Chapter 10
FDI, ICT and Economic Growth in Developing Countries: An Empirical Analysis

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10.1 Introduction

Inflows of foreign direct investment (FDI) are well recognized as one of the efficient channels for transferring the advanced technologies and fostering economic growth in developing nations. A group of some mainstream economists under the school of New Theory of Economic Growth considers FDI inflow as a driver of the engine of growth of the economy. They think that inflows of FDI affect not only the per capita economic output but also the rate of economic growth. Bringing this background into the current phase of globalization, it would be observed that advancement of technology through the means of FDI inflows having a vital role in the economic growth process is deeply fuelled by the promotion of information and communication technology (ICT) particularly in developing countries. It is a fact that during last three decades, globalization has performed with its high-speed engine particularly in developing world as reflected in terms of chunk amount of FDI flows, volume of trade, etc., and ICT has also entered into the process with its long and wide wings as a complementary matter. However, with the versatile views several studies document manly two kinds of empirical outcomes; firstly, the huge amount of FDI inflows is nothing but a results of a parallel upgradation of ICT base in developing nations, and another side says that the observed development of ICT in developing

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economies is a complementary results of a big size of FDI inflows from developed world. So, in order to find out the dynamic impacts of FDI on economic growth the present scenario should incorporate ICT as one of the most important drivers of digitalization in developing countries.

The improvement of ICT has made the globalization as a truth mainly in developing economies. Moreover, ICT enables the respective nations to extract their potentiality in economic sphere in terms of the expansion in productivity and competitiveness, and it can also augment the economic efficiency through spreading the flow of relevant information across various sectors, communities, producers, consumers as well as policy planners within and between nations. Through the channel of growing global linkages ICT directly affects FDI inflows significantly, and it also might be considered as a determinant of FDI inflows[1] and economic growth. According to the theoretical view in economics, knowledge developed from international economic activity is important for all nations; in particular for those lagging behind the developed ones. For instance, ICT puts forth a direct impact on two important determinants of economic activities, such as innovation and entrepreneurship.

The newly developedinformation-based economy during last two and half decades is associated with the development of ICTs, which are anticipated to raise efficiency and foster economic growth (Dimelisa and Papaioannou 2010). Through all of these outcomes, inflows of FDI enable the hosting country to achieve a better growth trajectory (Lee 2013).[2] Moreover, FDI inflows, especially from the developed to the developing nations may be act as a stimulus to the ICT investment, as the improvement in ICT eases the process of the advancement of technology and skill formation in the latter countries. Therefore, FDI inflow can expand use the use of ICT and ICT expansion may stimulate FDI inflow, and that is why hypothetically both FDI and ICT should have their positive multiplier effects on economic performances of the country. It is also worth to be noted that progress of ICT and FDI inflow both have numerous beneficial influences on the developing trends of the society.

Based upon these underlying theoretical views, to the best of analytical knowledge gathered, as of now a few empirical research works have been conducted by researchers and policymakers for examining the influence of ICT on the expansion of economic activities in several countries. Findings of the existing studies are not unambiguous particularly in developing economies. Moreover, there are a couple of studies exploring impacts of FDI on economic performances where ICT is also taken into account in mostly in the cases of developed countries. The results of the existing

[1]The finding of the study of Gani and Sharma (2003) reveals that ICT and the transmission of the new instruments of ICT, i.e., internet hosts, mobile phones, etc., are playing as important 'pull' factors for the volume of FDI inflows. Gholami et al. (2006) have identified that in the developed countries there is a causal relationship between ICT and FDI inflows, i.e., rise in the investment for the expansion of ICT investment will increase the FDI inflow.

