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ICT and its Impact on Economic Growth in SAARC Countries

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Abstract: *The aim of this study is to investigate the impact of ICT on economic growth in SAARC countries. It used ARDL technique to analyze the data which range from 2001 to 2018. The result extracted from the ARDL model shows that mobile cellular subscriptions are positively significant to economic growth in the long run in five SAARC member countries. The result also shows the elasticity of economic growth with respect to mobile cellular subscription is about 0.09, suggesting that if total mobile cellular subscription goes up by 1 percent, on average, the economic growth speed up by about 0.09 percent. Besides that labor and investment are positively and significantly integrated with economic growth in the SAARC countries in the long run. The error correction term (ECT) is -0.270229 implying that the speed of adjustment to the correction disequilibrium to reaching long-term equilibrium is 27%. For ensuring economic growth and development of the region, respective authorities and policymakers should increase investment in technology related infrastructure.*

Keywords: *ICT, SAARC, Economic Growth, ARDL, ECT*

Introduction

ICT stands for "information and communication technology". It refers to telecommunication-based technologies that enable information access which includes internet, wireless networks, cell phones and other communication media (Ratheeswari, 2018). With the blessing of information and communication technology (ICT), the world is acting as a global village.

ICT has an influential effect on human life and economic growth and development across the world. ICT consists of hardware, software, and networking equipment (Toader *et al.*, 2018), which also includes ICT goods, imports and exports. ICT has become a major factor in international trade and also a key driver in transforming the domestic economy of both developed and developing countries (Sudan *et al*., 2010). By expanding trade and creating employment, it can help to alleviate poverty. ICT development is essential for long-term socioeconomic growth in all sectors and promotion of globalization and regional integration (Mitra, 2013).

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Early macro studies, dating back to the late 1980s and early 1990s, suggested that ICT's contribution to productivity and economic development was negligible (Roach, 1991). Later macroeconomic research revealed that investments in ICT had a significant impact on worker productivity and economic development (Jorgenson, 2001). Due to the introduction of new technology on ICT sector, it contributes to the economic development. Most of the developed countries have well-developed ICT infrastructure but in developing countries, there is a lack of ICT infrastructure. The SAARC countries as developing countries remain far behind in the case of ICT terms and ICT cannot strongly affect the economic growth in these countries but is sometimes positively related to economic growth (Shamimul, 2013).

ICT contributes to the growth in various ways like exporting of ICT goods. According to the report of the World Bank (2021), exports of ICT goods are displayed in Table 1 of SAARC countries.

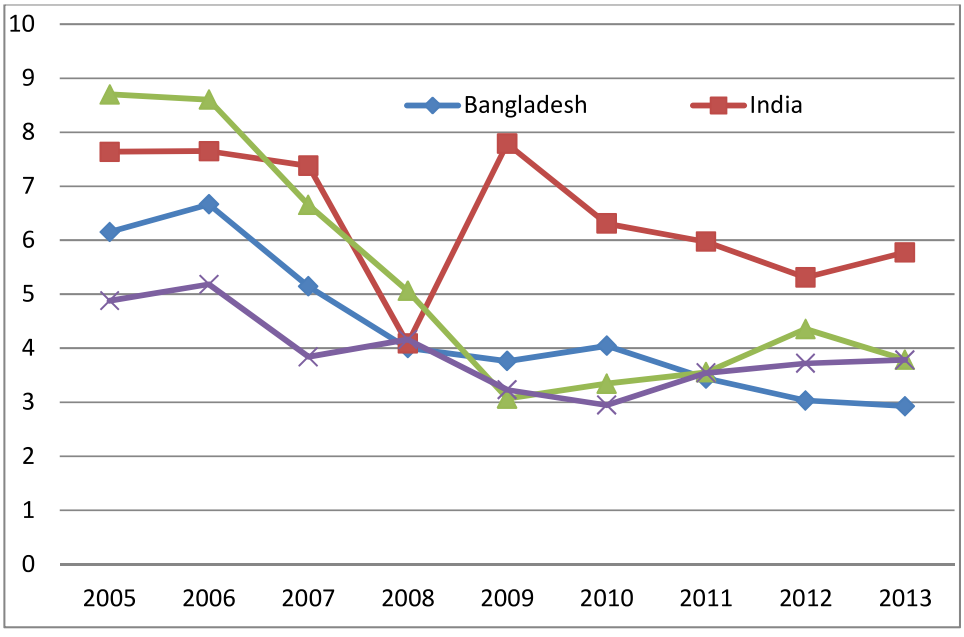
Table 1. Country-wise export of ICT goods (% of total goods exports)

