Chapter 3
Conceptual Framework and Reviews of Theoretical and Empirical Literature

3.1 Introduction

Information and Communications Technologies (ICT) has been essential for the acceleration and improvement of economic growth and welfare in any society. The crucial role of ICT and its impacts on the global knowledge economy has long received particular recognition and increasing interest in the international literature. The rapid progress in information and communications technologies led to a new economic system characterised by intensive knowledge production and diffusion that has attracted a great deal of interest. It has also raised debate on the effects of ICT and the economic opportunities and the challenges that ICT imposes on the production and dissemination of knowledge in the world economy, particularly for developing countries. Recently, the continuous move towards globalisation has made ICT one of the most important factors in achieving success as well as in seeking new markets, improving quality, providing better and faster customer service and bringing the flexibility needed to make changes quickly.

It is admitted that ICT like many other forms of technological progress has imposed both the positive and negative impacts (opportunities and challenges) on the world economy. On the one hand, some studies provide robust results showing the various influences of ICT on economic growth and development (cf. Jorgenson and Stiroh 1995; Pohjola 2000, 2001), productivity (cf. Hitt and Brynjolfsson 1996; Brynjolfsson and Yang 1996), employment, work organisation (cf. Bresnahan et al. 1999) and skill upgrading (cf. Acemoglu 1998; Hwang 2000). One interesting finding in the literature confirms the importance of ICT for enhancing economic growth not only directly, but also indirectly through enhancing knowledge (cf. Smith 2000) and through the complementary relationships between ICT, human capital/skill and skill upgrading (cf. Goldin and Katz 1998; Bresnahan et al. 1999; Autor et al. 1998; Acemoglu 1998; Hwang 2000).

On the other hand, several studies discuss the hazards ICT creates for economic development. Most of this literature is based on the idea that technical change is a

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creative destruction process that creates opportunities for development, while also imposing certain restrictions to development and negative impacts on employment and labour markets (cf. Bound and Johnson 1992; Berman et al. 1994; Freeman and Soete 1985, 1994, 1997; Acemoglu 1998; Aghion and Howitt 1998; Autor et al. 1998).

It has also been hypothesised that ICT could impose adverse effects in the developing world because greater advantages will accrue to the industrialised world from global competitiveness than to the developing world, thus making it hard for the less developed countries to compete on the international market. Furthermore, the rapid evolution in ICT will make it harder for the developing countries to bridge the already widening gap between the developed and developing world. ICT, by increasing inequality in income distribution and thus adding to the poverty of the poor, will have adverse results on the status of the poor. ICT may intensify the competition and hence widening the already existing gap and digital divide between the developed and developing countries (cf. OECD 2001; ITU 2013).

In light of this background and the findings in Chap. 2 above, it is therefore reasonable to highlight the need for improvement of investment in ICT to alleviate the digital divide, enhance production, creation and transfer of knowledge in higher education institutions and to enhance economic growth and sustainable development in Sudan. Before starting the empirical analysis, it is useful in this chapter to briefly explain the concepts, measures and theoretical and empirical literature in relation to ICT, knowledge, economic growth and digital divide. We provide a background for the empirical analysis in the following chapters by surveying the theoretical and empirical literature that emphasizes the positive effects of ICT in enhancing knowledge and economic growth and the negative effects of ICT through exacerbating the digital divide, the digital divide continues to cause intense debate.

The rest of this chapter is organized as follows: in Sect. 3.2 we define the concepts of "information and communications technology (ICT)", "digital divide", "global digital divide" and "gender digital divide"; the theoretical and empirical literature on the relationship between ICT, knowledge and digital divide are presented in Sect. 3.3. Section 3.3.2 describes the relationship between ICT and economic growth; Sect. 3.3.4 discusses relations between ICT and knowledge production and higher education institutions, and finally, Sect. 3.4 concludes.

3.2 Conceptual Framework: Definition of Information and Communications Technology, Digital Divide, Global Digital Divide, and Gender Digital Divide

Before presenting the theoretical and empirical literature, it is useful to begin with the definition of the concepts of "information and communications technology (ICT)", "digital divide", "global digital divide" and "gender digital divide".

3.2.1 Information and Communications Technology

The term Information and communications technology (ICT) is often used as an extended synonym for information technology (IT), but is a more specific term that stresses the role of unified communication and the integration of telecommunication (telephone lines and wireless signals), computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information. The term *ICT* is also used to refer to the convergence of audio-visual and telephone networks with computer networks through a single cabling or link system.[1]

3.2.2 Digital Divide

This section explains the distinction that has been made between the term "digital divide", "global digital divide" and "gender digital divide".

3.2.2.1 Digital Divide

We start with the concept digital divide, according to the definition of Oxford dictionaries: "*the digital divide is the gulf between those who have ready access to computers and the Internet, and those who do not*".[2] According to the definition provided in other dictionary "*the digital divide is the socioeconomic and other disparities between those people who have opportunities and skills enabling them to benefit from digital resources, especially the Internet, and those who do not have these opportunities or skills*".[3] According to OECD (2001) "*the term "digital*

[1] See http://en.wikipedia.org/wiki/Information_and_communications_technology.

[2] See Oxford dictionaries: http://www.oxforddictionaries.com/definition/english/digital-divide, accessed on September 08, 2014.

[3] See http://dictionary.reference.com/browse/digital+divide, accessed on September 08, 2014.

divide" refers to the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities, the digital divide reflects various differences among and within countries" (OECD 2001).[4] The U.S. Department of Commerce—National Telecommunications and Information Administration (NTIA) (1999) defines the "digital divide" as "*the divide between those with access to new technologies and those without*".[5] More broadly, the term digital divide is used to describe a gap between those who have ready access to information and communication technology and the skills to make use of those technology and those who do not have the access or skills to use those same technologies within a geographic area, society or community. Based on this, a digital divide is an economic and social inequality between groups of persons, according to categories of persons in a given population in their access to, use of, or knowledge of information and communication technologies (ICT) (NTIA 1995; Chinn and Fairlie 2004). It may refer to inequalities between individuals, households, businesses, or geographic areas, usually at different socioeconomic levels or other demographic categories.[6] The term digital divide also refers to "*an inequality in the power to communicate and to process information digitally*" (cf. NTIA 1995, 1999; OECD 2001; Hilbert 2011a, b), it is considered as "*a new form of inequality added to all the existing forms of discrimination*" (cf. Hilbert 2011a, b). Based on this definition some studies argue for shifting attention from the "digital divide"—inequality between "haves" and "have-nots" differentiated by dichotomous measures of access to or use of the new technologies—to digital inequality, which refers not just to differences in access, but also to inequality among persons with formal access to the Internet (cf. DiMaggio and Hargittai 2001). Data on Internet penetration show five dimensions of digital inequality in equipment, autonomy of use, skill, social support, and the purposes for which the technology is employed, this suggests the need to study institutional issues in order to understand patterns of inequality as evolving consequences of interactions among firms' strategic choices, consumers' responses, and government policies (cf. DiMaggio and Hargittai 2001).[7] The concept is widely used to describe the divide within countries (such as the digital divide in the United States), it was originally popularized in regard to the disparity in Internet access between rural and urban areas of the United States of America.[8] However, research shows that the digital divide is more than just an access issue and cannot be alleviated merely by providing the necessary equipment. There are at least three factors at play: information accessibility, information utilization and information receptiveness. More than just accessibility, individuals

[4] See OECD (2001), p.5.

