Asymmetric Relationships Between Information and Communication Technology (ICT), Globalization, and Human Development in India: Evidence From Non-Linear ARDL Analysis

Jayanti Behera (jb15@iitbbs.ac.in)
Indian Institute of Technology Bhubaneswar https://orcid.org/0000-0003-3737-7058
Dukhabandhu Sahoo
Indian Institute of Technology Bhubaneswar

Research

Keywords: ICT, Globalization, Human development, NARDL

Posted Date: August 26th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-832453/v1

Asymmetric relationships between Information and Communication Technology (ICT), Globalization, and Human Development in India: Evidence from Non-Linear ARDL Analysis

Jayanti Behera[1] and Dukhabandhu Sahoo[2]

Abstract

The objective of the paper is to examine the asymmetric relationships between ICT, globalization, and human development in India by analyzing the annual data from 1991 to 2019 through the non-linear autoregressive distributed lag (NARDL) model. The result shows that positive and negative changes in globalization lead to a decline in human development in the long run, consistent with the literature. Further, a positive change in mobile density increases human development in the long run. A decline in internet density has a positive impact on human development in the long run, and it needs further investigation. In the short run, a positive shock in globalization with one lag has a positive impact on human development. Moreover, a previous year positive and negative shocks in internet density have a positive effect on human development while the previous two years positive and negative shocks in internet density have a negative effect on human development in the short run. It is also found that the global financial crisis 2008 has a negative impact on human development. Thus, it is suggested that India has to promote both globalization and ICT judiciously and consciously in order to improve the human development.

Keywords: ICT; Globalization; Human development; NARDL

JEL Classification: O47, F00, I32, C51

1. Introduction

Since the last quarter of the 20th century, information & communication technology (ICT) has been playing a significant role in economic development across economies in the world. The widespread dissemination of the mobile, telephone, internet, and broadband networks-all reveal how prevalent this technology has become (Organisation for Economic Co-operation and Development, OECD 2004). It has changed the way in which the people communicate with each other, how they find the required information, work, perform business activities,

[1]PhD Scholar (corresponding author), School of HSS&M, IIT Bhubaneswar, PIN: 752050,Odisha, India, E-mail: jb15@iitbbs.ac.in

[2]Assistant Professor, School of HSS&M, IIT Bhubaneswar, PIN: 752050,Odisha, India, E-mail: dsahoo@iitbbs.ac.in

interact with government agencies, and how they manage their social lives (Roztocki et al. 2019). It increases productivity and economic growth by reducing transaction and communication costs (Erumban and Das 2020) and by investing in human and physical capital (Maurseth 2020). It also plays a major role in contributing towards the United Nations sustainable development goals (SDGs) (Tjoa and Tjoa 2016), particularly in contributing to SDG 9 i.e., to build resilient infrastructure, promote sustainable industrialization, and foster innovation. According to recent United Nations data, 96 percent population of the world lived within reach of a mobile-cellular signal, while 90 percent population accessed the internet through a third-generation (3G) network in 2018. Moreover, due to the big revolution in the ICT sector, a paradigm shift has been taking place in human development (Yakunina and Bychkov 2015). The revolution of ICT is considered as the main driving force for globalization (Ogunsola 2005) by promoting trade, investment, and business both domestically and internationally. It contributes to the globalization process by contributing to infrastructure for trans-world connections (Faye 2000). Globalization is important for human development because it influences its three dimensions, income, health, and education. And the interaction of globalization and ICT considered as an important tool for human existence (Ogunsola 2005). Many developing countries like Africa and India are using ICT as a powerful tool in order to eradicate poverty, reduce health hazards and mortality, and to increase universal education and sustainable development (United Nations Development Programme, UNDP 2004).

India, one of the fast-growing economies in the world, is the largest exporter of ICT related services since the 1990s.The information technology (IT) and IT enabled services, which are the components of ICT contribute nearly 8 percent to the gross domestic product (GDP) of India and provide employment opportunities to nearly four million people in 2018 (Seconded European Standardisation Expert in India, SESEI 2019). Moreover, the Government of India has launched the *Digital India* programme in 2015 to make ICTs a key policy strategy to transform the country into a digital economy by providing infrastructure, access to technology, and government services to citizens. According to a recent report of Telecom Regulatory Authority of India (TRAI), the total internet subscribers base increased by 743.19 million in 2020 from a total of 636.729 million in the country in 2019, and the total base of broadband subscribers increased by 687.44 million in 2020 from a total of 563.31 million in 2019 (Telecom Regulatory Authority of India, TRAI 2020). It is also estimated that a 10 percent increase in broadband could increase economic growth by 1 percent in India (Upadhyay 2021). Additionally, it is also expected that by 2025, India's core digital sectors like IT and business process management, electronics manufacturing, and digital communication services could increase the GDP level to \$355–\$435 billion. The newly developed digitizing sectors such as education, healthcare, financial services, agriculture, energy, retail, logistics, government, and labour markets could contribute \$10–\$150 billion of incremental economic value in 2025, and approximately 60–65 million job opportunities could be generated through the productivity surge by 2025 (Kaka et al. 2019).

Despite the strong and rapid growth of the IT sector in India, people who are living in rural areas (and especially the poor people) have limited access to ICTs in terms of accessibility of internet, mobile and computer facilities for which they face the problem of incomplete/asymmetric information in their daily life (Rao 2005).Therefore, India is still lagging behind the other developed as well as developing countries in terms of ICT contribution to human development. On the other hand, there are a significant amount of studies that are only based on ICT and economic growth (Kurniawati 2021; Sahoo et al. 2021; Tripathi and Inani 2020; David and Grubler 2020; Haftu 2019; Zhang and Danish 2019; Niebel 2018; Toader et al. 2018; Ghosh 2017; Hwanga and Shin 2017; Albiman and Sulong 2017; Hofman et al. 2016; Salahuddin and Alam 2016; Farhadi et al. 2012). Also some studies like David and Grobler 2020; David 2019a, 2019b; Asongu and Roux 2017; Gupta et al. 2019; Gholami et al. 2010; UNDP 2004, focus on ICT and human development. Moreover, a couple of studies in literature had tried to study globalization and human development (Tsai 2007; Cieślik 2014; Sapkota 2011; Figueroa 2015; Ajija and Kusreni 2011; Sabi 2007). In India, though a large number of studies are undertaken on ICT and economic growth (Erumban and Das 2016; Sahoo 2012; Krishna et al. 2018; Singh 2015; Veeramacheneni et al. 2008) a few studies are carried out on ICT and human development (Neogi 2020; Sahay and Walsham 2017; Jensen 2007). However, most of the previous studies theoretically tried to examine the relationship between ICT and socio-economic development in the process of globalization in developing countries (Simba 2004; Ogunsola 2005; Alexandru et al. 2007). A study by Simba (2004) has discussed how ICT in the wake of globalization affects the health information system (health) in developing countries. It is found that the developing countries nourish their health by applying ICT with the help of globalization. Similarly, another study by Ogunsola (2005) has tried to measure how the ICT affects developing countries with the help of the globalization process. In India, particularly in Bangalore, Narayan (2010) has shown the contribution of ICT sector towards globalization and urban economic growth. But this study is limited to economic growth rather than human development.

To date, there have been no empirical studies that analyse the relationships between ICT, globalization, and human development in India. Though a very few studies like Narayan (2010) are there, it takes 1) international trade and capital (FDI) to measure globalization KOF globalization index (which is a recent one and widely used; 2) economic growth rather human development; 3) this study is limited to one city (Bangalore) of India rather the country as a whole; and 4) time period 1980–2004. This paper has answered the relevant research questions, i.e., how does ICT through globalization affect human development in India? Does there exist any asymmetric relationships between ICT, globalization, and human development? It is also essential to know whether the increase in investment in ICT enhances the socio-economic development of India. Therefore, the objective of the paper is to examine the asymmetric relationships between ICT, globalization, and human development in India from 1991 to 2019.The originality of the paper is based on three things. Firstly, this paper has studied the relationships between ICT, globalization, and human development in India for the first time. Secondly, this paper has employed the latest method, i.e., the NARDL model which has not been adopted in the previous studies to account for the non-linear or asymmetric relationship between ICT, globalization, and human development and thirdly, this paper has used the latest data (i.e. from 1991 to 2019) which can give an updated scenario for policymakers.

This paper is organized in the following manner: Section 2 discusses the review of the literature on ICT, globalization, and human development. Section 3 presents the data sources and method. Section 4 includes the result and discussions while Section 5 concludes with some policy suggestions.

1.2. Some Stylized Facts on Indian Economy

Since the objective of the study is to examine the asymmetric relationships between ICT, globalization, and human development in India from 1991 to 2019, so it is pertinent to have some idea about the status of these variables over the period of time. Figure 1 shows the trends of mobile density (MD), internet density (ID) and KOF globalization index (KOFGI) of India. From this figure, it is clear that the MD and ID have increased at an increasing rate from 2004 onwards, but after 2011, MD has declined. It increased again from 2015 onwards. This is because of the launch of Reliance Jio SIM on 27 December 2015 which intended to provide free mobile services (cheapest data and free voice calls) to all Indians. MD remained higher than ID. Though ID follows a fluctuating trend in recent years, i.e., from 2014 onwards, but there was a sudden increase after 2015 because of the launch of the programme *Digital India* by the Government of India which provided digital infrastructure and digital empowerment to the citizens. India's performance in the globalization index has quite satisfactory but after 2008 onwards it follows a declining trend due to the 2008 global financial crisis. Figure 2 displays the trend of the human development index, and it follows an upward trend throughout the period.

