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COMPETITIVENESS AND KNOWLEDGE-BASED ECONOMY: INFORMATION AND COMMUNICATION TECHNOLOGY IMPACT EVALUATION

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Abstract. The article reveals economy competitiveness and knowledge-based economy questions and the basis of information and communication technologies influence on this. Methods and competitiveness estimation are presented. The work contains the methods of competitiveness estimation; researching of competitiveness level, human development index, science linkage index of GDP in Ukraine and the stage of high technology development. The authors evaluate the information and communication technologies influence on knowledge-based economy and country's common wealth.

Keywords: competitiveness, knowledge-based economy, human development index, science linkage index of GDP, information and communication technologies, information and communication technologies impact.

1. Introduction

Country's potential is defined in modern world not so much by the amount of present resources, but more by quality of human capital, level of creation and practical use of knowledge, innovative activity of economy.

The competitiveness increase model of most highly developed countries is based on development of high technologies, production of hi-tech products and services and entry into the world markets.

The long-term base rates of economy growth depend on support and expansion of global knowledge base in the developed countries that became possible in the knowledge-based economy conditions. These countries reconstruct the economies which now are based on knowledge and creating millions of workplaces connected with the use of the newest knowledge. The globalization process will enhance these processes. National economies comparative advantages are measured by less of natural resources riches or cheap labour force already. And the knowledge and scientific innovations stand out as competition application.

In particular, we see information and communication technologies branch as a priority. There are all essential preconditions: skilled potential, telecommunications, investments, resources base for the anticipatory development of information and communication technologies (that gives an opportunity to increase science linkage index of GDP and be favourable to decrease rough relation of national economics).

The main tasks of the research are systematization of competitiveness activities, analysis of global and foreign countries economies and competitiveness indexes, to find out information and communication technologies influence on development of scientific and technical innovations, scientific and technical progress, state development in the field of knowledge-based economy as the key factor of competitiveness increasing.

Theoretical basis of research is made by a systematic approach to the knowledge-based economy analysis, influencing information and communication technologies development. Methodological basis is made by the comparative method, logical generalization method, systems analysis and mathematical logic apparatus.

2. The country competitiveness evaluation and knowledge-based economy

The problems of international competitiveness have been studied by many famous scientists and practices (all governments in the world). But there is no unified essence understanding of this term [1].

Country competitiveness is first of all competitive in-

dustrial production of goods and services that advantaged foreign analogues on domestic and international markets.

The estimation of economy competitiveness consists of two basic approaches: relative costs results of production and production required present resources [2, 3].

The economy competitiveness on the basis of systems approach is defined by indexes: profitability, medium explicit costs, factors productivity, growth of factors productivity (microlevel); the indexes of enterprises aggregate competitiveness (mesolevel); the profits per capita, the balance of current account of trade balance, world market segment value, hi-tech products share in the general export (macrolevel); the indexes of institutional organizations, social and cultural values (metalevel) (Fig. 1).

The basic ranking methods of countries by competitiveness are developed by the World Economic Forum and Institute of Management Development in Lausanne. In particular, the Lausanne Institute analyses over 320 indexes among which: 83 are economic, 77 – Government and Management Efficiency Indexes (rate of enterprises competitiveness aid by governmental policy), 69 – Business Efficiency Indexes (rate of conformance to principles of innovativity, profitability and social responsibility), 94 – Infrastructure Indexes (rate of infrastructure conformance to the business necessities) (Fig. 2).

The World Economic Forum (Davos) made competitiveness estimation by two approaches: by the Microeconomic Competitiveness Index (MCI) which consists of two measuring factors, i.e. the company sophistication and the business climate condition of a country; and the Growth Competitive Index (GCI) which consists of three categories of indexes – technologies and innovations, state institutes and macroeconomics. The GCI defines the ability of national economy to amount to stable economic growth in a medium-term prospect and to control the level of current economic development. A country is able to reach the high living standards (by the capital-saving) without technological progress but will not be able to support the stable rates of economic growth. The scientific and technological progress is the key factor of economic development in the WEF Report.