[5] See (NTIA) (1999), p. xiii.

[6] See: http://en.wikipedia.org/wiki/Digital_divide, accessed September 09, 2014.

[7] See DiMaggio and Hargittai (2001).

[8] See: http://en.wikipedia.org/wiki/Digital_divide, accessed September 09, 2014.

need to know how to make use of the information and communication tools once they exist within a community (Mun-cho and Jong-Kil2001). Information professionals have the ability to help bridge the gap by providing reference and information services to help individuals learn and utilize the technologies to which they do have access, regardless of the economic status of the individual seeking help (Aqili and Moghaddam 2008). Conceptualization of the digital divide has been described as follows: (Buente and Robbin 2008; Hilbert 2011a, b): subjects (who have connectivity, or who connects: individuals, organizations, enterprises, schools, hospitals, countries, etc.); characteristics of connectivity (or which attributes: demographic and socio-economic variables, such as income, education, age, geographic location, etc.); means of connectivity (or connectivity to what: fixed or mobile, Internet or telephony, digital TV, etc.); intensity of connectivity (or how sophisticated the usage: mere access, retrieval, interactivity, innovative contributions.); purpose of connectivity, or why individuals and their cohorts are (not) connecting: reasons individuals are and are not online and uses of the Internet and information and communication technologies ("ICTs"); and dynamics or evolution, (whether the gap of concern will increase or decrease in the future, when the gap of concern would be maximized) (Huang and Chen 2010). Based on different answers to the questions of who, with which kinds of characteristics, connects how and why, to what there are hundreds of alternatives ways to define the digital divide (Hilbert 2011a, b). "The new consensus recognizes that the key question is not how to connect people to a specific network through a specific device, but how to extend the expected gains from new ICTs" (Galperin 2010). In short, the desired impact and "the end justifies the definition" of the digital divide (Hilbert 2011a, b).

3.2.2.2 Global Digital Divide

Distinction has been made between the term digital divided and global digital divide. The term "global digital divide" refers to *the divide between differing countries or regions of the world* (NTIA 1995; Norris 2001); it examines the technological gap between developing and developed countries on an international scale (Chinn and Fairlie 2004). The global digital divide describes global disparities, primarily between developed and developing countries, in regards to access to computing and information resources such as the Internet and the opportunities derived from such access (Ming-te 2001). The global digital divide describes an inequality that exists, referencing a global scale, it is a special case of the digital divide, the focus is set on the fact that "Internet has developed unevenly throughout the world" (Guillen, and Suárez 2005) causing some countries to fall behind in technology, education, labor, democracy, and tourism; the global digital divide mirrors this disparity on an international scale. The global digital divide also contributes to the inequality of access to goods and services available through technology. Computers and the Internet provide users with improved education, which can lead to higher wages; the people living in nations with limited access are

therefore disadvantaged (Krueger 1993; Attewell and Battle 1999). This global divide is often characterized as falling along what is sometimes called the north–south of "northern" wealthier nations and "southern" poorer ones.[9] "The digital divide can be measured using the ratio in penetration rates between different groups of economies: for example, "developed" and "developing" economies"[10] (ITU and World Information Society Report 2007). According to ITU and World Information Society Report (2013) "*the digital divide can be understood as the difference in ICT access and use between countries, between regions, or between other groupings that share common characteristics*." "at the global level, a common way of identifying differences between countries is to look at national ICT levels in relation to the world average, or to group the world into developed and developing countries and compare their respective performance. The ICT Developments Index (IDI) is an especially useful tool (for assessing and tracking the global digital divide and) for comparing differences in ICT developments since, as a composite index, it consolidates several ICT indicators into one single value"[11] (ITU and World Information Society Report 2013).

3.2.2.3 Gender Digital Divide

Distinction has been made between the term digital divided and gender digital divide. The gender digital divide describes an inequality that exists defined by gender, it is a special case of the digital divide, the focus is set on the fact that the gender gap between men and women implies that women fall behind men in terms of access to and use of ICT. The term gender digital divide refers to the gap in ICT access rates between men and women (cf. Seybert 2007; Hilbert 2011a, b; ITU 2013). It adds to the longstanding challenges of gender inequalities in developing countries, in access to employment, income, education and health services.[12]

3.3 Theoretical Framework and Reviews of Empirical Literature

Based on the above conceptual framework, in this section we show the theoretical and empirical literature on the relationship between ICT and digital divide, ICT and economic growth, and ICT and education and knowledge production in knowledge institutions.

[9] See: http://en.wikipedia.org/wiki/Digital_divide, accessed September 09, 2014.

[10] See ITU (2007) "Bridging the digital divide," chapter two in "World Information Society Report 2007," p. 21.

[11] See ITU (2013), pp. 39–40.

[12] See Hilbert (2011a, b).

3.3.1 ICT and Digital Divide: Theoretical Framework and Empirical Literature

In this section, we show that the interaction between ICT and digital divide motivates theoretical and empirical literature to postulate several explanations of the incidence of the digital divide and the main reasons for the incidence of the digital divide.

3.3.1.1 ICT and Digital Divide: Theoretical Framework

The theoretical framework discussed in several studies in the international literature illustrates the debate concerning the incidence and the main reasons for the digital divide. From existing research on the digital divide we may surmise two plausible theoretical interpretations of the incidence and the main reasons for the incidence of the digital divide, which are closely related to Internet *diffusion* and theories of *Social Stratification in the Networked World*. These theoretical interpretations provide the proponents and opponents arguments concerning the incidence of the digital divide. On the one hand, the more optimistic '*normalization*' hypothesis predicts that, at least in affluent post industrial societies, the social profile of the online community will gradually broaden over time, like the early audience for radio or television, until eventually it comes to mirror society as a whole (see Resnick 1998). In countries at the forefront of the information revolution, like the United States, Australia and Britain, Internet use has rippled out within the last decade from an information source networking scholars and scientists at elite research institutions to become a medium of mass communications for the delivery of news, music, video and audio programming, as well as e-commerce and home shopping. The *normalization* thesis suggests that in developed societies the Internet could eventually become as popular as TV today, so that we can expect penetration levels to reach 90–95 % of the population, encouraged by falling costs for hardware, software and services, and the growth of online home entertainment. Surrounded at home and work by easy access to all Internet, all the time, often assume that eventually most will succumb to the digital onslaught. Competition in the marketplace, some assume, will eventually take care of any residual major disparities, removing the need for government intervention or regulation for the provision of universal service, beyond the minimal prevention of monopolistic practices. In contrast the more pessimistic diffusion theory developed by Everett Rogers provides an alternative interpretation of social stratification in technological adaptation (see Rogers 1995). Case studies implies that compared with laggards, early adopters of new innovations are characteristically drawn from groups with higher socioeconomic status. Education, literacy, and social status provide access to the essential financial and information resources required to adapt flexibly to innovative technologies. Moreover, diffusion theory suggests that the adoption of successful new technologies often reinforces economic advantages, like the greater

productivity facilitated in agriculture by mechanized tractors, artificial fertilizers and specialist seed-corn, so that the rich get richer, and the less well- off sectors fall further behind. Everett Rogers emphasizes that this pattern is far from inevitable, since the conditions under which an innovation is implemented determines, in part, their social consequences. Active initiatives to level the playing field by the state and non-profit sectors can broaden technological access. The existing social structure also plays a role; innovations in highly stratified societies will usually reinforce existing socioeconomic disparities. The type of technology can also influence this process, for example the initial resources required for access, including both financial investments and educational skills. Nevertheless diffusion theory predicts that without successful state intervention, if the spread of the Internet follows the conventional trajectory established by many previous technologies, then the initial adoption of wired computers can be expected to exacerbate existing social divisions, at least in the early-to- middle stages of the 'S' shaped diffusion curve, and perhaps in the longer—term as well if the new technology produces substantial productivity gains and continuing access barriers (Norris 2001).[13]

3.3.1.2 ICT and Digital Divide: Empirical Literature

Based on the above theoretical framework, since long, there is increasing debate around the incidence, measurement and reasons of the incidence of the digital divide; recently the topic has received increasing interest in the international and empirical literature.

