Confirming the links between socio-economic variables and digitalization worldwide: the unsettled debate on digital divide

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Abstract

Purpose – This study aims to statistically verify the links of income and education with information and communication technology (ICT) diffusion across 191 countries of the world taking into account a total of 9 indicators best representing the socio-economic variables.

Design/methodology/approach – Multivariate regression analysis was used as a prime method to rigorously test the relationships of income and education with ICT diffusion across 191 countries. Statistical Package for the Social Sciences (V. 22) was used to analyze and predict patterns in the data.

Findings – The results support the hypotheses that income and education are positively related to ICT diffusion. The findings statistically confirm that poverty is a leading cause of digital divide worldwide.

Research limitations/implications – Academic, policy and practice groups should work in collaboration to fight against digital divide. Present results also imply that digital divide shall never end but rather it can be controlled to an extent with multiple collaborative efforts.

Originality/value – Prior research assignments on the digital divide concentrate on exploring the links between few socio-economic and ICT variables in select few regions theoretically. The present work addresses this literature gap by developing and testing two hypotheses to statistically investigate the relationships between a broad set of socio-economic and ICT indicators.

Keywords ICT, Digital divide, Socio-economic indicators

Paper type Research paper

1. Introduction

During the past two decades, the digital divide has been studied extensively; however, without reaching any adequate solution. Despite this, the digital divide is deepening across the world (Dutton and Reisdorf, 2019; Van Deursen and Mossberger, 2018; Van Deursen and Helsper, 2015).

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Yaman (2015) perfectly embodies this idea by asserting that the digital divide is still unknown as a concept despite its apparent known presence. For instance, a common misconception among government agendas was that providing access to internet would solve the problem of digital divide (Van Deursen and Van Dijk, 2019). It is increasingly being considered as a multidimensional phenomenon beyond access to digital technologies (Billon *et al.*, 2009; Chipeva *et al.*, 2018). Thus, in simple terms, the digital divide may be defined as a gulf between those who have access as well as usage for digital technologies and those who do not.

The imbalances in access and usage of information and communication technology (ICT) have been widely investigated since the evolution of the digital divide concept, back in mid-1990s. Vodoz *et al.* (2007) found that individuals with high education levels are likely to adopt the digital technologies faster than people with low or no education at all. Two large-scale studies (Zhang, 2013; Quibria *et al.*, 2003) determined the positive correlation between GDP and the internet diffusion.

However, much uncertainty still exists about the relation between education and ICT diffusion as two major studies (Middleton and Chambers, 2010; Cruz-Jesus *et al.*, 2012) defy any relation between the two. Stanley (2003) identifies psychosocial resistances as key factors responsible for the digital divide, thus putting aside income and education. Stanley's views appear to be grounded on the assumption that psychosocial variables primarily drive the ICT use; whereas, based on the evidence reviewed above, education may be taken as a main promoter of ICT usage.

What is not yet clear is the measured impact of socio-economic indicators on ICT adoption in the current period of time. Does education primarily drive the ICT use in developing and underdeveloped countries? If dependency of education on ICT is broken, shall it reinforce the digital divide? How do the different socio-economic variables relate to ICT indicators? The answers can give us further insights into the complex nature of the digital divide and may help leverage the policies to combat the problem. While prior research has mostly concentrated on single factors depicting education and income, it might be useful to examine the subsequent effects of other factors related to education and income to help draw rigorous insights into their relationship with ICT indicators.

New terminologies such as "e-inclusion" or "digital inclusion" are increasingly visible in literature. However, the classic problem of digital divide has further deepened; new digital divides are born when existing are being minimized. For example, rate of change of technologies appears to refute old technologies very fast. Even if old ICT equipment becomes available to masses seemingly controlling the digital gap, new divide can be on quality and capability as well as skills needed to use new ICT equipment. Digital divide is multidimensional and multidimensional attempts are required to control it.

The goal of this research is, therefore, to develop a more rigorous understanding of the relationships between different socio-economic variables and ICT variables on a global level and present the possible implications for policymakers, which was not favored in prior research attempts. Hypothetical premises, at this point, rest on two assumptions: income is positively related to ICT adoption and ICT adoption drives from education. A side aim of this research is to raise implications for policymakers, researchers and practitioners alike rather than just seeking a solution for the applied problem.