In addition, the World Bank offered the Competitive-

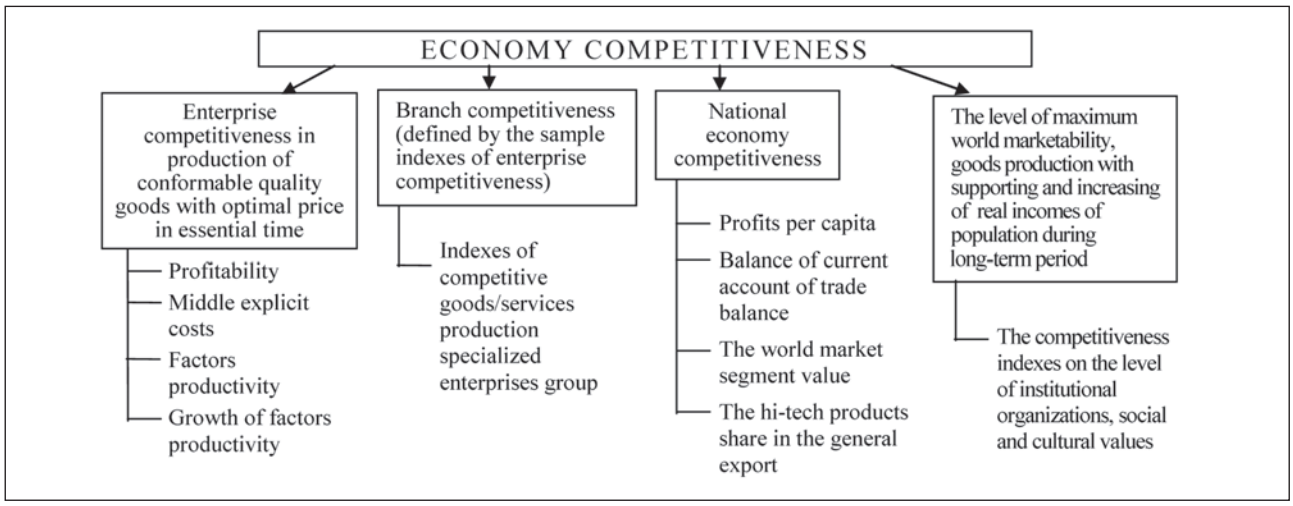

Fig. 1. The nomenclature of economy competitiveness indexes on the basis of systems approach

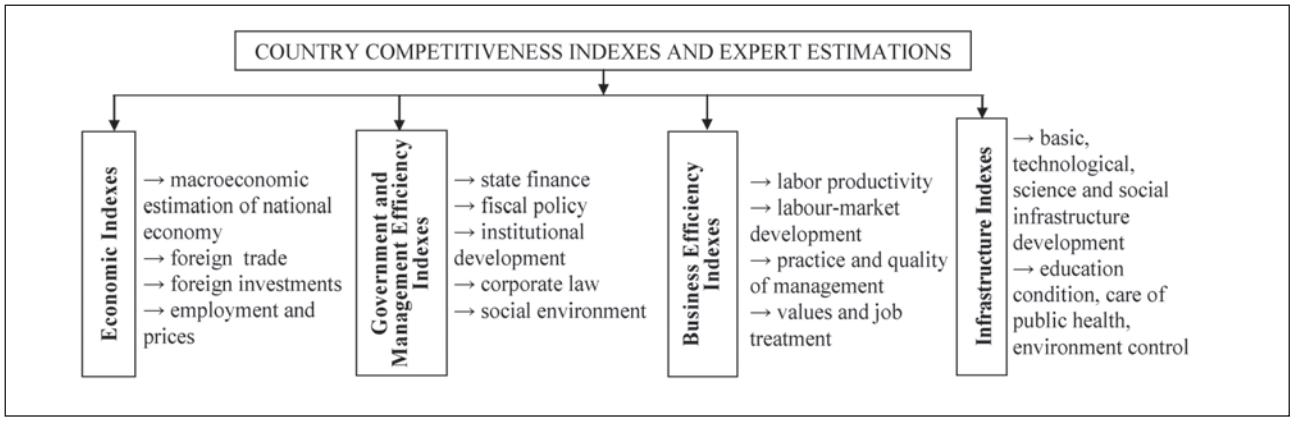

Fig. 2. Components of competitiveness estimation method (under the report of Institute of Management Development [4])

ness Index in 1986 which analyzed 381 indexes (100 of which defined by expert estimations). These indexes are reduced to 8 ganged groups: economic potential; external economic links; government control; monetary control; the infrastructure; management; scientific and technological potential; manpower resources.