Year	*India*	*Sri Lanka*	*Pakistan*	*Nepal*
2010	*1.998*	*0.462*	*0.1989*	*0.4015*
2011	*2.1826*	*0.3877*	*0.2368*	*0.1535*
2012	*1.9800*	*0.49667*	*0.2407*	*0.0034*
2013	*1.5917*	*0.2955*	*0.2332*	*0.0661*
2014	*0.9736*	*0.6181*	*0.1939*	*0.0127*
2015	*0.8890*	*0.3496*	*0.2412*	*0.0014*
2016	*0.9525*	*0.3913*	*0.3048*	*0.0427*
2017	*0.8641*	*0.5587*	*0.1953*	*0.6315*

Source: WDI (2021)

Table 1 shows the country-wise ICT goods exports (% of total goods exports) from 2010 to 2017 of India, Sri Lanka, Pakistan, and Nepal. India has a higher export rate of ICT goods. Comparing these three countries, India exports more ICT goods than Sri Lanka, Pakistan, and Nepal. Besides that, imports of ICT goods are comparatively higher in India among all the SAARC countries.

Figure 1: Imports of ICT Goods (% of total goods imports)



Source: WDI (2021)

Imports of ICT goods are comparatively higher in India among all the SAARC countries. In Figure 1, the line diagram below shows the trends in ICT goods imports in SAARC countries (Bangladesh, Pakistan, India, and Sri Lanka).
Day by day the number of ICT infrastructure users is increasing and contribute to economic development. Table 2 shows fixed telephone subscriptions from 2010 to 2018 for Bangladesh, India, Sri Lanka, Pakistan, and Nepal.

Table 2. Number of Fixed Telephone Subscriptions

Fixed telephone subscriptions					
Year	*Bangladesh*	*India*	*Sri Lanka*	*Pakistan*	*Nepal*
2010	*1280782*	*35090000*	*3578463*	*6079095*	*841698*
2011	*977700*	*32835261*	*3608392*	*5721725*	*845542*
2012	*961589*	*30940618*	*3449391*	*5861915*	*831703*
2013	*1082348*	*29032974*	*2706787*	*6370860*	*829097*
2014	*974181*	*27000105*	*2709848*	*4897814*	*837266*
2015	*864263*	*25520000*	*3287676*	*3537600*	*846940*
2016	*766183*	*24404000*	*2479802*	*3104415*	*858237*
2017	*707568*	*23234687*	*2603178*	*2940243*	*861299*
2018	*1449646*		*2466256*	*2798606*	*799368*

Source: WDI (2021)

Over the last two decades, a growing number of scholars have been pushed to study and measure the technology's influence on economic growth due to the rapid advancement of information and communication technology (Toader *et al.*, 2018). There are several studies on this topic but all of these do not provide the same result. ICT and growth may positively or negatively relate to economic growth.

Problem Statement

Economic growth is consisting of various factors. ICT is one of them. Like other countries or regions, it is required to investigate the impact of ICT on economic growth in SAARC countries. Though there is a dearth of study, this research with upgrade data. Besides that, it is also required to know the impact of labor force participation and investment on economic growth in SAARC countries.

Objectives of The Study

Our main objective is to find out the impacts of ICT on economic growth in SAARC countries.

The specific objectives are following:

i. To find out the contribution of labor on the economic growth in SAARC countries
ii. To investigate the impact of investment on growth in SAARC countries

Significance of the Study

The study shows ICT`s impact on the economic development of SAARC countries. The contribution of mobile cellular subscriptions to economic growth can be known through this paper. Besides, the contribution of investment and labor on growth can be identified through this study. The result of the paper may be helpful for the policy makers to take a step to improve the ICT infrastructure as well as labor force participation and investment to boost economic growth. This paper will be helpful for the existing literature and further research.

There are five sections of the research analysis. A literature review is discussed in section two. In the third section, the methodology is addressed. Section four includes the result analysis and discussion. Finally, section five displays conclusion of the study.

Literature Review

There are several studies on this topic both on the national and international levels.

Empirical Studies at the National Level of Different Countries

Kawai *et al.* (2016) found in their report that ICT accelerates gross national happiness both negatively and positively in Bhutan. Jalava and Pohjola (2005)

observed ICT's impact on output and labor productivity growth in Finland where the data ranges from 1995 to 2002 and found that one-third of GDP growth stemmed from information and communication technology. Holt and Jaminson (2009) conducted a literature survey for finding the connection between ICT and economic growth and also for the connection between broadband and economic growth and concluded a positive relationship between ICT and growth.

Islam and Mamun (2013) showed that within the SAARC countries Maldives bears the lowest digital divide that is acquired the highest ICT facilities and GDP per capita income. But Bangladesh cannot do better in this case of achieving the highest facilities of ICT. Ukwuoma (2019) showed that economic growth is negatively related to ICT in Nigeria.