ICT and Digital Divide

Several studies in the empirical literature indicate that measuring the digital divide is important in order to understand development in the information society and to inform ICT policy-makers, analysts and other stakeholders addressing issues of digital equality and ICT for development. Traditionally the nature of the divide has been measured in terms of the existing number of subscriptions and digital devices. Given the increasing number of such devices, the conclusion has been that the digital divide among individuals has increasingly been closing as the result of a natural and almost automatic process (Compaine 2001; Dutton et al. 2004). According to OECD (2001) for measuring the digital divide important indicators appear to be communications infrastructures, computer availability—and potentially the availability of alternative access through TVs or mobile phones—and Internet access (these are "readiness" indicators). Recent studies have measured the digital divide not in terms of technological devices, but in terms of the existing bandwidth per individual (in kbit/s per capita) (Hilbert 2013). The term "digital

[13] For all this part see Norris, P. (2001) "Social inequalities" Chapter 4 in Norris, P. (2001) "Digital Divide," Chapter 4, pp. 1– 4.

divide" doesn't necessarily mean that someone doesn't have technology; it could mean that there is simply a difference in technology. These differences can refer to, for example, high-quality computers, fast Internet, technical assistance, or telephone services. The difference between all of these is also considered a gap. Despite the differences in the focus and methodological approach of studies on the digital divide, all of them answer (part of) the following questions: who (individuals vs. organizations/communities, vs. societies/countries/world regions, etc.), with which attributes (income, education, geography, age, gender, or type of ownership, size, profitability, sector, etc.), connect how (pain access vs. usage vs. real impact), to what kind of technology (phone, Internet, computer, digital TV, etc.) (see Hilbert 2011a, b).

Some studies in the empirical literature provide explanation of the incidence of the digital divide and indicate that the gap in a digital divide may exist for a number of reasons and determinants. Previous research has shown that ICT adoption patterns are characterized by the same long established determinants of inequality as other aspects of social life, such as those related to income, education, skills, employment, geography, age and ethnicity, and gender, among others (e.g. Cullen 2001; Compaine 2001; OECD 2002; Warschauer 2003; Mossberger et al. 2003; van Dijk 2005; OSILAC 2007; Hilbert 2010).[14]

One important reason to explain the incidence of the digital divide is income, "as income rises so does Internet use, strongly suggesting that the digital divide persists at least in part due to income disparities" (Rubin 2010). Obtaining access to ICTs and using them actively has been linked to a number of demographic and socio-economic characteristics: among them income, education, race, gender, and geographic location (urban–rural), age, skills, awareness, political and cultural and psychological attitudes (Mossberger et al. 2006; Lawton 2012; Wensheng 2001; Guillen and Suárez 2005; Wilson 2004; Deborah 2007; Kenneth et al. 2003; Hilbert 2010). Previous studies across countries has shown that income levels and educational attainment are identified as providing the most powerful explanatory variables for ICT access and usage (Hilbert 2010). As for geographic location, people living in urban centers have more access and show more usage of computer services than those in rural areas. Gender was previously thought to provide an explanation for the digital divide, many thinking ICT were male gendered, but controlled statistical analysis has shown that income, education and employment act as cofounding variables and that women with the same level of income, education and employment actually embrace ICT more than men (see Women and ICT4D) (Hilbert 2011a, b).

The U.S. Department of Commerce has drawn attention to these disparities in successive studies since 1993. Falling through the Net emphasizes the lack of access to computers and the Internet commonly found in America among poorer households, those with only high-school education, the black and Hispanic populations, rural communities and women. Pew surveys in Spring 2000 confirm

[14] See Hilbert (2011a, b).

the familiar pattern found in many American studies, with sharp inequalities of Internet access by age, education, race and ethnicity, plus the more modest gender gap. Three-quarters of all American college graduates use the Internet compared with less than a fifth of those who failed to graduate from high school. One half of all whites are online compared with one third of all blacks. And two-thirds of the younger generation is online compared with one in ten senior citizens. The OECD has documented similar patterns of stratification among the Internet population in Canada, Australia and Finland. The chief concern about the digital divide is that the underclass of info-poor may become further marginalized in societies where basic computer skills are becoming essential for economic success and personal advancement, entry to good career and educational opportunities, full access to social networks, and opportunities for civic engagement (See Norris 2001).[15]

According to OECD (2001) "the ability of individuals and businesses to take advantage of the Internet varies significantly across the OECD area as well as between OECD and non-member countries. Access to basic telecommunications infrastructures is fundamental to any consideration of the issue, as it precedes and is more widely available than access to and use of the Internet. The digital divide among households appears to depend primarily on two variables, income and education. Other variables, such as household size and type, age, gender, racial and linguistic backgrounds and location also play an important role. The differences in PC and Internet access by household income are very large and increasing, but access in lower income groups is rising. Largely through its effects on income, the higher the level of education, the more likely individuals are to have access to ICTs. Other important indicators concern differences in the profiles of countries, individuals and businesses that use, and make the most use of, the possibilities offered by the new information technologies and the Internet" (OECD 2001).[16]

ICT and Global Digital Divide

Several studies in the international literature examine the incidence of the global digital divide. For instance, ITU World Information Society Report (2013) provides monitoring of the global digital divide between developed, developing and least connected countries. ITU (2013) uses the ICT Developments Index (IDI) as a useful tool for assessing and tracking the global digital divide and for comparing differences in ICT developments.[17] On the basis of the 2012 and 2011 data presented in ITU (2013), measures the magnitude of the current (2012) divide and also the increasing or decreasing divide over the past year. An analysis of the IDI points to a significant divide between the developed and developing world. In 2012, the

[15] See Norris (2001) "Digital Divide" Chap. 4, pp. 1–4.

[16] See OECD (2001), p. 5.