It is necessary to note the Human Development Index (HDI) which was offered by the group of researchers of UNIDO in 1990 to make the integral estimation of human development. HDI calculates the weighted average of human development measuring indexes (a life interval is measured by one index, educational level – by two indexes, GDP per capita – by one index):

$$\mathrm{HDI} = \sum_{j=1}^{j} \alpha_j \cdot \frac{X_j - m_j}{M_j - m_j}, \qquad (1)$$

where M_j, m_j is the maximum and minimum value of human development indexes; X_j: X_1 is a life interval (minimum value – 25 years, maximum – 85 years), X_2 is an educational level of adults (from 0 to 100 %), X_3 is an education density in primary, secondary and high schools (from 0 to 100 %), X_4 is the special indicator of welfare which is calculated as a common logarithm of real GDP per capita (from 100 to 40 000 USD by PPP); α are weighting coefficients of indexes which are assorted so that three measuring human development indexes had equal weight.

HDI level in the range of 0,8 – 1 is identified as high, in the range of 0,5 to 0,8 – as medium, and less than 0,5 – as low.

The developed countries name the competitive models of national economies development – 'knowledge-based economy' and it became a widely used term.

V. V. Glukhov examines the knowledge-based economy as a system of common presentations, theories, practice achievements aggregation, system of methods for creation, functioning and support of research activity [5, p. 12].

The economy development idea on the basis of scientific and technical progress is not new. In particular, a well-known scientist, academician V. Vernadskiy proposed a noosphere theory at the beginning of the 20th century. The main place in his theory was taken to human scientific genius as to productive force of the economic growth.

We can find the term 'interpretation of knowledge-based economy' in the analysis of the world economy evolution stages. The basic of them are: economy of commodity (quality of commodity comes forward the main competitiveness criterion), relations (defined by projects quality), corporate management (by management quality), services (by quality of services), knowledge economy (by quality of intellectual level of worker, personnel, company and country).

The knowledge-based economy is based on intellectual and human capital, generating an industrial use of knowledge [6].

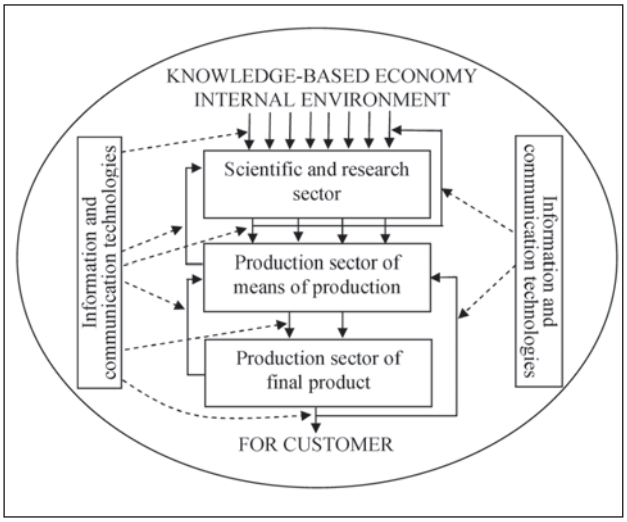

Fig. 3. The scheme of knowledge-based economy internal scientific and technical progress

Transformation of commodity (and afterwards, service) into economy in the knowledge-based economy became possible due to the coincidence in time of the following factors: 1) appearance of data processing digital facilities – information technologies; 2) the expansion of spheres of human influence on external environment; 3) the information computing features are meshed in a network for a rapid information exchange, which is the information and communication technologies creation [7].

The scientific and technical progress comes forward on the basis of knowledge-based economy. The scheme of internal scientific and technical progress with the information and communication technology is shown in Fig. 3.

