

THE DEVELOPMENT OF ECONOMIC KNOWLEDGE IN THE ERA OF MODERN INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) APPLICATION

1. Introduction

The 20th and the 21st centuries are the periods of the common use of modern information and communication technologies (ICT) in organizations, enterprises, among ordinary people, as well as in state administration, and in nearly all aspects of everyday life. In the era of information society, the use of network technologies is in a sense becoming a necessity in order to achieve the efficiency growth and to achieve competitive advantage among the enterprises themselves, as well as among the countries. Figure 1 shows a model indicating the factors responsible for the IT industry success.

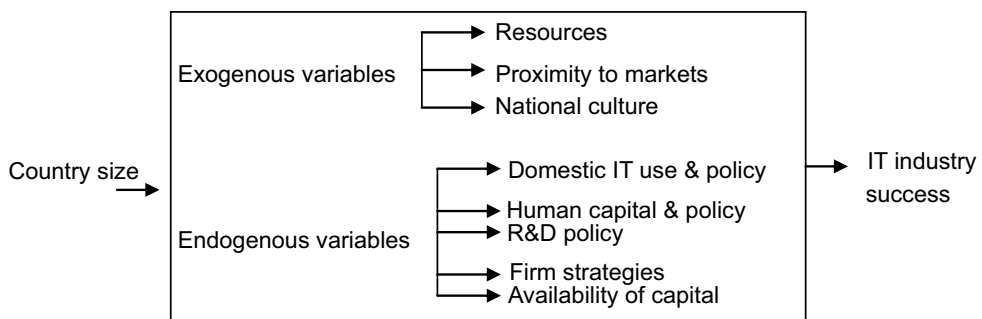


Figure 1. Model of IT industry success factors, [1, p. 8]

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It is worth noticing that the use of the new ICT technologies may refer to many aspects of human life, and their application may not only make our life easier, improve it, but it sometimes proves to be so essential that the proper functioning of the society without the new ICT technologies becomes hardly possible. Table 1 shows selected examples of ICT R&D as solutions to pressing global socioeconomic challenges.

Table 1. Examples of ICT R&D as solutions to pressing global socioeconomic challenges, [2, p. 97]

Health care	Environmental challenges	Transport and mobility
Health-care management, patient files, health database, clinical information systems; Telemedicine, remote health monitoring, drug delivery using RFID and biosensors; Detection of adverse health events, early warning systems; Remote surgery using hepatic interfaces, virtualization and advanced network technologies; Data mining in medical images; Bioinformatics and biomedical computing; Collaborative networking and grid computing in medical research, stimulated surgeries	Energy-efficient ICT for data centers and internet infrastructures; ICT for energy-intensive industries; Digitization and digital delivery of goods and services; Pollution monitoring using adaptive sensor networks; Improved product design for recyclability; Tracking waste streams using sensors; Environmental information systems for decision makers, businesses, citizens	Traffic monitoring and control systems; Personalized traffic information; Driver assistance systems using sensors, embedded systems and augmented reality technologies; Software optimization for freight route planning; Sensor and satellite-based navigation and positioning systems; Adaptive safety systems using RFID; Teleworking solutions
Independent living and social inclusions	Emergency and disaster management	Defense
Accessibility of ICT solutions for the young, the elderly impaired users; Improved usability through advanced software and hardware interfaces – for example, natural language control, brain-computer interfaces; Mobile monitoring, detection of adverse health events through sensor-based and wearable computing; Smart home technologies to assist elderly and chronically ill patients; Adapted online services to assist administrative tasks	Remote, sensor-based detection systems connected to geo-spatial information systems; Mobile ad-hoc networks for immediate disaster relief; Interoperability of observation and monitoring systems; Holistic warning systems integrating disaster-specific solutions	Command-and-control systems; Real-time language translation; Surveillance robots, such as unmanned armored vehicles (UAVs); Augmented reality systems to assist decision making in theaters; Sensor-based threat detection – for example biochemical substances; Electronic warfare – example radio frequency jamming; Combat simulations using immersive virtual reality technologies; Mobile ad-hoc networks in theaters

Thus, we can find the application for the ICT in numerous aspects of everyday life of people, organizations and societies. Undoubtedly, apart from obvious conveniences one gets by taking advantage of the ICT accessibility, it is also possible to use these technologies for economic reasons connected with obtaining financial profits (in the narrow sense), as well as in the wider sense, concerning economy itself. Economy as a science also tries to keep up with the changes that appear in our reality and to explain them within certain definite theories and cause and result relations. Getting to know these theories and their evolution over the centuries is the base for understanding the rules and the possibilities for the use of modern information and communication technologies in today's world in the light of economic sciences.