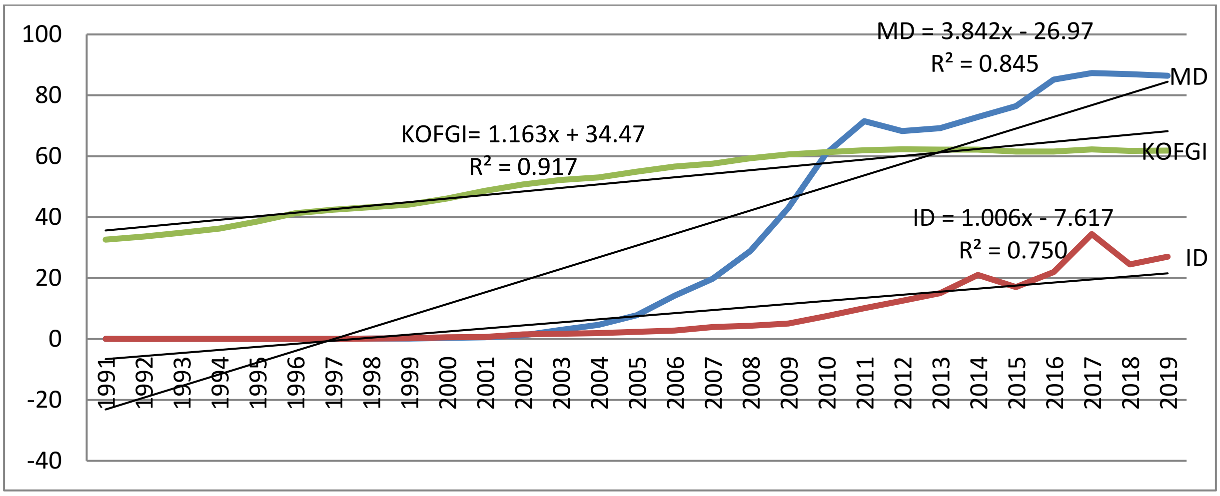

Fig. 1 Trends of Mobile Density, Internet Density, and KOF Globalization Index

Source: Author's illustration based on WDI and ETH Zurich KOF data.

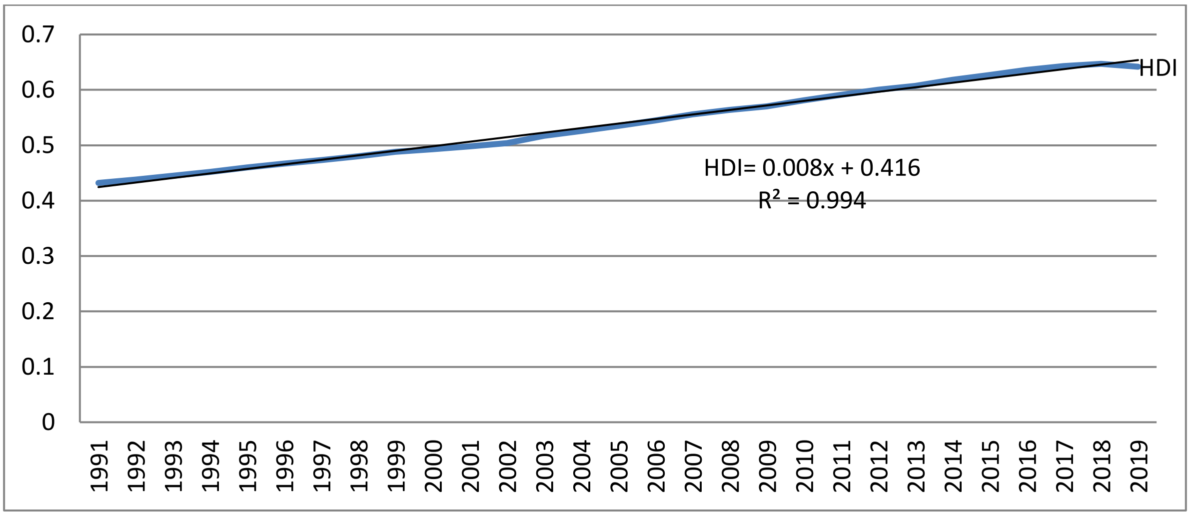

Fig. 2 Trends of Human Development Index

Source: Author's illustration based on UNDP data.

2. Review of Literature

As discussed earlier, India is the major hub of ICT related services. According to World Bank, ICTs are now documented as critical tools for development by making contribution to global integration and by increasing public sector efficiency, effectiveness, and transparency with the increase of mobile telephony and the internet. In view of this, a brief and key review of literature on ICT, globalization, and human development has been presented. The review of literature is classified into three categories, first, it has discussed the relationship between ICT and human development; second, globalization and human development, and third, ICT, globalization, and human development.

2.1. ICT and Human Development

Human development is a process of increasing capabilities and choices which are essential for the people to lead a long and healthy life, to acquire knowledge, and to have access to a decent standard of living, at all levels of development (Human Development Report, HDR 1990). ICT plays an important role in enhancing socio-economic development across the world (Ogunsola 2005). The use of ICT strengthens the people's capabilities and their choices by enhancing access to information, communication, and network (UNDP 2005). Several studies have established the positive association of ICT with human development (Neogi 2020; Cortes and Navarro 2010; Asongu and Roux 2017; Iqbal et al. 2019, Hoz-Rosals et al. 2019, Ejemeyovwi et al. 2019; Gupta et al. 2019; Balouza 2019; Badri et al. 2019; Nosiru and Sodique 2019; Bankole et al. 2011; David and Grobler 2020). The knowledge and development report produced by World Bank (1998) has discussed the positive impact of ICT on socio-economic development. Moreover, a study by UNDP (2004) has found a positive relationship between the ICT components and HDI across all the countries of the world during two different periods (i.e. in 1991 and 2001).By taking nine countries of Asia i.e., China, India, Indonesia, Malaysia, Mongolia, Pakistan, Sri Lanka, Thailand and Vietnam, the same result is also found by UNDP (2005). Investment in ICT enhances human development by generating employment opportunities in the service sector as well as in business and industrial activities, spreading health and health-related information, training to the medical workforce and teachers, disseminating awareness, access to education, knowledge, and training facilities. More use of television, mobile, and internet builds awareness in health, education and income (UNDP 2004). Thus, it could be concluded that ICT plays a significant role in achieving human development.

2.2. Globalization and Human Development

The concepts of globalization and human development are multi-dimensional. Globalization has both positive and negative impacts on human development, especially for developing countries like India. Large strands of research have found a positive relationship between globalization and human development (Sirgy et al. 2004; Sapkota 2011; Ajija and Kusreni 2011; Sabi 2007; Tsai 2007; Cieślik 2014; Badooei 2014; Kocourek et al. 2014; Tsakiri 2010; Shafeeq et al. 2019; Chhorn and Chhorn 2017; Mazlan et al. 2019; Sharma and Gani 2004; Asongu and Jacinta 2016; Figueroa 2015; Ullah and Azim 2017). On the other hand, some studies have found a negative relationship between globalization and human development (Sirgy et al. 2003; Haseeb et al. 2019; Tsakiri 2010). A recent study by Gani et al. (2019) using exports of agricultural raw materials, fuel, ores, and high technology as the proxies for globalization, have found a positive relationship between exports of fuel, ores, and high technology and human development, but a negative relationship between exports of agricultural raw materials and human development. However, as argued by Ahmed (2005) and Haseeb et al. (2019), some factors like bad governance, corruption, and income inequality may trigger the negative relationship between globalization and human development.

2.3. ICT, Globalization, and Human Development

Since the study on the asymmetric and dynamic relationship between ICT, globalization, and HDI is new, a conceptual analysis has been developed to analyse the relationships between the variables. The ICT affects the socio-economic development of the country through globalization. It affects globalization by influencing its three dimensions i.e., economic, social, and political (Ogunsola 2005), i.e., an increase of trade of goods and services, investment (foreign direct investment and portfolio investment), migration, access to the internet and mobile subscriptions, human capital, international NGOs, and treaties. With the increase of globalization, there is the increase in income and employment opportunities (by working in multinational corporations (MNCs) and abroad, conducting business activities), education (by studying abroad, collaboration with foreign educational institutes, accessing online courses), and health (by importing better medicines, health-care equipment, and medical training resulting in enhanced longevity of the population), and thereby has a positive impact on human development. This mechanism through which human development is influenced by globalization is also observed in the literature (Ogunsola 2005).

However, only some sections of the people benefit from globalization with an increase in income and employment, but it may lead to inequality (Atif et al. 2012), deprivation, massive unemployment and increase the conflicts for the other sections of people of the country. Globalization also may favour capital intensive techniques by investing (Foreign investment) more in relatively higher skill and technology intensive sectors, which increases the demand for and wages of more skilled workers, and thereby increases their incomes, which further leads to income inequality. It is also evident from the literature that globalization leads to income inequality. By taking the period of 1995–2007 for three different countries, i.e., developed, developing, and miracle countries, it is found that globalization leads to income inequality in developing and developed countries (Celik and Basdas 2010). The same result is also found in the USA for the period 1980–1990 (Zhong et al. 2007) and in provinces of China (Wan 2007). On the other hand, globalization hits hard on labour intensive sector by saving labours through skill biased effects that reduces employment opportunities particularly for unskilled workers. Thus, the increase in inequality and unemployment in turns reduces the human development of the country. It is also argued that the main concern in both developing and developed countries is income inequality which is related to rising globalization and in the end, it hampers the process of sustainable human development (Haseeb et al. 2019). Another study by Bjørnstad and Skjerpen (2006) which is based on Norwegian countries for the period 1972–1997 has found that globalization (measured by foreign direct investment) produces more unemployment which in turn leads to inequality and thereby hampers human development. This theoretical interrelationship between the variables is expressed in the following figure 3:

