“Economic growth of the country and national intellectual capital (evidence from the post-socialist countries of the central and eastern Europe)”

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ECONOMIC GROWTH OF THE COUNTRY AND NATIONAL INTELLECTUAL CAPITAL (EVIDENCE FROM THE POST-SOCIALIST COUNTRIES OF THE CENTRAL AND EASTERN EUROPE)

Abstract

The purpose of the article is to study the innovation levers of developing the intellectual background for economic growth in two groups of post-socialist Central and Eastern European countries (middle-income and lower-middle-income countries). To achieve that, the quantitative effect of the national intellectual capital components (human capital, market capital, structural capital and capital of renewal and development) on the dynamics of the countries’ economic growth was determined.

For both groups, multiple regressions have been constructed that reflect the quantitative relationship between the economic growth rates (in the regressions – the indicator of real gross domestic product per capita) and the components of national intellectual capital in 2010–2018. It has been established that the key innovative indicator of the economic growth of middle-income countries is the national capital of renewal and development, which in general corresponds to the pan-European model of innovation and investment development. Education is the main factor that provides the basis for the economic growth of lower-middle-income countries. Recommendations on improvement of national innovation policy are offered.

Keywords

- country, innovation levers, capital, linear production functions, correlation and regression models

JEL Classification

- C1, O38, O47, O57, P52

INTRODUCTION

Currently, a gradual transition to a new technology, i.e., an information-innovation economy, or an economy based on knowledge, information and innovation, is taking place in the world. Its characteristic features are: creation of innovations, introduction of resource and energy saving technologies, state support for science-intensive industries and protection of intellectual property (patents, licenses, know-how, innovation projects, etc.). As a result, not only the sectoral structure of national economies changes, but also factors influencing the dynamics of their economic growth. The processes of creating and using new knowledge, ideas and information are key factors ensuring economic stability, sustainable economic development and technological competitiveness of modern macro-economic systems. Highly skilled and educated workers with their knowledge, skills and abilities become the main driving force of social progress and provide the formation of a new, innovative type of economic systems.
The research of innovation levers of the formation of the intellectual background for the economic growth of modern macro systems, as well as the definition of tools, methods and organizational and economic mechanisms for optimizing the relationship between the indicators characterizing these processes, is an urgent task. Awareness of this requires developing a new paradigm of knowledge about shaping the economic growth intellectual basis, which in the long run will allow to improve the state policy of innovation development based on increasing the efficient management of the national intellectual capital components.

1. LITERATURE REVIEW

The introduction of scientific and technological progress, the focus on the production of science-intensive products, which belongs to the fifth and sixth technological paradigms, paying particular attention to education, science, culture, healthcare, which form qualitative human capital, have provided the world’s major economies with due basis for achieving economic stability and competitive advantages on world commodity markets. Therefore, it is not surprising that economies based on knowledge, information and innovation are the most successful and economically developed ones (see Table 1).

In the economic literature, identifying innovation levers of the country’s economic growth can be considered at least in the context of the two groups of methodological approaches. The first group should include work in which the linear production functions are used to study the innovation levers of economic growth of the country. This allows determining the quantitative relationship between the volume of investment in intangible assets (utility models, inventions, software products, databases, trademarks, brands, etc.) and the level of social productivity of labor. This group includes the scientific works by Corrado, Hulten, and Sichel (CHS model) (2005, 2009), Barnes and McClure (2009), Castells and Himanen (2002), Ferreira and Hamilton (2010), and Edquist (2011) who calculated the quantitative effect of aggregate investment in non-physical capital (intellectual property objects and new technologies) on the growth rate of social productivity in the European Union countries and have concluded that such a connection is more noticeable in the leading European economies (Great Britain, Germany, France, Austria) and less noticeable in other countries (Sweden, Italy, Poland, Czech Republic).

Taking the basic provisions of the CHS model as a basis and using comparative statistics and indices for the Southern European countries, Corrado (2005), Roth and Thum (2010), and Piekkola (2011) found that the main tool of supporting economic growth in this region is an innovation lever, which requires increased spending on raising the educational and qualification level of employees, implementation of scientific and technical works, software development and organizational and marketing innovations. Corrado (2005), Roth and Thum (2010) confirmed their findings by the following statistical data: in 2005–2007, an increase in the cost of conducting fundamental research by 15% provided Italy, Spain and Portugal with steady economic growth of 3-5%.

Table 1. Main indicators of the innovative development of the world’s major economies

| Country/economy     | The Global Innovation Index | The Global Competitiveness Index | Real GDP per capita |
|---------------------|----------------------------|---------------------------------|---------------------|
|                     | Points | Rating | Points | Rating | USD    | Rating |
| Singapore           | 59.83  | 5      | 83.5   | 2      | 98,014 | 4      |
| Switzerland         | 68.41  | 1      | 82.6   | 4      | 63,380 | 11     |
| USA                 | 60.13  | 4      | 83.5   | 1      | 61,152 | 12     |
| Netherlands         | 63.32  | 2      | 82.2   | 6      | 56,436 | 14     |
| Denmark             | 58.39  | 8      | 80.6   | 10     | 51,643 | 22     |
| Luxembourg          | 54.53  | 15     | 76.6   | 19     | 110,870| 3      |
| Hong Kong           | 54.62  | 14     | 82.3   | 7      | 64,533 | 10     |