2. Economy as a scientific discipline

According to the division of sciences accepted by OECD (Organization for Economic Co-Operation and Development), we can distinguish the following kinds of sciences [3, pp.1–9]:

- natural sciences, including: mathematics, computer science and informatics, physics, chemistry, Earth and environment science, biological sciences;
- engineering and technical sciences, comprising: civil engineering, electrical engineering, electronics, IT engineering, chemical engineering, mechanical engineering, material engineering, medical engineering, environmental engineering, environmental biotechnology, industrial biotechnology, nanotechnology;
- medical sciences and sciences concerning health: general medicine, clinical medicine, medical biotechnology and health sciences;
- agricultural sciences, such as: farming, forestry, fishery, animal science, dairying, veterinary sciences, agricultural biotechnology;
- social sciences, including: psychology, economy and business, pedagogy, sociology, law, political sciences, social and economic geography, mass media and communication;
- humanities, such as: history, archeology, languages and literature, philosophy, ethics and religion, art.

As it results from the above classification of sciences, economy is ranked among social sciences which, together with natural sciences, create so called “the core of empirical sciences” [4, pp.183–185]. The very word „economy” is a combination of two Greek words: “oikos” meaning “house” and “nomos” meaning “law”. Undoubtedly, economy is a scientific discipline dealing with the social process of management [5, p.118]. It is divided into various schools and trends. This division results, among other things, from the fact that the subject of economic studies is not homogenous and we can distinguish at least several sections in it [5, p.118]. According to the

criterion of the studied objects' size, economy deals with both households and enterprises, which is the grasp in the micro scale, as well as with enterprises in macro scale, national, regional economies, and the global economy. By the criterion of the level of the studied objects' development in national economies, economy distinguishes developed, developing and underdeveloped countries [5, p.118]. In accordance with the criterion of the regulation mechanisms used in a given economy, we can talk about centrally managed economies, capitalist (market) economies and mixed economies. "Constant changes of the studied economic processes pose to economy (and other social sciences) challenges which are unknown to natural sciences" [5, p.118]. It is the consequence of the way certain phenomena are explained in these scientific disciplines. In natural sciences, evolution is the theory explaining the past, and in economy it is the product of evolution that is the subject of the research. Therefore, we can admit that for social sciences (including economy), evolution is not the past but rather the present, and the subject of the research undergoes constant evolution [5, p.118]. But despite typical variability of the research subject in the time and spatial dimension in economic sciences, it is nevertheless possible to formulate conclusions which are laws and this proves its universal value (for example, supply and demand law) [6, pp. 250–251]. We can therefore question the division according to which social sciences (economy included) fall into two categories: ideographic (descriptive) sciences and nomothetic sciences (i.e. formulating laws) [7, p. 1].

The fact that the research methods that are used in economy are not homogenous, results, among other things, from the occurring changes which appear very quickly with reference to managing societies. The changes are connected, among others, with the scale of production (starting with individual craft production to long-run production), as well as the organizational forms in the scope of conducting business activity (from sole trader units, through private partnerships, limited liability companies, joint-stock companies, and finishing with multinational businesses), and also the market structures (from free market structures to monopoly and oligopoly).

Some experts in the history of economic thought track the beginning of economy in the in 16th century Mercantilism (so-called merchants' capitalism), whereas others in the 18th century Physiocratism [8, p. 31]. However, already in the antiquity and in the Middle Ages people deliberated ethical consequences of conducting business.

The idea of Mercantilism was shaped after the great geographical discoveries, which was connected with the primary capital accumulation, creating institutions connected with trade development (stocks, insurances in the sea transport, the beginnings of the economic jurisdiction), as well as with the increasing economic freedom [9, p. 265]. Its representatives, A. de Montchrestien (who introduced the idea of political economy), J. Colbert (the finance minister at the court of Louis XIV King of France), T. Mun (the head of the East India Company) and W. Petty (the founder of economic statistics) claimed that the wealth of the country is connected with the

amount of ore gathered in this country and the adverse trade balance is the factor which favours its gathering. This evokes customs protectionism and acts in favour of supporting domestic production, the development of colonialism, as well as influences social preferences to decrease the demand for imported goods [9, p. 265].