So, Fig. 3 shows a significant place of information and communication technologies in the system of scientific and technical development of enterprise. We suggest a hypothesis that information and communication technologies exert influence on scientific and technical development of enterprise as connecting-links between enterprise (on macrolevel – economy branches) and departments (the instrumental supporting of information and communication technologies of connecting-links shown in Fig. 1 by dotted arrows). So, growth of the information and communication technology indexes must provoke the growth reaction of scientific and technical progress.

3. The ranking of Ukraine in the Global Economy and its components

The place of Ukraine in Global Economy is defined by its competitiveness on the whole. The conditions for entrepreneurial activity in Ukraine are a reflection of an adverse business climate according to the World Economic Forum's Report. At the same time the United Nations Organization defined Ukraine as one of the most perspective countries of Eastern Europe for influx of foreign investments.

Table 1. The economic indexes and technologies and innovations determinants of Ukraine

Organization	The name of rating index	Publication date	Place and shift of Ukraine in the list	Number of countries in the rating list	Heritage [8]	Index of Economic Freedom
Heritage [8]	Index of Economic Freedom		01-05-2006	99 (–11)		161
Foreign Policy Journal [9]	Globalization Index		02-2004	43 (0)		62
Transparency International [10]	Bribe Payers Index		10-6-2004	99 (+8)		163
WEF [11]	Microeconomic Competitiveness Index		10-13-2004	69 (+4)		104
	Growth Competitive Index (GCI)			86 (–2)		
	GCI determinant: using index of technologies and innovations	Innovations		83	39	
		Information and communication technologies			76	
UNCTAD [12]	Foreign Direct Investment (FDI) Inflows Index		09-22-2004	73 (+16)		140
	Foreign Direct Investment (FDI) Inflows Potential Index			94 (–2)		

Under the World Competitiveness Report 2005 by Institute of Management Development (IMD) the first three places have been ranked: the USA, Hong Kong (rose from 6th in 2004 to 2nd place) and Singapore (in 2004 took 2nd place). Russia takes 54th place but in 2004 it ranked 50th. Venezuela completes the list of 60 countries of the world. Ukraine is not presented in the IMD report.

According to the Growth Competitive Index Ukraine occupied 86th place out of 104 countries of the world (Table 1). According to the rating of the technologies and innovations used Ukraine takes 83th place. According to innovative potential Ukraine is ranked the 39th place for the subindex of innovations.

In „Global competitiveness report 2006–2007" published by the World Economic Forum Ukraine during a year went down from 68th to 78th place [13, p. 1]. We will remind that Ukraine took 84th position out of 117 ranked countries in 2005. In the count on new GCI last year's 84th place began to answer 68th. After the renewed method of WEF the amount of accounted factors was multiplied from 35 to 90.

Table 2. The science linkage index of GDP (ratio of the national inputs on R&D to GDP), %

Years	1985	1990	1995	2000	2005	2015 (prospect)
USA	2,8	2,7	2,6	2,8	2,8	3,0
Japan	2,6	2,9	2,7	2,9	3,1	3,0
Germany	2,7	2,8	2,5	2,7	2,5	2,9
France	2,3	2,4	2,4	2,4	2,2	2,6
UK	2,3	2,2	2,2	2,3	2,4	2,5
Italy	1,1	1,3	1,3	1,7	1,8	2,3
Canada	1,4	1,5	1,5	1,6	1,7	1,9
Ukraine	3,76	1,54	1,45	1,2	0,9	2,0

The ICT capabilities are not used in Ukraine fully. The indexes of ICT penetration remain at low level. The representative low index is the number of Internet Users (180 users per 10 000 inhabitants). ICT development provides considerable potential for growth of the productivity in economy.

The science linkage indexes of GDP of the developed countries were stabilized with the retention of insignificant annual fluctuations in the last ten years. This index was averaged at the level of 2,5–2,8 % for the USA, Japan and Germany, 2,4 % – for France and Great Britain, 1,3–1,5 % – for Italy and Canada. Experts forecast gradual and insignificant increasing of science linkage index of GDP (Table 2 by the OECD data [14]). The science linkage index level will be 3 % for the USA and Japan and obtained to present index level of the country-leaders of the European countries.