Empirical Studies of Cross-Section Studies

Moradi and Kebraee (2010) conducted with 48 Islamic countries and summarizes that inflation negatively accelerates growth where investment in ICT is positively related to economic growth. But there is a paradox in the case of marginal production that the outcome of investing in non ICT capital is higher than investment in ICT capital. Roller *et al*. (2001) revealed from OECD countries' analysis that a positive causal link exists with telecommunications infrastructure and economic development. Jin and Cho (2015) indicate that ICT has the ability to accelerate the growth of the economy.

Bahrini and Qaffas (2009) showed that ICT goods have influential impacts on growth in MENA and SSA countries. Lee *et al.* (2005) conducted a study with 20 countries and found that ICT contributes to growth in developed and newly industrialized economies, but not in developing countries. Nipo *et al*. (2018) also investigated the relationship between ICT and growth in 149 countries and used pooled OLS and GMM methods and find a significant impact on economic growth. In MENA countries there was a positive contribution of ICT on economic growth and it was needed to reinforce their ICT policies and should improve using of new ICT scope (Sassi and Goaied, 2013).

Nasab and Aghaei (2009) suggested that OPEC countries should implement specific policies in ICT to accelerate growth and found a significant impact of ICT on growth. Toader *et al*. (2018) find a positive relationship between economic growth and ICT in the European Union (EU) countries. Karlson and Liljevern (2017) used Cobb-Douglas production functions and found that there were only significant contributions of ICT to growth in the top-three richest countries, with the exception of the middle-income countries. Pilat (2004) also exposed that ICT accelerates economic performance and the success of individuals firms and for boosting economic growth investment in skills,

innovation, and new firm creation are required. To extract more advantages from ICT it's important to invest more in the ICT sector. Latif *et al*. (2017) found a positive relationship between ICT and environmentally sustainable development with a minor in conformity among the relevant variables in the long run. These findings provided that ICT and sustainable development were proportional to each other.

Guetat and Drine (2007) showed a significant contribution to the growth of ICT, especially for 14 MENA countries. Sharif (2018) revealed that the telecommunication industry might have a strong positive association with the country's economic growth. Naym and Hossain (2016) revealed that Bangladesh is lagging in most of the ICT indicators. Iscan (2012) also indicates through time series analysis that ICT has a positive influence on growth. Ahmed and Ridzuan (2013) found out the positive influence of telecommunications investment on GDP in ASEAN countries. Haacker (2010) showed that ICT-related capital deepening contributed 0.2% points to growth in low income and 0.3% points in low Middle-Income countries. Aghaei *et al.* (2017) found significant impacts of ICT investment on growth. Vu (2011) also examined that ICT had positive effects on economic growth. Piatkowski (2003) also ensures ICT's impacts on growth.

Bubanja (2015) analyzed the contribution of ICT on the growth of national economies and higher productivity-based companies. Niebel (2014) showed in their study of ICT's impact on developing, emerging, and developed countries. It takes 59 countries covering the year 1995 to 2010 and also concludes a positive effect of ICT on economic growth. Shamimi (2010) also showed a positive relationship between ICT and economic growth. Latif *et al.* (2018) researched with BRICS economies and found that ICT positively accelerates economic growth. Farhadi *et al.* (2012) applied the GMM method for 159 countries and revealed positive impacts of ICT on growth.

Khan and Majeed (2020) also discovered that ICT and e-government have a beneficial and considerable impact on South Asia's economic growth. Usman *et al.* (2021) did research on South Asian economies and discovered that ICT contributed significantly and favorably to India's economic growth. Verma and Giri (2020) evaluated the effect of ICT spread on economic growth in SAARC economies from 2000 to 2017 and discovered that ICT diffusion boosted growth.

Tripathi and Inani (2020) also conducted a study on SAARC countries for the duration of 1990 to 2014 employing annual panel data. They employed augmented Cobb–Douglas production function and used teledensity as the proxy of ICT. The result of the paper revealed a positive and statistically significant

effect of ICT on economic growth. Bhujabal and Sethi (2020) conducted research with the objectives of finding the relationship between FDI, ICT, trade, and per capita gross domestic product growth across SAARC countries from 2000 to 2017 and found unidirectional causality from FDI to ICT and bidirectional causality between trade and ICT.