[17] ICT Development Index (IDI) is a composite index, it consolidates several ICT indicators into one single value.

average developed-country IDI value was exactly twice as high as the developing-country average. At the same time, the developing-country average IDI value is growing faster, at a rate of 5.8 %, as against 3.5 % for developed countries. While developed countries are starting to reach saturation levels, in particular in terms of mobile-cellular subscriptions and household ICT access, developing countries, where penetration levels remain much lower, continue to have ample potential for growth. The difference in the access sub-index, which measures ICT infrastructure and readiness, is smaller than the difference in the use sub-index, thus confirming that developing countries have been able to make greater progress in providing basic ICT access. Progress has been achieved particularly through mobile-cellular technology, but also through an increase in household access to ICTs and increased availability of international Internet bandwidth. Between 2011 and 2012, the access sub-index in the developing countries grew three times as fast as in the developed world. The divide, which is measured as the difference in IDI values between groups, is largest in terms of the use sub-index, which measures the uptake and intensity of ICT use. Here, developed countries have reached over three times the average 2012 IDI value of developing countries. This gap points to the considerable differences that exist between the developed and developing world in terms of Internet users and fixed (wired)-broadband and wireless-broadband subscriptions, in many developing countries, broadband access remains very limited. At the same time, the use sub-index is growing at twice the speed in developing countries. This is a positive development, suggesting that developing countries are catching up. The smallest differences between developed and developing countries and smallest change between 2011 and 2012 are found in the skills sub-index, where changes take time to come into effect. While developed countries have reached very high levels of literacy and school enrolment, developing countries need to ensure that all citizens are equipped with basic skills to enable them to participate in the information society. This is particularly—and increasingly—important as infrastructure barriers are being overcome and ICTs are made available to an increasingly large proportion of the world's population.[18]

Some studies provide explanation for the occurrence of the global digital divide. For instance ITU (2013) show that there are many reasons why some countries lag behind in terms of ICTs. There is a strong link between ICT uptake (and other development issues) and income levels. A regression analysis of IDI values and GNI per capita confirms the strong relationship that exists between how wealthy countries are and how advanced their information societies are. Despite the strong link between income and ICT development variables, some countries are faring comparatively better (or worse) than their income levels would predict. Countries such as the Republic of Korea, Estonia and Moldova, for example, lie well above the regression curve and have relatively high IDI values in relation to their gross national income (GNI) level. The Republic of Korea and Estonia, in particular, have made ICTs a national priority and showcased clear leadership in developing and

[18] For all this part see ITU (2013), pp. 39–40.

using ICTs and formulating targeted ICT policies that have driven ICT growth and uptake. Countries with relatively high income levels but comparatively lower IDI values include the United Arab Emirates, Brunei Darussalam, Angola, Gabon and Botswana. The comparison suggests that, in these countries, focused policies and government action could quickly lead to higher ICT levels. ITU highlighted the link between the uptake of ICTs and the price of telecommunication services, [differences in prices explains] differences between countries. A comparison of the IDI with the ICT Price Basket, and comparison of the affordability of ICT services in more than 160 countries worldwide, confirms the link between ICT uptake and affordability. [The result] substantiates the claim that relatively high prices tend to hamper the spread of ICTs, while affordable services foster their uptake and use. Countries with very high ICT prices and very low ICT levels, in particular, must address pricing policies to allow more people to join the information society.[19]

A number of studies confirm the occurrence of the global digital divide, indicating that many developing countries have computer and Internet penetration rates that are 1/100th of the rates found in North America and Europe. For example, there are less than 6 personal computers per 1,000 people in India, whereas more than 6 out of 10 people in the United States own a computer (ITU 2003). Although these differences in technology diffusion may have substantial economic consequences, the empirical literature aimed at identifying the causes is limited. A few factors have been identified as being important, such as differentials in income, human capital, regulatory effectiveness, and telecommunications infrastructure. The income per capita differential accounts for the single most important component (see for example Quibria, et al. 2002; OECD 2001; U.S. Department of Commerce 2002), but it is not by any means the only component. Differences of the digital divide in the telecommunications infrastructure and the role to human capital (see Dasgupta, et al. 2001; Barro 1991; Wallsten 2003) and institutional factors (see Hall and Jones 1999) are also important. According to Dasgupta, et al. (2001) computers may require substantial levels of education for use, but telephones and the Internet may require very little. Additional results include a large (positive) impact of regulatory quality or property rights on the Internet digital divide, which suggests that the diffusion of the Internet may be particularly dependent upon the quality of institutions prevailing in an economy. Finally, the results for demographic controls suggest that the global digital divide would be even larger if developing countries had an age composition that was more similar to the United States.[20]

Other studies provide explanations and identify the determinants of cross-country disparities in personal computer and Internet penetration. For instance, Chinn and Fairlie (2004) examine cross-country disparities using a panel of 161 countries over the 1999–2001 period and use the economic variables (income per capita, years of schooling, illiteracy, trade openness), demographic variables (youth and aged dependency ratios, urbanization rate), infrastructure indicators

[19] See ITU (2013), p. 43.

[20] See Chinn and Fairlie (2004).

(telephone density, electricity consumption), telecommunications pricing measures, and regulatory quality. With the exception of trade openness and the telecom pricing measures, these variables enter in as statistically significant in most specifications for computer use. A similar pattern holds true for Internet use, except that telephone density and aged dependency matter less. Their results imply that the global digital divide is mainly—but by no means entirely—accounted for by income differentials. For computers, telephone density and regulatory quality are of second and third importance, while for the Internet, this ordering is reversed. Their results suggest that public investment in human capital, telecommunications infrastructure, and the regulatory infrastructure can mitigate the gap in PC and Internet use[21] (See Chinn and Fairlie 2004).

ICT and Gender Digital Divide

Several studies in the international literature examine the incidence of the gender digital divide. For instance, ITU (2013) monitoring the ICT gender gap and indicating that data show that there is a gender gap in the use of computers, mobile phones and Internet, and that the gap is more prevalent in developing than developed countries. For example, by end 2013, ITU estimates that the gender gap in Internet usage will be 11 % globally, 2 % in developed countries and 16 % in developing countries. Indeed, there is a close relationship between Internet access differences by gender and other variables, such as level of income and level of education (Deen-Swarray et al. 2013). Gender differences can also be observed when it comes to the location of Internet use, activities carried out over the Internet and frequency of Internet use. For example, available data suggest that women tend to use the Internet more than men for educational activities; that men access the Internet more than women in commercial Internet access facilities (such as cybercafés); and that men tend to be online more frequently than women. Another area where critical gender-relevant information is in high demand is the participation of women in the ICT workforce.[22]

Several studies in the international literature on the digital gender divide examine the differences between men's and women's access to and use of ICT in developed countries (cf. World Internet Project 2009) and in developing countries (cf. Hilbert 2011a, b). In nearly all European countries and in all age groups, however, men are more regular users of both computers and the internet than women and many more men than women are employed in computing jobs throughout the EU (Seybert 2007).[23] Other studies find similar results in Latin American and African countries from 2005 to 2008, indicating that the reason why fewer women access and use ICT is a direct result of their unfavorable conditions with

[21] See Chinn and Fairlie (2004).
[22] See ITU (2013), p. 12.
[23] See Seybert (2007).

respect to employment, education and income (Hilbert 2011a, b).[24] In the international literature there are two arguments concerning the differences between men's and women's access to and use of ICT. The first argument considers ICT as an opportunity for empowering women [especially, in developing countries], and considers ICT and digital technologies as tools for women to overcome longstanding inequalities. ICT can help women to gain employment (for example through telework or newly created information jobs), obtain cost-effective health services and education (such as through online courses or software-based literacy programs) and to increase their income (such as through e-business channels and online transactions). In contrary to this first optimistic argument, the second pervasive and persistent counterargument believes that women are at a natural disadvantage to benefit from the digital revolution because they are less tech savvy, and more technophobic, and because the technology is not built for their needs and intuition. [Hence,] the increasing socio-economic importance of ICT would add a new dimension to the already existing vicious circle between discrimination and women's backwardness, which can be expected to be particularly severe in developing countries. A well-known stylize facts in the literature indicate the lack of employment, income and education affect ICT usage negatively (e.g. NTIA 1999; Cullen 2001; Warschauer 2003; Mossberger et al. 2003; OSILAC 2007), and the digital revolution would pose a severe threat to women (cf. Hilbert 2011a, b).