The long-term implications of this study shall impact the way the global digital divide is seen in relation to the socio-economic factors. To accomplish this aim and to respond to a recent call for research into quantitative uptake on the digital divide, we perform a multivariate regression analysis on a broad set of socio-economic and ICT indicators worldwide to determine their relationships while maintaining rigor in analysis. For the purposes of this study, the chosen socio-economic indicators are gross domestic product (GDP) per capita, gross national income (GNI) (PPP), government expenditure on education, literacy rate, secondary school enrollment and primary school enrolment; whereas internet

users per 100 people, broadband internet subscribers per 100 people and cellular subscribers per 100 people represent ICT indicators.

Although some research has studied the socio-economic links with ICT, most have been verified theoretically. This paper statistically verifies these links through rigorous multivariate statistics. Bearing in mind the lack of quantitative literature on digital divide, this paper is expected to address this gap and contribute toward quantitative accounts of digital divide. It is possible to further improve the research design and scope by using a combination of methods for all countries of the world whose data can be extracted from the World Bank. Based on this debate, the present research seeks to perform a multivariate statistical analysis and visualizations between the major disputed factors responsible for the digital divide and the ICT. As the digital divide draws its roots from a host of socio-economic variables, we extend our analysis to include a broad range of indicators best matching the concerned factors in the hypothesis. Drawing upon this stand of research into the digital divide, this paper shall verify the aforementioned claims in preceding paragraphs by examining the links of income and education with ICT patterns across all countries of the world included in the database of the World Bank. A secondary aim is to shed light on the implication of the findings and suggest a direction for future developments.

2. Literature review

2.1 Digital divide appears to be a disputed theme in literature

Considerable evidence was found confirming that the subject of digital divide is disputed among researchers; some studies (Dewan and Frederick, 2005; Miranda *et al.*, 2014; Menou, 2001; Drouard, 2011) consider the digital divide to be a matter of gap in access to ICT, while others (Edwards, 2005; Moss, 2002; Mordini *et al.*, 2009; Couldry, 2007; Tavani, 2003; DiMaggio *et al.*, 2001; Katz *et al.*, 2001; Noh *et al.*, 2015; Fuchs and Horak, 2008; Kyriakidou *et al.*, 2011; Guillén and Suárez, 2005; Ferro *et al.*, 2011; Grubesic and Murray, 2002) consider the digital divide as a complex and broad phenomenon where several variables play their respective part. The traditional view of the digital divide as a matter of "access" is problematic, as studies (Ferro *et al.*, 2011; Hilbert, 2011; Thomas and Parayil, 2008; Van Dijk, 2006; Al-Jaghoub and Westrup, 2009; Bruno *et al.*, 2011; Chen *et al.*, 2010; Busch, 2011; Scanlan, 2008) remind that such views are naive and undermine the influence of various socio-economic factors on the digital divide.

Novo-Corti *et al.* (2014) argue that promoting access to digital technologies is a simple solution to overcome the digital divide. Then again, Klimaszewski and Nyce (2009) appear to challenge this view by noting that ICT penetration rates cannot be taken as firm representation of digitalization, rather actual gains from the penetration should be taken into account. Although the study (Novo-Corti *et al.*, 2014) was targeted toward a particular region, the claim is questionable because the digital divide has been proved as a complex phenomenon and a variety of factors are responsible for the divide other than just access. Bach *et al.* (2013) and Luyt (2006) call for effective policies for organizations and governments to combat the digital divide. This corroborates the findings of Graham (2002), who highlights the need for effective government systems with effective subsidies to minimize the digital divide. Peng (2010) points out that although governments have access to household profile data, such as education, income and gender, they often lack reliable insights into psychological and cognitive profiles of individuals.

2.2 Debate on link between education and information and communication technology

The long-sought link between education and ICT has been extensively studied; however, with contradictory conclusions. Pick and Nishida (2015) found education to be the principal

determinant of technology usage. It can be inferred from the study's conclusion that the role of education is significant in increasing the adoption of digital technologies. It was earlier hypothesized (DiMaggio and Hargittai, 2001) that higher levels of education determine higher levels of internet usage for occupation, education and other information needs. Results from a major multivariate study (Robinson *et al.*, 2003) confirmed that education is highly correlated with the use of the internet. Similarly, Cooke and Greenwood (2008) maintain that the educational sector has made significant progress in promoting the adoption of ICT. Pittman (2007) postulates that the role of ICT is essential in fostering a globally diverse educational system.