Under the estimations of the science linkage index of GDP the level of inputs on R&D in 0,9 % of GDP does not enable to realize the economic function of science and provides cognitive function only.

Under the HDI Ukraine occupied 45th place (0,798) in 1990, 102th in 2001, and 70th in 2003 out of 177 countries of the world. HDI in Ukraine approaches the mean value (0,800) that goes for countries of Central and Eastern Europe and also some countries of the CIS (Russia, Byelorussia). HDI level in the range of 0,8–1 is identified as high, in the range of 0,5 to 0,8 – as medium, and less than 0,5 – as low under the expert estimation.

The knowledge-based economy basic indexes (index groups) of Lithuania and Ukraine are shown in Figs. 4, 5).

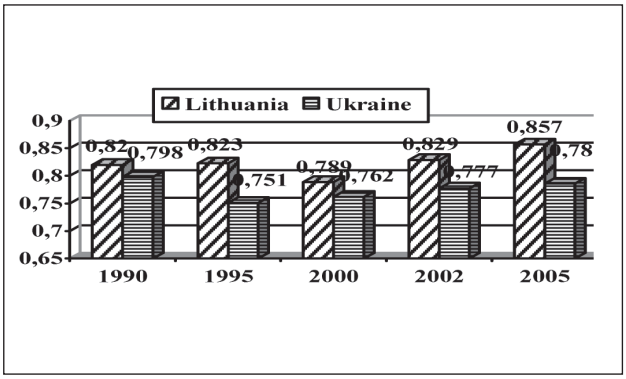

Fig. 4. Human development indexes of Lithuania and Ukraine (by the UNDP data [15])

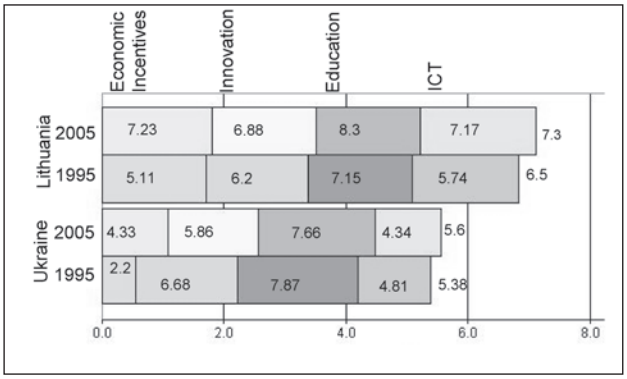

Fig. 5. Complex knowledge-based economy index (all components weighted by population, %) (by the World Bank data [16])

4. The evolution of influence factors on competitiveness growth

The scientific and technical progress was clarified during the centuries by physical indexes: speed, temperature, pressure, mass, sizes, amount. That is why economic development depended on country's ability to make competitive products with less expenditure. This required to carry out the search for new approaches, technologies, materials – different innovations.

The role of production technology information grew up because of production infrastructure development, smoothing of technological manufacturabilities, the capital accumulation. The value of country-producer was lost at equal possibilities (resources – capital, land, materials, staff). The availability of information about good production technology reduces the role of country-producer. The competitive advantage became not only geographical position of the country-producer, availability of natural and other resources but to a great extent, information about production technology in the 20th century.

Access to developed innovative information diminishes the value (cost) of information for a production process by the time. The access is represented by the patents, know-how, license trade, industrial espionage. The competitive advantage became not the direct information about the innovation but ability of enterprise to create the scientific and technical innovations that depends on the presence of high geared personnel with the constitutive learning curve for the novelty creation. The knowledge capitalization enables to talk about the knowledge-based economy.

