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The Advancement in Information and Communication Technologies (ICT) and Economic Development: A Panel Analysis

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This study analyses the impact of advancement in information and communication technologies (ICT) on economic development over the period of 2000 to 2017 in the case of 87 developed and developing countries. The developed and developing countries are selected following the ranking of the International Monetary Fund's World Economic Outlook Database, October 2018. This article uses three types of analysis: the first is based on the whole sample, and for comparative analysis developed and developing countries' analysis are done separately. The results of panel least squares reveal that advancement in information and communication technologies has an insignificant relationship with economic development, whereas the advancement in information and communication technologies is playing a positive and significant role in the economic development of developing countries. This shows that developed countries are getting more benefits from advancement in information and communication technologies in comparison with developing countries in the process of economic development. The developed countries have a more stable macroeconomic environment in comparison with developing countries, so macroeconomic stability is playing a more significant role in the case of developed countries. If developing countries want to achieve higher economic development, they must increase trade and physical capital within a stable macroeconomic environment. Moreover, developing countries should adopt advancement in information and communication technologies (ICT) to compete with developed countries in the process of economic development.

Key words: *ICT, economic development, macroeconomic stability*

Introduction

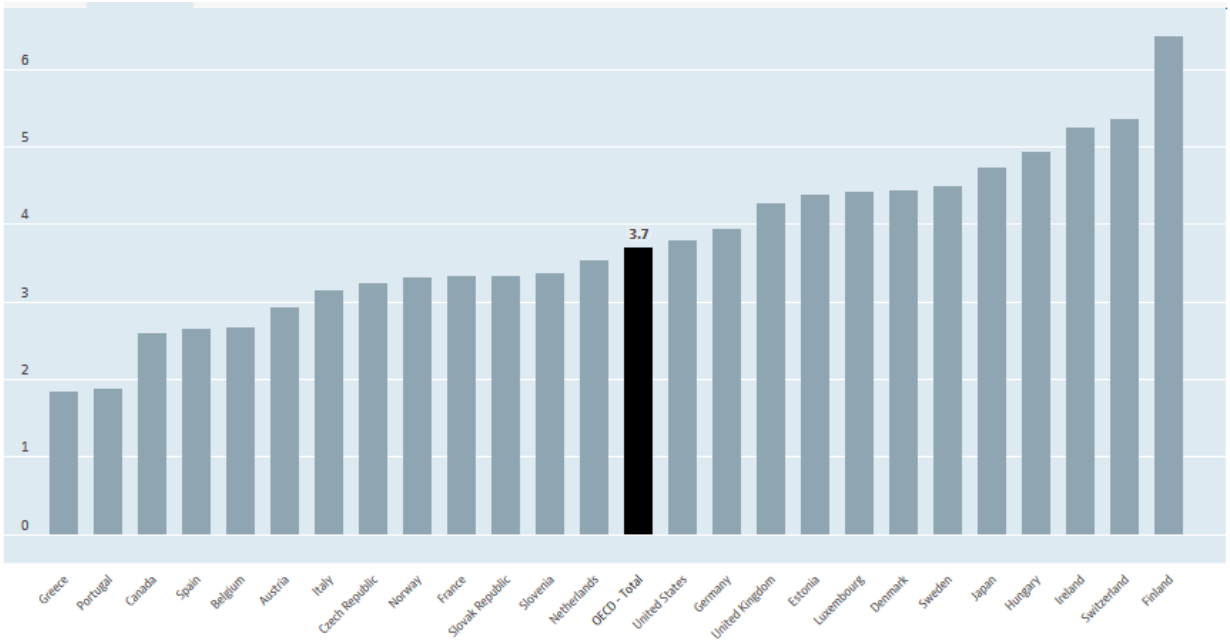
From the early days of modern economics, the sources of economic development remained a topic of discussion among economists. Solow (1958) links traditional production function to technological changes, whereas Romer (1986) focuses on the endogenous growth model. De Long and Summers (1991), Mankiw et al., (1992), Barro and Sala-i-Martin (1992) and Grossman and Helpman (1994) empirically highlighted physical capital and some external determinants of economic development. From the days of Solow (1958) many studies have considered information and communication technologies (ICT) as an important determinant of economic development. The advancement in information and communication technologies can impact economic development in a number of ways. First, ICT itself enhances economic growth with better and advance methods of production. Second, the ICT investment creates new employment opportunities and raises masses well-being at the aggregate level. Third, the economic returns due to advanced information and communication technologies are higher than ICT investment. If a country is operating with older ICT, the firms bear high transaction costs with higher risks as well (Hardy, 1980). Advanced ICT enables firms to enhance their productive ability and lower their transaction costs.

During the present age with globalisation, the socioeconomic and environmental structure is entirely changed from the last centuries. The conventional development model has failed in the case of developing countries (Robinson et al., 2006). ICT emerges as a new force to change culture, geography and socioeconomic environment of the world (Nasir and Kalirajan, 2016). The first decade of the present century brings dynamic changes in ICT, now people are more connected, well-educated and have better living conditions compared to their forefathers (Mago & Mago, 2015). Shirazi et al., (2009) and Bon et al., (2015) highlight the importance of ICT for democracy, finance, infrastructure, FDI and economic development. There are many valid reasons why ICT impacts the economic development of countries'. On one hand, most countries are working at their maximum level with the help of available human capital, and it is the availability of advanced ICT that increases the absorption capacity of the country at the maximum utilisation of existing human capital. On the other hand, traditional methods of production are unable to enhance output growth and overall economic development, at this stage advanced ICT helps in boosting economic development of a country (Steinmueller, 2001).