Bimber (2000) finds that the gap in ICT usage between women and men is the product of both socioeconomic differences and some combination of underlying, gender-specific effects. Women remained less frequent and less intense users of the Internet (Ono and Zavodny 2003; Wasserman and Richmond-Abbott 2005). The focus of attention started to shift towards differences in how men and women use ICT (Bonfadelli 2002). For example, it was found that girls use the Internet for instant messaging and chat-rooms, whereas boys downloaded games and music, engaged in online trading, and created Web pages (Lenhart et al. 2001; Roberts et al. 2004). According to Fallows (2005) men like the internet for the experiences it offers, while women like it for the human connections it promotes. Statistical data from the USC led World Internet Project (2009) reconfirm these findings. In Canada, 79 % of men and 75 % of women were online in 2007. The study also confirms differences in usage. In 2004, Canadian men spent on average more time online than women (14.3–12.0 h per week). This difference increased from 2.3 to 3.5 h in 2007 (18.8–15.3 h). As the main reasons for non-usage, Australian women state lack of interest (35 %), not having a computer or Internet connection (26 %) or lack of skills (16 %). The percentage of men to women who use the Internet is reported for the following developed countries: Australia: 74–71 %. Czech Republic: 55–46 %; Hungary: 45–39 %; New Zealand: 78–77 %; Singapore: 69–54 %; United Kingdom: 68–65 %. The two exceptions to this trend seem to be Sweden (with 75 % of men online and 78 % of women) and the United States (71–73 %).

[24] See Hilbert (2011a, b).

However, even in these countries, men are more frequent and more intense users. In 2008, men from the U.S. are more likely than women to surf the web—at least daily (54–41 %) and men spend 1.5 h more than women at their monitors reading. In short, differences have become smaller in developed countries, but still remain, especially in usage. Similar to the above-cited data from developed countries (World Internet Project 2009); existing data from developing countries show that women are less likely than men to use ICT, this divide applies to access and to the frequency and intensity of usage (Park 2009). Looking for reasons, researchers found that women face barriers that include lack of access and training, and that they were confronted with software and hardware applications that did not reflect their female interests and needs (Arun and Arun 2002; Ng and Mitter 2005; Best and Maier 2007).[25]

3.3.2 ICT and Economic Growth: Empirical Literature

Apart from the above debate in the empirical and international literature concerning the digital divide, empirical literature examine the interaction between ICT and economic growth. The rapid progress in ICT and its impacts on the global knowledge economy have intensified in recent years, leading to a new economic system characterised by intensive knowledge production that has attracted a great deal of interest. It has also raised debate on the effects of ICT and the economic opportunities and the challenges that ICT imposes on the production and dissemination of knowledge in the world economy, particularly for developing countries.

More recently, the continuous move towards globalisation has made information and communication technologies one of the most important factors in achieving success as well as in seeking new markets, improving quality, providing better and faster customer service and bringing the flexibility needed to make changes quickly.

The impacts of technical changes in knowledge production, economic growth and development have received particular interest in the recent literature focusing on economic growth. In particular, many of the recent studies have shed some light on the impact of IT on knowledge production, economic growth, productivity, employment, work organisation, competitiveness and human capital development.

While it is admitted that the impact of ICT like many other forms of technological progress is difficult to measure, much recent theoretical and empirical literature uses several indicators to approximate their effects in economic growth and investigate both the positive and negative impacts (opportunities and challenges) that ICT has imposed on the world economy. For instance, some recent studies use an index of investment or expenditures on ICT, IT, computers or computer equipment and provide robust results showing the various influences on economic growth and development (cf. Jorgenson and Stiroh 1995; Pohjola 2000, 2001), productivity

[25] See Hilbert (2011a, b).

(cf. Hitt and Brynjolfsson 1996; Brynjolfsson and Yang 1996), employment, work organisation (cf. Bresnahan et al. 1999) and skill upgrading (cf. Acemoglu 1998; Hwang 2000). One interesting finding in the literature confirms the importance of ICT for enhancing economic growth not only directly, but also indirectly through the production of knowledge and the complementary relationships between ICT, human capital/skill and skill upgrading. For instance, several studies use many indicators to examine the complementary relationships between technological progress, as measured by ICT and human capital, as measured by the increasing utilisation of higher educated workers (cf. Goldin and Katz 1998; Bresnahan et al. 1999; Autor et al. 1998; Acemoglu 1998). In conjunction with these interpretations, some studies explain the relationship between ICT, IT or computer use and skill upgrading defined by the increase either in the incidence of training (cf. Bresnahan 1999) or the share of high skilled workers (cf. Autor et al. 1998; Bresnahan 1999; Hwang 2000).

On the other hand, several studies discuss the hazards ICT creates for economic development. Most of this literature is based on the idea that technical change is a creative destruction process that creates opportunities for development, while also imposing certain restrictions to development. For instance, several studies have highlighted the negative impacts and implications of the increasing use of IT or ICT on employment and labour markets (cf. Bound and Johnson 1992; Berman et al. 1994; Freeman and Soete 1985, 1994, 1997; Acemoglu 1998; Aghion and Howitt 1998; Autor et al. 1998). Some of these studies raised the issue that, as with most other technical change, ICT or IT has the so-called labour saving or skill-biased effect through the displacement of unskilled labour that results from either the reduction or elimination of some basic non-skilled jobs.

It has also been hypothesised that ICT could impose adverse effects in the developing world because greater advantages will accrue to the industrialised world from global competitiveness than to the developing world, thus making it hard for the less developed countries to compete on the international market. Furthermore, the rapid evolution in ICT will make it harder for the developing countries to bridge the already widening gap between the developed and developing world. ICT, by increasing inequality in income distribution and thus adding to the poverty of the poor, will have adverse results on the status of the poor. ICT may intensify the competition and hence widening the already existing gap and digital divide between the developed and developing countries. The recent literature indicates the growing but limited effects of ICT diffusion in developing countries due to a lack of sufficient investment in the complementary infrastructure such as education, skills and technical skills (cf. Pohjola 2002; Kenny 2002).

Several studies discuss the role of ICT in enhancing knowledge.[26] For instance, Smith (2000) indicates four approaches to the knowledge economy, in particular, the argument for the positive role of ICT in knowledge ". . .. Finally, there are those who argue that the knowledge economy rests on technological changes in ICT,

[26] See for instance, Quah (2001), Pohjola (2001) and Smith (2000).