Source: Compiled based on Data for the Sustainable Development (2017), The Global Innovation Index (2017) and World Development Indicators (2010–2017).
Attention is drawn to studies focusing on innovation levers of economic growth based on quantitative assessment of the impact of individual components of the national intellectual capital on the economic growth rates in the leading world’s economies. In particular, Corrado, Haskel, Jona-Lasinio, Iommi (2010, 2012, 2016), Piekkola (2011, 2014), Nadiri (2011), Nadiri and Nandi (2015), Chun and Nadiri (2016), Haskel and Westlake (2018) analyzed the quantitative effect of the type of intangible assets such as a national structural capital on the GDP dynamics of the economically developed countries. In their models, national structural capital is characterized by four indicators: the number of educational institutions per 1,000 people, the number of libraries per 1,000 people, the number of Internet providers per person, and the number of mobile operators per person. The aforementioned scholars have pointed out that such interconnection is closest in countries that are leaders according to “hidden” assets – South Korea and North America (the United States and Canada).

Hao, Manole, and Ark (2009), Halten and Hao (2012) investigated the relationship between the volume of investment in intangible assets and the dynamics of macroeconomic growth in the Chinese economy. They found that at the beginning of the 21st century, increased investment in the development of innovation and communication technologies and software development contributed to a significant increase in gross domestic product of China.. Hao at al. (2009) pointed to the important role of investment in the main (physical) capital in the economic growth of China during 2003–2011.

In their further research, Ark at al. (2009), Nakamura (2010), Ark and Halten (2007) have proved that in China, as well as in the majority of other Asian countries (Thailand, the Philippines, Indonesia), the growth of real GDP in 2006–2009 was driven not by increased investment in the formation and development of innovative, structural and/or market capital, but by an increase in investment in the main (physical) capital, namely development of transport infrastructure, construction of new industrial facilities, production of heavy machinery, etc. Ultimately, Ark at al. (2010) concluded that the Chinese economy is currently on the way towards an information and innovation economy based on knowledge, information and intelligence.

Representatives of another group of scientific approaches to the analysis of economic growth are mainly using methods of economic and mathematical modeling, in particular regression, factor and discriminatory analysis. Thus, Bontis (2004) used a regression analysis as a tool for research on innovative levers of economic growth in the Middle Eastern countries (Egypt, Kuwait, Qatar, Tunisia, and the United Arab Emirates). He proved that the main innovation lever that has ensured the steady positive dynamics of the economic growth of countries located in the region is human capital represented as knowledge, skills and motivation of employees that bring them income in the form of labor rent. Based on Bontis’ calculation results, Uziene (2014) has constructed a regression model to analyze innovation levers of economic growth in the Baltic economies (Latvia, Lithuania and Estonia), which are at the stage of transition to information and innovation drivers. Uziene (2014) has established that the global index of intellectual capital and the index of human development have the most significant impact on the level of national competitiveness of the Baltic countries.

While developing the idea of using the methods of economic and mathematical modeling to determine the innovation levers of the country’s economic growth, P. Stahle and S. Stahle (2007, 2011) demonstrate the role of national intellectual capital and its innovative component in increasing the volume of domestic production. They found that such a relationship differs considerably at different stages of the country’s economic development. In addition to the scientific developments of P. Stahle, S. Stahle, Ruiz, Navarro, and Pena (2016), based on the analysis of 70 countries, proved the importance of each of the four components of national intellectual capital (human capital, market capital, structural capital, and capital of renewal and development) and concluded that human capital and capital of renewal and development are the determining factors of economic growth only in the innovative world’s economies, namely the USA, Japan, South Korea and most of the EU countries.
At the same time, Stam and Andriessen (2009), Crass, Licht, and Peters (2010), Abdullaeva and Warden (2011), Dal-Borgo, Goodridge, Haskel, and Pesole (2011), Andrews and de Serres (2012), just to name a few, proved that national intellectual capital positively affects the level of social productivity of labor both in economically developed OECD countries and in the so-called third world countries.

The purpose of the article is to study the innovation levers of developing the intellectual basis of economic growth in two groups of post-socialist countries of the Central and Eastern Europe (middle-income countries (Belarus, Bulgaria, Estonia, Latvia, Lithuania, Poland, Russia, Romania, Slovakia, Slovenia, Hungary, Croatia, Czech Republic) and countries with below than middle incomes (Albania, Bosnia and Herzegovina, Macedonia, Moldova, Serbia, Ukraine, Montenegro) by determining the quantitative effect of the national intellectual capital components (human capital, market capital, structural capital, capital renewal and development) on the dynamics of their economic growth. The research is based on the following hypothesis: There is a close relationship between the country’s economic growth rates and the national intellectual capital components (national human capital, national market capital, national structural capital, and national capital of renewal and development). This correlation is varying in different types of economic systems: the major world’s countries, economically developed countries, post-socialist countries and developing countries.

2. METHODS

The study uses a method of regression analysis, which will determine the quantitative relationship between the economic growth rates of the country and the components of national intellectual capital. Regression models take into account four components of national intellectual capital, namely human capital, market capital, structural capital, and capital of renewal and development. The economic value of the factors (regressors) consists in the fact that they show how much (in percentage terms) the dependent factor will change (in the models of the current study, the amount of real GDP per capita), if independent factors (indicators characterizing the national intellectual capital components) change by one percent.