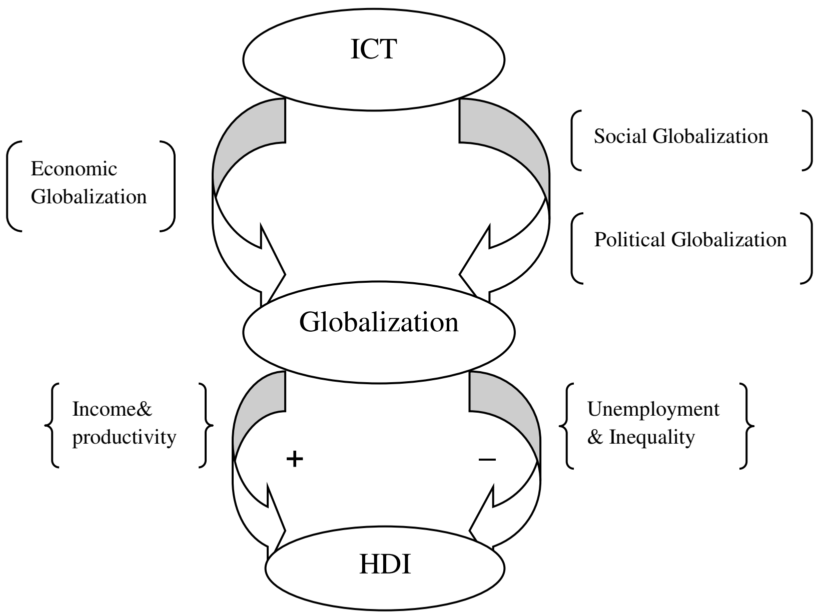

Fig. 3 Analytical Framework
Source: Authors' compilation from the literature

3. Data Sources and Method

The data used for the study are secondary in nature and are collected for the period 1991–2019. The starting year for the data is 1991 because mobile density and internet density data are not available before 1991. Further, the globalization data are not available for the years 2018 and 2019, so these missing values are addressed by adopting the three-year moving average method. The data for the independent variables such as KOF globalization index, mobile density, and internet density are collected from ETH Zurich KOF, and World Development Indicators (WDI), World Bank, respectively. The data for the dependent variable i.e., human development index are collected from United Nations Development Programme (UNDP). During the study period, there is a major transformation of the Indian economy with the introduction of Telecom and Regulatory Authority of India (TRAI) which was established in 1997 in pursuance of TRAI (Ordinance) 1997, to regulate the telecommunication services (Department of Telecommunications 2020). This is considered as the period of new economy, and it affects the Indian economy. Therefore, to account for ICT policy changes, the dummy variable TRAI is introduced. Further, India was integrated with the world economy with much vigour since 1991 through its Structural Adjustment Programme (SAP) and macroeconomic stabilization policies. Therefore, India had to go through global financial crisis (FC) in 2008. To account for the effect of the global financial crisis of 2008 on the Indian economy, the dummy variable FC is introduced. The variables used for the study are described in Table 1.

Table 1 Data Sources and Variables Description

Quantitative Variables	**Description**	**Sources**
HDI	Human Development Index	UNDP
KOFGI	KOF Globalization Index	ETH Zurich KOF
MD	Mobile Density (Mobile cellular subscription per 100 people)	WDI, World Bank
ID	Internet Density- Individuals using internet (percentage of population)	WDI, World Bank
Qualitative Variable(s)	**Description**	
TRAI	Dummy, TRAI=1, for post-TRAI act 1997 period, and '0' otherwise	
Financial crisis (FC)	Dummy, FC=1, for post-financial Crisis period, and '0' otherwise	

Source: Authors' compilation from different sources

3.1. Method

The variables selected for the study are based on the review of the literature. Both internet density and mobile density are used in the present study to represent the ICT, while to measure globalization and human development, Konjunkturforschungsstelle globalization index (KOFGI) and human development index (HDI) are used respectively. Moreover, the period (1997 and after) when TRAI was introduced and the period (2008 and after) when the financial crisis (FC) took place has a significant impact on the Indian economy. Therefore, the two dummy variables with the values 1 for 'post TRAI act 1997 period' and 0 'otherwise', and 1 for 'post-financial crisis 2008 period' and 0 for 'otherwise' are taken to capture the impact of post TRAI act as well as the financial crisis on HDI. All the variables (except the dummy variables i.e., TRAI and FC) are transformed into the natural logarithmic to examine the relationships between the variables. The estimation of the data is carried out by econometric software Eviews version 9.

The relationship between KOFGI, MD, ID, and HDI is expressed in the following functional form:

$$HDI = f(KOFGI, MD, ID) \tag{1}$$

By taking the natural logarithmic of the variables, equation 1 can be expressed in the following form:

$$LnHDI_t = \alpha + \alpha_1 LnKOFGI_t + \alpha_2 LnMD_t + \alpha_3 LnID_t + \epsilon_t \tag{2}$$

Where, LnHDI is the outcome variable and LnKOFGI, LnMD, and LnID are the explanatory variables. The above functional form equation can be converted into the following autoregressive distributed lag model (ARDL) form for estimation purpose:

$$\Delta LnHDI_t = \alpha + \beta_1 LnHDI_{t-1} + \beta_2 LnKOFGI_{t-1} + \beta_3 LnMD_{t-1} + \beta_4 LnID_{t-1} + \sum_{t=1}^{p} \gamma_1 \Delta LnHDI_{t-i} + \sum_{t=0}^{q} \gamma_2 \Delta LnKOFGI_{t-i} + \sum_{t=0}^{r} \gamma_3 \Delta LnMD_{t-i} + \sum_{t=0}^{s} \gamma_4 \Delta LnID_{t-i} + \varepsilon_t \tag{3}$$

In equation 2, the linear association is assumed between the explanatory variables and explained variables. The ARDL model estimates the symmetric cointegration relationships between the variables. But in the real field or in actual situation the relationship is something different, i.e., there exists non-linear association between KOFGI, MD, ID, and HDI. In addition, in real situation, the rate or magnitude at which the response of HDI to positive change of ICT and KOFGI (increase) is different from the rate at which the response of HDI to negative change of ICT and KOFGI (decrease). In other words, there is no symmetric i.e., asymmetric relationships exist between the explanatory variables and explained variable. Moreover, most of the variables like ICT (MD and ID), KOFGI, and HDI are non-linear in nature. Thus, the linear model may not reveal the appropriate relationship between ICT, KOFGI, and HDI. Thus, the non-linear autoregressive distributed lag (NARDL) model, which was introduced by Shin et al. (2014), is used for examining the asymmetric relationships between the ICT, KOFGI, and HDI.

The NARDL model is an extended version of the linear ARDL model (Pesaran et al. 2001).This method analyses the long run and short run asymmetric impact of both positive and negative components of ICT and globalization on human development. In addition, it captures the asymmetric effect of the explanatory variables on explained variable. The model can be adopted when the variables are stationary at level i.e., I(0) or at the first difference i.e., I(1), except stationary at the second difference I(2).Besides, the NARDL model allows the ARDL bounds tests approach for computing the asymmetric short-run and long-run coefficients in a cointegration framework. When there is the analysis of the cointegration relations in small samples, the NARDL model performs better (Romilly et al. 2001).

Thus, first the asymmetric long run regression can be expressed in the following form before going into the full representation of the NARDL model:

$$HDI_t = \alpha + \beta^{+}KOFGI_t{}^{+} + \beta^{-}KOFGI_t{}^{-} + \delta^{+}MD_t{}^{+} + \delta^{-}MD_t{}^{-} + \vartheta^{+}ID_t{}^{+} + \vartheta^{-}ID_t{}^{-} + e_t \tag{4}$$

Where, the coefficients β^+, β^-, δ^+, δ^-, ϑ^+, and ϑ^- are the asymmetric long run coefficients. To capture the asymmetric effect, the explanatory variables are decomposed in the following forms:

$$\left.\begin{aligned} KOFGI_t &= KOFGI_0 + KOFGI_t{}^{+} + KOFGI_t{}^{-} \\ MD_t &= MD_0 + MD_t{}^{+} + MD_t{}^{-} \\ ID_t &= ID_0 + ID_t{}^{+} + ID_t{}^{-} \end{aligned}\right\} \tag{5}$$

Where, $KOFGI^+$, $KOFGI^-$, MD^+, MD^-, ID^+, and ID^- are partial sum process of positive and negative changes in KOFGI, MD, and ID as follows:

$$\left.\begin{aligned} KOFGI_t{}^{+} &= \sum_{j=1}^{t} \Delta KOFGI_j{}^{+} = \sum_{j=1}^{t} \max\left(\Delta KOFGI_j, 0\right) \\ KOFGI_t{}^{-} &= \sum_{j=1}^{t} \Delta KOFGI_j{}^{-} = \sum_{j=1}^{t} \min(\Delta KOFGI_j, 0) \\ MD_t{}^{+} &= \sum_{j=1}^{t} \Delta MD_j{}^{+} = \sum_{j=1}^{t} \max\left(\Delta MD_j, 0\right) \\ MD_t{}^{-} &= \sum_{j=1}^{t} \Delta MD_j{}^{-} = \sum_{j=1}^{t} \min\left(\Delta MD_j, 0\right) \\ ID_t{}^{+} &= \sum_{j=1}^{t} \Delta ID_j{}^{+} = \sum_{j=1}^{t} \max\left(\Delta ID_j, 0\right) \\ ID_t{}^{-} &= \sum_{j=1}^{t} \Delta ID_j{}^{-} = \sum_{j=1}^{t} \min(\Delta ID_j, 0) \end{aligned}\right\} \tag{6}$$

