Chapter 1
Information and Communication Technologies for Economic Development

Identifying the Channels of Impact

Ewa Lechman and Adam Marszk

Abstract This chapter is intended to explain why and how information and communication technologies may affect the process of socio-economic development, especially with regard to economically backward economies. It sheds light on why technological changes constitute prerequisites enabling advancements along the socio-economic development pattern. It is also designed to exhibit the special relevance of information and communication technologies when implemented in developing countries. Additionally it discusses the potential channels through which information and communication technologies may contribute to social and economic development in developing world, with the special focus on the financial systems.

Keywords ICT • Economic development • Social development • Financial markets • Developing countries

> (…) the biggest beneficiary of the Industrial Revolution has so far been the unskilled (Gregory [13], p. 3)

1.1 Introduction

Over last few decades (since 1970s onwards), the world has witnessed, the process of rapid diffusion of new information and communication technologies (ICTs), and undeniably, this process has enforced remarkable changes and structural shifts

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E. Lechman (✉) • A. Marszk
Faculty of Management and Economics, Gdańsk University of Technology, Gdańsk, Poland
e-mail: eda@zie.pg.gda.pl; amarszk@zie.pg.gda.pl

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going far beyond economic sphere of life. At a time, the process of ICT diffusion radically differs, mainly in terms of speed and geographic coverage, from the process of diffusion of 'old' technologies [14]. As claimed by many, the year 1971 was the turning point as it gave rise to the technological (information) revolution, and hence it determined the emergence of new techno-economic regime [19, 25, 49]. Since then onward, new technologies are profoundly transforming social and economic landscape [27, 40]. The ICT revolution allows for introducing technologies, which are quickly distributable throughout societies and countries. ICTs are claimed to be the general purpose technologies (GPTs) [6] – technologies, which by generating deep structural and qualitative changes, pervasively impact society and economy. Bersnahan and Trajtenberg [6] underline that broad adoption of general purpose technologies fosters radical changes of social norms and structures, which leads to transformation of social systems and ways of doing business, heavily impacting growth of productivity [32] and, at a time, providing solid background for long-term economic growth and development. Importantly to note, these technologies easily overcome geographical, infrastructural and financial constraints and hence may be used by almost everybody regardless of location and income status. That is to say that ICT may be accessed and used by low-income and low-skilled societies, offering them unlimited opportunities to benefit from global information and knowledge flows [40]. Looking back, we may argue that in economically backward countries, advanced technological solutions have been rarely adopted and used. It does not mean, however, that in developing economies, no type of technological progress has ever been introduced. But, importantly to note, that the spread and access to various past technological solutions was extremely limited in poor countries (see, e.g. low electrification rates or negligible access to railway networks). Today, those countries, which are perceived as economically backward, are rapidly heading towards broad deployment of ICT, and this radical change, undoubtedly, is revolutionary and one of the most striking facts in their development paths.

1.2 ICT for Social and Economic Development

Undeniably, new information and communication technologies have triggered profound shifts of societies and economies, allowing for advances in their overall well-being. Today, however, the ongoing information revolution is more deeply changing the global landscape than it was observable in the past.

ICTs become fast available, and, as already stated, the rate of diffusion is extremely high [15]. Importantly to say is that the dynamic process of diffusion of ICT is not limited to the developed economies, but it is also observed in economically backward countries, where the per capita income is low, which lack basic backbone infrastructure, where the majority of society is poorly educated and lives below poverty line [27, 28]. When analyzing the process of ICT diffusion, some characteristic features of the process may be easily observed. These unique features distinguish the process of ICT diffusion from the diffusion of 'old' technologies, and

additionally they become of special importance when considering the impact of ICT on long-term economic growth and development. First of all, the adoption of ICT allows for fast growth of social networks [11, 56), which generates economic advantages, like, for instance, economics of scale [38, 20], providing solid foundations for long-term economic growth and development. Dynamic growth of socio-economic networks is predominantly facilitated by the type of technological solution offered by ICT. These are, for instance, wireless networks, which enable direct connections among society members, allowing for information and knowledge flows, regardless the physical location of the agents, diminishing their economic and technological marginalization. Cairncross (2001) [9] writes about the 'death of distance' showing that the geographic distance is no longer a barrier for various types of economic activities, as ICTs become widely adopted and used. Broad adoption of ICT enables fast and, at low cost, flows of knowledge and information [51, 62], which become easily acquirable for all society members who, so far, have been permanently technologically and informational marginalized.

Hanna [27] and Perez [48] indicate that, if considering the developing economies, the process of ICT diffusion deserves special attention for two major reasons.