Advancement in information and communications technology enables an economy to work with the competitive global network economy for achieving its socioeconomic and political targets. Empiric evidence reveals that those economies, who have excelled in next generation technologies are mastering the whole world. Moreover, these economies are also deciding the economic growth process of other generations. The worldwide expenditures on ICT have reached $4 trillion during 2018 (International Data Corporation, 2018). This rising trend in investment is mostly due to private enterprise investment in different sectors of the economy and hybrid infrastructure of information and communication technologies. However, the

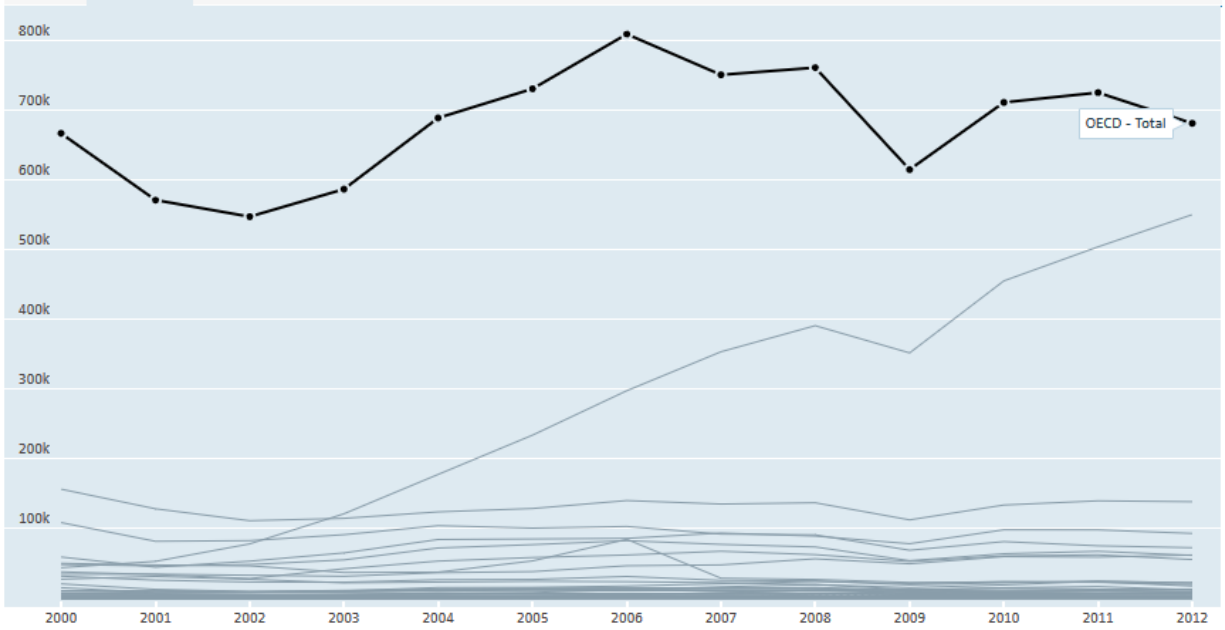
consumer market is also not far behind as more than $1.5 trillion was spent by consumers on ICT during 2018 and it is predicted that in the future this spending will reach to one third world spending. Around 80 percent of spending by the consumer is done on mobile and other devices of telecom services. It is expected that spending on information technology will be up to $2.16 trillion by the year 2019. The main reason behind this expansion is that the world is entering into a new phase of technology and the use of applications and IT will reach a new maximum level. Around, $300 billion expenditure is completed on outsourcing of businesses and consultancy every year. Only spending on telecommunications will reach $1.5 trillion by the year 2019, and around a 95 percent increase will occur in the services of mobile telecom. Mobile phones have become the largest sector of spending in technology and it is accounted to $500 billion in the year 2018.

Figure 1: Employment in ICT



Source: OECD, 2018

Figure 2: Investment in ICT



Source: OECD, 2018

Literature Review

There are a number of theoretical and empirical studies which examined the determinants and outcomes of advancement of information and communication technologies (ICT). But here most relevant and recent are selected as a literature review. Norton (1992) examines the link between telephone growth and the growth of macroeconomic indicators in the case of 47 developed and developing countries over the period of 1957 to 1977. The study finds that telecommunication has positive and significant impact on economic development, infrastructure of telecommunication reduces the overall transaction costs of firms. During the start of the 20th century, there is a reverse relationship between economic development and telecommunication infrastructure in the case of selected countries. Greenstein and Spiller (1995) explore the link between ICT and manufacturing sector growth of the USA. The estimated results of the study reveal that there is a positive and significant relationship between telecommunication growth and manufacturing sector growth in the USA.