Therefore, the NARDL model which uses the positive and negative partial sum decompositions is given as follows:

$$\Delta LnHDI_t = \gamma + \tau LnHDI_{t-1} + \theta_1{}^{+}LnKOFGI_{t-1}{}^{+} + \theta_2{}^{-}LnKOFGI_{t-1}{}^{-} + \theta_3{}^{+}LnMD_{t-1}{}^{+} + \theta_4{}^{-}LnMD_{t-1}{}^{-} + \theta_5{}^{+}LnID_{t-1}{}^{+} + \theta_6{}^{-}LnID_{t-1}{}^{-} + \sum_{j=1}^{p-1}\pi_j\,\Delta LnHDI_{t-j} + \sum_{j=0}^{q-1}(\varphi_1{}^{+}\Delta Ln\;KOFGI_{t-j}{}^{+} + \varphi_2{}^{-}\Delta Ln\;KOFGI_{t-j}{}^{-}) + \sum_{j=0}^{q-1}(\varphi_3{}^{+}\Delta Ln\;MD_{t-j}{}^{+} + \varphi_4{}^{-}\Delta LnMD_{t-j}{}^{-}) + \sum_{j=0}^{q-1}(\varphi_5{}^{+}\Delta Ln\;ID_{t-j}{}^{+} + \varphi_6{}^{-}\Delta LnID_{t-j}{}^{-}) + \mu_t \quad (7)$$

Where, θ's are the long run coefficients and φ's are the short run coefficients. μ represents the error term which independently and identically distributed with zero mean and constant variance. Similarly, p and q represent the lag orders. The long run asymmetric effects of the explanatory variables on explained variable can be estimated by $\sigma_1 = -\frac{\theta_1{}^{+}}{\tau}$, $\sigma_2 = -\frac{\theta_2{}^{-}}{\tau}$,$\sigma_3 = -\frac{\theta_3{}^{+}}{\tau}$,$\sigma_4 = -\frac{\theta_4{}^{-}}{\tau}$,$\sigma_5 = -\frac{\theta_5{}^{+}}{\tau}$, and $\sigma_6 = -\frac{\theta_6{}^{-}}{\tau}$ while the short run asymmetric effects can be estimated by $\sum_{j=0}^{q-1}\varphi_j{}^{+}$ and $\sum_{j=0}^{q-1}\varphi_j{}^{-}$. By incorporating the dummy variables into the NARDL model can be expressed as follows:

$$\Delta LnHDI_t = \gamma + \tau LnHDI_{t-1} + \theta_1{}^{+}LnKOFGI_{t-1}{}^{+} + \theta_2{}^{-}LnKOFGI_{t-1}{}^{-} + \theta_3{}^{+}LnMD_{t-1}{}^{+} + \theta_4{}^{-}LnMD_{t-1}{}^{-} + \theta_5{}^{+}LnID_{t-1}{}^{+} + \theta_6{}^{-}LnID_{t-1}{}^{-} + \sum_{j=1}^{p-1}\pi_j\,\Delta LnHDI_{t-j} + \sum_{j=0}^{q-1}(\varphi_1{}^{+}\Delta Ln\;KOFGI_{t-j}{}^{+} + \varphi_2{}^{-}\Delta Ln\;KOFGI_{t-j}{}^{-}) + \sum_{j=0}^{q-1}(\varphi_3{}^{+}\Delta Ln\;MD_{t-j}{}^{+} + \varphi_4{}^{-}\Delta LnMD_{t-j}{}^{-}) + \sum_{j=0}^{q-1}(\varphi_5{}^{+}\Delta Ln\;ID_{t-j}{}^{+} + \varphi_6{}^{-}\Delta LnID_{t-j}{}^{-}) + \rho_1 TRAI + \rho_2 FC + \mu_t \quad (8)$$

Some steps need to be followed before and after applying the NARDL model: first the stationary of variables should be checked through different unit root tests, and the variables must be either stationary at level or first difference or both. Second, estimate the NARDL model. Third, after estimation of NARDL model, there is a need to test the cointegration between the variables i.e., to test the existence of long run relations through the NARDL bounds test and NARDL cointegration approach. Fourth, after confirmation of the cointegration between the variables, then the long run and short run asymmetric relationship need to be tested through Wald test. The Wald test measures whether the difference between the coefficients of positive and negative variations is significant in the long run and short run and is given as follows:

Null hypothesis (H_0): $-\frac{\theta_i{}^{+}}{\tau} = -\frac{\theta_i{}^{-}}{\tau}$ (no long run asymmetric relationship)

Alternative hypothesis (H_1): $-\frac{\theta_i{}^{+}}{\tau} \neq -\frac{\theta_i{}^{-}}{\tau}$ (long run asymmetric relationship exists)

Null hypothesis (H_0): $\sum_{j=0}^{q-1}\varphi_j{}^{+} = \sum_{j=0}^{q-1}\varphi_j{}^{-}$(no short run asymmetric relationship)

Alternative hypothesis (H_1): $\sum_{j=0}^{q-1}\varphi_j{}^{+} \neq \sum_{j=0}^{q-1}\varphi_j{}^{-}$(short run asymmetric relationship)

Where, i and j =1, 2, . . . , n.

Fifth, NARDL dynamic multiplier graph can be used to examine the pattern of adjustment of the explained variable to its new long run equilibrium following the positive and negative shocks, as follows:

$$m_h{}^+ = \sum_{j=0}^{h} \frac{\partial HDI_{t+j}}{\partial KOFGI_t{}^+},\ m_h{}^- = \sum_{j=0}^{h} \frac{\partial HDI_{t+j}}{\partial KOFGI_t{}^-},\ m_h{}^+ = \sum_{j=0}^{h} \frac{\partial HDI_{t+j}}{\partial MD_t{}^+},\ m_h{}^- = \sum_{j=0}^{h} \frac{\partial HDI_{t+j}}{\partial MD_t{}^-}$$

$$m_h{}^+ = \sum_{j=0}^{h} \frac{\partial HDI_{t+j}}{\partial ID_t{}^+}, m_h{}^- = \sum_{j=0}^{h} \frac{\partial HDI_{t+j}}{\partial ID_t{}^-},\ \text{for h} = 0,1,2, \ldots$$

Where, if h→∞, then $m_h{}^+ = \theta^+$, and $m_h{}^- = \theta^-$

Lastly, the residual tests should be carried out to test the validity of the model before the results are finally interpreted to draw any relevant conclusion.

4. Results and Discussions

Before examining the asymmetric relationship between the variables, it is essential to describe the characteristics of the variables and their correlation which is shown in Table 2.The mean per capita of HDI, KOFGI, MD, and ID in India during 1991–2019 are -0.626, 3.928, 1.072, -0.315 respectively. Besides this, KOFGI and HDI are highly and positively correlated with each other with a correlation coefficient 0.949. Similarly, MD and ID are also highly and positively correlated with HDI at the coefficients 0.963 and 0.915, respectively.

Table 2 Descriptive Statistics and Correlation between the variables

Variables	Mean	Standard Deviation	Minimum	Maximum	Skewness	Kurtosis	Correlation with HDI
HDI	-0.626	0.130	-0.839	-0.435	-0.039	1.689	1.000
KOFGI	3.928	0.216	3.485	4.131	-0.734	2.161	0.949*
MD	1.072	3.278	-4.834	4.470	-0.399	1.562	0.963*
ID	-0.315	3.711	-9.103	3.540	-1.140	3.203	0.915*

***implies correlation is significant at 1% level.**
Source: Authors' estimation from UNDP, WDI, and ETH Zurich KOF data

The unit root tests like Augmented Dicky-Fuller (ADF), (1981), Philips-Perron (PP) (1988), Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (1992), Zivot-Adrews (ZA) (1992), and Ng-Perron (2001) are presented in Table 3 through 4. A perusal of the Tables reveals that KOFGI, MD and ID are stationary at first difference as per the ADF, PP, and KPSS tests while HDI is only stationary at first difference by KPSS and ZA tests. But according to Ng-Perron test, HDI is stationary at first difference while other variables are stationary at level. This implies that none of the variables is stationary at second difference, so the NARDL model can be estimated.

Table 3 Unit Root test results

Variables	ADF			PP			KPSS			Zivot-Andrews		
	Level	1st Difference	Inferences	Level	1st Difference	Inferences	Level	1st Difference	Inferences	Level	1st Difference	Inferences
LnHDI	0.060	-1.442		0.357	-1.441		0.110*	0.178*	I(0)/ I(1)	-1.435	-3.379**	I(1)
LnKOFGI	-0.050	-4.755*	I(1)	2.600	-3.883**	I(1)	0.186*	0.500	I(0)	-2.730	-5.581	
LnMD	-0.863	-5.472*	I(1)	-1.075	-5.472*	I(1)	0.192*	0.138*	I(0)/ I(1)	-3.707	-8.722	
LnID	-1.132	-5.199*	I(1)	-0.211	-5.821*	I(1)	0.190*	0.178*	I(0)/ I(1)	-10.470	-4.746	

Note: (1) the value of ADF for 1%, 5% and 10% are -4.339, -3.588, and -3.229, respectively.

(2) The value of PP for 1%, 5% and 10% are -4.324, 3.581, and -3.225, respectively.

(3) The value of KPSS for 1%, 5% and 10% are 0.216, 0.146, and 0.119, respectively.

(4) The value of Zivot-Andrews for 1%, 5% and 10% are -5.57, -5.08, and -4.82, respectively.