Table 3. Indexes-determinants of scientific and technical progress in 2005 by the influence extent on economic growth

Index \ Country	China	Russian Federation	Lithuania	Ukraine
GDP (mlrd. USD)/GDP growth during 2001–2005 (%)	2228,9/9,48	763,7/6,12	25,5/7,6	81,7/7,7
Exports of Goods and Services as % of GDP	34,0	34,4	52,3	61,2
FDI Inflows as % of GDP	3,89	1,36	3,39	2,26
Researchers in R&D / Mil. people	708,0	3319,0	2136,0	1749,1
Total Expenditure for R&D as % of GDP	1,44	1,17	0,76	1,16
Manufacturing trade as % of GDP	50,35	17,85	61,56	47,86
High-Tech Exports as % of Manufacture exports	29,8	9,1	4,6	4,7
Total Telephones per 1000 People [19]	499,4	773,1	1234,0	545,4
Main Telephone Lines per 1000 People [19]	241,1	255,8	238,7	255,9
Mobile Phones per 1000 People [19]	258,3	517,3	995,9	289,5
Computers per 1000 People	140,9	132,2	155,1	128,0
Internet Users per 1000 People [19]	72,5	111,2	281,8	79,0
ICT Expenditure as % of GDP * [20]	5,28	3,58	8,6*	8,15

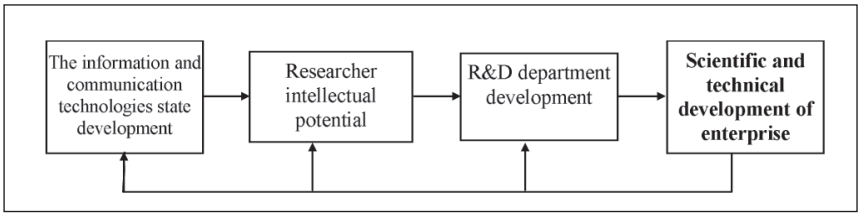

Fig. 6. Enterprise scientific and technical development process by the growth of information and communication technologies

5. Scientific and technical factors of economic growth

The famous scientists L. V. Kantorovich, S. I. Golosovsky, R. Solow arrived at the conclusion that the factor of scientific and technical innovations carried out GDP growth influence for developed countries from 67 to 87 %. For example, V. P. Solovyov [17] estimated this influence in the following way: from increasing of man-hours – 32 %, from increasing of labour productivity– 68 % (including: by the innovations – 28 %, by the education – 14 %, by the capital – 10 %, by the changing of manufacturing scope – 9 %, by the resource allocation – 7 %).

There is a generous amount of indexes which characterize the state of scientific and technical progress. Groups of indexes of the state of scientific and technical progress are counted six, among them: economic, trading, institutional (indexes of scientific and technical development assistance by the regulative organs of country), innovative, educational, information and communication.

The research consists of comparative analyses of economic development factor indexes for country-four by the influence extent. The country-four is composed of two twains – country-leader and country-follower in the sphere of scientific and technical progress. So, the China-Russian Federation is one pair of country-four in the case of limiting in the Eurasian region and Lithuania-Ukraine in the case of limiting in the post-soviet republics space except Russian Federation because it is analyzed in the other group. The results composite is in Table 3 (by the World Bank data [18]).

6. The information and communication technology influence on scientific and technical development and common wealth growth – hypothesis verification

The information and communication technologies state influence on scientific and technical development of enterprise could be described as a multifactor feedback process: high development level of information and communication technologies → personnel intellectual potential → R&D effectiveness → scientific and technical development of enterprise (Fig. 6).

The feedback scheme in Fig. 3. can be explained as using a highly developed instrument in R&D specialist activity impact on labour productivity of the specialist. For example, labour productivity of R&D specialist with PC (with the Net connection) is higher than of the same specialist using a typing-machine for typing the text and drawing board for engineering design. Meanwhile, modern technologies need the additional expenditures which can be allowed by rich enterprises (developed economies on macrolevel). Then using of modern information and communication technology brings the economic effect that is indicated in researcher intellectual potential, R&D department development of enterprise as a whole and enterprise scientific and technical development properly. And vice versa, low expenditures on instrumental support of R&D activity decrease the scientific and technical development and economic development properly of enterprise.

The choice of indexes for hypothesis verification needs to choose parameters of scientific and technical progress and information and communication technologies.

The basic factor of scientific and technical development is labour productivity of R&D personnel. The most usually used index from quantity indexes of R&D activity is the number of scientific articles. The number of scientists during the years is unstable. In fact, the employment place change is the usual appearance in transitional economy countries. So, we extort from using publication activity index (relation of the number of articles per 1 R&D specialist).