Many studies find a negative relationship between economic development and ICT. Berndt et al., (1992) find that ICT has negative impact on industrial productivity in the case of the United States. ICT has negative associations with banking productivity in the case of Canada (Parsons et al., 1993). Morrison (1997) mentions that ICT has insignificant relation with ICT and firms' productivity. Hulten and Schwab [(1984) finds that the manufacturing sector is positively derived by ICT in the case of panel analysis. Kelejian and Robinson (1994) and Nadiri and Mamuneas (1996) mention that public infrastructure decides the level of domestic and foreign investment in the country. Lau and Tokutsu (1992) explain that ICT has a

positive contribution to economic growth in the case of the United States over the period of 1960 to 1990. Schreyer (2000) points out that ICT has a positive and significant impact on labor productivity in the case of G7 countries. Daveri (2000) also finds the same type of relationship in the case of OECD countries. Poh et al., (2001) finds a positive and significant relationship between ICT and overall productivity in the case of Singapore from 1977 to 1997. Kim (2003) finds the same type of relationship between ICT and overall productivity in the case of Korea from 1971 to 2000. Garcia-Mila and McGuire (1992) and Holtz-Eakin (1993) conclude that each country has a unique type of relationship between ICT and economic development because socioeconomic, political and cultural factors play significant role in deciding economic development.

Braga and Alberto (1998) point out that it is the desire of the country for ICT, which decides the role of ICT in the process of economic development. Because widespread ICT is attached to educated consumers and labour-force, moreover, the availability of institutions which promote and disseminate the existing knowledge. The study mentions that there are lots of socioeconomic disadvantages which put backward pressure on the advancement of ICT in the case of developing countries. Mansell and Wehn (1998) also find the same type of relationship in the case of developing countries. Castells (1999) studies the role of global financial markets and multinational corporations for the advancement of information and communication technologies. The results of the study reveal that global financial markets and multinational corporations are playing a significant role in the process of advancing ICT. Chowdhury (2000) defines poverty on the basis of different characteristics. The study points out that lack of accurate information and literacy rate are the main forces behind high poverty rates. The UN task force on ICT also highlights that a lack of ICT use in the case of developing countries is the main cause of poverty. The results of the study reveal that appropriate skills and telecommunication infrastructure reduce poverty. d'Orville (2000) also points out that telecommunication infrastructure plays a significant role in the process of economic development and poverty reduction at the same time. Brown (2001) mentions that there are a number of tools available for the reduction of poverty. The study finds that ICT creates new jobs and enhances overall economic development of a nation. So, it is the responsibility of the government to arrange the proper advance education system for the masses in this age of information.

Bresnahan et al., (2002) examine the relationship of ICT and firm productivity in the case of the USA over the period of 1987 to 1994. The ICT investment increases the innovation capacity of a nation, and innovation demands skilled workers, which further enhances overall economic development of a country. The results of the study reveal that USA firms which have adopted innovations demand skilled labour and heavily invested in ICT. The study concludes that ICT is attached with higher firms' productivity and overall economic development of the country. Brynjolfsson and Hitt (2003) use the same data set and examine the impact of computerisation on firms' productivity and output growth. The results of the

study reveal that ICT impacts productivity because firms have adopted advance methods of production. The study concludes that computerisation impacts output growth in the long run, but in the short run computerisation has minimal impact on output growth. The reason for a short run minimal impact is due to advanced ICT, the overall cost of the firm rises which lowers the profits of the firms. Barba-Sanchez et al., (2006) examine the relationship of firm productivity and internet in the case of Spanish firms. There are three main channels through which internet affects the productivity of a firm, first it reduces cost of production by reducing transaction and communication cost among the producers, distribution and consumers. Second, it increases the efficiency of the firm's management, because internet enables a firm to manage its supply chain procedure effectively and firms can quickly check the reaction of partners and customers as well. Third, the internet increases competition among firms and consumers receive transparent prices. Moreover, the internet puts pressure on producers and suppliers to adopt new and advance methods of production and distribution. The study concludes that the internet has a positive and significant impact on firm's productivity in the long term but may reduce productivity in the short term.

Polder et al., (2010) analyse the relationship of productivity and ICT in the case of 5000 Dutch firms over the period of 2002 to 2006. The investment on R&D is used as a measure of advancement of ICT. The study highlights that it is the process of innovation, which decides the level of ICT. As an input ICT plays an important role in the productivity of firms. The results of the study reveal that ICT investment is one of the main drivers of a firm's productivity in the case of Dutch firms. Cirera et al. (2016) examine the impact of ICT on the firms' productivity in the case of six Sub-Saharan countries. Zambia, Uganda, Tanzania, Kenya, Ghana and Democratic Republic of Congo are selected Sub-Saharan countries. The study reveals that although these countries are lagging behind the developed countries, the advance in ICT has a positive and significant impact on firms' productivity. But there is heterogeneity existing among the productivity of each nation. Kenya is using a larger number of internet access, software and computers in the production process, and productivity is largely impacted by ICT. The ICT of Tanzania and Democratic Republic of Congo has a lower impact on firms' productivity. The study suggests that ICT is an important factor in the production process of all selected countries, but this impact depends on the degree of innovation and development in ICT. Niebel (2018) examines the impact of ICT on economic growth in the case of selected developed, emerging and developing countries. For this purpose, 59 countries' data from 1995 to 2010 is used. The panel regression results show that ICT has a positive impact on GDP and capital growth. The estimated outcome reveals that the response of ICT is larger as compare to compensation of ICT. The results of the regression line show that developed, emerging and developing countries' economic growth has significant responsiveness towards ICT. But the estimate shows that developing countries are not achieving the desired economic growth due to lack of ICT.

The model

To examine the impact of advancement in information and communication technologies (ICT) on economic development, this study follows the basic Cobb-Douglas methodology for a set of panel countries.