However, recently some literature has emerged that offers contradictory findings regarding the role of education in ICT adoption. Two empirical investigations (Katz *et al.*, 2001; Lee, 2010) suggest that demographic factors (age, gender and education) have little effect on the digital divide. One study (Pieper *et al.*, 2003) drew attention toward the fact that students used computers for playing games rather than for completing school home work. Unlike Pittman (2007), a survey study of 158 small and medium-sized enterprise owners by Middleton and Chambers (2010) found that education has no effect on the adoption of the internet. However, this attitude would appear to be debatable. This is because the ICT landscape has significantly changed in the past five years with the emergence of high-tech gadgets being used by students in schools, such as tablets and smartphones. Thus, there are limits to how far the idea of Middleton and Chambers (2010) can be adopted, because ICT is being increasingly incorporated into the education systems worldwide.

2.3 Debate on link between income and information and communication technology

As reported in a few studies (Ya'u, 2005; Doong and Ho, 2012), it is regrettable that the ICT landscape is highly uneven with varied resources distributed across the planet. One group, consisting of developed countries, is continuously reaping the benefits of ICT (Drori and Jang, 2003), that allows social and economic transformation (Preston, 2004); whereas the other group, consisting of developing countries, is missing out on many benefits because of lack of access to digital technologies (Meng and Li, 2002; Chinn and Fairlie, 2006; Antonelli, 2003). An analogy may be drawn here between ICT resources and economic prospects, as monetary and other resources exhibit a similar pattern of uneven distribution. This has led some scholars (Tipton, 2002; Olaniran and Agnello, 2008; Beckman *et al.*, 2008) to assert income disparity as the leading cause of the digital divide by noting that the digital divide reflects high income levels in the developed world whereas the opposite is true for the developing world. Quibria *et al.* (2003) report a strong correlation between GDP per capita and the usage of computers. However, Tavani (2003) develops the claim that there are numerous other factors responsible for the breach in access and usage of ICT other than income alone. Brooks *et al.* (2005) maintain that cost of internet connectivity in developing countries is significantly higher than those in developed countries. This corroborates with the view of Norris (2001) who maintains that richer countries are better in reaping the benefits of ICT than the poorer countries.

The evidence presented in the above paragraph suggests that there is a strong connection between GDP per capita and the patterns of digitalization. However, a number of studies (Hess and Leal, 2001; Cruz-Jesus *et al.*, 2012; Kyriakidou *et al.*, 2011; Dijk and Hacker, 2003; Rao, 2003; Vicente and López, 2011; Sipior *et al.*, 2011) have reported significant digital divide within developed countries, which questions the relation of GDP per capita with the ICT diffusion. This doubt is further reinforced as some researchers (Schleife, 2010; Douglas, 2000) report a regional digital divide with respect to urban and rural settlements in high-income developed countries. The digital divide should be of an equal research and policy

focus in urban along with rural settlements (Hess and Leal, 2001). Europe is currently experiencing ageing-related challenges that is hindering the way for an information inclusive society (Niehaves and Plattfaut, 2014). The evidence reviewed thus far urges an important question: Will there still be a digital divide if wealth was distributed equally on the planet?

2.4 Hypothesis

The evidence reviewed in the scholarly literature advances us toward testing two empirically verifiable hypotheses. First, GDP per capita bears a positive relation with ICT adoption. Second, education bears a positive link with ICT adoption. The hypotheses shall reveal insights into the nature of the digital divide concerning two important socio-economic variables: income and education. Digital divide is a multidimensional phenomenon. However, our goal here is to verify existing claims about the relationship of income and education with ICT. As observed from literature review, there exists a debate on such relationships. Therefore, we test the starting assumptions with multivariate regression analysis on a large sample of countries to weigh the arguments. Table 1 lists the hypothesis that shall be tested with inferential statistics tools in the forthcoming sections.