First, ICT may be easily adopted in all countries regardless their level of economic development, because:

- ICTs are fast installable in regions with poorly developed infrastructure and in those regions which are geographically isolated, permanently suffering from heavy infrastructural underdevelopments. As argued by many, ICTs go far 'beyond geography' and thus allow overcoming physical barriers.
- The costs of adoption and broad use of ICT are relatively low (the marginal cost of adoption of ICT by consecutive users is close to zero – especially in case of wireless technologies), which means that ICT may be acquired even by low-income societies. In economically backward economies, a vast majority of people suffers from material deprivation, while ICT may be easily acquired at relatively low prices.
- ICTs offer technological solutions which may be used even by low-educated, illiterate and unskilled people. This is the main reason why ICTs are claimed to be technologies 'for all'.
- ICTs are fast deliverable, imitable and adoptable, and thus the number of its users grows at high rate, which was not observed in case of the 'old' technologies.

Second, the information and communication technologies may constitute an important determinant of long-term economic growth and development [27], as they allow for unbounded flows of information (reducing the information asymmetries) and access to global markets and mobilize resources – especially labour force, stimulating economic growth.

Through improved access to financial markets (e.g., e-finance and mobile-finance solutions), ICTs allow for greater mobilization of people's savings and provide opportunities to convert them into investments, which, through the banking system channel, may positively affect long-term economic growth and development. ICTs foster greater mobilization of the labour force, enhancing increasing participation in

formal labour markets, which in consequence provides a solid fundament for obtaining regular income. Moreover, these changes may shift people from subsistence and extreme poverty, reducing their vulnerability and risk exposure to external shocks.

Growing engagement of people in formal employment creates long-run economic gains and allows eradicating of socio-economic deprivation, which constitutes the first and the most important step through which the ICT potential may be exploited and exhibited in developing countries.

Moreover, the special role of ICT in the process of development of countries is perceived through the educational opportunities that these technologies create. ICTs play a critical role in the socio-economic development process by broadening access to information and all types of knowledge, which improves people's empowerment and their participation in various spheres of life [42, 63]. ICTs allow for eradication of information asymmetries, hence one of the market failures [64], and therefore they enhance the efficiency of resource allocation. Perez and Soete (1988) [57] argue that for many countries, ICTs are the opportunity windows, as they facilitate elimination of multiple barriers disabling entering the pattern of stable economic growth and development. ICT may contribute to overall socio-economic development through improved access to education and knowledge, improved and more effective functioning of healthcare systems or, for instance, e-government solution. ICT may effectively foster increases in human capital and skills, contributing to social cohesion and enhancing empowerment of all social groups.

Many empirical studies demonstrate, however, that unrestricted Internet access remains limited in some of examined countries (especially in low-income economies), but the promising aspect of the latter is that many of these economies are rapidly improving Internet accessibility, which is mainly facilitated by development of wireless networks. As claimed by, inter alia, Hanna [27], Torero and von Braun [60], Unwin [61] or Gruber and Koutroumpis [26], these trends are promising and reveal prospects for the future, providing poorly developed countries with the opportunity to enter a stable socio-economic development pattern.

1.3 ICT for the Development of Financial Systems

Development of the financial system is undeniably an important factor of the economic growth [52]. Even though the number of factors influencing the activities of financial systems has been identified, new technologies (above all ICT) are one of the most significant in both advanced and developing economies [65, 66]. However, as discussed below, the effects of the growing ICT adoption on the financial system may also be negative.

Key channels through which ICT influence financial systems are reduction in the information asymmetry, increase in the information sharing between financial market participants, decrease in the marketing costs and increased market participation [5]. These channels are linked with one of the fundamental features of the financial markets – they are claimed to be 'information markets' [43, 59]. Widely adopted ICTs enable information and data dissemination through which various

market failures may be reduced [1, 2, 44]. Due to increasingly more popular usage of the Internet services, including the ones obtained in the high-speed networks, ICTs also enable various market participants to undertake transactions which are not limited by the physical distance, i.e. investing into assets domiciled in distant countries or regions. Such operations may be conducted with shortened time delays [41].

The impact of ICT on the financial systems is not solely positive. There are certain areas where more intensive usage of new technologies may potentially lead to threats for the financial stability, e.g. through increasing the volatility of the financial markets [35] or growing interest in the short-term investments (consequently decreasing focus on the long-term capital uses [58]). According to CFA Institute [12], new technologies may increase fragmentation of the financial markets' liquidity. Another channel, through which ICTs influence financial systems, is the increasing financialization of other, initially nonfinancial markets, including commodities [17, 47]. From the point view of the developing economies, significant threats may result from the varying levels of the ICT adoption between the developing and advanced economies. As a result, the financial exclusion of the countries or regions unable to benefit from the new or improved financial services and products may emerge [50].