$Y_{it}=f(K_{it},L_{it})$ (1)
Y = Economic Development
K = Physical Resources
L = Human Resources
i = with country
t = time period

This explains the economic development of set of panel countries depends on available human and physical resources. Studies like Kormendi and Meguire (1985), Grier and Tullock (1989), Barro (1991), Ghura (1997), Sala-i-Martin (1997), Barro and Sala-i-Martin (2003), Hendry and Krolzig (2004), Christopoulos and Tsionas (2004), Sala-i-Martin et al, (2004) and Ali and Rehman (2015) highlight some other determinants of economic development. But hardly any study explains the impact of advancement in information and communication technologies (ICT) on economic development. So, by using the procedures of the previous literature, the model of this study will is:

$ED_{it} = f(ICT_{it}, MES_{it}, TRADE_{it}, PHCAP_{it})$ (2)
ED = GDP per capita growth is used for measuring the economic development of the nations
ICT = ICT goods exports and imports (% of total goods exports and imports) are used for measuring the advancement in information and communication technologies
MES = GDP deflator is used for measuring the macroeconomic stability
TRADE = Percentage of merchandise trade excluding ICT imports and exports
PHCAP = Capital formation as a percentage of GDP is used for measuring the availability of physical resources
i = Selected countries (87 developed and developing countries)
t = Time period (2000 to 2017)

Econometric Methodology

For examining the stationarity of the data LLC, IPS and ADF-FC unit root tests, Levin et al., (2002) have developed a panel unit root with the help of unique specifications. The LLC unit root test is based on the homogeneity of the panel and unlike others the LLC unit root test follows the procedure of ADF in the process of the unit root problem in the data set. The common form of an LLC is as:

$$\Delta y_{i,t} = \gamma_{0i} + py_{it-1+} \sum_{i-1}^{pi} \gamma_{1i} \Delta y_{i,t-j} + u_{i,t} \quad (3)$$

γ_{0i} is intercept in the equation (3) with is unique across the cross sectional entities and p is identical for the autoregressive coefficient, whereas γ_i denotes lag order, $u_{i,t}$ is the residual term which has been supposed to be independent for all the across of panel entities. The equation (3) follows the ARMA stationary process for each cross section is:

$$u_{i,t} = \sum_{j-0}^{\infty} \gamma_{1i} \Delta y_{i,t-j} + \varepsilon_{i,t} \quad (4)$$

Following the equation (4), null and alternative hypotheses can be developed as:

H_0: $p_i = p = 0$

H_a: $p_i = p < 0$ for all i

LLC model is based on t-statistic, where p is supposed to fix across the entities under the null and alternative hypothesis.

$$t_p = \frac{\overset{\Lambda}{p}}{\overset{\Lambda}{SE(p)}} \quad (5)$$

In this whole procedure, we have supposed that the residual series is white noise. Further, the regression of the panel has t_p test statistic, which presents the convergence of standard normal distribution when N and $T \to \infty$ and $\sqrt{\frac{N}{T}} \to 0$. On the other hand, if any sectional unit is not independent, then the residual series are corrected and have an issue of autocorrelation. Under such circumstances the LLC test proposes a modified test statistic as:

$$t_p = \frac{t_p - N\hat{T}\overset{\wedge}{S_N}\overset{\wedge -2}{\sigma}(\hat{p})u_m^*}{\sigma_m^*} \quad (6)$$

Where u_m^* and σ_m^* are modified the error term and standard deviation of the error term, the values of these are generated from Monte Carlo Simulation by LLC (2002).

Im et al., (2003) develop a panel stationarity test in the case when panel data is heterogeneous. This panel unit root test is also based on ADF unit root methodology, but this test is based on the arithmetic mean of individual series, this test is as follows:

$$\Delta y_{i,t} = \bar{w}_i + p y_{it-1+} \sum_{i-1}^{pi} \gamma_{1i} \Delta y_{i,t-j} + v_{i,t} \quad (7)$$

The IPS test allows for heterogeneity in v_i value, the IPS unit root test equation can be written as:

$$\bar{t}_T = \frac{1}{N} \sum_{i-1}^{N} t_{1,i}(p_i) \quad (8)$$

Where $t_{i,t}$ is the ADF test statistic,p_i is the lag order. For the calculation process, this test follows:

$$A_t - = \frac{\sqrt{N(T)}[\bar{t}_T - E(t_T)]}{\sqrt{Var(t_T)}} \quad (9)$$

Following the existing literature, researchers consider panel data analysis the most efficient procedure for data handling in econometrics. Our selected panel data is a balanced panel data set, and following the properties of selected data we have used fixed effect method. The intercept is considered group specific in the case of the fixed effect method. It reveals that the selected model can provide different intercepts for every group. Following the procedure of fixed effect analysis, it is also known as a dummy variable, because when every group has a different intercept in one equation then a specific dummy has been introduced for every group. So, the following equation becomes:

$$Y_{it} = \alpha_i + \beta_1 X_{1it} + \beta_2 X_{2it} + ... + \beta_k X_{kit} + u_{it} \quad (10)$$

Which can be written in a matrix notation as:

$$Y = D\alpha + X\beta' + u \quad (11)$$

$$Y=\begin{pmatrix} Y_1 \\ Y_2 \\ . \\ . \\ . \\ Y_N \end{pmatrix}, \quad D=\begin{pmatrix} i_T & 0..... & 0 \\ 0 & i_T & 0 \\ 0 & 0 & i_T \end{pmatrix}_{NTxk}$$

$$X=\begin{pmatrix} x_{11} & \cdots & x_{1k} \\ \vdots & \ddots & \vdots \\ x_{N1} & \cdots & x_{NK} \end{pmatrix}_{NTxk}$$

$$\alpha=\begin{pmatrix} \alpha_1 \\ \alpha_2 \\ . \\ . \\ . \\ \alpha_N \end{pmatrix}_{Nx1} \quad \beta^{/}=\begin{pmatrix} \beta_1 \\ \beta_2 \\ . \\ . \\ . \\ \beta_k \end{pmatrix}_{Nx1}$$

Here the dummy variable takes different groups specific estimation procedures in the case of each section separately. For checking the validity of the fixed effects method, we can apply the Hausman test.

