference
INT	49.31737	104.2831	-54.96576
ATM	19.83503	83.98931	-64.15427
INTERACTION (ICT×FI)	-0.1664131	-1.163785	0.9973718
TO	-47.40987	116.5691	-163.9789
INF	163.5967	39.08609	124.5106
GEXP	-74.38556	282.2727	-356.6582

Chi² = 94.75, and Prob > chi² = 0.0000

The chi² statistic for this test is 94.75, which indicates that it is significant and that the FE model should be more suited for this model. Finalize the outcomes of FE model. There is no further need to perform BPLM test.

Diagnosis Test

Our panel data was well balanced, a critical condition for the use of some econometric models, particularly fixed and random effects models. The balance of the panel data helps make the regression analysis more reliable and stronger. Below are the findings of some key diagnostic tests to test for econometric assumptions.

Test for Heteroskedasticity

There is no evidence of heteroskedasticity because of the p-value was larger than the standard significance level of 0.05. This implies that the null hypothesis of homoscedasticity could not be rejected.

Table 9: Heteroskedasticity

Variables	Chi2(1)	Prob>chi2
GDPPC	1.38	0.2407

Multicollinearity Test

The results of the VIF test show that all variables had VIF values well below the commonly accepted threshold of 10. This indicates that multicollinearity is not a worry in our data.

Table 10: VIF of Independent variable

Variables	VIF	1/VIF
ATM	4.35	0.230102
INT	3.23	0.309188
INF	1.18	0.849691
TO	1.82	0.548201
GEXP	2.77	0.361018
Mean VIF	2.67	

Discussion

This study aimed to empirically examine the impact of ICT diffusion on economic growth in E7 countries, with financial inclusion as a moderating factor. The dependent variable is EG, measured as GDP per capita (constant 2015 US\$) for E7 countries. The impact of independent variables, as proxies for Individuals using the Internet (% of population), is measured. Besides this, for the moderating variable, Financial Inclusion is measured by the proxy of ATM per hundred thousand (100,000) adults. In this analysis, the descriptive statistics provided initial insights into the data distribution, while the correlation analysis examined the relationships among all significant variables. The findings indicated that ICT and financial inclusion were positively correlated with economic growth, indicating that advances in technology and access to finance could contribute to fostering higher GDP levels in E7 nations. Generally speaking, the correlation matrix gave initial indications of potential linkages, which were then tested

again in regression models. The fixed-effect regression analysis revealed a statistically significant positive relationship between ICT and EG (using their proxies). This supports the endogenous growth theory, which argues that technological advancement drives long-term growth. These findings are consistent with previous studies, which also emphasise the role of ICT in enhancing productivity and output (Niebel, 2018; Vu, 2011). When examining the moderating role of financial inclusion, the interaction between ICT and financial inclusion yielded a statistically significant, adverse effect on economic growth. This result contrasts with earlier expectations and suggests that while ICT diffusion on its own fosters growth, the presence of FI might not always amplify this effect. In some E7 countries, financial services may not efficiently reach productive sectors; as an alternative, financial burdens may appear in the form of consumer loans rather than supporting investment and innovation (Demirguc-Kunt et al., 2018). Also discussed similar complexities and pointed out that access to finance must be accompanied by effective use for positive macroeconomic outcomes. These findings highlight the importance of improving financial infrastructure and ensuring that inclusion is not just about access, but also about quality and impact. Beyond this, the lack of heteroskedasticity and multicollinearity confirms the reliability and validity of the regression results. In short, the findings support the hypothesis that ICT positively contributes to Economic Growth. However, Financial Inclusion, though significant, may require further structural improvements to act as a positive enabler in this relationship.

Conclusion

With the rapid digital transformation and expansion of financial services, understanding how ICT and Financial Inclusion jointly influence EG is critical for these emerging markets. The Study initially considered the direct relationship between ICT and EG. Panel data analysis revealed a positive, significant relationship between ICT and EG. This means that improvements in ICT infrastructure and access contribute positively to economic performance. These results also align with theories such as the Endogenous Growth Theory, which emphasises the role of innovation and technology in driving long-term economic growth. Similarly, Neo-Schumpeterian theory supports this finding by suggesting that technological advancements create a wave of "creative destruction," displacing traditional ways with a more efficient system, leading to overall progress.

After establishing the direct impact of ICT on EG, the study explored the moderating role of Financial Inclusion. The results showed that FI significantly moderates the relationship between ICT and economic growth, but in a negative direction. This suggests that while financial inclusion plays a role in the ICT-economic growth nexus, it may not be fully effective or may present barriers. This finding could be due to factors such as unbalanced access to financial services, limited financial literacy, or weak financial infrastructure in some E7 countries.

The study contributes to the literature by offering empirical evidence from emerging economies and by integrating ICT and financial inclusion within a single analytical framework. It adds value by showing that ICT alone is not enough to boost economic growth unless practical, inclusive financial systems accompany it. In this regard, policymakers need to focus not just on expanding ICT access but also on improving the depth, usage, and quality of financial services.

In addition, the study closes a gap in previous research by employing fresh data from 2001 to 2023 and adopting credible panel data estimation methods. The choice of ATMs per 100,000 adults as a financial inclusion proxy further emphasizes the empirical relevance of such infrastructure. To leverage ICT to its full potential in emerging markets, there must be an equilibrium emphasis on FI policies that extend beyond access and concentrate on usage and affordability. This finding provides a solid foundation for policymakers and researchers to

develop comprehensive strategies for sustainable economic development through digital and financial innovation.

Policy Recommendations

Based on the empirical findings of this research, government and policymakers in the E7 nations need to do two things. Firstly, must keep investing in ICT and enhance digital access in urban and rural areas. In other words, enhance ICT infrastructure and provide people with inexpensive and convenient access to digital tools. The government needs to extend broadband services, enhance digital literacy, and foster an innovation-driven economy.

Conversely, special care should also be given to financial inclusion. Just expanding access points is not enough; also, emphasise usage and service quality. Provide financial literacy to individuals, encourage the use of digital financial services, and particularly extend these services to individuals outside the system, such as in poor neighbourhoods and remote areas. Better coordination between FI and ICT systems is necessary so that the technology's benefits are not restricted to economic progress; individuals at all levels can enjoy them, and their living standards improve.

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