In the middle of the 18th century another trend in the economic thought developed. The trend was called Physiocracy. Its founder, F. Quesnay, created an economic table illustrating flows among different sectors in economy [8, p. 32]. The Physiocrats introduced the first complex vision of rules concerning the proper functioning of economy, based on so-called pillars of natural order: personal freedom, economy freedom and respecting the law of ownership [7, p. 2]. The Physiocrats were the first supporters of the laissez-faire trend in economy and created the foundations of liberal economy [10, p. 163]. In the period of the Great Industrial Revolution in England, a new classical school in economy was created. This school was considered to be the first scientific theory in economy. The theories concerning the ideas of Mercantilism and Physiocracy are thought to be the so-called pre-scientific phases in the development of economy. A. Smith, the founder of the classical school, was the author of the book entitled *An Inquiry Into the Nature and Causes of the Wealth of Nations* published in 1776. In the book he recommended that the state should not influence economic life and restrict its role to the defence and security functions. His views were then developed in the first half of the 19th century by D. Ricardo, who, among others, proclaimed the theory of international trade (the comparative cost theory), and so-called Ricardian equivalence, according to which increasing public expenses may lead to the reductions in the private sector expenses [7, p. 3].

In the second half of the 19th century, the neoclassical theory in economy was formed. The theory was critical towards the classical one, especially in relation to the idea of free market and full liberalism. According to the neoclassical theory, these ideas were justified in case of rich countries but not in case of the underdeveloped ones [7, p. 4].

In the middle of the 19th century, one of the most important, so-called heterodox trend, Marxism, was also formed. It criticized the capitalistic economy of those days. Simultaneously with Marxism, a historical school in economy was developing in Germany. It denied the output of the classical economy, opposed the idea of freedom in economy and propagated protectionism.

In the last decade of the 19th century, three more new schools appeared. The schools laid the foundations for the contemporary economy. Those were: The Austrian (psychological) school, the school of Lausanne (the mathematical one), and the Anglo-American one (neoclassical). It was at that time that the theory of consumption was created (H.H.Gossen, K.Menger – the Austrian school). A. Marschal from the neoclassical school formulated the theory of production and L. Walras and V. Pareto, representing the school of Lausanne, created the general equilibrium theory.

In the twenties and thirties of the 19th century, E. Chamberlin i J. Robinson created the theory of imperfect competition, which explained the results of the concentration processes caused by the second technical revolution from the end of the 19th century [5, p. 119]. Their theory played an important role in shaping the way of thinking about markets, the market regulation processes and competition [5, p. 119].

The Great Depression in 1929 brought about huge negative consequences in numerous countries of the world. The effects of that crisis were, among others, the decrease in production in many countries by 40%, and multi-million unemployment which strained trust of ordinary citizens, as well as economists and politicians, to the rules of market regulations [5, p. 119]. On the basis of the hitherto prevailing social discontent and pessimism, a theory by J. M. Keyens as formed, presented in 1936 and entitled *The General Theory of Employment, Interest and Money*. Keyens suggested combining the market as the regulation mechanism with active macroeconomic policy of the state [8, p. 174]. The theory opposed the output of the neoclassical school in economy but it was the Keyens' theory that dominated economy and the macroeconomic policy of many countries after II World War [7, p. 8]. Only the stagflation evoked by the petrol shock in 1973 caused criticism towards this theory because it could not properly explain this phenomenon and made economists open to the new economic trends.

The seventies of the 20th century brought opening to the theory of monetarism, whose founder was M. Friedman who postulated the limitation of the state activity, decreasing state interventionism and supporting the supply instead of controlling the demand [5, p. 120]. The monetarism theory found its practical reflection in the economic policy of the USA in the times of R. Reagan's presidency, and in the U.K., when M. Thatcher was the Prime Minister.

In the eighties of the 20th century, a new classical macro-economy developed. Its founders, T. Seargent and R. Lucas, criticized the Keynesian trend and the state interventionism referring to the microeconomic justifications in theory.

The criticism made the Keyens supporters justify their views again, which, when verified, based on the theory of imperfect competition, giving the beginning to the Neo-Keynesian trend.