3. RESULTS

The research of innovation levers of developing the intellectual basis for economic growth in post-socialist countries involves several stages (see Figure 1).

![Figure 1. Stages of the study of innovation levers for developing the intellectual basis of countries’ economic growth](http://dx.doi.org/10.21511/ppm.17(1).2019.30)
At the first stage, based on the analysis of research (Ark & Hulten, 2009; Barnes & McClure, 2009; Chun & Nadiri, 2016; Corrado, Hao, Hulten, & Ark, 2009; Ferreira & Hamilton, 2010; Majcen, Verbić, & Polanec, 2011; Piekkola, 2011, 2014; P. Stahle & S. Stahle, 2007; Cherkashyna, 2016, 2017), the regress and and the appropriate regressors were chosen. As a regress, the amount of real GDP per capita is determined, and regressors (the most significant factors) are indicators that characterize the national intellectual capital components (see Table 2).

Hereafter, an input matrix is formed that characterizes the process of forming the intellectual basis for economic growth in post-socialist countries during 2010–2018. As a research object, 20 countries of Central and Eastern Europe were selected, which, depending on the per capita GDP values, were divided into two subgroups (clusters): middle-income countries (> 15 thousand dollars) and lower-middle-income countries (< 15 thousand dollars) (see Table 3).

### Table 2. Indicators characterizing the components of national intellectual capital

| National intellectual capital components | Indicators |
|------------------------------------------|------------|
| National human capital                   | The number of teachers per 1,000 people \(X_1\), the number of teachers in higher educational institutions per 1,000 people \(X_2\), the share of people with higher education in the total population \(X_3\), the number of health care workers per 1,000 people \(X_4\), the expected lifespan \(X_5\). |
| National market capital                  | The balance of intellectual property purchase and sale transactions \(X_6\), the number of acquired or transmitted technologies \(X_7\), the number of economically active population aged 16 to 60, who traveled abroad for study or internship throughout the year, per 1,000 people \(X_8\). |
| National structural capital              | The number of educational institutions per 1,000 people \(X_9\), the number of libraries per 1,000 people \(X_{10}\), the number of telephone lines per person \(X_{11}\), the number of Internet providers per person \(X_{12}\), the number of social media per person \(X_{13}\). |
| National capital of renewal and development (or innovation capital) | The amount of internal expenses for scientific and innovative activity \(X_14\), the volume of foreign investment in scientific and innovative activity \(X_15\), the number of employed in high-tech sectors of the domestic economy per 1,000 people \(X_16\), the share of venture enterprises in the total number of economic entities \(X_17\), the number of patents issued by the United States Patent and Trademark Office \(X_18\), the number of employees who upgraded their qualifications during the year, per 1,000 people \(X_{19}\). |

### Table 3. Dynamics of real per capita GDP in post-socialist Central and Eastern European countries

| Country | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---------|------|------|------|------|------|------|------|------|------|
| **Belarus** | 15.919 | 17.153 | 17.790 | 18.257 | 18.901 | 18.345 | 18.060 | 18.349 | 20.140 |
| **Bulgaria** | 15.670 | 16.695 | 17.113 | 17.645 | 18.291 | 18.249 | 19.199 | 21.499 | 22.410 |
| **Estonia** | 23.919 | 25.494 | 26.373 | 27.694 | 28.451 | 28.947 | 29.365 | 30.765 | 33.842 |
| **Latvia** | 19.817 | 21.296 | 22.439 | 23.585 | 24.919 | 26.031 | 27.190 | 29.011 | 31.649 |
| **Lithuania** | 22.752 | 24.384 | 25.908 | 27.529 | 28.588 | 28.936 | 29.966 | 31.849 | 34.596 |
| **Poland** | 21.084 | 22.575 | 23.360 | 24.068 | 25.333 | 26.856 | 27.811 | 29.349 | 31.430 |
| **Russia** | 22.639 | 24.032 | 25.323 | 26.046 | 26.691 | 27.303 | 27.163 | 27.466 | 28.140 |
| **Romania** | 17.326 | 17.850 | 18.850 | 19.844 | 20.934 | 22.071 | 23.626 | 25.189 | 28.190 |
| **Slovakia** | 24.555 | 25.799 | 26.610 | 27.409 | 28.590 | 29.907 | 30.632 | 33.055 | 35.095 |
| **Slovenia** | 28.055 | 28.774 | 28.443 | 28.542 | 29.922 | 30.933 | 32.885 | 33.579 | 35.044 |
| **Hungary** | 21.906 | 22.811 | 22.983 | 23.904 | 25.399 | 26.436 | 26.681 | 28.965 | 31.370 |
| **Croatia** | 20.433 | 20.416 | 20.583 | 20.937 | 21.684 | 22.489 | 23.596 | 24.053 | 25.111 |
| **Czech Republic** | 28.561 | 28.803 | 29.097 | 30.432 | 32.076 | 33.743 | 34.711 | 34.849 | 37.546 |

Source: Data for the Sustainable Development (2017) and World Development Indicators (2010–2017).
Accordingly, it was concluded that the distribution of the regressions obtained, there is a clear tendency of grouping the input data close to the center. Positive and negative deviations from the center are equally probable, with the frequency of deviations decreasing rapidly in the event of a significant increase in deviations from the center. Accordingly, it was concluded that the distribution of the feature investigated, namely the volume of real GDP per capita, is close to normal with a more acute peak of distribution.