3. Research design

3.1 Methodology

To date, various methods have been developed and introduced to determine the connection between two or more variables. Quantitative research on the digital divide is very limited (Quibria *et al.*, 2003). This was also evident when we conducted our literature review; most of the studies were qualitative in nature. This also presented us an opportunity to address this methodological literature gap. It was believed that multivariate analysis would usefully supplement and extend the prior research methodology to assess the relationships between socio-economic and ICT indicators.

Hypothesis	Independent variables	Dependent variables	Hypothetical assumptions	Existing studies in support	Existing studies in denial
Hypothesis 1	Digitalization	Income	Rise in income determines the rise in ICT adoption	Beckman *et al.* (2008), Olaniran and Agnello (2008), Tipton (2002), Quibria *et al.* (2003), Norris (2001), Skok and Ryder (2004), Billon *et al.* (2009), Brooks *et al.* (2005), Herling (2007)	Tavani (2003)
Hypothesis 2	Digitalization	Education	Growth in education boosts ICT adoption	Pick and Nishida (2015), Dimaggio and Hargittai (2001), Robinson *et al.* (2003), Cooke and Greenwood (2008), Pittman (2007), Stachokas (2014), Vodoz *et al.* (2007), Quibria *et al.* (2003), Zhang (2013)	Katz *et al.* (2001), Lee (2010), Pieper *et al.* (2003), Middleton and Chambers (2010), Cruz-Jesus *et al.* (2012)

Table 1. Hypothesis development

As the name implies, multivariate statistics refer to multiple statistical techniques and processes where more than one variable is involved in analysis. Multivariate statistics is an assortment of descriptive and inferential techniques often deployed in complex circumstances where variables are either predictors or measures of performance (Harris, 2014). In statistical terminology, multivariate techniques, in contrast to univariate methods, allow the simultaneous analysis of more than one variable (Pripp, 2013). Because the principal objective of multivariate analysis is to treat multivariate data as a whole (Gauch, 1982), it offers a low level of susceptibility of error, especially when an analysis is conducted for a wide assortment of data.

Multivariate statistical methods are particularly useful in studying the relationships among various factors with a great degree of accuracy from an applied point of view. The second advantage of using the multivariate method is that it creates rigor in the statistical analysis, as Stevens (2012) reminds that using multivariate statistics renders a comprehensive description of phenomenon under examination. A third advantage of the multivariate method lies in the clear procedures to combine several variables into a single weighted variable which helps in implying the effects of all variables on the responses of interest.

The multivariate technique chosen for the present study was the multivariate regression analysis. Regression analysis refers to procedures attempting to fit a developed model with a purpose of quantifying the relationship between two groups of variables. This method examines the influence of several independent variables over a dependent variable. In addition, it calculates the statistical significance of the test and provides an estimate of standard error. Further, multivariate regression analysis offers insights to researchers about the degree of confidence for the actual results.

3.2 Sample construction and data selection

The data was sourced from the World Bank because of credibility and ease of data downloads. Another reason for choosing the World Bank lies in the vast coverage of countries, which other data banks usually do not provide. Data management and analysis were performed using Statistical Package for the Social Sciences (SPSS, 22.0, 2015). This research aimed at conducting the digital divide analysis across the entire world with 215 countries in the database of the World Bank. Some countries considerably lacked the volume of data required for performing the analysis. The final number of countries was brought down to 191. The data for each indicator was chosen over a span of five years, from 2010 to 2014. The mean score of each indicator was taken and then combined together into a single weighted indicator using SPSS advance functions. Significance levels for the test were set at 0.405.

The challenge of engaging in quantitative analysis lies in the data complexity and certainty, particularly if the sample size is enormous. One significant challenge encountered encompasses how to deal with the missing values in retrieved data sets. It was decided to take the mean of the entire series of data set and fill in the missing values with that mean. This was done to attain a near realistic value for the missing fields in the data set. This was the only possible option to fill up the missing values to not compromise the accuracy of statistical calculations; otherwise regression analysis would not have been possible for a large number of countries because many countries would have been left out. For each factor, a few indicators were chosen that would best represent the overall factor.