[2]FDI inflow and GDP growth linkage can be sketched from early neoclassical theories of growth. According to them, FDI inflow raises capital stock of the hosting nations and promotes economic growth. It is also revealed from the new theories of economic growth that inflow of FDI enables a nation to achieve a better trajectory of economic growth not only in short-run but also in long-run. This achievement can be realized through technological improvement in the production process.

studies based on the developed countries substantiate some positive influences of FDI inflows and ICT on economic growth. However, for the developing nations there is no unambiguous result on the relationships. Furthermore, the number of studies investigating the impacts of FDI and ICT on economic output is relatively sparse and country-specific for both developed and developing nations.

Therefore, there is a necessity to look at the dynamic impacts of FDI inflows and evolution ICT on gross domestic product (GDP) across a group developing nations which experience a considerable amount of FDI inflows to those countries. Against this background, the present study attempts to conduct an empirically investigation to provide an insight into the impacts of the inflows of FDI and expansion of ICT on economic expansion measured by GDP growth in selected 36 developing nations during the era of digitalization. The remainder of the chapter is organized as follows. The next section carefully documents the brief review of available, related and existing literature followed by the discussions on data sources and methodological issues used in this empirical study. Empirical results are well described thereafter, and the final section concludes the study.

10.2 Review of Literature

With the vast background of theoretical and empirical literature analysing the economic impacts of FDI inflows, the choice of studies incorporate both FDI and ICT together in order to look into their significances in economic growth during the recent past is really a difficult issue particularly in developing countries. Reviewing the studies which are carried out to examine the effects of FDI inflows on economic performances, different types of findings have been observed. The outcomes of Hejazi and Safarian (1999) reveal that FDI inflow is an important way for technology dissemination across the OECD countries. Invoking both panel data regression and time series regression techniques, and by using the data collected from some OECD and non-OECD countries during the period from 1970 to 1990, De Mello (1999) showed that the effects of capital inflows for direct investment on economic growth depend on the complementarity or substitutability between domestic and foreign capital across the hosting nations. By using panel data set of 24 Chinese provinces over the period of 1985–1996, Barthelemy and Demurger (2000) found a significant direct influence of the inflow of foreign capital on the expansion of economic activities, i.e. on economic growth. Likewise, Alfaro (2003) identified that rise in the inflow of FDI does not raise the GDP of the hosting country unambiguously. More specifically this study has found that rise in FDI inflow has a negative influence on the growth of the primary sector and a positive influence on the growth of the manufacturing sector.

Using the data from 66 developing nations, Makki and Somwaru (2004) pointed out a positive influence of FDI inflow and exports on economic growth. Using the data set collected from some selected East and Southeast Asian nations, Hsiao and Hsiao (2006) recommended a unidirectional direct and indirect influence of FDI inflow on the GDP through exports. Sharma (2013) referred that FDI inflows perform as an

amplifier for the growth of the economy and subsequently promote employment and output through entering different external investment activities in host economies. Sahoo et al. (2014) reviewed the consideration of the classical economists referring that FDI inflow is a driver of economic growth having a positive influence on per capita income. Kida (2014) examined the dynamic inter-linkage between FDI inflow and economic growth within Solow and endogenous growth models, results imply that a direct influence of FDI inflow on economic growth in both developing and developed countries. Sârbu (2015) documented that countries experience better economic growth while receiving better FDI inflow.

During last twenty years, a considerable number of research works are conducted to examine the influence of ICT on the growth of the productivity (Brynjolfsson and Hitt 1996; Timmer and Van Ark 2005; Chun and Nadiri 2008), and also on the expansion of economic activities and growth (Jorgenson and Stiroh 1995; Mansell and Wehn 1998; Pohjola 2001; Papaioannou and Dimelis 2007; Ishida 2015; Erumban and Das 2016). Findings of most of those studies reveal the direct relationship between the expansion of ICT and economic growth of the respective nation. However, observing the findings of these studies it can be identified that there is a sharp disparity between developed and middle- or low-income countries while we focus on the effects of the advancement of ICT on economic growth. According to the findings of these studies, advancement of ICT influences economic growth positively and significantly across the developed countries. However, the expansion of ICT base through the rise in investment in this sphere has no significant influence on economic growth for the middle countries and poor income countries across the world (Pilat and Lee 2001). However, Kraemer and Dedrick (1994) conducted a study by using the data set of 12 Asia Pacific nations and found a quite different result, i.e. there is a positive and significant correlation between growths in investment in information technology and GDP.