The statistical significance of the regressions obtained is confirmed by many indicators. First of all, the parameters of *t*-statistics (T-Stat) were calculated. Thus, it is proved that it is necessary to exclude those indicators from the regression equations whose values exceed the maximum acceptable norms. In this regard, the following indicators were excluded from the regressions that determine the relationship between economic growth rates and the national intellectual capital components in the middle-income countries: the number of telephone lines per person ($X_{16}$), the number of Internet providers per person ($X_{10}$) and the number of patents issued by the United States Patent and Trademark Office ($X_{15}$). And from regressions determining the relationship between economic growth rates and the components of national intellectual capital in the Central and Eastern European post-socialist countries with lower than middle income of the population, the following indicators were excluded – the expected lifespan ($X_5$), the number of employees with an upgrade in qualifications during the year, and the number of employees who upgraded their qualifications during the year.

Statistical information was processed in the Stat Graphic Centurion software environment (module – Regression Analysis) and tested for accuracy, homogeneity and compliance with the normal distribution law. The research has shown that in the regressions obtained, there is a clear tendency of grouping the input data close to the center. Positive and negative deviations from the center are equally probable, with the frequency of deviations decreasing rapidly in the event of a significant increase in deviations from the center. Accordingly, it was concluded that the distribution of the feature investigated, namely the volume of real GDP per capita, is close to normal with a more acute peak of distribution.

### Table 4. Relationship between the dynamics of economic growth and the national intellectual capital components in the Central and Eastern European post-socialist countries

| Components of the national intellectual capital | All countries under study | Middle-income countries | Lower-middle-income countries |
|------------------------------------------------|---------------------------|-------------------------|-------------------------------|
| Regression equation | Determination coefficient ($R^2$) | Regression equation | Determination coefficient ($R^2$) | Regression equation | Determination coefficient ($R^2$) |
| National human capital | $Y = 0.7428X_5 + 0.3482X_6 + 0.1911X_7$ | 0.8185 | $Y = 0.7212X_5 + 0.6431X_6 + 1.0345X_7 + 0.2526X_8 + 0.1988X_9$ | 0.7893 | $Y = 0.7885X_5 + 0.7486X_6 + 1.0019X_7$ | 0.8483 |
| National market capital | $Y = 0.1192X_5$ | 0.7771 | $Y = 0.9896X_5$ | 0.8184 | $Y = 0.9336X_5 + 0.2956X_6$ | 0.9124 |
| National structural capital | $Y = 0.0811X_{10} + 0.1094X_{16}$ | 0.9112 | $Y = 0.3126X_{10} + 0.2539X_{16}$ | 0.8685 | $Y = 0.9536X_{10} + 0.8423X_{16} + 0.1656X_{12} + 0.0012X_{16} + 0.0078X_{16}$ | 0.8789 |
| National capital of renewal and development (or innovation capital) | $Y = 0.7186X_{10} + 0.1234X_{15} + 1.2529X_{16} + 0.6589X_{16}$ | 0.8208 | $Y = 0.6411X_{14} + 1.7685X_{15} + 1.1123X_{16}$ | 0.9113 | $Y = 0.5658X_{14} + 0.6413X_{15} + 0.4125X_{16}$ | 0.8689 |
terminated (1.35 ≤ DW ≤ 1.9), indicating no autocorrelation of the first-order residues. The statistical significance of the constructed regressions has been confirmed by the values of the determination coefficients varying from 0.7771 to 0.9112 and making it possible to assert that the models obtained are adequate and explain the dynamics of the dependent variable (real GDP per capita) from 77.11% to 91.12% (see Table 4).

4. DISCUSSION

Formation use and reproduction of human capital is the main lever of developing the intellectual basis for economic growth of the countries under investigation. This is confirmed by the quantitative effect of the following indicators: the number of teachers per 1,000 people (0.7428X₁), the number of teachers at higher educational institutions per 1,000 people (0.3482X₂), the number of health care workers per 1,000 people (0.1911X₄).

Another lever for the innovation and investment model of development is the national capital of renewal and development, that is, the national innovation capital, which in the regressions received is characterized by indicators such as the amount of internal expenses for scientific and innovation activity (0.7186X₁), the number of employed in high-tech sectors of the national economy per 1,000 people (0.1234X₆), and the number of employees who upgraded their qualifications during the year, per 1,000 people (0.6589X₈). It has also been established that financing of innovation infrastructure objects (design bureaus, research institutes, technoparks, technopoles, technoecopoles) (0.7186X₁₄, 0.7934X₁₅) contributes to the implementation of innovative projects, the production of high-tech industrial products, the development of knowledge-intensive business, and hence, and to an increase of the technological competitiveness of countries belonging to this cluster.

At the same time, there are some differences between the multiple regression equations obtained for the two groups of post-socialist countries: middle-income countries and lower-middle-income countries. The results obtained for middle-income countries (Belarus, Bulgaria, Latvia, Lithuania, Estonia, Poland, Russia, Romania, Slovakia, Slovenia, Hungary, Czech Republic) are generally in line with the pan-European model of innovation and investment development, which is based on the commercialization of new scientific and technical knowledge, introduction of modern information and communication technologies, organization of science-intensive business and development of high-tech sectors of the domestic economy. It is, therefore, not surprising that the objects of innovation infrastructure (technopoles, technoecopoles, venture companies, knowledge consortia, knowledge and technology transfer centers, centers of excellence, business incubators) have been recognized as the main factor for successful economic development and social progress by the governments of the “new members” of the European Union (Bulgaria, Estonia, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia, Croatia, Czech Republic).