This study uses panel the Granger causality test for examining the causality among the variables of the model. The panel Granger causality test has several benefits when compared to other panel causality tests. The panel Granger causality test has the ability to control for individual heterogeneity, it can increase the precision of the regression estimates, it can reduce the identified problems and it has the ability check the model temporal impacts without aggregation bias. For testing the relationship between two variables in the Granger sense, following linear panel model can be used.

$$Y_{it}=\alpha_i+\sum_{k=1}^{K}\gamma_i^{(k)}y_{it-k}+\sum_{k=1}^{K}\beta_i^{(k)}T_{it-k}+E_{it} \qquad (12)$$

Here α_i measures the individual specific effect across *i*, and the coefficients $\gamma^{(k)}$ and $\beta^{(k)}$ are implicitly assumed to be constant for all *i*.

The null hypothesis of the test is $\beta^{(1)} = ... \beta^{(K)} = 0$, there is no causal relationship between x and y, whereas the alternative hypothesis is that x and y have a causal relationship for all the cross-sectional units.

Results and Discussion

This study analyses the effect of the advancement in information and communication technologies on economic development in the case of 87 developed and developing countries. This study uses 58 developing countries and 29 developed countries, the list of selected countries are given in the appendices. The developed and developing countries are selected from the International Monetary Fund's World Economic Outlook Database, October 2018. The outcomes of the descriptive statistic are given in appendix Table A1. The outcomes explain that the average value of economic development in developing countries is greater than developed countries, whereas the average values of advancement in information and communication technologies is higher in developed countries as compared to developing countries. The results of descriptive statistic reveal that the whole sample and in the developing countries case, all variables have positive skewness and kurtosis during the selected time frame. The results reveal that developed countries' data has a positive kurtosis and skewness except the economic development variable. The overall results of descriptive statistic reveal that all the selected variables meet all the requirements of the panel analysis.

The estimated results of the correlation matrix are presented in appendixes Table 2A, Table 3A and Table 4A. The results of the whole sample show that economic development has significant and positive correlation with advancement in information and communication technologies, macroeconomic stability, merchandised trade and availability of physical resources. Advancement in information and communication technologies has a positive and significant correlation with merchandised trade and availability of physical resources, but advancement in information and communication technologies has negative and significant correlation with macroeconomic stability. Macroeconomic stability has negative and significant correlation with merchandised trade and availability of physical resources. Merchandise trade and the availability of physical resources have significant and positive correlation. The results of selected developed countries show that economic development has positive and significant correlation with advancement in information and communication technologies, macroeconomic stability, merchandised trade and availability of physical resources. Advancement in information and communication technologies has positive and significant correlation with merchandised trade and availability of physical resources. Whereas advancement in information and communication technologies has negative and insignificant correlation with macroeconomic stability. Merchandise trade and macroeconomic stability have negative and insignificant correlation. The availability of physical resources has positive and significant correlation with macroeconomic stability and merchandised trade in the case of developed countries. The results of developing countries

reveal that economic development has a positive and significant correlation with advancement in information and communication technologies, macroeconomic stability, merchandise trade and availability of physical resources. Advancement in information and communication technologies has positive and significant correlation with merchandised trade and availability of physical resources. Advances in information and communication technologies and macroeconomic stability have negative significant correlation. Merchandise trade has positive and significant correlation with macroeconomic stability, where macroeconomic stability has negative and insignificant correlation with availability of physical resources. Merchandise trade has positive and significant correlation with availability of physical resources in the case of developing countries.

This study has used data over the period of 2000 to 2017. Therefore, for checking the stationarity of the variables, PP-Fisher Chi-square (PP-FC), ADF-Fisher Chi-square (ADF-FC), Im, Pesaran and Shin W-stat (IP&S) and Levin, Lin & Chu t* (LLC) unit root tests have been applied. The estimated results of the unit root tests are presented in appendix Table 5A. The results of the LLC, IPS and ADF-FC show that all the selected variables are stationary in all selected categories (whole sample, developed countries and developing countries).

This study is based on panel analysis, following the nature of the data, this study will use the random effects model or fixed effects model for empirical analysis. So, for this purpose the Hausman test is used. The Hausman test can use endogenous regressors for estimating the selected regression model. For this purpose, the endogenous variables follow a unique system of equations. If the regressors are endogenous in the model, then the ordinary least squares method is unable to estimates the model due to violation of OLS assumptions of no correlation between error term and explanatory variable. So, as an alternative now the instrumental variables can be used for an estimation process. In the analysis process of panel data, the Hausman test provides help in choosing between the random effect and fixed effect models. The acceptance of null hypothesis means we use random effects; while in other case we use fixed effects. The results of the Hausman test are presented in Table 1. The estimated results of the Hausman test reveal that fixed effects analysis is more appropriate for whole sample analysis, for developed country analysis and for developing country analysis.