In numerous scientific dissertations and specialist elaborations, the orthodox neoclassical and Neokeyesists' analysis [11, p. 42] are rejected. Also the dominating trend of the economic thought, so-called radical trend, may be used for a special kind of argumentation and formulating conclusions in economy. However, the economic theories formed after the World War II have their roots in the pre-war tradition, or even in the methodological assumptions formed in the 19th century [7, p. 9]. Both the world economy and the economic theories are still facing challenges related to new economic and civilization trends and social ideas of the contemporary world, such as, for example [12, p. 3]:

- the shaping of so-called new economy and information society,
- globalization processes and increasing civilization and income inequalities in the world,
- the influence of cultural differences, as well as the ones which result from pluralism of world-views on the patterns of microeconomic behaviour and social and economic development models.

Thus, contemporary economy must still analyze, describe new economic phenomena, and assess their influence on economic processes.

3. ICT as an important element of the development of contemporary economies and its predication in economic theories

The technological changes which have taken place since mid-seventies of the 20th century are sometimes called the Second Industrial Divide [13, p. 5]. The most important ones are the innovations connected with the new technologies in informatics and telecommunication, called ICT (Information and Communication Technology). The ICT has a great influence on today's economy because it causes great changes both in the production sector and in the service sector, bringing about changes in banking, information transfer, mass media, consulting and advisory sector, as well as in education [14, p. 55]. The changes also concern gathering and creating knowledge as a base for building competitive advantage in economies, also based on the use of the modern information and telecommunication technologies. According to this conception, we can distinguish five main branches of economy, being of greatest importance in this scope. These are [15, p. 10]:

- high technology industries with the greatest level of B&R expenses;
- education and subsidiaries of B&R;
- education, especially university education;
- specialist business services;
- informatics- related service sector.

The contemporary world economy is somehow dependent on modern technique and technology development because they influence the level of the development of the economic growth in a given country. Economic theories, keeping up with changes in economy and describing certain relations, try to show the right way for those who make decisions concerning the economy.

Theoretical basis for the causes of the diversity in economic development could be explained, for example, by so called neoclassical models and endogenous growth models. The neoclassical theories concerning production functions and output

capacity show that the product diversity in relation to one working person is an effect of the quotient of assets divided by employment and the differences in total productivities of production factors, and also from the fact that the total factor productivity should be higher if the level of human capital and the economy innovativeness level are higher, and also if the sector structures of the created product are more modern [16, p. 51]. The neoclassical models of the economic growth point out that on the balanced growth path the rates of economic growth will be higher if the rates of investment in both the real and human capital are higher, and if the capital input-output coefficients are lower [16, p. 52]. In turn, the endogenous growth theory suggests that it is possible to increase the long-term rate of the economic growth permanently as a result of external effects (connected with the technological progress) [16, p. 52]. Nevertheless, it is necessary to intensify high income rate investments (i.e. the investments concerning costs in technical knowledge and research, as well as human capital), and also relatively high preferences concerning future consumption.

It is also worth mentioning so-called new growth theory having its roots in the works of P. Romer and other researchers who, following the works of other economists, such as Joseph Schumpeter, Robert Solow, have proposed a change to the neo-classical model by seeing technology (and the knowledge on which it is based) as an intrinsic part of the economic system [17]. His theory has several important elements [17]:

- “knowledge is the basic form of capital and economic growth is driven by the accumulation of knowledge;
- while any given technological breakthrough may seem to be random, Romer considers that new technological developments, rather than having one-off impact, can create technical platforms for further innovations, and that this technical platform effect is a key driver of economic growth;
- technology can raise the return on investment, which explains why developed countries can sustain growth and why developing economies, even those with unlimited labour and ample capital, cannot attain growth. Traditional economics predicts that there are diminishing returns on investment. New Growth theorists argue that the non-rivalry and technical platform effects of new technology can lead to increasing rather than diminishing returns on technological investment;
- investment can make technology more valuable and vice versa. According to Romer, the virtuous circle that results can raise a country’s growth rate permanently. This goes against traditional economics;
- Romer argues that earning monopoly rents on discoveries is important in providing an incentive for companies to invest in R&D for technological innovation. Traditional economics sees “perfect competition” as the ideal”.