Table 2 lists the factors and the corresponding indicators representing them. These indicators were obtained from the World Bank Development Indicators 2016 (World Bank, 2016). GDP per capita and GNI (PPP) represent income factor. Primary school enrolment,

secondary school enrolment, literacy rate and government expenditure on education represent education factors. Initially, the internet user percentage and broadband internet subscription percentage were chosen to represent digitalization factors. As Srinuan *et al.* (2012) acknowledge, with the growing popularity of mobile internet over traditional fixed line internet, it becomes significantly justified to include mobile broadband subscribers as a potential indicator depicting digitalization.

The next step was to ensure whether or not the chosen indicators had any correlation among them, before combining them into a single weighted data set. For this purpose, Cronbach's alpha test was used, which is a check for rigor and to ensure whether the indicators representing a particular variable correlate with each other. To achieve a feasible value of Cronbach's alpha, several indicators representing respective factors (income, education and digitalization) were analyzed. The value of Cronbach's alpha was high for education and digitalization factors. Another variable set, "Fairness" including the Corruption Perception Index and the Gini index, was also brought into the initial analysis, but each time Cronbach's alpha value would significantly drop. Therefore, it was decided to include two indicators for income, three for education and four for digitalization, which would best represent the respective factors; Cronbach's alpha test was feasible, and the data was widely available.

4. Results and discussion

4.1 Results

Multivariate regression analysis was used to test the relationship of income and education with the ICT adoption. The indicators were standardized in SPSS to get weighted variables representing the respective indicators. The regression equation is presented below.

$$R^2 = 0.69\,\mathrm{F}\,(2.188) = 214.384\,P\,0.001$$

The value of R^2 (0.695), also known as coefficient of determination, suggests that the regression model explains a considerable level of the response variability by almost 70%. In other words, almost 70% of the time, changes in income and education cause changes in ICT adoption. *F*-value (214.364) indicates that the regression model is a good fit for the data and further suggests a significant effect of income and education on ICT adoption.

The regression model summary is presented in Table 3. The *t*-values (9.863) for education and (14.20) income indicate that these dependent variables are statistically significant in current multivariate regression results at the standard degree of freedom N-3.

Socio-economic variables	Indicators
Income	1. GDP per capita
	2. GNI (PPP)
Education	1. Secondary school enrollment
	2. Primary completion rate
	3. Literacy rate
	4. Government expenditure on education
Digitalization	1. Internet users per 100 people
	2. Broadband internet subscriptions per 100 people
	3. ellular subscriptions per 100 people

Table 2. Socio-economic variables and ICT indicators

Overall, the results of the multivariate regression analysis reveal the strong relationships of income and education with ICT. The magnitude of relationship between income and ICT is stronger than the education–ICT relationship. This confirms that income is the leading cause of the digital divide across the world. However, over time as ICT shall be increasingly integrated with education, the magnitude of the education–ICT relationship is likely to increase. The results of multivariate regression analysis were visualized to obtain a graphical representation of the links between independent and dependent variables. Forthcoming sections shall individually report and draw on the links of income and education with ICT.

4.2 Confirmation of link between income and information and communication technology indicators

Figure 1 depicts the relationship between income and ICT; the linear trend in the beginning shows a strong correlation between the two variables. The figure suggests that as the income grows, the ICT adoption is likely to grow in correspondence. The box plot along the figure suggests how values are distributed for each variable. The value distribution of variables is not symmetric as displayed by varying box plots. The data set for income variables is skewed, whereas the data set for ICT variables is symmetric.

There are few points in the figure where one can notice that the linear pattern of the curve is somehow disturbed. This may be because some low-income countries are in close geographical proximity with high-income countries, making access to ICT possible and affordable. However, while understanding the geographical placement of the world's regions, there is another element to consider. The differences in the curve also leave room for taking into account the global cultural differences regarding attitude toward adopting ICT.

4.3 Confirmation of link between education and information and communication technology indicators

Figure 2 represents the relationship between education and ICT marking a considerably significant correlation between the two. Data from the World Bank indicates that ICT is widely integrated with education in the developed world, and the developing world is gradually catching up. A key policy implication is, therefore, to encourage widespread internet diffusion in developing countries.