***, **, and *** imply significant at 1%, 5%, and 10% level, respectively**

Source: Authors' estimation from UNDP, WDI, and ETH Zurich KOF data

Table 4 Ng-Perron test results

Variables	MZa		MZt		MSB		MPT		Inference
	Level	1st Difference	Level	1st Difference	Level	1st Difference	Level	1st Difference	
LnHDI	-214.459	-8.906*	-10.167	-1.585*	0.047	0.178*	0.914	11.866*	I(1)
LnKOFGI	-11.812*	-26.400	-2.260*	-3.632	0.191*	0.138	8.567*	3.457	I(0)
LnMD	-3.024*	-13.053*	-1.038*	-2.547*	0.343*	0.195*	25.488*	7.023*	I(0)/ I(1)
LnID	-4.174*	-9.505*	-1.320*	-2.178	0.316*	0.229*	20.539*	9.595*	I(0)/ I(1)
Critical values:	1%	-23.800	-3.420		0.143		4.030		
	5%	-17.300	-2.910		0.168		5.480		
	10%	-14.200	-2.620		0.185		6.670		

***, **, and *** imply significant at 1%, 5%, and 10% level, respectively**

Source: Authors' estimation from UNDP, WDI, and ETH Zurich KOF data

The result of the NARDL model with and without dummy variables is shown in Table 5. By taking without dummy variables, it is found that the previous year shocks in HDI have a positive impact on HDI. By taking with dummy variables, it is found that the previous two year shocks in HDI have a positive impact on HDI. The positive and negative shocks in globalization lead to a decline in human development (with the coefficients -0.342, -5.678, -0.423, and -1.862 respectively) in the long run by taking with and without dummy variables. The negative relationship between globalization and human development is supported by the literature (Sirgy et al. 2003; Haseeb et al. 2019; Tsakiri 2010). It is evident from the literature that globalization leads to income inequality (Atif et al. 2012; Singh 2012; Naqvi 2009; Celik and Basdas 2010; Wan 2007; Zhong et al. 2007; Bergh and Nilsson 2011) which in turn leads to a decline in human development (Haseeb et al. 2019; Atif et al. 2012; Wicaksono et al. 2017; Bjørnstad and Skjerpen 2006). In contrast, a positive shock in mobile density increases human development (with the coefficient 0.013 and 0.015) by taking with and without dummy variables. In other words, an increase in mobile density increases human development. A negative shock in internet density also increases the human development in the long run by taking without dummy variables. Though the direct reason for the positive relationship is not observed but the indirect reason is that an increase in internet in the form of e-commerce removes the unskilled workers from the e-commerce economy or it may provide employment through a contractual basis which is insecure for the workers (Singh 2008). It is also found that in India as well as in other low income countries, the employment of unskilled workers working under e-commerce companies is not protected by any legislative law (Singh 2008). Moreover, more use of the internet also gives rise to the risk of isolation from society, and stress and depression (Gunduz 2007; Quaglio and Millar 2020) which has a negative impact on human development. Tavares (2018) has observed that more use of ICT leads to chronic health problem in 28 European Union countries. A study by Niebel (2018) has found that the emerging and developing economies have not benefited much from investment in ICTs. Another study by Maurseth (2020) has found a negative relationship between economic growth and ICT in developed countries. Even if the positive relationship is validated with the literature but it needs further investigation.

In the short run, a previous year negative shock in globalization has a negative impact on human development whereas the previous two years negative shocks in globalization have a positive impact on human development by taking without dummy variables. A positive shock in globalization with one lag has a positive impact on human development with a coefficient of 0.153 by taking with dummy variables. Similarly, a short run previous year positive shock in internet density has a positive effect on human development while the previous two years positive shocks in internet density have a negative impact on human development by taking with and without dummy variables. The reason behind the negative relationship between the previous two years positive shocks in internet density and human development may be due to the high initial cost in the development of infrastructure for providing internet services (Tripathi and Inani 2016). A negative shock in internet density with lag one has a positive effect on human development while with lag two it has a negative effect on human development by taking without dummy variables. It is also found that the post-global financial crisis 2008 has a negative impact on the human development. Moreover, there exist the long run relationships between MD, ID, KOFGI, and HDI confirmed by the NARDL bounds test[1]. The cointegration equation coefficient (-0.274) is also negative and significant, this implies that there are long run relationships between the variables.

Table 5 Results of NARDL Model

Variables	Without Dummy Variables		With Dummy Variables	
	Coefficients	Probability	Coefficients	Probability
LnHDI (-1)	0.479* (0.153)	0.017	0.314 (0.178)	0.137
LnHDI (-2)	0.247 (0.144)	0.129	0.514** (0.205)	0.054
Long run				
LnKOFGI_POS	-0.342* (0.065)	0.001	-0.423* (0.082)	0.004
LnKOFGI_NEG	-5.678** (2.220)	0.038	-1.862 (2.922)	0.552
LnMD_POS	0.013** (0.006)	0.058	0.015** (0.005)	0.037
LnMD_NEG	0.001 (0.005)	0.907	0.001 (0.005)	0.843
LnID_POS	0.004 (0.004)	0.282	0.005 (0.003)	0.135
LnID_NEG	0.137** (0.048)	0.023	0.061 (0.061)	0.361
Short run				
LnKOFGI_POS(-1)	0.148 (0.086)	0.131	0.153*** (0.077)	0.104
LnKOFGI_NEG(-1)	-5.741** (2.093)	0.029	-2.141 (2.757)	0.473
LnKOFGI_NEG(-2)	47.662*** (22.563)	0.073	8.919 (29.698)	0.776
LnMD_POS(-1)	0.009 (0.006)	0.203	0.009 (0.005)	0.148
LnMD_POS(-2)	-0.003 (0.003)	0.416	-0.005 (0.003)	0.164
LnMD_NEG (-1)	0.008 (0.005)	0.159	0.007 (0.004)	0.138
LnID_POS(-1)	0.008** (0.003)	0.043	0.007** (0.003)	0.052
LnID_POS(-2)	-0.010* (0.002)	0.004	-0.008** (0.003)	0.054
LnID_NEG(-1)	0.151* (0.046)	0.013	0.080 (0.056)	0.208
LnID_NEG(-2)	-2.234*** (1.061)	0.073	-0.410 (1.396)	0.781
C	-2.984*** (1.427)	0.075	-0.490 (1.890)	0.806
TRAI dummy			-0.008 (0.010)	0.462
FC dummy			-0.005***	0.077

[1]If the calculated F-statistic of the model exceeds the upper bound critical value, then the null hypothesis of long-run cointegration relationship between the variables will be rejected. Alternatively, if it falls below the lower bound critical value, then the null hypothesis will be failed for rejection. And, if the calculated F-statistic value falls within the bounds, the test is inconclusive.

			(0.002)	
Diagnostics result	R^2		0.99	0.99
	F statistics		6095.052	7811.157
	Probability		0.000	0.000
	Durbin-Watson test statistic		2.311	2.476
NARDL Bounds test (Null Hypothesis: no long run relationships exist)				
F statistics	7.814*			
Critical value bounds	Significance	I 0 Bound		I 1Bound
	1%	3.15		4.43
	2.5%	2.75		3.99
	5%	2.45		3.61
	10%	2.12		3.23
NARDL Cointegration and long run form				
Variables	**Coefficients**		**Probability**	
Coint Eq(-1)	-0.274* (0.053)		0.001	
Long run				
LnKOFGI_POS	-0.709 (0.448)		0.158	
LnKOFGI_NEG	132.312** (55.265)		0.048	
LnMD_POS	0.068** (0.023)		0.022	
LnMD_NEG	0.031 (0.020)		0.172	
LnID_POS	0.009 (0.009)		0.336	
LnID_NEG	-7.104** (2.896)		0.044	
C	-10.894** (4.160)		0.035	

***, **, and *** imply significant at 1%, 5%, and 10% level, respectively**
Source: Authors' estimation from UNDP, WDI, and ETH Zurich KOF data

The long run and short run asymmetric relationships are evaluated in Table 6 by using Wald test. The result reveals the long run asymmetric relations between positive shocks and negative shocks in KOFGI, MD, and ID. In addition, there exist short run asymmetric relationships between positive and negative shocks of KOFGI and ID. But, in the case of MD, it shows short run symmetric relationship between positive and negative shocks.

Table 6 Long run and Short run asymmetric test (Wald test)

Variables	**Long run asymmetry**		**Short run asymmetry**	
	χ^2	**Probability**	χ^2	**Probability**
LnKOFGI	3.251***	0.071	4.155**	0.042
LnMD	3.080***	0.079	0.044	0.833
LnID	3.955**	0.047	4.175**	0.041

***, **, and *** imply significant at 1%, 5%, and 10% level, respectively**
Source: Authors' estimation from UNDP, WDI, and ETH Zurich KOF data

The NARDL dynamic multiplier Graph is illustrated for KOFGI, MD, and ID in the respective diagrams. Figure 4 reveals that the negative globalization shocks are high in comparison to positive globalization shocks on human development. Similarly, the positive shocks in mobile density and internet density are high on human development compared to the negative shocks in mobile density and internet density which are shown in Figure 5 and 6.