In addition, the national human capital has a significant positive impact on the dynamics of economic growth in the Central and Eastern European post-socialist middle-income countries. This is manifested in the quantitative effect of the following indicators: the number of teachers per 1,000 people (0.7122X₁), the number of teachers of higher educational institutions per 1,000 people (0.6431X₂), the share of people with higher education in the general structure of the country’s population (0.0345X₃), the number of health care workers per 1,000 people (0.2526X₄), the expected lifespan (0.1988X₅). These results are explained by the fact that the governments of this group of countries recognize the knowledge, skills, and motivation of people as the main productive force of the national economy, and proper financing of the branches of education, culture and healthcare is an integral part of the national innovation policy of these countries. Therefore, in countries with “fast-growing markets” (Poland, Slovakia and Hungary), significant budget funds are allocated to the industries that form human capital, thus providing training for highly skilled professionals capable of producing new ideas, developing and implementing innovative products, which belong to the fifth and sixth technological patterns and are competitive on world commodity markets. The dynamics of the economic growth of the Central and Eastern European post-socialist middle-income countries is significantly influenced by in-
dicators that characterize the national structural capital, namely the number of educational institutions per 1,000 people (0.3226X₇) and the number of libraries per 1,000 people (0.2539X₉).

In addition, the multiple regression equation obtained for middle-income countries points to the important role of information and communication technologies, the latest electronic communications, as well as global, regional and local systems in providing structural and innovation transformations and the formation of the intellectual basis of economic growth, as they promote the interest of domestic investors in the Central and Eastern European post-socialist lower-middle-income countries that an innovative lever of economic growth such as education, science, culture, and health care are still significantly behind more developed post-socialist countries of the Central and Eastern Europe (Poland, Slovakia, Slovenia, Hungary, etc.), it is in lower-middle-income countries that an innovative lever of economic growth such as education has the greatest positive impact on the dynamics of economic growth. This makes it possible to recognize the knowledge, intelligence, erudition, emotions, creativity and system thinking of people as key factors in shaping the basis for the successful economic development and social progress of this group of countries.

At the same time, despite the considerable scientific and technical potential, the national capital of renewal and development (or innovation capital) does not have a very significant effect on the dynamics of economic growth in Central and Eastern European countries with lower than middle incomes. This is evidenced by the relevant indicators: the volume of internal expenses for scientific and innovative activity (0.5658X₇), the volume of foreign investment in scientific and innovative activity (0.6413X₇), the number of people employed in the science-intensive sector per 1,000 people (0.4125X₉), the number of persons who arrived in Moldova for study and/or training during the year, per 1,000 people (0.2956X₉), which has a serious impact on the dynamics of economic growth in this group of countries. In addition, the number of acquired (transferred) technologies (0.3536X₇) plays an important role in shaping the intellectual basis of the economic growth of the post-socialist countries of this region. This is a very important point as it statistically confirms the need for finding more effective mechanisms for innovative transformations and technological modernization of industrial complexes in the Central and Eastern post-socialist countries with lower than middle incomes.

Considerable attention is also paid to the fact that national market capital does not play a key role in ensuring economic growth of the Central and Eastern European countries with lower than middle incomes. That is these countries do not actively participate in international scientific and technological exchanges. This is evidenced by the following data: in 2017, the number of persons who arrived in Moldova for study and/or training was 4,278, in Belarus – 20,504, and in Romania – 27,908. As a comparison, the number of persons who arrived in Poland for study and/or training during the same period was 65,904, in Russia – 240,509, in Hungary – 57,632, and 47,232 came to Czech Republic. This is also confirmed by the value of the corresponding regressor – the number of economically active population aged 16 to 60 who traveled abroad for study or internship during the year, per 1,000 people (0.2956X₉), which has a serious impact on the dynamics of economic growth in this group of countries. In addition, the number of acquired (transferred) technologies (0.3536X₇) plays an important role in shaping the intellectual basis of the economic growth of the post-socialist countries of this region. This is a very important point as it statistically confirms the need for finding more effective mechanisms for innovative transformations and technological modernization of industrial complexes in the Central and Eastern post-socialist countries with lower than middle incomes.
China, Germany, Switzerland, creating the gross domestic product of these countries and thus increasing their national wealth.

It should also be noted that the regression equations determining the relationship between the national intellectual capital components and the dynamics of economic growth in countries with lower than middle incomes, in part duplicate results obtained for middle-income countries. Thus, the dynamics of economic growth in the 20 surveyed countries are influenced by indicators characterizing the national structural capital, namely the number of educational institutions per 1,000 people \((0.9536X_9)\), the number of libraries per person \((0.8423X_{10})\) and the number of telephone lines per one person \((0.1656X_{11})\). This is due to the fact that in the context of the modern information and technological revolution in most world’s countries, including post-socialist ones, a new social pattern is being shaped – an innovation and information society, which creates favorable conditions for the effective use of scientific and technical knowledge in solving urgent economic problems. Social media (social networks, blogs, microblogging, etc.) play a key role in this process. They result from convergence and development of information and communication technologies and global computer networks and serve as an effective tool for the exchange of experience and faster dissemination and introduction of innovative ideas, projects and technologies. In the future, the development of precisely national structural capital can be a boost to the rapid economic growth of Central and Eastern European lower-middle-income countries (Albania, Bosnia and Herzegovina, Macedonia, Moldova, Ukraine, Montenegro) and increase their role and significance in the global economy.