The empirical data show that the theoretical hypotheses assumed during the research are true as far as the positive influence of ICT on business performance and

growth is concerned. Numerous analyses of the economic growth indicate three remarkable effects: „first, as a capital good, investment in ICT contributes to overall capital deepening and therefore helps raise labour productivity. Second, rapid technological progress in the production of ICT goods and services may contribute to more rapid multifactor productivity (MFP) growth in the ICT-producing sector. Third, greater use of ICT may help firms increase their overall efficiency, and thus raise MFP. Moreover, greater use of ICT may contribute to networks effects, such as lower transaction costs and more rapid innovation, which will improve the overall efficiency of the economy” [18, p. 36].

Figure 2 shows 10 out of 134 countries in which the NRI (Networked Readiness Index) indicator is the highest. The indicator characterizes the country development in the ICT technologies and informs about the readiness of the countries to use the network, teleinformatic technologies [19].

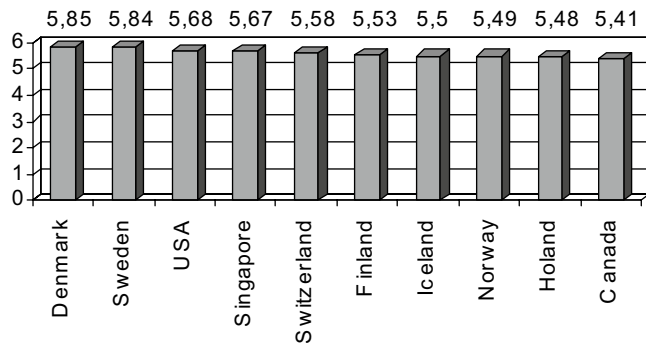


Figure 2. The countries with the highest NRI indicator in the years 2008–2009 [2]

The data from Fig. 2 show that the highest NRI indicator appears in Scandinavian countries and in other distinguished industrialized countries.

Despite the positive influence of modern technologies on national economies throughout the world, achieved by stimulating the economic growth and development, one cannot forget about dangers and threats connected with these technologies. Table 2 depicts chosen negative and positive aspects of using ICT.

Table 2. Chosen positive and negative aspects of using ICT technologies, [20, pp. 171–197; 21, 22, 23]

Specification	Negative influence	Positive influence
Psychological aspect	Too frequent use of ICT may lead to emotional and interpersonal distempers, computer games and Internet addiction, as well as exposing children and young people to harmful mental stimuli (physical and verbal violence and erotism in computer games and on the Internet). It may also weaken the will-power and personality, especially in case of children and young people.	Computers and the Internet may contribute to reinforcing the sense of self-worth by strengthening the self-belief in one's abilities and skills, and they can develop cognitive processes. Some computer games may develop personality.
Moral aspect	The possibility to get uncontrolled access to demoralizing and dangerous information.	Computers and the Internet may positively influence shaping moral attitudes of children and young people by exchanging views with other people and shaping positive ethical and legal attitudes towards respecting the intellectual property, data security and confidentiality, and others.
Social aspect	Restricting the peer contact, being anonymous on the Internet give the possibility of immoral behaviour, gradual disappearance of family tights, which leads to loosing the possibility to upbringing children and young people, gradual disappearance of social tights leading sometimes even to severing relations with the family and the environment.	Educational computer games help in the educational process by developing independence or helping to search for necessary information. The computer and the Internet are also the source of entertainment.
Intellectual aspect	Information shock; information is ill-suited to the age and the children's perception possibilities, the intellectual development is hindered.	Computer games may improve strategic thinking and problem solving. They also may develop certain skills.
Physical development aspect	Spine disorders and sight problems connected with too frequent computer use, long exposition to radiation outside and inside (mobile phones, computer television sets), reluctance towards active relax in the open air.	Computer games may improve the psychomotor skills.
Legal aspect	Crimes against confidentiality, integrity and accessibility of data and computer systems; crimes connected with the use of the computer (computer frauds and fakes), computer crimes committed in relation with the content of information being its subject; crimes against intellectual property.	Quick and full access to legal regulations, possibility of faster crime detection (also crimes connected with the use of the computers)
Political aspect	Informatics makes political life more distant and less transparent. Politicians can more easily manipulate the public opinion.	The use of ICT supports direct democracy-the public opinion can control the consistency of politicians' behaviour