Taken together, these results indicate that income and education bear a positive relationship with ICT adoption. In summary, the results support the assumptions presented in the introduction, with both hypotheses being supported. The next section, therefore, moves on to thoroughly discuss the findings and their implications, thereby weighing up ideas and themes identified by considering the available evidence.

4.4 Discussion

Although the research linking socio-economic and ICT indicators is still in its infancy, there are few important relationships. There has been a widespread belief among researchers that

Table 3.
Model summary for multivariate regression analysis

Model	Unstandardized coefficients		Standardized coefficients		
	B	*St. error*	*Beta*	*t*	Sig.
Constant	−0.29	0.035	0.416	−0.835	0.405
Education	0.439	0.044		9.863	0.000
Income	0.503	0.035	0.609	14.20	0.000

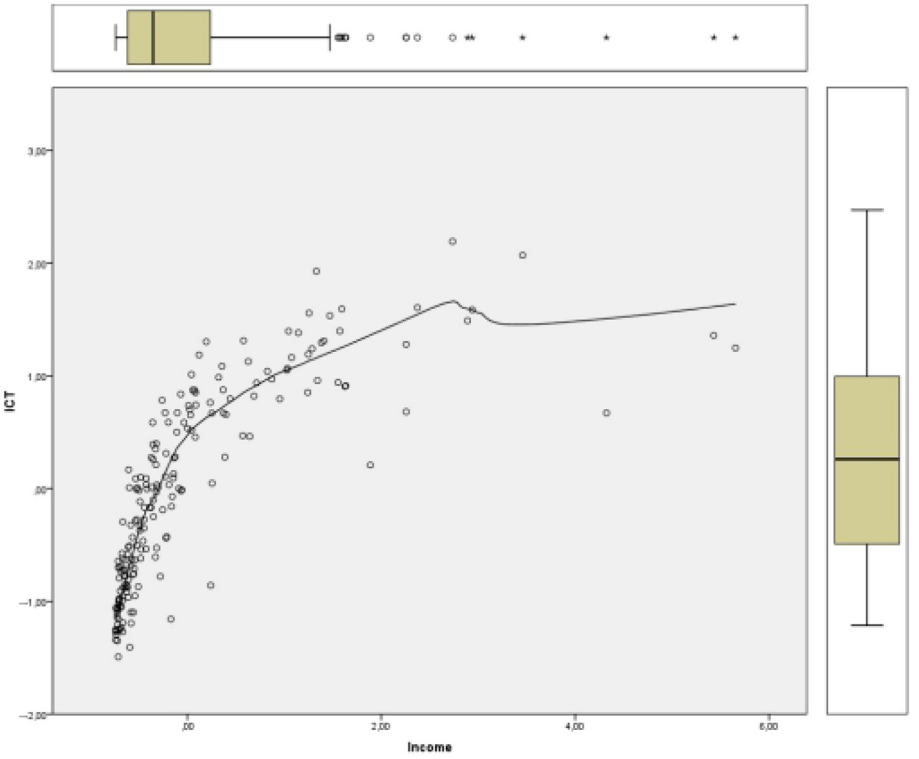

Figure 1.
Confirmation of link between income and ICT indicators

education and income factors are positively related to ICT adoption. Yet, much research has failed to establish any conclusive relationships between variables in question.

ICT has been integrated with education on a global scale, excluding unfortunate poverty-ridden areas. It then follows that, to continue education, one has to use ICT, which may be the main motivator behind the purchase decision of digital technologies. This finding has important implications for strengthening education systems, particularly in developing countries. Education and ICT, in several developing countries, are too expensive for students and general consumers, leaving millions of masses behind; for them, educational needs and ICT are pushed aside for the basic human needs of food and shelter. Poverty once again wins in breeding nuances of low standards of living, including a considerable portion of the digital divide pie. Governments, particularly in developing regions, should therefore concentrate on providing ICT-enhanced education at reasonable costs for the masses. Ideally, however, the solution should rest somewhere near providing free education and access to ICT wherever it is feasible.