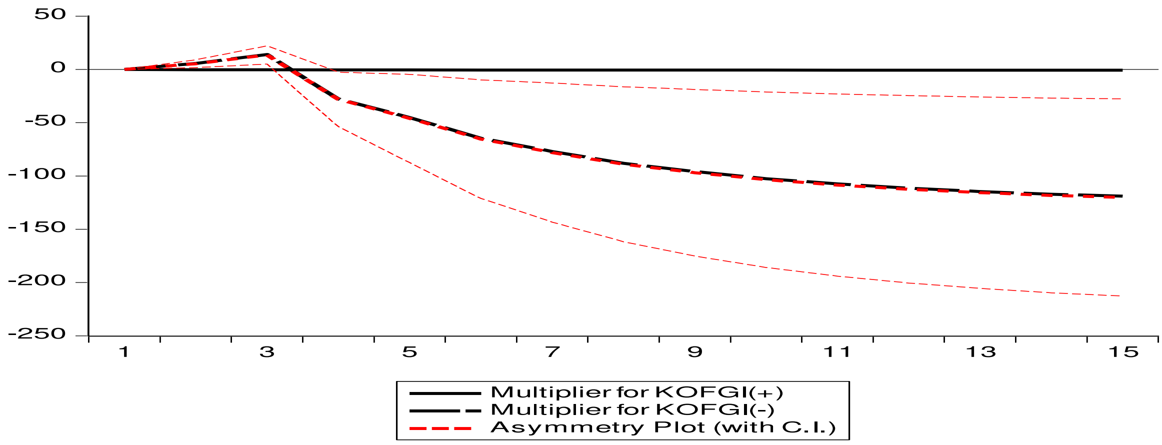

Fig. 4 NARDL Dynamic Multiplier Graph for KOFGI

Source: Authors' illustration from UNDP, WDI, and ETH Zurich KOF data

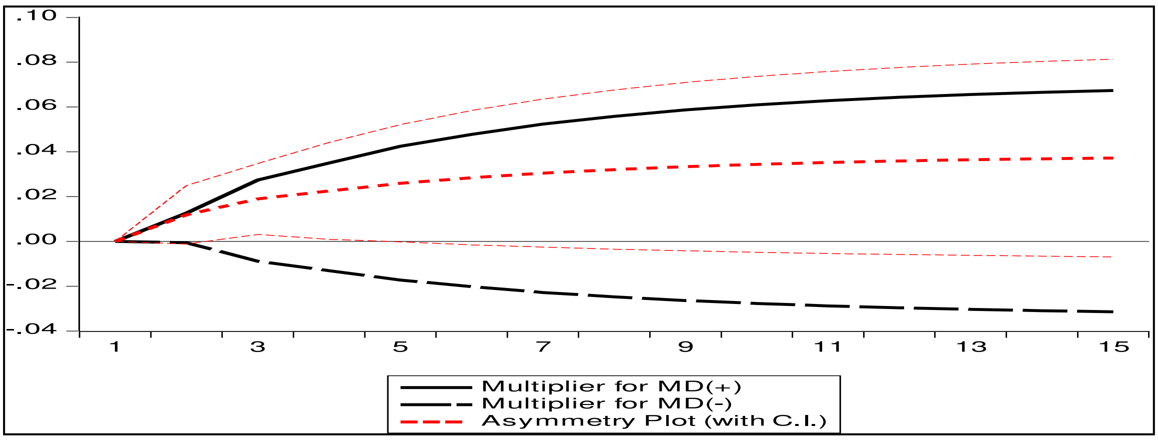

Fig. 5 NARDL Dynamic Multiplier Graph for MD

Source: Authors' illustration from UNDP, WDI, and ETH Zurich KOF data

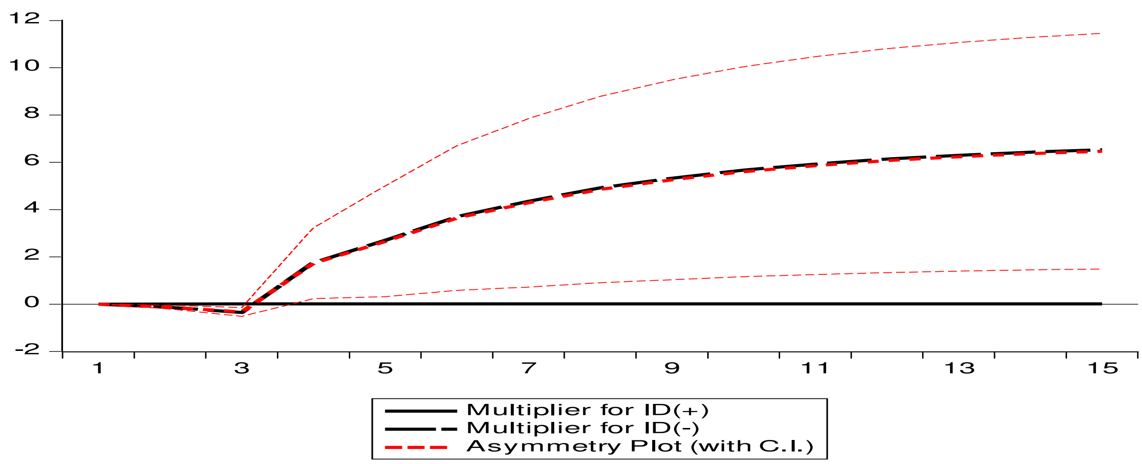

Fig. 6 NARDL Dynamic Multiplier Graph for ID

Source: Authors' illustration from UNDP, WDI, and ETH Zurich KOF data

Some residual tests like Bruese Pagan Godfrey (BPG) test for heteroscedasticity, LM test for serial correlation, Jarque-Bera (JB) test for normality, and the correlogram residual squared are conducted to validate the results of the NARDL model. As shown in Table 7, the model is free from the problem of heteroscedasticity and serial correlation but is not normally distributed and the correlogram residual squared confirms no autocorrelation and partial correlation problems (Table 8).

Table 7 Residual tests

Test	Test-statistics	Probability
BPG test for Heteroscedasticity	0.334	0.971
LM test for Serial Correlation	0116	0.893
Jarque-Bera test for Normality	12.755	0.002

Source: Authors' estimation from UNDP, WDI, and ETH Zurich KOF data

Table 8 Residual tests (Correlogram)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
. | . |	. | . |	1	-0.057	-0.057	0.0941	0.759
. *| . |	. *| . |	2	-0.136	-0.139	0.6524	0.722
. |**. |	. |**. |	3	0.336	0.326	4.2203	0.239
. |* . |	. |* . |	4	0.120	0.148	4.6980	0.320
*Probabilities may not be valid for this equation specification.						

Source: Authors' estimation from UNDP, WDI, and ETH Zurich KOF data

5. Conclusion and Policy Suggestions

It is observed from the above discussions that in the long run the positive and negative changes in globalization have a negative effect on human development by taking with and without dummy variables, consistent with the literature. In the long run, a positive change in mobile density has a positive impact on human development by taking with and without dummy variables. Moreover, a decline in internet density has a positive impact on human development in the long run by taking without dummy variables. The reason for the positive relationship between the decline in internet density and human development is that increase in the internet in the form of e-commerce removes the unskilled workers from the e-commerce economy or it may provide employment through a contractual basis which is insecure for the workers (Singh 2008). It is also found that in India as well as in other low income countries, the employment of unskilled workers working under e-commerce companies is not protected by any legislative law (Singh 2008). Moreover, more use of internet also gives rise to the risk of isolation from society, stress and depression (Gunduz 2007; Quaglio and Millar 2020) which has a negative impact on human development. In India the number of youth and adolescents are more in comparison to other countries, they are more prone to internet addiction, which may cause isolation and depression. Tavares (2018) has observed that more use of ICT leads to chronic health problems in 28 European Union countries. A study by Niebel (2018) has found that the emerging and developing economies have not benefited much from investment in ICTs. The positive relationship between the decline in internet density and human development needs further investigation.

In the short run, a negative change in globalization with one lag has a negative effect on human development whereas with lag two it has a positive effect on human development by taking without dummy variables. A positive shock in globalization with one lag has a positive impact on human development by taking with dummy variables. The positive and negative changes in internet density with lag one has a positive impact on human development while the positive and negative changes with lag two has a negative impact on human development in the short run. The reason behind the negative relationship between the previous two years positive shocks in internet density and human development may be due to the high initial cost in the development of infrastructure for providing internet services (Tripathi and Inani 2016). However, the global financial crisis has a negative impact on human development in the study. Since the effect of the global financial crisis is realised due to the integration of the Indian economy with the world economy, India needs to promote globalization judiciously and cautiously.

From the cointegration equation, it is also confirmed that there exists a long run relationship between ICT, globalization, and human development. On the other hand, it is also found that there is both short run and long run asymmetric relationships between the variables except mobile density in the short run through the Wald test. In addition, the result also shows that the effect of positive components of mobile density and internet density is high than the effect of negative components of mobile density and internet density on human development. Similarly, the effect of negative components of globalization is high on human development than the effect of positive components of globalization.

It is suggested from the above findings that the Government of India needs to promote ICT, particularly internet use and globalization more cautiously in order to improve the human development of the country. Since the decline in internet density is positively related to human development, one could go for future research on this issue.

Declarations

Acknowledgement

Not applicable

Authors' contributions

Both authors have contributed equally to the paper. Both authors have read and approved the paper.

Funding

Not applicable

Availability of data and materials

All the data will be made available upon request.

Competing interests

The authors declare that they have no competing interests.

References

Ahmad N (2005) Governance , Globalisation , and Human Development in Pakistan. The Pakistan Dvelopment Review 44(4): 585–593.

Ajija S R, Kusreni S (2011) Globalization and Socio Economic Welfare of Muslim Countries A Case Study of Indonesia and Malaysia. European Journal of Social Sciences 25(3): 329–343.

Albiman M M, Sulong Z (2017) The Linear and Non-linear Impacts of ICT on Economic Growth, of disaggregate Income Groups within SSA region. Telecommunications Policy 41(7–8): 555–572. http://dx.doi.org/10.1016/j.telpol.2017.07.007

Alexandru A, Ianculescu M, Parvan M, Jitaru E (2007). ICT and Its Impact upon the Globalization and Accessibility of the Education in the Health Domain. Paper presented in 6th WSEAS International Conference on Education and Educational Technology, Italy, November 2007 (Vol. 11, No. 21, pp. 287-291). Retrieved from http://www.wseas.us/e-library/conferences/2007venice/papers/570-332.pdf?origin=publication_detail

Asongu S, Jacinta N (2016) Globalization and Inclusive Human Development in Africa. Man and the Economy.

Asongu S, Roux S L (2017) Enhancing ICT for inclusive human development in Sub-Saharan Africa. Technological Forecasting & Social Change. https://doi.org/10.1016/j.techfore.2017.01.026

Atif S M, Srivastav M, Sauytbekova M, Arachchige U K (2012) Globalization and Income Inequality: A Panel Data Analysis of 68 Countries. MPRA Paper No. 42385. Retrieved from https://mpra.ub.uni-muenchen.de/42385/

Badooei Y S (2014) The exploration into the effect of globalization on Human Development Index (HDI): The selected Developing and Developed Countries. Advances in Environmental Biology 8(19): 136–148.