Undeniably, modern financial system has become reliant on ICT and financial innovations boosted by new technologies. As a consequence, its complexity has increased, thus hindering proper execution of the supervisory activities by regulators and governments [17, 36].

ICT may also change the features of competition in the finance industry, making it more technology based, with notable example of exchange systems – floor-based exchanges have lost market shares to exchanges with electronic systems (especially among derivative exchanges) as ICTs have diminished some of the entry barriers [22].

The impact of the ICT adoption on the financial system (especially its development) has been verified in a number of empirical studies, yet their results are far from conclusive. Shamim [55] analyzes empirical linkages between increasing ICT penetration and financial markets in 61 economies over the period 1990–2002, formulating the conclusion about the positive impact of ICT on the financial development. Some studies on this topic have concentrated on the developing economies. Among the most recent, Andrianaivo and Kpodar [3] state that adoption of ICTs positively impacted economic growth in a sample of African economies between 1988 and 2007, partially through greater financial inclusion. Sassi and Goaied (2013) [53] as well as Falahaty and Jusoh [24] found that ICTs positively influence financial development in the MENA region. Asongu and Moulin [5] provide results for 53 African countries for 2004–2011, stating that interactions between adoption of ICT and efficiency of private credit bureaus and registries are mixed yet weak – ICTs play very limited role in boosting financial access (one of the elements of financial development).

New technologies have significant impact on the financial services provided by the banking sector. The most notable examples of the services in the banking industry facilitated by ICT are electronic payments, processing of financial transactions through electronic systems, online and mobile retail banking services, mobile applications for banking customers and online services for the corporate clients [18].

Other, well-established example of the ICT adoption in the banking industry is ATMs. It should be underlined that the rate of adoption of the new technologies in the banking industry differs among countries. What is important, though, is that in developing economies often more technologically advanced financial services are used due to leapfrogging and adoption of the most recent solutions. One of the most important examples is the @widespread use of mobile banking services in the developing economies, e.g. in many African countries, where the saturation levels of such services are often higher than in advanced economies, in which traditional banking remains more popular.

Apart from the impact on the range of services offered by the banking companies, ICTs influence also the structure of the financial institutions by allowing increasingly complex task sharing, i.e. with various operations conducted in often physically distant countries. As a result, the largest financial corporations are present in many countries and often move their back offices to locations which enable lowering the costs or increasing the level of services (e.g. in India or Eastern Europe). These changes may be beneficial for the developing countries where such offices are usually opened – they may boost the growth of the local services sector and positively influence its environment, e.g. educational system (large number of highly educated employees is required to provide services for the global financial corporations).

Adoption of new technologies such as ICT is one of the most significant factors which have influenced the development of the financial markets over the last few decades, especially at the end of twentieth and beginning of twenty-first century. Increasing penetration of ICT has transformed the infrastructure of the financial markets, above all in their most dynamic segment, i.e. capital markets. Infrastructure of the financial markets has been defined by Essendorfer et al. ([23], p. 306) as: *innovation that facilitates between-agent (or counterparties) trading and processing, and settlement of securities, commodities and currencies or aggregates data or information from multiple sources to facilitate trading.* Crucial role is played by the introduction and development of fully electronic trading platforms, facilitating algorithmic and high-frequency trading (HFT) with the limited impact of human traders – in case of HFTs computers are responsible for the evaluation of the market data and transactions. The microstructure of the financial markets, especially stock markets, has changed [44]. Costs of the financial transactions as well as the time delays have been decreasing which led to improvements in terms of liquidity and efficiency of the financial instruments' pricing [33].

In case of electronic trading platforms, trading speeds may now even be measured in nanoseconds, i.e. they are much shorter than in case of fully human turnover [36]. However, emergence of the sophisticated algorithmic and HFT systems may also lead to a number of threats for the financial markets, e.g. large and irreversible losses of the markets' participants, lack of adequate control [37] or higher volatility [18]. In 2014, HFT accounted for ca. 50% of all equity trading in the United States, in Europe its share was at ca. 25%, in Japan at ca. 45% which shows its high importance in the advanced economies (in the emerging countries its share was much lower due to, e.g. lower rate of ICT penetration [37]).

Technologically advanced trading platforms are typical for the highly developed economies, yet there are other areas where the impact of ICT on financial markets can be observed, also in developing countries. Adoption of ICT enables more widespread dematerialization of securities, i.e. keeping them as digital record at depositary institution instead of physical form [37]. Dematerialization reduces the cost and duration of transactions as no exchange of physical securities (i.e. printed documents confirming holding the shares or bonds of particular company) is required. Another important benefit is the possibility to use the same trading infrastructure by various market participants (trading infrastructure with the centralized depositary institution).