There is an inherent relationship between economic prospects and commodities; the same can be seen in the case of the digital divide. From the current results, the relationship between income and ICT diffusion was slightly stronger than the education–ICT relationship. This leaves room for interpreting that income disparity is the ruling factor responsible for the digital divide. However, the reader must bear in mind the ease of access to public free internet in developed countries; the opposite results are likely in some

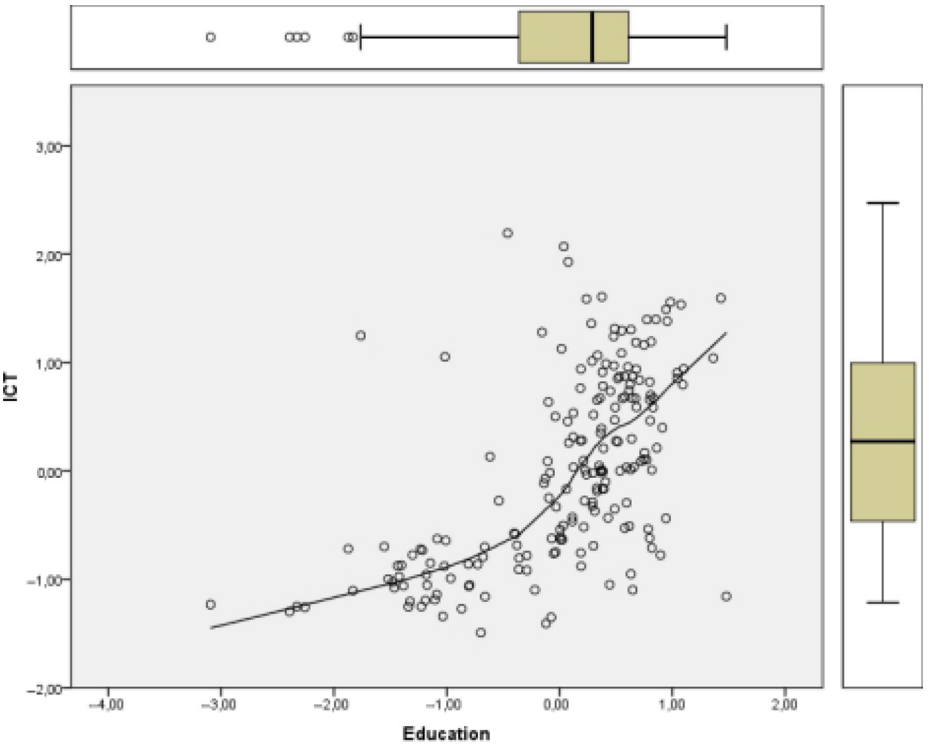

Figure 2.
Confirmation of link between education and ICT indicators

underdeveloped countries where one may only/mostly adopt digital technologies for the purposes of higher education.

The results of this research will now be compared to the findings of prior reported work. The present findings are consistent with earlier research (Norris, 2001; Olaniran and Agnello, 2008; Tipton, 2002), which documents income disparity as the principal reason for the digital disparities in the world. While the current findings about the positive relation between education and ICT match with prior research, they negate the work of Pick and Nishida (2015), Cooke and Greenwood (2008) and Middleton and Chambers (2010) who report that education has no effect on ICT adoption. This difference urges itself as evidence of dispute in the research concerning factors responsible for the digital divide.

Turning now to the hypotheses posed at the beginning of the study, it is now possible to state that income and education bear strong ties with the ICT adoption. Current research appears to validate the assumption that growth of income and education will likely result in growth of ICT adoption. This combination of findings provides some support for the conceptual premise that poverty is mainly responsible for breeding the nuances of the digital divide. An implication of this could be to provide subsidies on ICT-related products so that the masses can reach and benefit from the digital revolution.

The lightning advance of the digital technology, while beneficial through an economic lens, is placing the digital divide research at risk of being obsolete. This is because of the fact that the rate of change of technology is faster than the scholarly production on the digital divide, which already has lately received little research attention. Two brief examples might

clarify this view. First, a computer purchased 10 years ago can be practically considered as antique today, because of limited capabilities of meeting the latest demands of educational and industrial needs. Second, the change in ICT infrastructure subtly affects the digital skills of individuals to operate the latest gadgets to their benefit. Therefore, rather than being clearly understood, the digital divide has become an over-generalized rant, discussing its nature without focusing on the solution to the problem itself. There is no escaping the fact that the skills barrier is highly contingent on the disparities regarding ICT use. Thus, it is inappropriate to definitively assert that the digital divide is because of a gap in the "access" of ICT. Instead, it might be more feasible to define the concept beyond access, including several socio-economic variables that play a significant role in the digital divide.