CONCLUSION

National capital of renewal and development (that is the national innovation capital) is the main lever of shaping the intellectual basis for the economic growth of middle-income countries (Belarus, Bulgaria, Estonia, Latvia, Lithuania, Poland, Russia, Romania, Slovakia, Slovenia, Hungary, Croatia, Czech Republic). Therefore, the strategic task of the state policy in these countries is shaping an innovation-investment model of “catchup” economic growth dominated by science-intensive industries in the structure of national economy.

Equally important for middle-income countries is the formation and efficient use of high-quality human capital. In view of this, the main priorities of governments should be, on the one hand, economic and social motivation of every citizen to be healthy, educated, highly moral and building on this basis an innovation and information society of highly educated and creative people. On the other hand, the state should ensure legal, economic, organizational and infrastructural conditions for following the appropriate way of life. As a result, these countries will be able to solve the main task, i.e. developing effective innovative systems and achieving high rates of economic growth based on the unity and balance of public policy in the fields of education, culture and health care.

Human capital is also the main driver of the economic growth in the Central and Eastern European post-socialist countries with lower than middle incomes. It is necessary to improve the quality and competitiveness of national innovation systems and thus solve two pressing problems: to lower the drain of highly skilled scientific and technical personnel, which is characteristic for lower-middle-income countries; and to increase the efficiency of the system for transferring new knowledge and technologies from the scientific sector to the manufacturing sector and accelerate the process of convergence. The development of national structural capital through the spread of global computer networks, Internet technologies, electronic communications, mass media, social networks and artificial intelligence systems is important for shaping the intellectual basis for economic growth.

In the long run, the implementation of the identified measures in the economic policy of the post-socialist countries under investigation will make it possible to significantly improve the efficiency of national
innovation systems and, based on the balance of the three interconnected components (economic, social and environmental), create all the necessary conditions for the transition to a new technological structure, i.e. the information and innovation economy based on knowledge, information and intelligence.

REFERENCES

1. Abdullaeva, N., & Warden, C. (2011). Theoretical and practical aspects of implementing intellectual capital approaches for sustainable economic development. Paper presented at The European Conference on Intellectual Capital, 18-19, (pp. 585-590).

2. Andrews, D., & de Serres, A. (2012). Intangible Assets, Resource Allocation and Growth. OECD Economics Department Working Papers, 909, 1-48. https://doi.org/10.1787/18151973

3. Ark, В., Corrado, K., & Hulten, С. (2007). The information society and the welfare state: The Finnish model. Oxford: Oxford University Press. Retrieved from http://www.oxford-scholarship.com/view/10.1093/acprof:oso/9780199256990.001.0001/acprof-9780199256990

4. Ark, В., & Hulten, С. (2009). Measuring intangible capital and its contribution to economic growth in Europe. EIB Papers, 14(1), 62-93. Retrieved from https://ideas.repec.org/p/ris/eibpap/2009_003.html

5. Ark, В., Bart, О., & Jäger, K. (2010). Intangible capital in the Netherlands and its implications for future growth. New York: The Conference Board Inc. Retrieved from https://www.conferenceboard.org/pdf_free/EWP-IntangibleNetherlands.pdf

6. Barnes, P., & McClure, A. (2009). Investments in intangible assets and Australia’s productivity growth. Melbourne, Vic.: Productivity Commission. Retrieved from https://www.pc.gov.au/research/supporting/intangible-investment-sectoral-estimates

7. Barro, R. J., & Sala-i-Martín, H. (2010). Economic growth. Moscow: BINOM. Knowledge lab.

8. Bontis, N. (2004). National intellectual capital index: A United Nations initiative for the Arab region. Journal of Intellectual Capital, 5(1), 13-39.

9. Castells, M., & Himanen, P. (2002). The information society and the welfare state: The Finnish model. Oxford: Oxford University Press. Retrieved from http://www.oxford-scholarship.com/view/10.1093/acprof:oso/9780199256990.001.0001/acprof-9780199256990

10. Cherkashyna, T. S. (2016). Дослідження впливу структури державних витрат на динаміку економічного розвитку постсоціалістичних країн Східної Європи [Doslidzhennia vplyvu struktury derzhavnykh vytrat na dynamiku ekonomichnogo rozvytku postsotsialistychnyh krain Skhidnoi Yevropy]. Finansovyj prostir, 4(24), 63-71. Retrieved from http://www.repository.hneu.edu.ua/jspui/handle/123456789/15455

11. Cherkashyna, T. S. (2017). Estimation and forecasting of the value of national intellectual capital of Ukraine in terms of structural and innovative transformations. Finansovyj prostir, 3(27), 62-68. Retrieved from http://www.repository.hneu.edu.ua/jspui/handle/123456789/18165

12. Chun, H., & Nadiri, M. I. (2016). Intangible investment and changing sources of growth in Korea. Japanese Economic Review, 67(1), 50-76. https://doi.org/10.1111/jere.12079

13. Corrado, C. A., Haskel, J., Jona-Lasinio, C., & Iommi, M. (2016). Intangible investment in the EU and US before and since the Great Recession and its contribution to productivity growth (EIB Working Papers, 08). Retrieved from https://ideas.repec.org/p/zw/eibwps/201608.html

14. Corrado, C., Hao, J. X., Hulten, С., & Ark, B. (2009). Measuring intangible capital and its contribution to economic growth in Europe. European Investment Bank Papers, 14(1), 63-93.