Raleva (2014) discovered that labor has a negative effect on economic growth in Bulgaria. However, Young discovered that labor force participation had a beneficial effect on economic growth in Nigeria (2018). Soava *et al*. (2020) discovered that labor and investment had a beneficial effect on economic growth in European Union (EU) countries. Paudel and Perera (2009) discovered that labor force, trade openness, and foreign debt all had a favorable long-run effect on Sri Lanka's economic growth. It is demonstrated that in Nigeria, there is a negative association between female labor force participation and economic growth (Anyanwu *et al.,* 2021). Hussin and Saidin (2012) discovered that gross fixed capital creation had a favorable effect on GDP in each of the ASEAN-4 member nations. Bal *et al*. (2016) have demonstrated that capital development has a favorable effect on economic growth.

Our study is different from others on the basis of variables, updated data (2000 to 2018), 8 member countries of SAARC are included, advanced econometric model e.g. ARDL technique has employed. Previous studies mostly used 4 SAARC countries likely Bangladesh, India, Pakistan and Sri Lanka. For example, Usman *et al*. (2021) have found that in the long-run, ICT has positively influenced the economic growth in India only. They didn't find any relationship of ICT and economic growth for other member countries of SAARC. Tripathi and Inani (2020) also have conducted a study on SAARC countries by using annual data for the period 1990–2014 using pooled OLS. They have taken only four countries such as Bangladesh, India, Pakistan and Sri Lanka. They used teledensity as the proxy of ICT. Bhujabal and Sethi (2020) conducted the research with the objectives of finding the relationship between FDI, ICT expansion, trade, and per capita gross domestic product growth across SAARC countries from 2000 to 2017 and found unidirectional causality from FDI to ICT and bidirectional causality between trade and ICT. The dependent variable of their study is foreign direct investment which is totally different from our study.

So, our study is different from those studies which are mentioned in above. This study adds to the existing body of knowledge by examining the link between economic growth, information technology, labor, and investment in South Asian countries from 2001 to 2018 using panel ARDL technique. This research paper aims at measuring the impact on economic growth of the technologies of information and communication and control variables. As a result, we are motivated to investigate the impact of ICT on the economic growth in the SAARC region.

Methodology

Data and Sample

For conducting this research, panel data were collected from the World Development Indicators (2021) of Bangladesh, India, Pakistan, Sri Lanka, and Nepal out of 8 SAARC countries from the year 2001 to 2018. Data analysis is conducted by E-views 11 statistical software.

Variables and Model Specification

In this study, the dependent variable is GDP per capita as the proxy of economic growth and the independent variables are Mobile Cellular Subscriptions, Labor and Gross Fixed Capital formation used as the proxy of investment.

GDP Per Capita= f(Mobile cellular subscriptions, Labor, Investment)

In the econometric form of the model,

$$(GDPPC)_{it} = \beta_0 + \beta_1(MCS)_{it} + \beta_2(Labour)_{it} + \beta_3(Invest)_{it} + \mu_{it} \quad \ldots (1)$$

By taking natural logarithm the final econometric of the model is showed in equation 2.

$$\ln(GDPPC)_{it} = \beta_0 + \beta_1\ln(MCS)_{it} + \beta_2\ln(Labour)_{it} + \beta_3\ln(Invest)_{it} + \mu_{it} \quad \ldots (2)$$

Here, β_0 is the intercept term and $\beta_1, \beta_2, \beta_3$ are the coefficients of the independent variables.

t = 1, 2, 3, …, T; i = 1, 2, 3, … , N. Where, *I* denotes countries and t denotes time. *GDPPC* = GDP per capita (current US$); *MCS* = Mobile Cellular Subscriptions, Labor = Labor force participation rate, total (% of total population ages 15+) (modeled ILO estimate), Invest = Gross Fixed Capital Formation (current US$).

Panel Stationarity Test of the Variables

For conducting research it is required to have stationary data otherwise spurious regression arises (Gujrati, 2005). For the panel unit root test Barbieri (2009) explained two generations, Levin, Lin and Chu test (2002); Im, Pesaran, and Shin test (2003) and Fisher type tests are included in the first generation where the second generation includes covariance restriction approach and factor structure approach. Abuaf *et al.* (1990) were the pioneer of unit root test, after than Levin and Lin (1992), Levin and Lin (1993) and Im *et al.* (1997), O'Connell (1998), and Taylor and Sarno (1998) updated the panel unit root tests. In literature, different unit root tests have been used to verify data for panel regression model in a stationary way but in this research, we have employed Levin, Lin & Chu t* and Im, Pesaran, and Sin W-stat tests.