Prior research has heavily stressed that governments should deploy a superior strategy by focusing on weakening the roots of the digital divide rather than just providing access to ICT, assuming that the market forces shall eliminate the digital divide over time. Unless governments execute impactful policies, the digital divide shall remain a difficult challenge to address in an already troubled world economy.

5. Conclusions and recommendations

This research has confirmed that there is indeed statistically significant relationship between ICT and socio-economic indicators. The page has given an account of validated positive links between income along with education and internet usage. Paired with literary clues, the visualizations paint a compelling picture in support of the hypotheses posed at the beginning of this study. This study has shown a strong positive association of income and education with levels of ICT penetration across the entire world. It is now possible to state that the rate of GDP per capita is linked inextricably to the rate of ICT penetration in the global world.

Along with methodological contribution related to quantitative analysis regarding digital divide, a primary contribution here is that this research clarifies the confusions in prior findings regarding the income and ICT relationship and contributes additional evidence that the growth in income and education determines the increasing ICT adoption rate. Among the plausible explanations for this finding is that high purchasing power encourages investment in general and modern education and is increasingly being embedded with ICT-based learning.

Role of governments in fostering positive ICT climate at affordable costs for public is recommended. First, governments should at least subsidize ICT if free access cannot be granted in the educational sector. Second, free public access ICT centers with trained staff should be on the policy agenda of developing and underdeveloped countries. Third, ICT should be increasingly incorporated into education globally to encourage the effective usage of digital technologies. Fourth, governments should prioritize digitization on their national agenda by fostering an ICT climate equally in both rural and urban areas. In summary, governments must start efforts on multiple fronts to round up the economic threats posed by the digital divide.

It is clear that rendering access to ICT does not bridge the digital divide. Digital divide is a multidimensional phenomenon and same should be understood across academic, policy, press and practice domains. Digital divide can be studied under different key terms such as digital inclusion and e-inclusion; however far more important is to acknowledge that multilevel efforts are required to control the digital divide.

It is also recommended to reconsider the concept of bridging the digital divide. From our understanding, the digital divide can never be bridged entirely; instead, it can be controlled to an extent. It is apparent that no one can be forced to embrace ICT if one does not want it.

Similarly, it is difficult to change the circumstances of everyone on the planet when it comes to acquiring or learning ICT. For example, ageing brings with itself health challenges that make it difficult to learn ICT or fully use it.

Taken together, these findings suggest a role for governments, press, academics and practitioners to understand and manifest digital divide as a dynamic multilevel phenomenon as well as fostering ICT climate in their respective regions according to their resources and capabilities. Press and policy documents in the name of effective policies against the digital divide shall remain fruitless without pronouncing a decisive aggression against the digital divide on a global scale. The relentless objections to the existing accounts on quantification of the digital divide make it advisable to reconsider the methodology and data used for analysis in future research on the topic.

From the analysis undertaken in the study, it can be inferred that boom in educational institutions shall reflect a boom in ICT adoption. Over the years, economies of scale shall bring basic ICT equipment within easy access of people. However, then new digital divides are likely based on quality and capability of ICT equipment and services as well as skills required to operate them. Therefore, stakeholders dealing with "bridging the digital divide" may want to shift their focus on "controlling the digital divide."

These recommendations should be interpreted with caution because role of culture cannot be denied in global ICT ecosystem. Likewise, personal preferences to use or not use ICT is another factor to be aware of. It has been a common observation that some people would never want to use ICT regardless of economic reason. Reasons may include many factors such as personal choice, religion, unavailability of learning resources to use ICT, lack of time to understand and adopt ICT and medical reason.

A limitation of this research is reliance on secondary data from the World Bank. There is a potential for bias from the data sets provided by the World Bank, as there can be uncertainty in the method used to calculate certain variables, such as school enrolment and internet per 100 people. Although fieldwork would have been beneficial; however, admittedly, fieldwork in all countries of the world was outside the practical boundaries of this paper because of resource and time constraints.

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