since innovation in computing and communications changes both physical constraints and costs in the collection and dissemination of information. So for some, the rise of ICT technologies and the complex of ICT industries is coterminous with the move to a knowledge society." [27] Lundvall and Foray (1996) argue a more sophisticated view: "Even if we should not take the ICT revolution as synonymous with the advent of the knowledge-based economy, both phenomena are strongly interrelated... the ICT system gives the knowledge-based economy a new and different technological base which radically changes the conditions for the production and distribution of knowledge as well as its coupling to the production system." [28] "Then there is the role of ICT. Knowledge refers to understanding and competence. It is clearly true that ICT makes major changes to our ability to handle data and information. It is sometimes argued that there is a distinction between knowledge and information, and that therefore that the data moved or analysed by ICT methods are not themselves knowledge, and that therefore ICT does not necessarily create knowledge or even extend knowledge. However this distinction between information and knowledge seems to me to be either a mistake or at least overdrawn, since neither information nor data can exist in the absence of background concepts and a knowledge referent. Nevertheless ICT are primarily an information management and distribution resource, and a major question that follows is, how does an information resource relate to the production and use of knowledge in society? Lundvall and Foray are almost certainly right in saying that ICT plays a new role in knowledge production and distribution, but this is a re-organisation of the technical and financial terms on which a resource (information) is available. It does not in itself expand the realm of accessible knowledge, let alone justify talking about a new mode of economic or social functioning. There is an empirical issue here as well, of course; if knowledge is a crucial input, and ICT is basic to its production, then seeing that the ICT revolution has been under way for at least 25 years there ought to be some robust relationship between ICT production, ICT investment and the growth of output and productivity. A series of studies have failed to demonstrate such a link."[29]

[27] See for instance, Smith (2000), p. 4. See Smith (2000) "Innovation indicators and the knowledge economy: concepts, results and policy challenges" Group for Studies in Technology, Innovation and Economic Policy, Oslo, Norway, November 2000.

[28] See B-Å. Lundvall and D. Foray, 'The knowledge-based economy: from the economics of knowledge to the learning economy', OECD Employment and Growth in the Knowledge-Based Economy (OECD: Paris), 1996, p. 14. See also Smith (2000), pp. 4–5.

[29] This literature on the impacts of ICT begins in the late 1980s, and is continuing. For an early example, see Martin Neil Bailey and Robert Gordon, 'The productivity slowdown, measurement issues and the explosion of computer power', Brookings Papers on Economic Activity, 2 (1988), pp. 347–423; a recent contribution is D. Jorgensen and K. Stiroh, 'Information technology and growth', American Economic Review (May 1999), pp. 109–116. For a comprehensive discussion see Daniel Sichel, The Computer Revolution. An Economic Perspective (Washington: Brookings Institution), 1997. See also Smith (2000), pp. 7–8.

3.3.3 ICT and Education: Empirical Literature

Along with the above debate in the empirical and international literature concerning the interaction between ICT and economic growth, the empirical literatures examine the interaction between ICT and education. For instance, Asian Development Bank (ADB) (2009) explains the importance of investment in ICT for Education. ADB (2009) argues that ICT has the potential to "bridge the knowledge gap" in terms of improving quality of education, increasing the quantity of quality educational opportunities, making knowledge building possible through borderless and boundless accessibility to resources and people, and reaching populations in remote areas to satisfy their basic right to education. As various ICTs become increasingly affordable, accessible, and interactive, their role at all levels of education is likely to be all the more significant in making educational outcomes relevant to the labor market, in revolutionizing educational content and delivery, and in fostering "information literacy." Information literacy is the sustaining force of a knowledge society. Information literacy is recognized as "a basic human right in the digital world" as it empowers individuals "in all walks of life to seek, evaluate, use, and create information effectively to achieve their personal, social, occupational, and educational goals" (UNESCO 2008). The digital divide is much more than a "technology access" divide; without the skills to use the technologies, an even greater divide emerges—the information literacy divide. This divide is not a "north–south, developed–developing" issue; it applies to all countries and is more a reflection of the extent to which education systems are—or are not—keeping up in the development of knowledge societies (UNESCO 2008). It is increasingly clear that a principal factor in stimulating economic growth is improvement in cognitive competencies and skills (ADB 2008). Good practice in information and communication technology for education to date; many initiatives in ICT for education in developing countries have been limited to increasing information access for educational institutions in general and specifically for teacher training, aimed at using ICT-based resources and tools in the classroom. Evidence that the use of ICT leads to higher student achievement or other positive effects is limited to pilots that have yet to be implemented on a larger scale in developing countries. However, ICTs enable access to and use of information that may not be commonly available in certain contexts, thus providing teachers with content they would not have had otherwise to engage their students. In addition, teacher training in ICT for education parallels training in teaching methodology that supports student-centered learning. Hence, investments in ICT for education are likely to lead developing countries toward educational reforms that are necessary for fostering an information-literate citizenry, which is the key to competing in the global economy. Investments in ICT for education at the basic and secondary levels support information literacy as a foundation for subsequent learning, as well as supporting teacher training in student-centered methodologies that foster critical and analytical thinking during the early years of the education cycle. ICTs have the potential to improve the teaching and learning process by enabling students to access information and

engage in interactive learning experiences that would not otherwise be available to them. Such ICT-enhanced classroom experiences have the potential for encouraging student-centered learning, allowing students to be active learners who construct knowledge rather than passively receiving information. As a further pedagogical development, ICT can support evolution from the student-centered approach and the use of interactive technology to team-centered pedagogy and the use of collaborative technology. In this context, the focus is evolving from ensuring appropriate learning styles to ensuring an appropriate learning environment. Investments in ICT for education at the higher educational level support the development of a skilled, "ICT-capable" labor force that may attract direct foreign investment, as well as research and development activities and university–private sector links that are important drivers of innovation and growth in advanced economies (ADB 2008). ICT capability involves technical and cognitive proficiency to access, use, develop, create, and communicate information appropriately, using ICT tools. Along with having the potential to enhance teaching and learning in the classroom, ICTs in higher education have the potential to encourage open communication between and among students, faculty, and others that supports active learning and knowledge construction; make available information and resources supporting academic research that would not be accessible otherwise; and foster development of learning materials, presentations, and lectures in an interactive manner that allows faculty to deliver them to and share them with students directly. The flexibility and accessibility enabled by ICT have led to the emergence of open distance learning (ODL), wherein the teacher is removed in space and/or time from the student, and most communication is through an electronic medium (e.g., internet, radio, television) (UNESCO 2002). ODL has taken the form of open universities that have adopted a student-centered approach in higher education systems in a number of countries. Open universities have been established to meet the increasing demand for higher and/or tertiary education while providing opportunities to working adults and others who face constraints in accessing such education in its traditional form. Investments in ICT for education in the area of technical and vocational education and training (TVET) further support the demand for a skilled, "ICT-capable" labor force, which is the hallmark of a country transitioning to a knowledge economy. ODL holds promise for addressing critical problems facing TVET, namely, the lack of qualified instructors, the need to greatly increase the delivery of skills training on a wide scale, and the need to deliver training at much lower unit costs (UNESCO 2003). ODL can be used in TVET to empower disadvantaged populations, such as women and ethnic minorities, and to allow greater participation by working adults who cannot afford to take time off from their jobs and who are interested in improving various aspects of their work and/or their general professional knowledge (UNESCO 2003). Additionally, ICT in TVET has the potential to provide such persons with real-life learning experiences that are applicable to their immediate work situations (e.g., ICT-based simulations that model best practices). In a number of developing member countries of the Asian Development Bank (ADB), TVET students are often from the working class or are minority students having limited access to ICT. The integration of ICT in TVET would provide equality of

opportunity for these students (UNESCO 2003). In alternative settings (e.g., programs for out-of-school youth, adult literacy, students in remote areas), ICTs have the potential to deliver education to those unable to participate in the mainstream education system.[30]