Badri A K, Badri P K, Cham M (2019) ICT and Human Development in Selected Devolving Countries. International Journal of Social Sciences Perspectives 5(2): 30–35. https://doi.org/10.33094/7.2017.2019.52.30.35

Balouza M (2019) The Impact of Information and Communication Technologies on the Human Development in the Gulf Cooperation Council Countries: An Empirical Study. Management Studies and Economic Systems 4(2): 79–113.

Bankole F O, Shirazi F, Brown I (2011) Investigating the Impact of ICT Investments on Human Development. The Electronic Journal of Information Systems in Developing Countries 48(1): 1–19. https://doi.org/10.1002/j.1681-4835.2011.tb00344.x

Bergh A, Nilsson T (2011) Globalization and Absolute Poverty-A Panel Data Study. IFN Working Paper No. 862. Stockholm, Sweden: Research Institute of Industrial Economics.

Bjørnstad R, Skjerpen T (2006) Trade and Inequality in Wages and Unemployment. Economic Modelling 23(1): 20–44. https://doi.org/10.1016/j.econmod.2005.07.006

Çelik S, Basdas U (2010) How does Globalization affect Income Inequality? A Panel Data Analysis. International Advances in Economic Research 16(4): 358–370. https://doi.org/10.1007/s11294-010-9281-0

Chhorn T, Chhorn D (2017) Modelling Linkage of Globalization and Financial Development to Human Development in CLMV Region. MPRA Paper.

Cieślik A (2014) Globalization and Human Development in Post-Transition Countries : Empirical Evidence from Panel Data.Oeconomia Copernicana 5(3): 7–27. https://doi.org/10.12775/OeC.2014.017

Cortés E A, Navarro, J-L A (2011) Do ICT Influence Economic Growth and Human Development in European Union Countries ?International Atlantic Economic Society 17: 28–44. https://doi.org/10.1007/s11294-010-9289-5

David O O (2019a) Nexus between Telecommunication Infrastructures, Economic Growth and Development in Africa: Panel Vector Autoregression (P-VAR) Analysis. Telecommunications Policy 43(8): 01–17. https://doi.org/10.1016/j.telpol.2019.03.005

David O O (2019b) Powering Economic Growth and Development in Africa: Telecommunication Operations. Applied Economics 51(33): 3583–3607. https://doi.org/10.1080/00036846.2019.1578852

David O O, Grobler W (2020) Information and Communication Technology Penetration Level as an Impetus for Economic Growth and Development in Africa. Economic Research-Ekonomska Istraživanja 33(1): 1394–1418. https://doi.org/10.1080/1331677X.2020.1745661

Department of Telecommunication, Government of India (2020) Telecom Regulatory Authority of India (TRAI) Act 1997.

Dickey D A, Fuller W A (1981) Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. Econometrica: Journal of the Econometric Society 49(4): 1057 – 1072.

Ejemeyovwi J O, Osabuohien E S, Johnson O D, Bowale E I K (2019) Internet Usage, Innovation and Human Development Nexus in Africa: The Case of ECOWAS. Journal of Economic Structures 8. https://doi.org/10.1186/s40008-019-0146-2

Erumban A A, Das D K (2016) Information and Communication Technology and Economic Growth in India. Telecommunications Policy 40(5): 412–431. http://dx.doi.org/10.1016/j.telpol.2015.08.006

Erumban A A, Das D K (2020) ICT Investment and Economic Growth in India: An Industry Perspective. In: Maiti D, Castellacci F, Melchior A (ed), Digitalisation and Development. Singapore: Springer Nature. https://doi.org/10.1007/978-981-13-9996-1_2

Farhadi M, Ismail R, Fooladi M (2012) Information and Communication Technology Use and Economic Growth. PloS one 7(11): 01–07. https://doi.org/10.1371/journal.pone.0048903

Faye M (2000). Developing National Information and Communication Infrastructure (NICI) Policies and Plans in Africa. Paper presented at Nigeria NICI Workshop, Abuja, Nigeria, March 28–30, 2000.

Figueroa A (2015) The Impact of Globalization on Human Development in the Developing Countries : The Case of Central and South America.Revista Eletrônica de Ciência Política 5(2): 24–41. https://doi.org/10.5380/recp.v5i2.37371

Gani A (2019) Globalisation and human development : Does export type. Quality & Quantity 53(4): 2235–2251. https://doi.org/10.1007/s11135-019-00868-8

Gholami R, Higon D A, Hanafizadeh P, Emrouznejad A (2010) Is ICT the key to Development?. Journal of Global Information Management (JGIM) 18(1): 66–83. https://doi.org/10.4018/jgim.2010091104

Ghosh S (2017) Broadband Penetration and Economic Growth: Do Policies Matter?. Telematics and Informatics 34(5): 676–693. https://doi.org/10.1016/j.tele.2016.12.007

Gunduz S (2007) Health Problems with the Use of Information Technologies. Retrieved from https://files.eric.ed.gov/fulltext/ED500181.pdf

Gupta S, Jain M, Nagpal A (2019) An Empirical Investigation on associated Linkage between Human Development and ICT: A South Asian Perspective. MPRA Paper 96167. Retrieved from https://mpra.ub.uni-muenchen.de/96167/

Haftu G G (2019) Information Communications Technology and Economic Growth in Sub-Saharan Africa: A Panel Data Approach. Telecommunications Policy 43(1): 88–99. https://doi.org/10.1016/j.telpol.2018.03.010

Haseeb M, Suryanto T, Hariyatie N (2019) Nexus Between Globalization , Income Inequality and Human Development in Indonesian Economy : Evidence from Application of Partial and Multiple Wavelet Coherence. Social Indicators Research. https://doi.org/10.1007/s11205-019-02178-w

Hofman A, Aravena C, Aliaga V (2016) Information and Communication Technologies and their Impact in the Economic Growth of Latin America, 1990–2013. Telecommunications Policy 40(5): 485–501. http://dx.doi.org/10.1016/j.telpol.2016.02.002

Hoz-Rosales D L B, Ballesta J A C, Tamayo-Torres I, Buelvas-Ferreira K (2019) Effects of Information and Communication Technology Usage by Individuals, Businesses, and Government on Human Development: An International Analysis. IEEE Access 7: 129225–129243.

Hwang W S, Shin J (2017) ICT-specific Technological Change and Economic Growth in Korea. Telecommunications Policy 41(4): 282–294. http://dx.doi.org/10.1016/j.telpol.2016.12.006

Iqbal K, Hassan S T, Peng H (2019) Analyzing the role of information and telecommunication technology in human development : panel data analysis. Environmental Science and Pollution Research 26: 15153–15161. https://doi.org/10.1007/s11356-019-04918-4

Jensen R (2007) The Digital Provide: Information (technology), Market Performance, and Welfare in the South Indian Fisheries Sector. The Quarterly Journal of Economics 122(3): 879–924. https://doi.org/10.1162/qjec.122.3.879

Kaka N, Madgavkar A, Kshirsagar A, Gupta R, Manyika J, Bahl K, Gupta S (2019) Digital India: Technology to transform a Connected Nation. McKinsey Global Institute. Retrieved from https://www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/digital%20india%20technology%20to%20transform%20a%20connected%20nation/digital-india-technology-to-transform-a-connected-nation-full-report.ashx

Kocourek A, Laboutková Š, Bednářová P (2013) Economic, Social, and Political Globalization and Human Development. International Journal of Business and Economic Development 1(2): 10–20.

Krishna K L, Erumban A A, Goldar B, Das D K, Aggarwal S C, Das P C (2018) ICT Investment and Economic Growth in India: An Industry Perspective. Working Paper No. 284. Retrieved from http://www.cdedse.org/pdf/work284.pdf

Kumar R R, Stauvermann P J, Samitas A (2016) The Effects of ICT on Output Per Worker: A Study of the Chinese Economy. Telecommunications Policy 40(2–3): 102–115. http://dx.doi.org/10.1016/j.telpol.2015.06.004

Kurniawati M A (2021) Analysis of the Impact of Information Communication Technology on Economic Growth: Empirical Evidence from Asian Countries. Journal of Asian Business and Economic Studies. https://doi.org/10.1108/JABES-07-2020-0082

Kwiatkowski D, Phillips P C, Schmidt P, Shin Y (1992). Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root. Journal of Econometrics 54(1-3): 159 – 178.

Maurseth P B (2020) ICT, Growth, and Happiness. In: Maiti D, Castellacci F, Melchior A (ed) Digitalisation and Development. Singapore: Springer Nature. https://doi.org/10.1007/978-981-13-9996-1_2

Mazlan N S, Fadzilah F Y Ibrahim S (2019) The Role of Globalisation in Improving Human Development in Malaysia. Jurnal Ekonomi Malayasia 53(2): 227–234.

Naqvi S N H (2002) Globalization and Human Development: An Overview. In: Sirageldin I (ed) Sustainable Human Development in 21st Century (Vol. II). Oxford, United Kingdom: Encyclopedia of Life Support Systems (EOLSS)/UNESCO.

Narayana M R (2010) Sector, Globalization and Urban Economic Growth: Evidence from Bangalore (India). WIDER Working Paper No. 2010/80. The United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki. Retrieved from http://hdl.handle.net/10419/54059

Neogi C (2020) Effect of ICT on the Performance of Indian States in Terms of Human Development Indices. In Maiti, D., Castellacci, F., & Melchior,A. (eds.), *Digitalisation and Development*. Singapore: Springer Nature. https://doi.org/10.1007/978-981-13-9996-1_2

Ng S, Perron P (2001) Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power. Econometrica: Journal of the Econometric Society 69(6): 1519–1554.