Table: 1: Random Effects - Hausman Test

Whole Sample			
Test cross-section random effects			
Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	31.966733	4	0.0000
Developed Counties			
Cross-section random	9.525418	4	0.0492
Developing Countries			
Cross-section random	23.751016	4	0.0001

The results of fixed panel least squares are presented in Table 2. The estimated results of the whole sample reveal that advancement in information and communication technologies has a positive but insignificant influence on economic development. Stiroh (2005) points out that developing countries' economic progress is less inclined to advancement in information and communication technologies as compared to developed countries. Most developing countries are still using old methods of communication. Merchandised trade has a positive and significant impact on economic development, the estimates reveal that 1 percent increase in merchandised trade increases economic development by (0.036815) percent. Following the ideology of comparative advantage both developed and developing countries gain from trade. The results reveal that macroeconomic stability has a positive and significant impact on economic development, it shows that a 1 percent rise in macroeconomic stability raises economic development by (0.028943) percent. The availability of physical resources has a positive and significant impact on economic development, the results reveal that a 1 percent increase in available physical resources (0.143125) percent increase is occurring in economic development.

The results of developed countries reveal that advancement in information and communication technologies has a positive and significant effect on economic development, a 1 percent increase in advancement in information and communication technologies (0.014437) percent increase is occurring in economic development in the case of developed countries. With the help of advancement in information and communication technologies, developed countries can provide easy delivery of public services and efficient business transaction in the process of economic development. Our findings are similar to the findings of Wang (1999), Roller and Waverman (2001), Hameed (2007), Kamel et al., (2009), and Timmer et al., (2011). The coefficient of merchandised trade reveals that merchandised trade has a positive and significant impact on economic development in the case of developed countries. The estimates reveal that a 1 percent increase in merchandise trade (0.024156)

percent increase is occurring in economic development. With liberalised trade, developed countries can increase their share in international markets and earn more profit for enhancing their economic development (Todaro and Smith, 2012). Moreover, with the help of comparative advantage, developed countries earn more (Ricardo, 1891). Macroeconomic stability has a significant and positive effect on economic development in the case of developed countries, a 1 percent rise in macroeconomic stability (0.124905) percent increase in economic development is occurring. Rising macroeconomic instability can hurt the economy, but developed countries have stable macroeconomic environment. Our findings can be supported by Bhatia (1960). The results reveal that availability of physical resources has a positive and significant impact on economic development in the case of developed countries. The estimates explain that a 1 percent increase in available physical resources by (0.251412) percent increase is happening in economic development. The availability of physical resources is the life blood of an economy (Averitt, 1987). The findings of our study are similar to Landau and Jorgenson (1989), Chow (1993) and Rosenstein-Rodan (2013).

The estimated results of developing countries explain that advancement in information and communication technologies has negative, but insignificant impact on economic development. The advancement in information and communication technologies is attached with higher labour productivity, which further enhances economic development of the country (Niebel, 2018). But developing countries are still attached to old methods of production as well as have outdated information and communication technologies. Erdil (2010), Samimi (2010) and Niebel (2018) also mention that advancement in information and communication technologies has an insignificant impact on economic development in the case of developing countries. The estimates show that merchandised trade has a positive and significant impact on economic development in the case of developing countries, a 1 percent increase in merchandised trade increases economic development by (0.061447) percent. The proponents of trade liberalisation use empirical evidence to show that rising merchandised trade is more beneficial as compared to developed countries [Gillis et al., (1992), Esping-Andersen (1996), Hummels et al., (2001), Yanikkaya (2003), Cuervo-Cazurra and Genc (2008)]. The results of our study support the ideologies of proponents of trade liberalisation for higher economic development in the case of developing countries. The results reveal that macroeconomic stability has a positive and significant impact on economic development in the case of developing countries, it shows that 1 percent rise in macroeconomic stability raises economic development by (0.018901). Dorrance (1963), Bleaney (1996), Fischer (1993), Ali (2015) and Ali and Rehman (2015) empirically examine that macroeconomic stability is necessary for higher economic progress. The results of our study support the idea that macroeconomic stability enhances economic development in the case of developing countries. The availability of physical resources has a positive and significant impact on economic development in the case of developing countries, the results reveal that 1 percent increase in available physical resources (0.099508) percent increase is occurring in economic development. Our findings are in-line with the findings of King and Levine (1994), Auty

(2001), Ali (2015), Ali and Rehman (2015), Chow (2017). This shows that availability of physical capital is vital in the process of economic development.

Table: 2: Method: Panel Least Squares

Variables	Whole Sample	Developed Countries	Developing Countries
Dependent Variable: ED			
ICT	0.016246	0.014437*	-0.007401
TRADE	0.036815***	0.024156***	0.061447***
MES	0.028943**	0.124905*	0.018901*
PCAP	0.143125***	0.251412***	0.099508***
Constant@	-3.599266***	-6.503656***	-3.114149***
R^2	0.305957	0.224214	0.312256
Adjusted-R^2	0.263608	0.173447	0.269535
No. Observation	1566	522	1044
Note: ***,**,* present significance level 1%, 5% and 10% respectively.			