Some studies examine the role of information and communications technology in education and raises some fundamental issues and questions whether ICT is suited to transmitting knowledge, particularly to students who are not already highly motivated to learn or well versed in the art of using and interpreting information (cf. Carnoy 2004). One study takes as a point of reference the world of business and offers a brief look at the changes brought to the sector by ICT. To date, the main application of ICT in the business sector has focused on aiding access and processing of large quantities of information for employees and management with the principal aim of increasing productivity. In the case of education, however, little or no information is being used to improve student performance, mainly because education managers are largely illiterate in information management tools. Like-wise, despite schools having more and more access to ICT, new technologies are still scarcely used as part of the teaching methodology. Once again, it is the lack of training that creates difficulties: many teachers do not have the necessary IT skills and feel uncomfortable, nor do they have the specific training needed to be able to use the new resources in the classroom. In the university sector, ICT has already made an important impact, whether in terms of teaching, research or administration; however, despite some exceptions, there are few real examples with educational models that are based on this technology and there is still an important social preference for traditional educational models (cf. Carnoy 2004).[31]

Other studies indicate that across the past 20 years the use of ICT has fundamentally changed the practices and procedures of nearly all forms of endeavour within business and governance, within education, ICT has begun to have a presence but the impact has not been as extensive as in other fields (cf. Oliver 2002). A number of people have attempted to explore this lack of activity and influence (e.g. Soloway and Pryor 1996; Collis 2002). There have been a number of factors impeding the wholesale uptake of ICT in education across all sectors. These have included such factors as a lack of funding to support the purchase of the technology, a lack of training among established teaching practitioners, a lack of motivation and need among teachers to adopt ICT as teaching tools (Starr 2001). Education is a very socially oriented activity and quality education has traditionally been associated with strong teachers having high degrees of personal contact with learners. The use of ICT in education lends itself to more student-centred learning settings and often this creates some tensions for some teachers and students. But with the world moving rapidly into digital media and information, the role of ICT in education is becoming more and more important and this importance will continue to grow and develop in the twenty-first century. In recent times, factors have

[30] See Asian Development Bank (2009).

[31] See Carnoy (2004).

emerged which have strengthened and encouraged moves to adopt ICTs into classrooms and learning settings. These have included a growing need to explore efficiencies in terms of program delivery, the opportunities for flexible delivery provided by ICTs; the capacity of technology to provide support for customized educational programs to meet the needs of individual learners (e.g. Kennedy and McNaught 1997); and the growing use of the Internet as a tool for information access and communication (e.g. Oliver and Towers 2000). One study highlights the various impacts of ICT on contemporary higher education and explores potential future developments and argues the role of ICT in transforming teaching and learning and seeks to explore how this will impact on the way programs will be offered and delivered in the universities and colleges of the future (cf. Oliver 2002).[32]

3.3.4 ICT and Enhancing Knowledge in Africa

Based on the above, this section presents some studies focused on the relations between ICT and knowledge production or ICT and higher education institutions in Africa. More recent literature establishes a link between technologies and society in Africa, in particular focusing on the impacts of ICT in connections and transformation and the production of knowledge in Africa.[33] For instance, the literature indicates that knowledge is evidently a constituent element of all the four dimensions of 'connections and transformations in Africa': material technologies; technologies of space; technologies of time; and technologies of management. Considering some definitional problems surrounding knowledge, one central theme is that knowledge constitutes a technology of (dis-)connection and transformation in its own right, as can be seen by considering collective representations (such as belief systems, myths, ideologies and implicit major orientations of a culture) as forms of collectively managed knowledge. Concretely, and with a view on technologies of connection, concentrating on the question as to how state-of-the-art technologies of information and communication are transforming the reality of African knowledge production and knowledge management in African universities, and integrating it progressively in global processes: How is the use of ICT contributing to transformations in the field of knowledge? How are the traditional knowledge systems affected by the introduction of state-of-the-art technologies of information and communication? Are they eradicated by the latter, or do these afford them a new lease of life, under a different format? Within the context of recent literature focused on connections in African knowledge and the current south–north collaboration in the production of knowledge.

[32] See Oliver (2002).

[33] See for example, ASC Thematic Research project on Connections and Transformations: Linking Technologies and Society in Africa and Beyond, Subgroup 4: Connections in African Knowledge.

Ahwireng-Obeng (2000) indicates that Africa's pursuit of a knowledge economy will have to be enhanced by an integrated continental connectivity strategy. The application of ICT could strengthen local education capacity, support distance education, connect places of learning and research and reduce communications and administrative costs. It can also improve the accessibility to rare manuscripts and artefacts and preserve them electronically. [34]

Unwin (2004) explores the use of information and communication technology (ICT) in contributing to changes in educational provision in Africa. In the final analysis, arguments about the effects of introducing ICT to African education rest on fundamental moral questions. Undoubtedly the introduction of ICT is expensive and there are countless other needs in Africa for school buildings with roofs, for paper and chalk, desks, clean water and decent salaries for teachers. However, it is not simply a question of either buildings and textbooks, or ICT. The crucial issue is to find ways in which ICT can be incorporated appropriately and sustainably into African educational strategies. Given the potential of ICT to reduce the gap in the availability and accessibility of information between those living in 'information-rich' and 'information-poor' places, it is incumbent on the global community to respond to requests for access to information from those who presently lack it. Too often the introduction of ICT into education across Africa has merely involved putting Microsoft packages into computers in schools. In effect, it has been 'education for ICT', and has failed to use the enormous potential of computers to deliver completely new kinds of learning environments, which optimise the multi-media potential availability. It is important to change this approach and replace it by one based on 'ICT for education'.[35]

Durrant (2004) indicates that advances in technology, particularly in the areas of electronic publishing and dissemination, have led to new ways of communicating information and knowledge and thus present a huge range of opportunities for developed and developing countries alike. They also bring many significant challenges, which are nowhere perhaps more keenly experienced than in developing countries. In her view the challenges include: the limited supply of ICT (limitations of printed resources) and profound lack of access to scholarly publications to meet the increasing demand for ICT (for printed learning and education materials) from the increasing number of students and researchers; rising costs of ICT and high expensive costs of access to scholarly information; and low speed of ICT infrastructure including slow transfer rate, low bandwidth and the need for improvement of ICT infrastructure, sustainability, training and skills. On the other hand, the important benefits and opportunities include helping bridge the knowledge divide by improving accessibility, availability and affordability, since the production and dissemination of online resources are different from printed counterparts, as they are not only cost-saving and cheaper, but also are not tied to or limited by physical space—they are accessible from any place. In addition there is: development of new

[34] See Ahwireng-Obeng (2000), pp. 3–9.