Most of the studies discuss these two above-mentioned factors (FDI and ICT) separately mainly in country-specific cases. However, a single analysis gathering a group of countries in order to find out economic impacts of FDI and ICT is really rare as of now. This background encourages conducting the present study.

10.3 Data and Methodology

The study builds up a balance panel of selected 36 developing countries[3] across the world from 2001 to 2017. All regions of the world are equally treated in order to choose countries for empirical illustrations with the consideration of the latest formula of the World Bank classifications of countries as per their per capita income

[3] Argentina, Azerbaijan, Bangladesh, Brazil, Cambodia, China, Colombia, Costa Rica, Dominican Republic, Egypt, Ethiopia, Ghana, India, Indonesia, Iran, Kazakhstan, Lebanon, Malaysia, Mexico, Morocco, Mozambique, Myanmar, Nigeria, Pakistan, Panama, Peru, Philippines, Romania, Russia, Serbia, South Africa, Thailand, Turkmenistan, Ukraine, Uzbekistan and Vietnam.

level. Finally, the countries are selected as per their performances in receiving of FDI inflows during current period. Besides FDI, ICT and GDP, the study employs some other variables to control them in regression analysis like gross domestic capital formation (DFC), volume of trade (TRD) measured by export plus import and real effective exchange rate (EXR) as a standard measure of foreign exchange rate. Data on all variables except ICT are collected from World Development Indicators (WDI) of the World Bank (2018). International Telecommunication Union (2018) provides the World Telecommunication Indicators (WTI) database, from which the data on ICT as per standard measure is collected for those countries over the same period.

In this study, the estimation of generalized method of moments (GMM) as prescribed by Arellano and Bond (1991) is employed within a dynamic panel structure in order to control the endogeneity issues. The regression models with panel data are more competent for controlling the individual level heterogeneity by gathering more information as compared to time series and cross-sectional data. To conduct the dynamic panel regression analysis, first the study uses Levin et al. (2002) and Im et al. (2003) proposed panel unit root test in order to examine the stochastic features of variables. Equation (10.1) presents the augmented Dickey–Fuller (ADF) specified panel unit root test.

$$\Delta y_{it} = \rho y_{i,t-1} + \sum_{j=1}^{P_i} \eta_{ij} \Delta y_{i,t-1} + X'_{it}\delta + \varepsilon_{it} \tag{10.1}$$

Levin et al. (2002) test allows the intercept including residual variances and the dynamic trends with autocorrelation order; however, it requires the auto-generated time series data with general sample size and the coefficient of autocorrelation (ρ). The individually varying lag order is chosen by t-statistic of η_{ij} by considering the highest lag and thereafter ρ would be estimated from the regression equation of Δy_{it} on $\Delta y_{i,t-j}$ and X_{it}. However, the general criterion of ρ is the major limitation of the Levin et al. (2002) test. But Im et al. (2003) test captures the different ρ for every cross-sectional unit within a heterogeneous panel.

The GMM estimation technique as referred by Arellano and Bond (1991) is extensively used in dynamic panel models with fixed effect, where the fixed effects are eliminated first by taking first-differenced form of the equation, and thereafter, the model estimates instrumental variables, and the study applies the same. Sargan (1958) test results validate the instruments. The dynamic panel equation with one-period lag is presented by Eq. (10.2).