Levin, Lin and Chu Unit Root Test (2002)

Levin, Lin, and Chu (LLC) Unit Root Test add some new dimension on panel unit root test and it takes homogeneity into account. LLC assumes homogeneous autoregressive coefficients between individuals. The LLC test can be expressed through the following equation,

$$\Delta X_{i,t} = \Omega_i + \Upsilon_i X_{i,t-1} + \sum_{p=1}^{\Upsilon i} \Upsilon_{ip} \Delta X_{i,t-P} + \varepsilon_{i,t} \quad \text{... (3)}$$

Where the null hypothesis is,

$$H_0: Y_1 = Y_2 = \cdots Y_n = Y = 0 \quad \text{... (4)}$$

And alternative hypothesis,

$$H_1: Y_1 = Y_2 = \cdots Y_n = Y \neq 0, \;\; Y \prec 0 \quad \text{... (5)}$$

Im, Pesaran and Shin Unit Root Test (2003)

Im, Pesaran, and Shin (IPS) offer a new and more compact, and simple unit root test method for panel data analysis and permits residual serial correlation and heterogeneity, both stationary and non-stationary (Barbieri, 2006). Im, Pesaran, and Shin unit root test is given through the equation below:

$$\Delta X_{i,t} = \delta_i X_{i,t-1} + \sum_{j=1}^{pi} \delta_{ip} \Delta X_{i,t-P} + \gamma_{i,t} \quad (6)$$

Where the null hypothesis is:

$H_0 : B_i = 0$

And alternative hypothesis:

$H_1 : B_i \prec 0$

Panel ARDL

The panel ARDL approach first introduced by Pesaran and Shin (1999) and later expanded by Pesaran, Shin, and Smith (2001) dealt with the long and short-run relationship among the variables. The bounds testing approach is an important cointegration procedure compare to other procedures. Banerjee et al. (1993) showed ECM can be derived from the ARDL approach and this approach can be used for finding the existence of a long-run relationship among the variables either the data is integrated at level or first difference or integrated in mixed order.

This method is first introduced by Pesaran *et al*. (1999) and then prolonged by Pesaran *et al*. (2001). The short-run equation of panel ARDL model is:

$$\Delta LN(GDPPC)_{it} = \beta_0 + \beta_1 LN(GDPPC)_{i,t-1} + \beta_2 LN(MCS)_{i,t-1} + \beta_3 LN(Labor)_{i,t-1} + \beta_4 LN(Invest)_{i,t-1} + \sum_{j=1}^{k} \gamma_{1j} \Delta LN(GDPPC)_{i,t-j} + \sum_{j=0}^{k} \gamma_{2j} \Delta LN(MCS)_{i,t-j} + \sum_{j=0}^{k} \gamma_{3j} \Delta LN(Labor)_{i,t-j} + \sum_{j=0}^{k} \gamma_{4j} \Delta LN(Invest)_{i,t-j} + \varepsilon_{it} \quad (7)$$

Where, Δ is first difference term, ε_{it} is the error tem and β_1, β_2, β_3, and β_4 communicate to the long-run coefficients and short run estimation showed by γ_{1j}, γ_{2j}, γ_{3j}, γ_{4j} and γ_{5j}.

The long run equation got from the following equation:

$$LN(GDPPC)_{it} = \beta_0 + \beta_1 LN(GDPPC)_{i,t-1} + \beta_2 LN(MCS)_{i,t-1} + \beta_3 LN(Labor)_{i,t-1} + \beta_4 LN(Invest)_{i,t-1} + \varepsilon_{it} \quad (8)$$

When, the long-run association exists among the variables, and then the error correction model has been performed. The equation of ECT is:

$$\Delta LN(GDPPC)_{it} = \beta_0 + \sum_{j=1}^{k} \gamma_{1j} \Delta LN(GDPPC)_{i,t-j} + \sum_{j=0}^{k} \gamma_{2j} \Delta LN(MCS)_{i,t-j} + \sum_{j=0}^{k} \gamma_{3j} \Delta LN(Labor)_{i,t-j} + \sum_{j=0}^{k} \gamma_{4j} \Delta LN(Invest)_{i,t-j} + \omega\, ECT_{i,t-1} + \varepsilon_{it} \quad (9)$$

Where, ω presents the coefficient of ECT means the speed of adjustment for a disequilibrium situation to move an equilibrium situation. To establish a long-run association we must consider the ECT estimation.

Hypotheses Statement

The hypotheses of this study are:

H_1 : Mobile Cellular Subscriptions significantly and positively affects economic growth in SAARC Countries

H_2 : Labor significantly and positively affects economic growth

H_3 : Investment significantly and positively affects economic growth

Data Analysis and Result Discussion

Statistical and econometric methods have provided various results where the results are presented below.

Descriptive Statistics of the Variables

Table 3 shows the statistical nature of the selected variables (GDP per capita, Mobile cellular subscriptions, Labor, and investment) of the SAARC countries through the values of the mean, median, maximum, minimum, and standard

deviation, Skewness, Kurtosis. The probability value of GDP per capita and investment showed the normal distribution of the data and the rest of the variables (mobile cellular subscriptions and labor) will be normally distributed after taking the first difference of the variables. Total observation for the study is 90.