The first choice defines choosing of parameters of information and communication technologies that are most necessary for researcher (scientist) for article creation. Most usually used product of information and communication technologies in research organizations or enterprises with significant R&D level is a computer with the Internet connection. So, the information and communication technology index is computerization and Internet using level by population in the country. The high level of computerization of population means a high level of computer and Internet using accordingly in R&D organizations.

The article consists of research on functional relation between population supply of computers with Internet connection (computerization and Internet using level denotes users of computer connected to the Internet per 1000 inhabitants) and publishing activity of researches in R&D (amount of scientific articles per 1 scientist).

The results are indicated in Fig. 7 (by the data [18, 20]) and by formulas (1–4) that used information and commu-

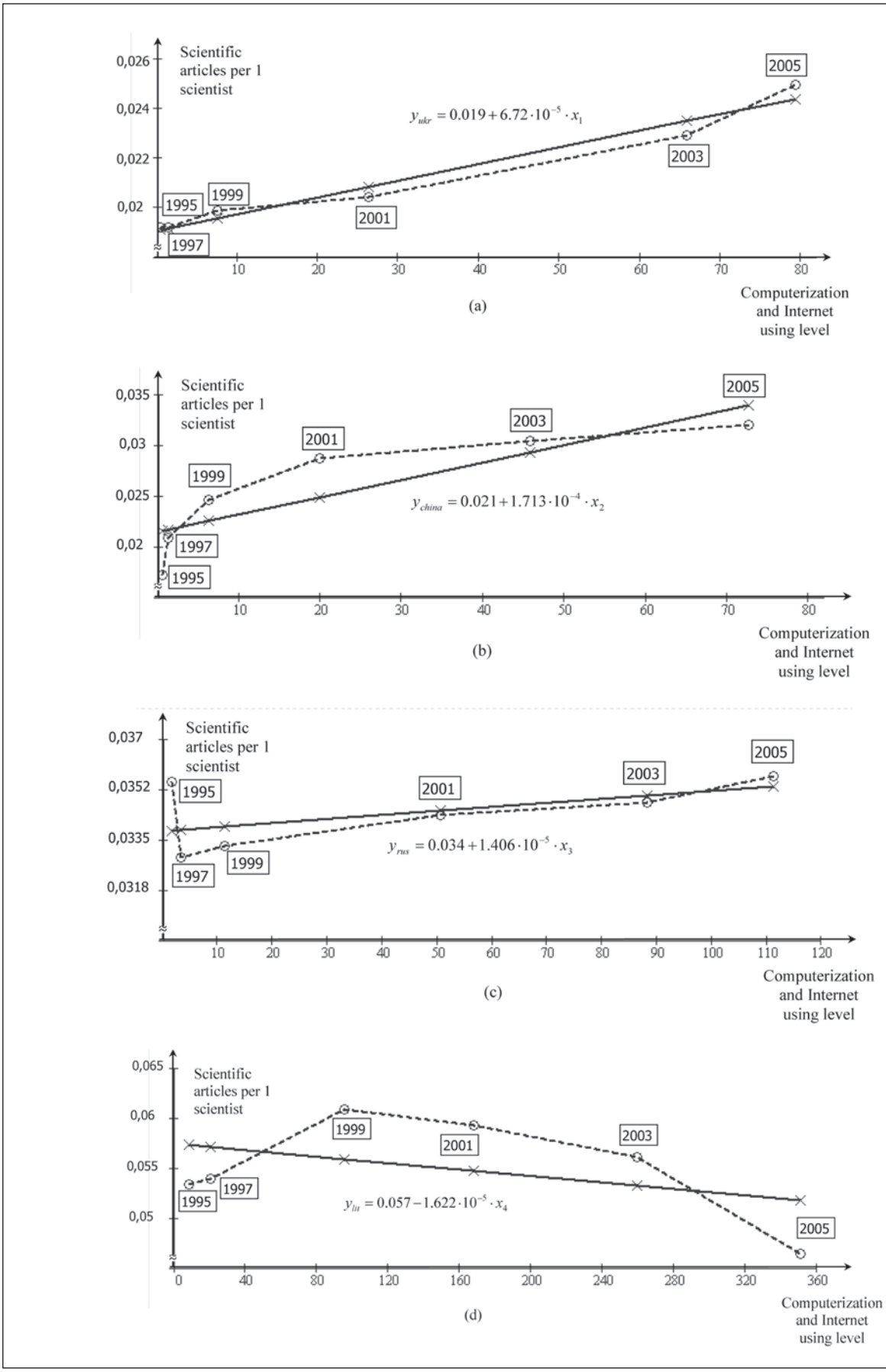

Fig. 7. Functional relation of computerization and Internet using level and scientific articles amount per 1 researcher (a – Ukraine, b – China, c – Russian Federation, d – Lithuania)