	<p>On the part of the state</p> <p>The decrease in the income and profits of enterprises in the scale of the country because some products are counterfeited. The income decrease may stop the salary increase. It may also result in the smaller number of workplaces and slower development of enterprises. The taxes paid are also lower so the general income in the national economy also drops. The profits from selling counterfeited goods are the source of money for the world of crime. The economic growth of the country is decreased by blocking the access to new technologies as a result of breaking copyright laws.</p> <p>Cyber terrorism-crackers acting for their own ambition or political reasons or paid by terrorists.</p>	<p>On the part of the state</p> <p>The development of modern technologies in economy supports innovativeness and new solutions, and has positive impact on the economic growth. It also increases productivity and effectiveness. The costs are also lower when ICT are used. These technologies are also used in the state defence and security systems.</p>
<p>Financial and economic aspect</p>	<p>On the part of the creator/enterprise</p> <p>Gets lower remuneration;</p> <p>Lack of copyright protection is a discouraging factor;</p> <p>Enterprises are reluctant to create their own local software versions;</p> <p>The danger of monopolization. (standardization of the used software and technologies);</p> <p>Polarization of markets;</p> <p>Decreasing number of workplaces in enterprises;</p> <p>Digital divide on the enterprise level;</p> <p>Lack of international legal regulations defining the rules of functioning of the new economy in the global area;</p> <p>Spam i.e. unwanted information imposed by advertisers.</p> <p>Disinformation, Internet pages are not updated on time;</p> <p>Frustrations and the constant feeling of being tired evoked by losing the possibility to rest after coming back home from work;</p> <p>The growing danger of losing the information confidentiality.</p>	<p>On the part of the creator/enterprise</p> <p>More modern and better security systems and programmes protecting copyrights;</p> <p>The decrease in the costs of sale, storage, supply and distribution;</p> <p>Lowering the marketing costs (for example, the possibility of finding new markets and business partners on the Internet and lowering the fixed costs of the enterprise by employing teleworkers);</p> <p>New possibilities for the enterprise development (employing people living outside the company location, so-called offshoring);</p> <p>The possibility of functioning on many markets at the same time;</p> <p>The possibility of quick vertical and horizontal communication in the enterprise nearly for free;</p> <p>Better quality achieved by increasing competition and better access to it by customers;</p> <p>Changes in the organizational culture (aiming at permanent development of all employed workers);</p> <p>Possibility of working and making financial operations 7 days a week, 24 hours a day;</p>
	<p>On the part of the purchaser</p> <p>Takes the risk of purchasing a defective product;</p> <p>Resigns from additional benefits (the warranty and service rights, etc.),</p>	<p>On the part of the purchaser</p> <p>Modern ICT may support consumer protection.</p>

Table 2 contains some information concerning the use of ICT in the contemporary world. ICT may have both positive and negative influence on the life of a human being, society and the whole human population in the global aspect. It should be emphasized here that Table 2 comprises only chosen aspects of ICT influence on human life and that new kinds of influence are still being discovered.

4. Conclusions

1. Modern ICT constitute one of the main factors of the development of enterprises, large organizations, national economies and the whole world economy. ICT make it possible to get information necessary for their proper functioning in a quick and easy way.
2. ICT are commonly used in nearly all aspects of human life, beginning with education in childhood, and ending with the help to get the specialist information in the adult life.
3. ICT evoke radical changes, both in production and in service sector, as well as in banking, information transfer, mass media, advisory and consulting or education. These changes have a huge influence on building competitive advantage in economies, mainly in such sectors as: high technology industry, education and subsidiaries of B&R informatics related service sector, as well as education, especially university education, or specialist business services.
4. ICT support faster development of all branches of science, also economics, where quickly gathered and processed by appropriate offices current statistical data is the base for making synthetic conclusions in the appropriate research institutes and organizations, which supports the development of science, enterprises and national economies.
5. The world economy and theories formulated in economy must still keep up with the new civilization and economic trends and ideas of the contemporary world, such as, for example, so-called „new economy”, the society in which fast access to information is a necessity, globalization processes and increasing social and economic inequities, cultural differences or those resulting from different philosophies of life, and their influence on microeconomic behaviour patterns and models of social and economic development.

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Abstract

The paper presents selected views and economic theories considering the influence of up-to-date information and communication technologies. Both positive and negative consequences of this influence on various aspects of the life of the man, the society and the whole country were indicated. Moreover, appropriate conclusions in this scope were formulated.

KEY WORDS: ECONOMY, SCIENTIFIC DISCIPLINES, ICT, DEVELOPMENT, KNOWLEDGE