15. Corrado, C., Haskel, J., Jona-Lasinio, C., & Iommi, M. (2012). Intangible capital and growth in advanced economies: measurement methods and comparative results (IZA Discussion paper, 6733). Retrieved from http://ftp.iza.org/dp6733.pdf

16. Corrado, C., Hulten, C. R., & Sichel, D. E. (2009). Intangible capital and U.S. economic growth. Review of Income and Wealth, 55(3), 661-685. http://dx.doi.org/10.1111/j.1475-4991.2009.00343.x

17. Crass, D., Licht, G., & Peters, B. (2010). Intangible Assets and investments at the sector level – empirical evidence for Germany, In Competitiveness, innovation and intangible investments in Europe, 7th Frame work Programme, Specific Programme “Socioeconomic Sciences and Humanitiestheme” (ZEW Discussion Paper, 14-049). Retrieved from http://ftp.zew.de/pub/zew-docs/dp/dp14049.pdf

18. Dal-Borgo, M., Goodridge, P., Haskel, J., & Pesole, A. (2011). Productivity and growth in UK industries: an intangible investment approach (Discussion paper, 6.) Retrieved from https://spiral.imperial.ac.uk:8443/bitstream/10044/1/9027/1/Haskel%202011-06.pdf

19. Data for the Sustainable development (2017). Retrieved from www.oecdbibliography.org

20. Edquist, H. (2011). Can investment in intangibles explain the Swedish productivity boom in the 1990s? Review of Income & Wealth, 57(4), 658-682. https://doi.org/10.1111/j.1475-4991.2010.00436.x
21. Edvinsson, L., & Stenfelt, C. (1999). Intellectual capital of nations – for future wealth creation. *Journal of Human Resource Costing & Accounting*, 4(1), 21-33. Retrieved from http://dx.doi.org/10.1108/ e029051

22. European Commission (2012). *The Global Europe 2050* (Directorate-General for Research and Innovation). Retrieved from https://ec.europa.eu/research/social-sciences/pdf/policy_reviews/global-europe-2050-report_en.pdf

23. Ferreira, S., & Hamilton, K. (2010). Comprehensive wealth, intangible capital, and development (Policy Research Working Papers, 5452). Retrieved from http://documents.worldbank.org/curated/en/77491146833609712/Comprehensive-wealth-intangible-capital-and-development

24. Görgiz, B., Piekkola, H., & Riley, R. (2011). Production of intangible investment and growth: Methodology. *INNODRIVE Working Paper, 1*, 1-41. Retrieved from http://www.innordrive.org/attachments/File/workingpapers/Innordrive_WP_1_GorgizPiekkolaRiley2011.pdf

25. European Union (2017). Growth, competitiveness, employment, the challenges and the ways forward into the 21st century (White paper).

26. Guellec, D., & Pottelsberger, B. (2001). R & D and productivity growth: panel data analysis of 16 OECD countries. *OECD Science, Technology and Industry Working Papers, 33*, 1-26. http://dx.doi.org/10.1787/652670318341

27. Hansen, E. B. (2017). *Econometrics*. US: University of Wisconsin Press.

28. Hao, J. X., Manole, V., & Ark, B. (2007). Intangible capital and growth: An international comparison of France, Germany, Netherlands, United Kingdom and the United States (The Conference Board, forthcoming).

29. Hao, J. X., Manole, V., & Ark, B. (2009, August). Intangible capital and economic growth – An international comparison.

30. Haskel, J., & Westlake, S. (2017). *Capitalism with out capital: The rise of the intangible economy*. Princeton, NY: Princeton University Press.

31. Haskel, J., & Westlake, S. (2018). Productivity and secular stagnation in the intangible economy. Retrieved from https://voxeu.org/article/productivity-and-secular-stagnation-intangible-economy

32. International Organization for Migration. Retrieved from http://www.iom.int

33. Jona-Lasinio, C., Iommi, M., & Manzocchi, S. (2011). Intangible capital and Productivity Growth in European Countries. *INNODRIVE Working Paper, 10*, 1-27. Retrieved from http://www.innordrive.org/attachments/File/workingpapers/Innordrive_WP_10_Jonalommi-Manzocchi2011.pdf

34. Kyoji, F., Miyagawa, T., Mukai, K., Shinoda, Y., & Tonogi, K. (2009). Intangible investment in Japan: Measurement and contribution to growth. *Review of Income and Wealth, 55*(3), 717-736. https://doi.org/10.1111/j.1475-4991.2009.00345.x

35. Lopez Ruiz, V.-R., Navarro, A., & Pena, D. N. (2016). Economic growth and intangible capitals: A international panel data model applied in the 21st century. *Romanian Journal of Economic Forecasting, XXI*(2), 102-113. Retrieved from https://ideas.repec.org/a/rjr/romjef/vy2016i2p102-113.html

36. Majcen, B., Verbič, M., & Polaneč, S. (2011). Innovativeness and Intangibles: The Case of Slovenia. *INNODRIVE Working Paper, 18*, 1-38. Retrieved from http://www.innordrive.org/attachments/File/workingpapers/Innordrive_WP_18_MajcenVerbicPolanecki2011.pdf

37. Makarov, P. Yu. (2015). Экономический рост России: механизм управления интеллектуальным капиталом региона как фактор экономического роста [Economic growth of Russia: mechanism of management of the intelectual capital of region as a factor of economic growth]. Moscow: INFRA-M.