Niebel T (2018) ICT and Economic Growth–Comparing Developing, Emerging and Developed Countries. World Development 104: 197–211. https://doi.org/10.1016/j.worlddev.2017.11.024

Nosiru O M, Sodique F R (2019) ICT, Development and Poverty Nexus in Africa: Way Forward. Ethiopian e-Journal for Research and Innovation Foresight (Ee-JRIF) 11(1): 13–26.

Ogunsola L A (2005) Information and Communication Technologies and the Effects Of Globalization: Twenty-first Century "Digital Slavery" for Developing Countries—Myth or Reality?. The Electronic Journal of Academic and Special Librarianship 6(1–2). Retrieved from file:///D:/PhD/My%20work/Literature/Ogunsola%202005.html

Organisation for Economic Co-operation and Development (2004) The Economic Impact of ICT: Measurement, Evidence, and Implications. France: OECD.

Pesaran M, Shin Y, Smith R (2001) Bounds Testing Approaches to the Analysis of Level Relationship. Journal of Applied Econometrics 16(3): 289–326.

Phillips P C, Perron P (1988) Testing for a Unit Root in Time Series Regression. Biometrika 75(2): 335 – 346.

Quaglio G, Millar S (2020) Potentially Negative Effects of Internet Use. European Parliamentary Research Service. Retrieved from https://www.europarl.europa.eu/RegData/etudes/IDAN/2020/641540/EPRS_IDA(2020)641540_EN.pdf

Rao S S (2005) Bridging Digital Divide: Efforts in India. Telematics and Informatics 22: 361–375.

Romilly P, Song H Liu X (2001) Car Ownership and Use in Britain: A Comparison of the Empirical Results of Alternative Cointegration Estimation Methods and Forecasts. Applied Economics 33: 1803–1818.

Roztocki N, Soja P, Weistroffer H R (2019) The Role of Information and Communication Technologies in Socio-economic Development: Towards a Multi-dimensional Framework. Information Technology for Development 25(2): 171–183.

Sabi M (2007) Globalization and Human Development, International Conference on Globalization and Its Discontents, Cortland: 102-119.

Sahay S, Walsham G (2017) Information Technology, Innovation and Human Development: Hospital Information Systems in an Indian State. Journal of Human Development and Capabilities 18(2): 275–292. http://dx.doi.org/10.1080/19452829.2016.1270913

Sahoo D (2012) Role of ICT in Economic Growth and Regional Inequality in India. In CPRafrica 2012/CPRsouth7 Conference, Port Louis, Mauritius.

Sahoo D, Nayak S, Behera J (2021) Digitalization and Economic Performance of Two Fast-Growing Asia Economies: India and the People's Republic of China. ADBI Working Paper 1243. Asian Development Bank Institute (ADBI), Tokyo, Japan. Retrieved from https://www.adb.org/publications/digitalization-economic-performance-fast-growing-asian-economies-india-prc

Salahuddin M, Alam K (2016) Information and Communication Technology, Electricity Consumption and Economic Growth in OECD countries: A Panel Data Analysis. International Journal of Electrical Power & Energy Systems 76: 185–193. http://dx.doi.org/10.1016/j.ijepes.2015.11.005

Sapkota J B (2011) Impacts of Globalization on Quality of Life : Evidence from Developing Countries: 1–28.

Seconded European Standardisation Expert in India (2019) Indian ICT Sector Profile Report. New Delhi: SESEI. http://www.eustandards.in .

Shafeeq F, Raza S H, Ramzan S (2019) The Impact of Globalization on Quality of Life : An Empirical Investigation For Asian Countries. Journal Globalization Studies 10(1): 97–110. https://doi.org/10.30884/jogs/2019.01.07

Sharma B, Gani A (2004) The Effects of Foreign Direct Investment on Human Development. Global Economy Journal 4(2): 01–18. https://doi.org/10.2202/1524-5861.1049

Shin Y, Yu B, Greenwood-Nimmo M (2014) Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework. In: Sickles R, Horrace W (ed) Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications. Springer, New York. https://doi.org/10.1007/978-1-4899-8008-3_9

Simba D O (2004) Application of ICT in Strengthening Health Information Systems in Developing Countries in the wake of Globalisation. African Health Sciences 4(3): 194–198.

Singh S (2008) Impact of Internet and E-commerce on the Labour Market. Indian Journal of Industrial Relations 43(4): 633–644.

Singh A (2012) Financial Globalization and Human Development. Journal of Human Development and Capabilities 13(1): 135–151. https://doi.org/10.1080/19452829.2011.637380

Singh N (2015) Information Technology and its Role in India's Economic Development: A Review. Paper presented at IGIDR, Mumbai, December 1–4, 2015. Retrieved from https://www.ncaer.org/uploads/photo-gallery/files/1438927028Singh_Paper_IGIDR25th_2015%20(1).pdf

Sirgy M J, Lee D-J, Miller C, Littlefield J E (2004) The Impact of Globalization on a Country's Quality of Life: Toward an Integrated Model.Social Indicators Research 68(3): 251–298.

Tavares A I (2018) eHealth, ICT and its Relationship with Self-reported Health Outcomes in the EU Countries. International Journal of Medical Informatics 112: 104–113. https://doi.org/10.1016/j.ijmedinf.2018.01.014

Telecom Regulatory Authority of India (2020) Annual Report 2019–2020. Telecom Regulatory Authority of India (TRAI). Retrieved from https://www.trai.gov.in/about-us/annual-reports

Tjoa A M, Tjoa S (2016) The Role of ICT to achieve the UN Sustainable Development Goals (SDG). In: Mata F, Pont, A (ed) ICT for Promoting Human Development and Protecting the Environment. IFIP World Information Technology Forum 2016 (pp. 3–13). IFIP Advances in Information and Communication Technology. Springer, Cham. https://doi.org/10.1007/978-3-319-44447-5_1

Toader E, Firtescu B N, Roman A, Anton S G (2018) Impact of Information and Communication Technology Infrastructure on Economic Growth: An Empirical Assessment for the EU Countries. Sustainability 10(10): 01–22. https://doi.org/10.3390/su10103750

Tripathi M, Inani S K (2016) Does Internet affect Economic Growth in Sub-Saharan Africa?. Economics Bulletin 36(4): 1993–2002.

Tripathi M, Inani S K (2020) Does Information and Communications Technology affect Economic Growth? Empirical Evidence from SAARC Countries. Information Technology for Development 26(4): 773–787. https://doi.org/10.1080/02681102.2020.1785827

Tsai M C (2007) Does globalization affect human well-being? Social Indicators Research 81(1): 103–126. https://doi.org/10.1007/s11205-006-0017-8

Tsakiri L T (2010) Is Globalisation Affecting the Quality of Life ? Abstract. European Research Studies XIII(4): 157–168.

Ullah S, Azim P (2017) Human Development in the Era of Globalization: An Asian Perspective. The Pakistan Journal of Social Issues VIII: 123–139.

United Nations Development Programme (1990) *Human Development Report 1990.*Retrieved from*http://hdr.undp.org/sites/default/files/reports/219/hdr_1990_en_complete_nostats.pdf*

United Nations Development Programme (2004) ICT and Human Development: Towards Building a Composite Index for Asia: Realising the Millennium Development Goals. Technical Paper. New Delhi: Elsevier. Retrieved from http://www.undp.org/content/dam/rbap/docs/Research%20&%20Publications/human_development/RBAP-HDR-2004-Building-Composite-Index-for-Asia.pdf

United Nations Development Programme (2005) Promoting ICT for Human Development in Asia: Realizing the Millennium Development Goals. New Delhi: Elsevier. Retrieved fromhttps://www.asia-pacific.undp.org/content/rbap/en/home/library/human_development/asia-pacific-hdr-2005-summary.html

Upadhyay R (2021) Role and Importance of Next Generation Wi-Fi Technologies: In Acceleration of Digital Transformation. Broadband India Forum. Retrieved from https://broadbandindiaforum.com/wp-content/uploads/2021/06/BIF-WP_Role-Importance-of-Next-Generation-Wi-Fi-Technologies-in-Acceleration-of-Digital-Transformation_June-2021.pdf

Veeramacheneni B, Vogel R, Ekanayake E M (2008) Information Technology, FDI and Economic Growth: An India Case Study. Southwestern Economic Review 35: 95–111.

Wan G (2007) Understanding Regional Poverty and Inequality Trends in China: Methodological Issues and Empirical Findings. Review of Income and Wealth 53(1): 25–34. https://doi.org/10.1111/j.1475-4991.2007.00216.x

Wicaksono E, Amir H, Nugroho A (2017) The Sources of Income Inequality in Indonesia: A Regression-based Inequality Decomposition. ADBI Working Paper No. 667. Tokyo, Japan: Asian Development Bank Institute (ADBI). Retrieved from https://www.adb.org/publications/sources-income-inequality-indonesia

World Bank (1998) Knowledge for Development. World Development Report. New York: Oxford University Press, Inc. Retrieved from https://openknowledge.worldbank.org/handle/10986/5981

Yakunina R P, Bychkov G A (2015) Correlation Analysis of the Components of the Human Development Index across Countries. Procedia Economics and Finance 24: 766–771. https://doi.org/10.1016/s2212-5671(15)00692-9

Zhang J, Danish (2019) The Dynamic Linkage between Information and Communication Technology, Human Development Index, and Economic Growth: Evidence from Asian Economies. Environmental Science and Pollution Research 26(26): 26982–26990. https://doi.org/10.1007/s11356-019-05926-0

Zhong X, Clark T N, Sassen S (2007) Globalization, Producer Services and Income Inequality across US Metro Areas. International Review of Sociology—Revue Internationale de Sociologie 17(3): 385–391. https://doi.org/10.1080/03906700701574299

Zivot E, Andrews D W K (1992) Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit Root Hypothesis. Journal of Business and Economic Statistics 10(3): 251 – 270. https://doi.org/10.1080/07350015.1992.10509904