ICTs are also one of the factors enabling listing of various financial instruments on more than one trading platform. They facilitate transactions between physically distant locations with very limited time delays and are required in the management of exchange rate risk (i.e. changes in the financial result of the transaction resulting from the variations in the prices of currencies) crucial in this type of investments [10, 54]. Such opportunities are particularly important in case of developing economies where costs of transactions in financial markets are usually higher and liquidity as well as pricing efficiency is lower than in advanced economies [8]. It means that adoption of ICT in those financial markets may attract foreign investors and contribute to integrating them into the global financial system.

Apart from the areas discussed above, ICTs have been influencing financial markets through establishment of electronic trading systems which boost the development of the derivative security markets. It has been evidenced, for instance, by introduction of new types of contracts [22] and higher level of the capital markets' integration and globalization [46].

Results of the empirical studies seem to confirm the impact of ICT on the stock markets, both in the advanced and emerging economies. Effects seem to be mostly positive. According to the study by CFA Institute [12], US stock market is critically dependent on new technologies due to its structure (decentralized electronic network). Essendorfer et al. [23] claim that ICTs have created new market ecology on the US stock market by making trading faster and cheaper but also more volatile and fragmented. Hossein et al. [34], in their study for the world's leading capital markets, found that ICT adoption had significant impact on the stock market development (with the exception of the ease of access). Bhunia [7], using the key stock market development indicators, argues that ICT adoption boosted the development of the Indian stock market. Okwu [45] studied stock exchanges in Africa (in Nigeria and South Africa) and stated that ICT adoption is one of the key development factors if transaction capacities are taken into account.

Global financial system has in the recent years undergone a deep and profound transformation. Even though the financial systems of the developing economies have to a varying degree been integrated into the global system, some of the key changes can also be observed in those countries. ICT played a significant role in those developments, especially in the field of financial innovations. They may be claimed to be one of the key factors affecting the spread of innovative financial products, such as exchange-traded funds (or, more broadly, exchange-traded products) which are currently offered and actively traded on the largest developing world financial markets, i.e. China, India, Brazil or Mexico.

Exchange-traded funds (ETFs) are investment funds listed and traded on the stock exchanges in a manner very similar to any other listed securities [17]. ETFs compete with some types of mutual funds (index funds) as well as stock index futures or options [4]. In their most popular form, the aim of ETF is to closely track the prices of the underlying assets (therefore they are considered tools for passive investing). Over the last years, many new types of ETFs have been launched (including active ETFs whose aims are very different from basic ETFs), yet ETFs tracking stock market indexes remain globally the largest category in terms of assets. Their introduction and trading in the financial markets is to a large extent dependent upon the adoption of ICT. Following areas of the potential impact of ICT on the development of the ETF market have been identified in the existing literature [41]:

1. Decreased cost of ETF trading resulting from the adoption of the electronic trading systems.
2. Lower tracking error (deviations of the rates of return of ETFs from the rates of return of the tracked assets) possible due to arbitrage transactions based on access to up-to-date information.
3. More potential for cross-listing of ETFs, i.e. listing on more than one stock exchange or listing of ETFs tracking foreign assets.
4. Increased potential for the development and launch of ETFs from the point of view of the companies which manage such funds – in order to offer ETFs which are able to compete with similar investment choices (such as index funds) and, therefore, gain profits; operational systems of ETF providers must be based on the technologically sophisticated solutions; it applies especially to more complicated types of ETFs, e.g. synthetic ETFs which are managed with the use of derivatives.

Discussion of the impact of ICT on innovative financial products has been presented above with reference to the example of ETFs, yet it may also be applied to other similar financial assets in the category of exchange-traded products (ETPs), for instance, exchange-traded notes (ETNs) or exchange-traded commodities (ETCs). The example of Mexico or China shows that innovative financial products may also be successfully launched in developing economies, partially due to the sufficient level of ICT penetration.

1.4 Summary

Recently observed rapid diffusion of ICT in many developing countries gives rise to questions about how these technologies may affect economic development and whether underdeveloped countries are able to effectively harness the potential that ICT offer [30, 21]. Many scholars argue that near-ubiquitous spread of information and communication technologies offers unprecedented opportunities to take off on the development path (see, for instance, works of Heeks [31], Desai and Potter [16], Hanson and Narural [29] and Khavul and Bruton [39]). However, the most the

remarkable impact of ICT on country's overall development can only be confirmed when it converts into growing human opportunities, capabilities and thus wealth.

The very optimistic scenario would be that ICTs will offer a way towards development and growth that will encourage developing countries to climb the ladder and enter a stable development pattern forging ahead economically.

ICTs deeply affect and transform social and economic life, playing an enabling and unlocking role for economic growth and development. There is a causal chain between ICT adoption and a country's ability to enter the pattern of long-term economic development, which finally should allow backward countries to catch up with the best performing economies.

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