38. Malhotra, Y. (2003). Measuring knowledge assets of a nation: knowledge systems for development. Retrieved from http://km.brint.com/KnowledgeManagementMeasurementResearch.pdf

39. Marcin, K. (2013). Intellectual Capital as a key factor of socio-economic development of regions and countries. *Procedia Economics and Finance, 6*, 288-295. https://doi.org/10.1016/S2212-5671(13)00142-1

40. McGrattan, E. R. (2017). Intangible capital and measured productivity (NIER Working Paper, 23233). Retrieved from http://www.nber.org/papers/w23233.pdf

41. Nakamura, L. I. (2010). Intangible assets and national income accounting. *Review of Income and Wealth*, 56(1), 135-155. http://dx.doi.org/10.1111/j.1475-4991.2010.00390.x

42. Navarro, A., López Ruiz, V.-R., & Peña, D. N. (2014). Economic growth and intangible capitals: Europe versus Asia. *Panoeconomicus, 3*, 261-274. http://dx.doi.org/10.2298/PAN1403261N

43. Nadiri, M., & Nandi, B. (2015). Modern Communication Technology and Its Economic Impact: A Survey of Research Findings. *Digi World Economic Journal, 4*(100), 125-144. Retrieved from https://ideas.repec.org/a/idt/journl/cs10006.html

44. OECD. (2010). *Hand book on deriving capital measures of intellectual property products*. Paris: OECD Publishing.

45. Piekkola, H. (2011). Intangible Capital: The Key to Growth in Europe. *Intereconomics, 46*, 222. Retrieved from https://link.springer.com/article/10.1007/s10727-011-0387-2

46. Piekkola, H. (2014). Intangible capital agglomeration and economic growth: A regional analysis of Finland (Working papers, 21). Retrieved from https://www.uni-vaasa.fi/materiali/pdf/isbn_978-952-476-518-3.pdf

47. Piekkola, H. (2011). Intangible Capital – Driver of Grow th in Europe. *Proceedings of the University of Vaasa. Reports, 167*, 20-60. Retrieved from http://www.innordrive.org/attachments/File/Intangible_Capital_Driver_of_Growth_in_Europe_Piekkola(ed).pdf
48. Roth, F., & Thum, A.-E. (2010). Does intangible capital affect economic growth? (CEPS Working Document, 335).

49. Ruiz, V. R., Navarro, J. L., & Pena, D. N. (2011). The relationship between Gross Domestic Product (GDP) and hidden wealth during the years 2000–2009: an international study. In Proceedings of the European Conference on Intellectual Capital, 18-19, Nicosia, Cyprus (pp. 187-198).

50. SORS – Statistical Office of the Republic of Slovenia (2010). SI-STAT Data Portal. Ljubljana: Statistical Office of the Republic.

51. Stahle, P., & Stahle, S. (2007). Intellectual capital and national competitiveness: conceptual and methodological challenges. Retrieved from http://www.stahle.fi/Bounfour_paper.pdf

52. Stam, C., & Andriessen, D. (2009). Intellectual capital of the European Union 2008: measuring the Lisbon strategy for growth and jobs. Electronic Journal of Knowledge Management, 7(4), 48-500. Retrieved from https://www.researchgate.net/publication/228440888_Intellectual_Capital_of_the_European_Union_2008_Measuring_the_Lisbon_Strategy_for_Growth_and_Jobs

53. The Global Innovation Index (2017). Retrieved from www.globalinnovationindex.org/about-gii#reports

54. United Nations, Department of Economic and Social Affairs (2015). Report of the Secretary-General on International migration and development (A/71/296). Retrieved from http://www.un.org/en/development/desa/population/migration/generalassembly/docs/A_71_296_E.pdf

55. Uziene, L. (2014). National intellectual capital as an indicator of the wealth of nations: the case of the Baltic States. Procedia-Social and Behavioral Sciences, 156, 376-381.

56. Vorontsovskii, A. V., Dikarev, A. U., Ahobadze, A. T., & Sherov-Ignat’ev, V. G. (2014). Моделирование экономического роста в условиях современной экономики [Modelirovanie ekonomicheskogo rosta v usloviyakh sovremennoy ekonomiki] (284 p.). S.-P.: Izdatelstvo Sankt-Peterburgskogo Universiteta.

57. World Development Indicators (2010–2017). Retrieved from http://databank.worldbank.org

58. World Investment Report (2012). Towards a New Generation of Investment Policies. New York and Geneva: United Nations (239 p.). Retrieved from http://unctad.org/en/PublicationsLibrary/wir2012_embargoed_en.pdf