Table 3. Results of Descriptive Statistics

	LnGDPPC	*LnMCS*	*LnLabour*	*LnInvest*
Mean	*2.985274*	*7.367601*	*1.773649*	*10.40077*
Median	*2.986702*	*7.444911*	*1.752421*	*10.34306*
Maximum	*3.613274*	*9.070415*	*1.931798*	*11.89522*
Minimum	*2.388671*	*4.237695*	*1.693903*	*9.061852*
Std. Dev.	*0.292160*	*1.051671*	*0.077194*	*0.750295*
Skewness	*0.228696*	*-0.694275*	*1.268226*	*0.392305*
Kurtosis	*2.772324*	*3.478111*	*2.969625*	*2.498892*
Jarque-Bera	*0.978913*	*8.087472*	*24.12941*	*3.250211*
Probability	*0.612959*	*0.017532*	*0.000006*	*0.196891*
Sum	*268.6747*	*663.0840*	*159.6284*	*936.0690*
Sum Sq. Dev.	*7.596793*	*98.43501*	*0.530338*	*50.10195*
Observations	*90*	*90*	*90*	*90*

Source: Eviews result

Correlation of the Variables

Table 4 shows the result of the correlation matrix of the selected variables. Mobile cellular subscriptions and investment positively associated with GDP per capita but labor negatively associated with GDP per capita. Labor negatively but investment positively associated with Mobile cellular subscriptions. Again, investment is negatively related to labor.

Table 4. Correlation of variables

Variable	*Ln(GDPPC)*	*Ln(MCS)*	*Ln(Labour)*	*Ln(Invest)*
Ln(GDPPC)	*1*			
Ln(MCS)	*0.5778*	*1*		
Ln(Labour)	*-0.5537*	*-0.50241*	*1*	
Ln(Invest)	*0.4051*	*0.82925*	*-0.63659*	*1*

Panel Unit Root Test

Multiple unit root tests for the panel regression validation are used in the literature. For the panel root unit tests, this study has used Levin, Lin & Chu t* and Im, Pesaran, and Sin W-stat tests. The results of the unit root tests are

presented in Table 5. It is found that *ln(GDPPC)*, *ln(MCS)*, and *ln(Labor)* are stationary at I(0) and *ln(Invest)* is stationary at I(1) and this mixed order integration suggests the Panel ARDL approach is suitable for this study.

Table 5. Panel Unit Root Results

	Levin, Lin &Chut t*				Im, Pearson and Shin W-stat				
	Level		First Difference		Level		First Difference		
Variables	T-stat	P value	T- stat	P value	T -stat	P value	T- stat	P value	Result
Ln(GDPPC)	-2.13567	0.0164	-2.77105	0.0028	0.18489	0.0164	-2.21566	0.0134	I(0)
Ln(MCS)	-5.78542	0.0000	-1.38229	0.0834	-3.56214	0.0002	0.28081	0.6106	I(0)
Ln((Labour)	-1.86789	0.0309	-0.73851	0.2301	0.84703	0.8015	-0.43735	0.3309	I(0)
Ln(Invest)	0.45133	0.6741	-1.71393	0.0433	1.51033	0.9345	-1.91128	0.0280	I(1)

Optimum Lag Length

The results of the optimum lag selection criterion are demonstrated in Table 6 where the optimal lag is selected by AIC criterion. The optimum lag for this model is 1 because most of the criterion suggest lag 1.

Table 6. Optimum Lag-length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	35.26660	NA	4.49e-06	-0.962049	-0.828241	-0.909253
1	673.5597	1178.387	2.17e-14*	-20.10953*	-19.44049*	-19.84555*
2	683.2972	16.77849	2.65e-14	-19.91684	-18.71256	-19.44167
3	697.0188	21.95441	2.89e-14	-19.84673	-18.10722	-19.16038
4	717.6108	30.41280*	2.58e-14	-19.98802	-17.71328	-19.09049
5	729.7447	16.42748	3.04e-14	-19.86907	-17.05909	-18.76035

Estimates of Panel ARDL Model

Table 7 shows the result of the panel ARDL model with respective coefficients, t-stat, and the probability of the variables.