$$y_{it} = \alpha_i + \theta_t + \beta y_{i,t-1} + x'_{it}\eta + \varepsilon_{it} \tag{10.2}$$

where α_i, θ_t and x_{it} denote the fixed effect, the time dummy and the vector of $(k - 1) \times 1$ exogenous variables, respectively, and $\varepsilon_{it} \sim N\ (0, \sigma^2)$ represents the random disturbances. In most frequent cases with this type of panel data framework, the fixed effect model is more suitable than the random effect model. For elimination of the unobserved cross-sectional specific effects, the first-differenced form of (10.2)

is taken as presented in Eq. (10.3).

$$\Delta y_{it} = \Delta\theta_t + \beta \Delta y_{i,t-1} + \Delta x'_{it}\eta + \Delta\varepsilon_{it} \tag{10.3}$$

The lagged difference form of the dependent variable might be correlated with the differenced form of the error term. To eradicate this kind of endogeneity problem in Eq. (10.3), lag instruments as recommended by moment conditions have to be used. The different form of components of endogenous independent variables also should be handled carefully. The GMM estimation process also absorbs the specifications for instruments, choice of weighting matrix and also the determination of estimator.

In order to examine the impacts of FDI and ICT on GDP empirically in selected developing countries over the period of 2001–2017, Eq. (10.4) is to be specifically estimated in a dynamic panel framework.

$$\Delta \text{GDP}_{it} = \beta_1 \Delta \text{GDP}_{it-1} + \beta_2 \Delta x'_{1it} + \beta_3 \Delta x'_{2it} + \Delta\varepsilon_{it} \tag{10.4}$$

In Eq. (10.4), x'_{1it} indicates a component matrix of FDI and ICT; x'_{2it} denotes the component matrix of control variables such as DFC, TRD and EXR, and ε_{it} is nothing but the error term. The main focus of the study goes to FDI and ICT to observe their influences on GDP, and that is why Eq. (10.4) is to be estimated first by excluding x'_{2it}, and thereafter each control variable has to be incorporated in sequence to check the robustness of outcomes.

10.4 Empirical Findings

To investigate the impacts of FDI and ICT on GDP empirically in the selected developing countries, first the study performs panel unit root tests as developed by Levin et al. (2002) and Im et al. (2003). The unit root test statistics of the specified panel variables are calculated by using the particular rules. Akaike (1969) information criterion (AIC) specifies the lag lengths of variables. All estimated equations for panel unit root incorporate both individual effects and linear trends as exogenous variables. Table 10.1 states panel unit root tests outcomes of all panel variables as taken into account for this study. Both Levin et al. (2002) and Im et al. (2003) panel unit root tests results indicate that variables are non-stationary at levels; however, they are found to be stationary at their first differences.

Table 10.2 specifies the estimated results of the dynamic panel regression model pointing out the exploration of the influences of FDI and ICT on GDP incorporating a few control variables like DFC, TRD and EXR. Model 1 shows the initial regression model followed by sequential inclusions of all control variables as mentioned above accounted by Model 2, 3 and 4, respectively. Ultimately, Model 5 ends the estimation process by checking the robustness through incorporating all major and control variables simultaneously in a single regression model. The GMM estimation technique in first difference equation as referred by Arellano and Bond (1991) is

Table 10.1 Result of panel unit root tests

Series	Levin et al. (2002) test		Im et al. (2003) test	
	Level	First difference	Level	First difference
FDI	1.22	−4.82**	−1.05	−5.31*
ICT	1.09	−4.97**	−1.11	−5.07*
GDP	−0.98	−4.73**	−1.02	−5.92*
DFC	−1.87	−5.01**	−1.14	−5.58*
TRD	−1.69	−5.19**	−1.57	−6.01*
EXR	−2.01	−5.66**	−1.43	−5.94*

Source Estimations of authors using WDI and WTI databases
Note **denotes the level of significance at 5% level