[35] See Unwin (2004), pp. 150–160.

licensing and purchasing models; enhancement of scholarly connections and communications (south–south, south–north and foster partnerships and connection to the wider research community, across the country, the continent or the planet); and improvement of the importance of services offered by libraries within educational institutions in African and less developed countries, by providing better affordable and available access to current, high quality information and e-resources to meet the needs of students and researchers and improve skills for both librarians and researchers.[36]

Olukoshi and Zeleza (2004) discuss the use of ICT in the African higher education system. They argue that the revolution of ICT that is going on offers various new opportunities at the same time as presenting challenges. African universities have generally been latecomers to the use of ICT and the reasons for this are many. In recent times, however, a significant number of universities have begun to enjoy investments in ICT. Some of these investments have come from donor sources, others from the state and philanthropic organisations/foundations; some universities have also invested their own resources in the procurement of new technologies. In all cases, anecdotal evidence suggests that ICT is transforming the ways in which some of the universities work, feeding into their revival as veritable centres of research and advanced learning. The Internet has been most widely cited in this regard, but even the widespread use of the computer has proved to be a significant new development. At the same time, the ICT revolution that is unfolding carries problems of its own ranging from simple network management difficulties, to more complex ethical issues and the challenges of avoiding technological determinism through a conscious social-shaping of the technological tools available. The task for African universities is not simply to acquire and use these technologies, but to strive also to produce their own content, and to add African ideas and knowledge to the information superhighway. Research on the impacts of ICT on the functioning of the African university is, therefore, a fertile area of inquiry waiting to be tapped more systematically in terms of its pedagogical, research, and economic and developmentalist implications.[37]

Beebe et al. (2003) chronicle and analyse the growth of the Internet in Africa, providing descriptions of regional initiatives and especially highlighting the role of ICT in higher education sector in selected countries.[38]

Adei (2003) discusses the positive and negative impacts of ICT and indicates that ICT in African universities has the potential of solving the problematic access to limited members in enrolment through distance education. For instance, the University of South Africa enrols about 130,000 students for distance education, which is ten or more times the actual on-campus enrolment figure. For this to blossom in all African higher education institutions, government policy and implementation of ICT-related issues will be required in order for the technology to

[36] See Durrant (2004), pp. 63–79.

[37] See Olukoshi and Zeleza (2004), p. 611.

[38] See Beebe et al. (2003).

undergo mass application. Moreover, in an era of globalisation, ICT can help formally isolated African higher education institutions plug into vast educational resources and academic networks, while on the other hand increase the gap between higher education institutions that are online and those are not.[39]

Radwan (2003) discusses the implementation of several initiatives to leverage IT and enhance ICT to improve higher education in Egypt by the establishment of a Higher Institute of Technology, higher education enhancement project fund, Egyptian National Scientific and Technical Information Network (ENSTINET), Egyptian Universities Network (EUN), Regional Distance Learning Programme (RDLP) and the 'Internet clubs'. These initiatives facilitate the encouragement of open education, for example, the Cairo University Center of Open Education uses distance learning and self-learning techniques via a number of educational tools, such as audio/video rooms, electronic reading and language labs. In addition to provision of professional training, the Information Technology Institute (ITI) is providing specialised software application development programmes for new graduates and offers a professional training programme in order to meet the needs of the government, ministries and local decision support centres. In addition to provision of regional information technology software, RDLP through Regional Distance Learning Programme (RDLP), which offers distance educational services such as course materials, administration tools, and facilities management, RDLP, and involves the development and delivery of tailored academic web-based programmes to a regional Arab student pool. It links universities, professors and students through its plat form, allowing them to customise their learning needs and requirements. Further to provision of university online courses, for instance, a cooperative initiative between the University of Illinois at Urbana Champaign, USA and University of Ain Shams in Cairo, Egypt has started to offer students in Egypt and elsewhere in the Middle East online chemistry courses in English and Arabic. Moreover, Menoufeya University also has plans to launch distance education services using ICT. In addition the Students Online (SOL) initiative is one of the main projects of the Egyptian Internet and info-structure company Nile on line, supported by the Ministry of Higher Education. It helps creates a qualitative transformation in the ways of learning for Egyptian students, and has reached nine universities including: Cairo, Ain Shams, Alexandria, Zakazik, Assiut, Helwan, Tanta, Suez Canal and Mansoura. Tens of thousands of students and educational staff have registered in the programme.[40]

Thairu (2003) indicates the use of ICT to connect higher education institutes in Kenya and addresses the successful public-private sector partnership that created the Kenya Education Network (KENET), formed in 1999, which now connects 16 higher education institutes to the Internet in Kenya.[41]

[39] See Adei (2003), pp. 90, 108–109.

[40] See Radwan (2003), pp. 387, 399, 400–401.

[41] See Thairu (2003).

Massingue (2003) focuses on the development of informatics and growth of the Internet in Mozambique and the major role played by the Center for Informatics at the Eduardo Mondlane University (CIUEM). The CIEUM is the main initiator of ICT developments in Mozambique, for instance, it runs an ISP, is involved in various ICT projects like school-net, telecentres, the government's website and formulation of the national information policy, it provides project management for several donor-supported ICT projects; it was established mainly to serve the academic community, but the impacts of its programmes also extends to wider Mozambican society. [42]

Oyeyinka and Adeya (2003) quantitatively compare Internet usage in ten African Universities in two countries: Nigeria (four universities) and Kenya (six universities). The study identifies trends and issues such as need for access to online literature resources, turning to cybercafés for better Internet connections and desire for more computer terminals in departments. They indicate that cheap access to ICT is as important in the information age as cheap access to electricity was in the industrial age, but African countries face structural problems such as low bandwidth, inadequate power supplies and lack of regional cooperation in Internet infrastructure. [43]

Mutagahywa (2003) focuses on the role played by the University of Dar es Salaam in the growth of the Internet in Tanzania and indicates the importance of sustainability of ICT resources at three levels: organisational, technical and financial. She discusses the role of the University of Dar es Salaam in the development of its ICT resources and deployed them into teaching, research and community services. She evaluates the role played by the university in the development of ICT in the education sector and other sectors of the national economy. The University of Dar es Salaam deliberately extended the wireless network to government departments to allow officials to access the net outside the telephone network. This reduced the cost of access and as such encouraged the use of the Internet by government.[44]

Mwenechanya (2003) outlines the role of the University of Zambia in leading the development of establishing and nurturing full Internet connectivity in Zambia in 1994. For instance, the University of Zambia participated in earlier international initiatives to provide an email-based communication forum for NGOs and health workers in a number of African countries. With experience gained, the university established the first private Internet service provider (ISP) in Zambia, Zamnet communication systems, as a separate, fully autonomous company, but essentially serving the university's research and teaching interests. It is shown that university governance may determine whether to advance the university can effectively deploy the Internet as a tool to advance its objectives in research and education.[45]

[42] See Massingue (2003).

[43] See Oyeyinka and Adeya (2003).

[44] See Mutagahywa (2003).

[45] See Mwenechanya (2003).

3.4 Conclusions

In this chapter we provide a background for the empirical analysis in the following chapters by surveying the theoretical and empirical literature that emphasizes the positive effects of ICT in enhancing knowledge and economic growth and the negative effects of ICT through exacerbating the digital divide. In Sect. 3.2 we define the conceptual framework. The theoretical and empirical literature on the relationship between ICT, knowledge and the digital divide are presented in Sect. 3.3 Section 3.3.2 describes the relationship between ICT and economic growth; Sect. 3.3.4 discusses the relationship between ICT, education and knowledge. We explain the debate on the effects of ICT and the economic opportunities and the challenges that ICT imposes on the production and dissemination of knowledge in the world economy. We illustrate that on the one hand, some studies provide robust results showing the various influences of ICT on enhancing economic growth and development, not only directly, but also indirectly through enhancing knowledge and through the complementary relationships between ICT, human capital and skill upgrading. We explain that on the other hand, several studies discuss the hazards ICT creates for economic development. In particular, the rapid progress in ICT will make it harder for the developing countries to bridge the already existing and widening gap and digital divide between the developed and developing countries. Based on our findings from the existing studies in the literature we highlight the need for improvement of investment in ICT to alleviate the digital divide, enhance production, creation and transfer of knowledge in higher education institutions and to enhance economic growth and sustainable development in Sudan.

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