Table 7. Long Term and Short Term Dynamics through Panel ARDL

Variables		Coefficients	T stat	Prob.
Long run	Ln(MCS)	0.090785	5.598016	0.0000
	Ln((Labour)	3.521569	2.519734	0.0143
	Ln(Invest)	0.286624	4.022443	0.0002
Short-run	ECT	-0.270229	-1.994281	0.0505
	Δ Ln(MCS)	-0.054508	-1.228559	0.2239
	ΔLn((Labour)	3.970763	0.842236	0.4029
	Δ Ln(Invest)	0.555109	4.800045	0.0000
	Constant	-1.873280	-1.943753	0.0565

From Table 7, we found that mobile cellular subscriptions positively and significantly related to economic growth in the long run. The slope of the coefficients of the double log model or log-log model is called elasticity. Here, the slope coefficient β_2 is the partial elasticity of GDP per capita (economic growth) with respect to mobile cellular subscriptions (ICT), holding rests of the variables (labor and investment) are constant. It means that the percentage change of economic growth for a percentage change of information and communication technology (ICT) factors, other things held constant (Gujarati, 2012). The interpretation of the coefficient of mobile cellular subscriptions, Ln(MCS) of about 0.09 is that if we increase the ICT input by 1 percent, on average the economic growth speed up by about 0.09 percent, holding other input like labor and investment are constant. So, it means that a 1% increase in Ln(MCS*)* will increase 0.09% of Ln(GDPPC) economic growth in SAARC countries and it is significant at 1% (prob. 0.0000) level. Thus we can accept the H_1 hypothesis. This result supports the findings of Toader *et al.* (2018); and Bahrini and Qaffas (2019). Labor also positively and significantly (prob. 0.0143) co-integrated with economic growth in the long run, where a 1% increase in Ln(Labor) will increase 3.52% of LnGDP growth and support our H_2 hypothesis. The result is similar to the findings of Young (2018); Soava *et al*. (2020); Paudel and Perera (2009). Again, investment positively and significantly (prob. 0.0002) integrated with economic growth in the SAARC countries, where a 1% increase in Ln(Invest) will increase 0.29% of economic growth and support H_3 hypothesis. The result is similar to the findings of Hussin and Saidin (2012); Bal *et al*. (2016).

The ECT value demonstrates the speed of adjustment of disequilibrium correction. In Table 7 it is observable that ECT stands at -0.270229 with statistically significant results which imply that the speed of correction disequilibrium adjustment is 27 percent to reach a long-term balance. In short-run, mobile cellular subscriptions are negatively but insignificantly associated with economic growth. Labor (insignificantly) and investment (significantly) has a positive impact on economic growth.

Country wise impact of ICT on Economic Growth

The following explanation below depicts the cross-country analysis for showing the impact of ICT on economic growth.

Bangladesh

For the specific analysis of the individual country like Bangladesh, from Table 8,it is seen that the coefficient of error correction term (ECT) is negative which is desirable and statistically significant implies that the speed of adjustment to

the correction disequilibrium to reaching long-term equilibrium is 5.7% in Bangladesh. Here, the speed of adjustment is very low though it is significant. In the short run, mobile cellular subscriptions and labor negatively affect economic growth in Bangladesh but investment has a positive and significant impact on economic growth in Bangladesh.

Table 8. Short run impacts of ICT in Bangladesh

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob. **
ECT	*-0.057230*	*0.000648*	*-88.33149*	*0.0000*
Δ (LnMCS)	*-0.028607*	*0.000158*	*-181.4295*	*0.0000*
Δ (LnLabour)	*-0.138949*	*0.091586*	*-1.517152*	*0.2265*
Δ (LnInvest)	*0.929525*	*0.008152*	*114.0197*	*0.0000*
C	*-0.406478*	*0.050659*	*-8.023775*	*0.0040*

India

In the case of India which is the largest country in the region, the coefficient of ECT is negative and significant also which implies that the speed of adjustment to the correction disequilibrium to reaching long-term equilibrium is 3.7% in India which indicates very slow adjustment. In the short run, mobile cellular subscriptions and investment positively and significantly impact economic growth in India. But labor is negatively associated with economic growth in India in the short run.

Table 9. Short run impacts of ICT in India

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob. **
ECT	*0.037833*	*0.001358*	*27.86459*	*0.0001*
Δ (LnMCS)	*0.067060*	*0.002715*	*24.70359*	*0.0001*
Δ (LnLabour)	*-0.890662*	*1.117812*	*-0.796790*	*0.4838*
Δ (LnInvest)	*0.680560*	*0.004647*	*146.4400*	*0.0000*
C	*0.268685*	*0.064905*	*4.139670*	*0.0256*

Pakistan

From Table 10, it is observed that the coefficient of ECT is negative which is statistically significant implies that the speed of adjustment to the correction disequilibrium to reaching long-term equilibrium is 5.7 % in Pakistan. In the short run, mobile cellular subscriptions and labor negatively impact economic growth in Pakistan. But investment is positively associated with economic growth in Pakistan in the short run.