The results of the panel Granger causality test are presented in Table 3. The results of the whole sample reveal that bidirectional causality is running between advancement in information and communication technologies and economic development, between merchandised trade and economic development, between macroeconomic stability and economic development, between availability of physical resources and economic development, between merchandised trade and advancement in information and communication technologies and between macroeconomic stability and merchandised trade. The estimated results reveal that unidirectional causality is running from advancement in information and communication technologies to macroeconomic stability, from availability of physical resources to merchandised trade, and from the availability of physical resources to macroeconomic stability. The estimates show that there is no causal relationship between advancement in information and communication technologies and availability of physical resources.

The results of developed countries in Table 3 reveal that there is a bidirectional causality running between advancement in information and communication technologies and economic development, between merchandised trade and economic development, between macroeconomic stability and economic development in the case of developed countries. The estimated results show that there is unidirectional causality running from economic development to availability of physical resources, from merchandised trade to advancement in information and communication technologies, from macroeconomic stability to

advancement in information and communication technologies, from macroeconomic stability to merchandised trade, from availability of physical resources to merchandised trade, from availability of physical resources to macroeconomic stability in the case of developed countries. The results show that there is no causal relationship between advancement in information and communication technologies and availability of physical resources in the case of developed countries.

The results of developing countries in Table 3 show that there is no causal relationship between advancement in information and communication technologies and economic development, between advancement in information and communication technologies and macroeconomic stability, between advancement in information and communication technologies and availability of physical resources, between macroeconomic stability and availability of physical resources in the case of developing countries. The estimates reveal that unidirectional causality is running from economic development to merchandised trade, from economic development to macroeconomic stability, from economic development to availability of physical resources, from advancement in information and communication technologies to merchandised trade, from availability of physical resources to merchandised trade in the case of developing countries. The results show that there is bidirectional causality running between macroeconomic stability and merchandised trade in the case of developing countries.

Table: 3: Panel Granger Causality

Whole Sample	Developed Countries	Developing Countries
ICT ⟺ ED	ICT ⟺ ED	ICT = ED
TRADE ⟺ ED	TRADE ⟺ ED	TRADE ⟸ ED
MES ⟺ ED	MES ⟺ ED	MES ⟸ ED
PCAP ⟺ ED	PCAP ⟸ ED	PCAP ⟸ ED
TRADE ⟺ ICT	TRADE ⟹ ICT	TRADE ⟸ ICT
MES ⟸ ICT	MES ⟹ ICT	MES = ICT
PCAP = ICT	PCAP = ICT	PCAP = ICT
MES ⟺ TRADE	MES ⟹ TRADE	MES ⟺ TRADE
PCAP ⟹ TRADE	PCAP ⟹ TRADE	PCAP ⟹ TRADE
PCAP ⟹ MES	PCAP ⟹ MES	PCAP = MES

Conclusions

This article has examined the impact of advancement in information and communication technologies (ICT) on economic development. A panel of 87 countries is selected for this purpose, among them 58 developing countries and 29 developed countries. The data from 2000 to 2017 is used for empirical analysis. The developed and developing countries are selected following the ranking of International Monetary Fund's World Economic Outlook Database, October 2018. The list of the selected countries is given in the appendices. This article uses three types of analysis, first is based on a whole sample, and for comparative analysis developed and developing countries' analysis is done separately. Economic development is used as a dependent variable and the advancement in information and communication technologies (ICT), merchandised trade, macroeconomic stability and availability of physical resources are taken as independent variables. The results of the panel least squares reveal that advancement in information and communication technologies has an insignificant relationship with economic development, whereas the advancement in information and communication technologies is playing a positive and significant role in the economic development of developing countries. This shows that developed countries are getting more benefits from advancement in information and communication technologies as compared to developing countries in the process of economic development. Trade is playing a more significant role in the case of developing countries as compared to developed countries. Following the traditional HO model, small countries gains more as compared to developed country. Developed countries have more stable macroeconomic environments as compared to developing countries, so macroeconomic stability is playing more significant role in the case of developed countries. Economic development of developing countries is more vulnerable to macroeconomic situations. A little macroeconomic instability hurts economic development of developing countries as compared to developed countries. Developed countries have more availability of physical resources, so they have higher economic development as compared to developing countries. The overall results reveal that merchandised trade, macroeconomic stability and availability of physical resources play a significant role in the process of economic development. If developing countries want to achieve higher economic development, they must increase trade and physical capital with stable macroeconomic environment. Moreover, developing countries should adopt advancement in information and communication technologies (ICT) to compete with developed countries in the process of economic development.

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APPENDIXES

Selected Countries (87)

Albania, Argentina, Armenia, Australia, Azerbaijan, Bangladesh, Barbados, Belarus, Benin, Bolivia, Botswana, Brazil, Bulgaria, Cambodia, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Ecuador, Egypt Arab Rep., El Salvador, Estonia, Finland, France, Georgia, Germany, Greece, Guatemala, Guyana, Honduras, Hong Kong SAR China, Hungary, India, Israel, Italy, Jamaica, Japan, Kazakhstan, Korea Rep., Kyrgyz Republic, Lebanon, Luxembourg, Macedonia FYR, Madagascar, Malaysia, Malta, Mauritius, Mexico, Moldova, Morocco, Namibia, Netherlands, New Zealand, Niger, Norway, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Senegal, Singapore, Slovenia, South Africa, Sri Lanka, Sudan, Sweden, Switzerland, Tanzania, Thailand, Togo, Tunisia, Uganda, Ukraine, United Kingdom, United States, Uruguay

Developed Countries (29)

Australia, Canada, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Greece, Hong Kong SAR China, Hungary, Israel, Italy, Japan, Korea Rep., Luxembourg, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, Slovenia, Sweden, Switzerland, United Kingdom, United States