nication technologies (x_i) and publishing activity of researches in R&D (y_i) for researched countries.

So, the resulting functions for Ukraine, China, Russia and Lithuania are accordingly:

1) line regression $y_{ukr} = 0.019 + 6.72 \cdot 10^{-5} \cdot x_1$ with correlation coefficient 0,983; (2)

2) line regression $y_{china} = 0.021 + 1.713 \cdot 10^{-4} \cdot x_2$ with correlation coefficient 0,863; (3)

3) line regression $y_{rus} = 0.034 + 1.406 \cdot 10^{-5} \cdot x3$ with correlation coefficient 0,575; (4)

4) line regression $y_{lit} = 0.057 - 1.622 \cdot 10^{-5} \cdot x_4$ with correlation coefficient –0,43. (5)

The supply growth of information and communication technologies to a large extent influences the publication activity growth for such countries as China, Russia, Ukraine (the correlation coefficients indicate a relation above average between indexes) but its influence on the publication activity growth is indicated least of all in Lithuania. This means that another social-economic parameter influences the publication activity growth (fall) to a larger extent. Nevertheless, the computerization and Internet using level is a maximum for Lithuania in comparing with four other countries during all the period of research (1995–2005).

The finding of determinative influence index on publication activity in Lithuania and scientific and technical progress properly was not our research aim.

7. Conclusions

The information and communication technologies are a self-developed system that defines the development rates themselves by their functional indexes. The information and communication technologies have influence on knowledge-based economy to a significant extent in several countries which were researched. These technologies take the role of instrument and ware of knowledge-based economy progress.

The information and communication technologies development stimulates innovative activity in the knowledge-based economy system.

The computerization (especially in R&D departments of enterprises) impacts on R&D personnel labour productivity a priori. Undoubtedly, PC using impacts on publication activity of researcher on microlevel. However, the computerizing level of population impacts on R&D development (quantitive index) in explicit conditions only on macrolevel. Because there are many social and economic factors which impact on labour productivity in R&D to a greater extent than previously mentioned index.

The primary low computerization and Internet using level (see the computerization and Internet using level by population in Fig. 4 (a, b, c) – abscissa axis), high economy growth indexes (GDP growth) and high expenditure for R&D as % of GDP (see above Table 1) can be related to explicit conditions of high relation between the computerization and Internet using level growth and publication activity growth for China, Russian Federation and Ukraine.

The political, socio-economic, psychological factors can be related to inhibiting factors of R&D development in Lithuania.

The following researches need an economic and mathematical modeling of information and communication technology influence factors on R&D labour productivity as a necessary condition for knowledge-based economy growth and its verification on different levels.

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KONKURENCINGUMAS IR ŽINIŲ EKONOMIKA: INFORMACINĖS IR KOMUNIKACINĖS TECHNOLOGIJOS ĮTAKOS ĮVERTINIMAS

V. H. Gerasymchuk, T. V. Sakalosh

Santrauka

Nagrinėjama, kaip informacinės technologijos ir orientacija į žinių ekonomiką veikia bendrą Ukrainos konkurencingumą. Autoriai pasiūlo savitą požiūrį į konkurencingumo įvertinimą, atsižvelgdami į mokslinių tyrimų lygį, žmogaus išsivystymo indeksą, mokslo ir BVP ryšio indeksą bei aukštųjų technologijų išsivystymo laipsnį.

Reikšminiai žodžiai: konkurencingumas, žinių visuomenė, žmogaus išsivystymo indeksas, mokslo ir BVP ryšys, informacinės bei komunikacinės technologijos.

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