Table 10.2 Results of dynamic panel GMM estimations

Dependent variable: ΔGDP (*it*)					
Method: panel GMM					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5
ΔGDP (*it* − 1)	0.2133*** (0.00)	0.2002*** (0.00)	0.1822*** (0.00)	0.1991*** (0.00)	0.1772*** (0.00)
ΔFDI (*it*)	0.0622*** (0.00)	0.0411** (0.02)	0.0579** (0.03)	0.0733** (0.01)	0.0399** (0.02)
ΔICT (*it*)	0.0917*** (0.00)	0.0807*** (0.00)	0.0612** (0.01)	0.0955*** (0.00)	0.0511** (0.01)
ΔDCF (*it*)		0.1003*** (0.00)			0.0822*** (0.00)
ΔTRD (*it*)			0.0698** (0.01)		0.0712** (0.01)
ΔEXR (*it*)				−0.0691** (0.02)	−0.0255** (0.03)
Observations	576	576	576	576	576
No of instruments	12	10	11	11	13
Arellano-Bond test for AR (2)	0.31	0.32	0.26	0.29	0.27
Sargan test *p*-value	0.22	0.28	0.33	0.31	0.26
Hansen test *p*-value	0.29	0.31	0.28	0.37	0.33
Wald test *p*-value	0.00	0.00	0.00	0.00	0.00

Source Estimations of authors using WDI and WTI databases
*Note*** and *** denote the level of significance at 5% and 1% levels respectively, *p*-values are in parentheses

used in order to control the unobserved heterogeneities raised in the estimated model. The existence of lag dependent variable as an explanatory variable in the proposed regression equation indicates the basic dynamism of the model. The Arellano-Bond specified second-order autocorrelation (AR (2)) text validates the accurate specification of the model. The *p* values of Sargan (1958), Hansen (1982) and Wald tests ensure that instruments are exogenous. It also favours the estimation process that the observed instruments numbers are lower than the total numbers of cross-sectional units in specified models.

Outcomes of the core empirical illustrations make known that both FDI and ICT have positive and significant impacts on GDP at their first-differenced forms. However, the degree of the influence of ICT on GDP in the observed developing countries is remarkably lower than that of FDI in terms of coefficient value and significance level both, and this judgement is robust as per all specified models, as Table 10.2 shows. Findings also imply that DFC and TRD positively and significantly cause GDP. However, economic growth (GDP) is negatively influenced by EXR in developing economies.

10.5 Concluding Remarks

The study empirically scrutinizes the dynamic impacts of FDI inflows and progress of ICT base on economic output (GDP) in developing countries across the globe over the period of 2017–2017. The technique of GMM estimation is applied in a framework of dynamic panel consisting of 36 developing economies selected on the basis of their position in the share of acquiring global FDI inflows. The results of two-step robust difference—GMM estimation imply that both FDI and ICT have positive and significant causal impacts of GDP, beside the lag impact of GDP itself. Moreover, the study also observes that the gross domestic capital formation and volume of trade are also causing GDP positively, and real effective exchange rate negatively impacts the output of those countries. So, to make a simple conclusion, it might be referred that both FDI and ICT are found to be pertinent macroeconomic factor having positive and significant multiplier effect on economic output.

The study depicts that enhancement of globalization has been a vital factor of economic growth reflected in terms of current trends in FDI inflows and promotion of ICT. In this regard, Dreher (2006) might be a prominent support of the arguments as made by the study i.e. globalization encourages economic growth through reducing the restrictions on capital flows and trade and also creating employment opportunities. An advanced ICT base helps transnational corporations (TNCs) in order to utilize the advantage of low cost of labour, effortless access to home and external markets, and also easy communications facilities; and in this context, the findings of the study is also consistent with the results of Gajjala (2006). Finally, by following the propositions of Stanley et al. (2018), the study could recommend that in order to promote the economic growth, developing nations should pay some additional attentions on the promotion of ICT and also their performances in receiving

FDI inflows to make them smoother, and in this regard, ICT could play a crucial role even with its significant impacts of FDI (Sinha et al. 2019), besides having its major influences on human capital formation, research and development activities, digitalization as well as advanced infrastructure development as per current needs.

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