Table 10. Short run impacts of ICT in Pakistan

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob. **
ECT	*-0.578716*	*0.028552*	*-20.26872*	*0.0003*
Δ (LnMCS)	*-0.063506*	*0.001762*	*-36.04332*	*0.0000*
Δ (LnLabour)	*-1.140774*	*1.669424*	*-0.683334*	*0.5434*
Δ (LnInvest)	*0.251906*	*0.010480*	*24.03682*	*0.0002*
C	*-3.877205*	*4.428990*	*-0.875415*	*0.4458*

Sri Lanka

From Table 11, in the case of Sri Lanka, the coefficient of ECT is negative which is desirable and it is also statistically significant which implies that the speed of adjustment to the correction disequilibrium to reaching long-term equilibrium is 14% in Sri Lanka. In the short run, mobile cellular subscriptions and labor negatively impact economic growth in Sri Lanka. But investment is positively and significantly associated with economic growth in the short run.

Table 11. Short run impacts of ICT in Sri Lanka

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob. **
ECT	*-0.142863*	*0.003879*	*-36.82725*	*0.0000*
Δ (LnMCS)	*-0.208158*	*0.011991*	*-17.35948*	*0.0004*
Δ (LnLabour)	*-0.793142*	*0.716766*	*-1.106556*	*0.3492*
Δ (LnInvest)	*0.468767*	*0.008421*	*55.66394*	*0.0000*
C	*-0.868348*	*0.209479*	*-4.145282*	*0.0255*

Nepal

As shown in Table 12, the coefficient of error correction is negative and statistically significant, implying that the speed with which Nepal adjusts to correcting disequilibrium in order to achieve long-term equilibrium is 6%. In the short run, mobile cellular subscriptions have a negative and material influence on Nepal's economic growth. However, in the short run, labor and investment are positively and significantly connected with economic growth in Nepal.

Table 12. Short run impacts of ICT in Nepal

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob. **
ECT	*-0.610167*	*0.032221*	*-18.93667*	*0.0003*
Δ (LnMCS)	*-0.039328*	*0.000498*	*-79.04157*	*0.0000*
Δ (LnLabour)	*22.81734*	*57.36993*	*0.397723*	*0.7174*
Δ (LnInvest)	*0.444788*	*0.016987*	*26.18436*	*0.0001*
C	*-4.483055*	*4.529502*	*-0.989746*	*0.3953*

Conclusion

The panel ARDL model was used in this study to assess the influence of ICT on economic growth in SAARC member countries. The panel ARDL model's output indicates that mobile cellular subscriptions, a proxy for ICT, are positively and strongly associated to economic growth over the long term. In SAARC countries, the elasticity of economic growth with respect to mobile cellular subscriptions (MCS) is about 0.09, suggesting that if total mobile cellular subscription goes up by 1 percent, on average, the economic growth goes up by about 0.09 percent. Labor and investment are also positively and significantly integrated with economic growth in the SAARC countries in the long run. The ECT value of the model is -0.270229, with statistically significant results indicating that the speed of rectification disequilibrium adjustment is 27% to achieve long-term balance. In the short run, mobile cellular subscriptions have a weak but negative correlation with economic growth. Labor and investment both contribute to economic growth.

Information and communication technologies are regarded to contribute to the knowledge spillover effect between countries. Thus, increased mobile cellular subscription (MCS) usage in a country is projected to have a beneficial and considerable effect on economic growth in South Asian countries. The study established that when labor and investment are used as control variables in the growth equation, ICT has a positive and significant effect on economic growth. According to research findings, South Asian countries must significantly expand their ICT activities in order to increase the use of new ICT technologies and the inclusion of trained personnel.

Based on the finding of the paper, some policies are recommended. For ensuring economic growth, authorities and policymakers should increase investment in mobile phone infrastructure as it has the probability to accelerate economic growth positively in the SAARC countries. Attention should be also given to

labor force participation as it also positively accelerates growth. Investment should be placed in the proper place as it positively influences growth. The Govt. and authority can increase ICT diffusion by tax reduction, subsidies, and promotions of e-commerce in SAARC countries. Tax reduction, subsidies, promoting e-commerce, decreasing tariffs can be helpful in this regard because reducing all these things inspires the industry to operate with ICT's infrastructure. Investment should place an appropriate sector to boost economic growth.

During the current Corona (Covid-19) epidemic, it has been observed that most South Asian countries have a substantial shortage of quality information and communication. In the case of Bangladesh, the government has taken steps to take classes online as educational institutions are closed to coronas. But due to the slowness of the internet and poor network in many parts of the country, not all students have had the opportunity to learn online equally. Even all public universities in Bangladesh are still struggling to take exams completely online. Therefore, our advice to the government's policymakers is to increase public and private investment to use advanced and modern quality technology to keep the economy at a constant pace. Only then will the desired development be achieved.

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