Developing Countries (58)

Albania, Argentina, Armenia, Azerbaijan, Bangladesh, Barbados, Belarus, Benin, Bolivia, Botswana, Brazil, Bulgaria, Cambodia, Cameroon, Chile, China, Colombia, Costa Rica, Ecuador, Egypt Arab Rep., El Salvador, Georgia, Guatemala, Guyana, Honduras, India, Jamaica, Kazakhstan, Kyrgyz Republic, Lebanon, Macedonia FYR, Madagascar, Malaysia, Mauritius, Mexico, Moldova, Morocco, Namibia, Niger, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Romania, Russian Federation, Senegal, South Africa, Sri Lanka, Sudan, Tanzania, Thailand, Togo, Tunisia, Uganda, Ukraine, Uruguay

Table: 1A: Descriptive Statistic

Whole Sample										
Variables	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Sum	Sum Sq. Dev.	Observations
ED	2.616249	2.404915	33.03049	-15.34	3.573984	0.457809	9.717826	4097.045	19990.31	1566
ICT	14.74353	8.080445	106.4842	0.009781	17.48072	2.514855	9.704974	23088.37	478226.0	1566
MES	5.364170	3.499383	185.2908	-25.1281	8.333169	8.577816	153.3275	8400.290	108676.3	1566
TRADE	69.61188	56.91666	419.9623	7.780557	48.41950	3.209906	17.66679	109012.2	3669062.	1566
PHCAP	22.76304	22.10616	57.71025	11.19994	5.500307	1.169926	5.945857	35646.92	47346.54	1566
Developed Countries										
ED	1.721908	1.753553	13.21649	-14.5599	2.874784	-0.6792	6.586949	898.8360	4305.744	522
ICT	22.51314	15.57214	106.4842	4.445004	19.39329	2.064799	7.269951	11751.86	195948.0	522
MES	2.034785	1.881128	15.43445	-6.00773	2.160237	1.008342	8.019990	1062.158	2431.310	522

TRADE	83.85698	58.77439	419.9623	17.24737	70.63683	2.454544	9.287914	43773.34	2599562.	522
PHCAP	22.35667	22.10941	36.73959	11.51858	3.869718	0.348347	3.758721	11670.18	7801.826	522
Developing Countries										
ED	3.063419	2.853056	33.03049	-15.3	3.799668	0.572286	9.752333	3198.209	15058.29	1044
ICT	10.85873	5.685005	93.84192	0.009781	15.01073	3.166741	13.57369	11336.51	235010.8	1044
MES	7.028862	5.248794	185.2908	-25.1281	9.671773	7.752427	121.2794	7338.132	97565.55	1044
TRADE	62.48933	55.82179	192.1234	7.780557	29.54775	1.004724	4.126743	65238.86	910611.6	1044
PHCAP	22.96623	22.10346	57.71025	11.19994	6.147391	1.154403	5.272110	23976.74	39415.41	1044

Table: 2A: Correlation Analysis: Ordinary: Whole Sample

Variables	ED	ICT	MES	TRADE	PHCAP
ED	1.000000				
ICT	0.058118**	1.000000			
MES	-0.139201***	-0.153516***	1.000000		
TRADE	0.114880***	0.536710***	-0.025009	1.000000	
PHCAP	0.303343***	0.109765***	-0.009139	0.135090***	1.000000
Note: ***,**,* present significance level 1%, 5% and 10% respectively.					

Table: 3A: Correlation Analysis: Ordinary: Developed Countries

Variables	ED	ICT	MES	TRADE	PHCAP
ED	1.000000				
ICT	0.233321***	1.000000			
MES	0.207111***	-0.044698	1.000000		
TRADE	0.239979***	0.710366***	-0.031598	1.000000	
PHCAP	0.307524***	0.237066***	0.240085***	0.209142***	1.000000
Note: ***,**,* present significance level 1%, 5% and 10% respectively.					

Table: 4A: Correlation Analysis: Ordinary: Developing Countries

Variables	ED	ICT	MES	TRADE	PHCAP
ED	1.000000				
ICT	0.073059**	1.000000			
MES	0.090962***	-0.090919*	1.000000		

		**			
TRADE	0.134062***	0.253534***	0.080034***	1.000000	
PHCAP	0.298219***	0.100991***	-0.044516	0.163909***	1.000000
Note: ***,**,* present significance level 1%, 5% and 10% respectively.					

Table: 5A: Panel Unit Root

	Whole Sample			Developed Countries			Developing Countries		
Variables	LLC	IPS	ADF-FC	LLC	IPS	ADF-FC	LLC	IPS	ADF-FC
ED	-12.12***	-10.58***	409.2***	-8.47***	-6.76***	147.2***	-8.99***	-8.18***	262.0***
ICT	-6.35***	-4.16***	250.9***	-5.11***	-2.10**	77.94**	-3.91***	-3.61***	172.9***
TRADE	-4.85***	-2.22**	211.6**	-3.92***	-1.59*	70.65*	-4.29***	-2.65***	154.3***
MES	-8.73***	-8.89***	364.9***	-5.09***	-4.71***	114.3***	-7.14***	-7.56***	250.6***
PCAP	-4.42***	-2.59***	211.6**	-4.15***	-3.57***	98.1***	-3.66***	-1.89**	140.9***
Note: ***,**,* present significance level 1%, 5% and 10% respectively.									