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COMPARATIVE MEASUREMENT OF INTELLECTUAL POTENTIAL IN ECONOMICS OF UKRAINE AND ROMANIA

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ABSTRACT
The article is devoted to solving methodological and practical problems of identification and measurement of national intellectual potential (IP). The relevance of this study is due to the fact that the level of IP is a determining factor in the prospects for the economic development of countries on an innovative basis.
Objectives: *The object of research is the IP of Ukraine and Romania. The subject of the study is a comparison of the PI of these countries. The choice of countries for research and comparison on this indicator is due to a number of factors: close geographical location, GDP, the duration of the period of market transformation of the economy and others.*
Methods/Approach: *A statistical method of measuring IP based on normalized indices is used. The authors substantiate the original set of indicators used in the calculation of the general IP index and its components.*
Results: *The article summarizes the results of the analysis of the advantages and disadvantages of the most common methodological approaches to measuring IP using the sum of the absolute values of the IP components (Scandia-navigator), the index method of dynamic measurement of IP (IC-dVal), the method of normalized indices, proposed by the UN. The article proposes the author's method of comparative measurement of individual entrepreneurs of the two countries on the basis of normalized indices. The system of indicators, which characterizes the level of human intelligence, artificial intelligence and intellectual products that are components of individual entrepreneurs, is substantiated.*
Conclusions: *To increase the reliability of the IP assessment, it is advisable to single out methodological tools for the influence of the state (government) and the market on the motivation of innovative work and innovative entrepreneurship. The approbation of the proposed methodology on the actual data of Ukraine and Romania, which are contained in international and national information resources, carried out in the article, makes it possible to draw a reasonable conclusion that Romania in the period 2016-2018 is approaching and ahead of Ukraine in terms of individual entrepreneurs.*

Keywords: human intelligence, artificial intelligence, intellectual resources, intellectual potential, intellectual capital

JEL classification: *J24, O15, O34, O52*
Paper type: Research article

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INTRODUCTION

Increased value of identification and measurement of the intellectual potential (IP) for the Ukrainian society is dictated by the need to define the implementability of the innovative model of the economic development on the basis of the better use of intellectual resources. It is especially relevant in terms of implementation of the Ukrainian strategy of European choice. The main issue is that the methodology for nationwide IP measurement has not been decisively formulated in the national economic science. At the same time, the

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attempts to borrow the theoretical concepts and methods common in the developed countries do not consider the peculiarities of the Ukrainian economy and its national innovation system.

The concept of intellectual capital is relevant for many countries, where a large role is given to the knowledge-based economy (Michalczuk & Fiedorczuk, 2017; Kim et al., 2006), migration of young people, as a part of the formation of intellectual potential (Fassman & Munz, 2002; Aidis et al., 2005), economic component of human capital (Petrova, Tepavicharova & Dikova, 2019; Odinokova et al., 2018), and the country's wealth factor (Labra and Sanchez, 2013; Labra and Sanchez, 2017). The first attempt to measure national intellectual capital was made in Sweden at the national level, and it's not surprising that Sweden is among the leaders in this indicator. Despite a significant range of work and research in the field of intellectual capital, where the active phase occurred in the late 90's (Edvinson & Sullivan, 1996; Kaplan & Norton, 1997; Sveiby, 1997; O'Donnell et al., 2000), there is still a lack of empirical research.

At the same time, scientific schools in Poland (Michalczuk & Paszko (Fiedorczuk), 2016-2021) and Croatia (Svarc et al., 2020) bring a fresh perspective on this issue.

Brief analysis of the internationally common methods for measurement of IP of the countries points out to the need of their modification in accordance with institutional peculiarities of the national innovation system of Ukraine, particularly taking into consideration impact of the market and state on the formation and use of intellectual potential.

Purpose of research is to develop methodology for measurement of nationwide IP in Ukraine, which will allow to identify the influence of market and state on its formation and use, as well as holding of comparative analysis in different countries.

This research brings both theoretical and practical contributions. In particular, the study considers the nationwide IP model and suggests a system of indicators for the calculation of indices at dynamic analysis. The most representative period in the development of national IP in Ukraine and Romania is triennium, 2016 – 2018.

The research has the following structure: in the first section we appreciate the background of intellectual potential (IP) at the national level. In the second chapter, we propose analyzing the study of the international experience in IP measurement powered by the model for nationwide IP at the level of the countries, as well as of institutional concepts. In the last section of the article, based on different types of indicators we carry out an analysis of aggregate IP index calculation in accordance with the comparative methodology.

Literature Review

Analysis of the foreign scientific publications gives us grounds to conclude that there are no generally accepted methods for IP measurement. It can be explained with different purposes, which the researches define for them researches, at the same time taking into consideration the institutional features of the countries. The following methods are the most common methods of measurement: the sum of the absolute values of the IP components (Skandia Navigator) (Lin and Edvinsson, 2011); index method for dynamic measurement of IP (IC-dVal) (Bounfour, 2003); method of standardized indices, presented by the UN (Anand and Sen, 1994).

Each of these methods has its own advantages and disadvantages restricting the possibilities for its use in Ukraine. Thus, the advantage of Skandia Navigator method is the possibility of comparison of absolute values of IP of different countries. However, the majority of indices, on the basis of which the absolute value of IP is calculated, are of a descriptive nature and estimated by experts by using their assessment score. So, in order to have consistent comparison between the countries, the research should be made by the same group of experts. IC-dVal method is based on the use of chain indices of changes of indicators values in the transformation chain: investments → intellectual resources and processes → assets → results. This method can be successfully applied for analysis of the temporary dynamics of the nationwide IP. All indicators, used in this method, are quantitatively measured, and most of them are measured in units of currency. The disadvantages of this method are that such factors as influence of the market and state on mobilization of the intellectual resources and their transformation to the intellectual capital are being left outside of the operative range of this method. Moreover, this method does not provide the comparative analysis of IP between countries. Even though the method of standardized indices, presented by the UN in 1990 for the human development studies, mostly meets the purpose of the present study, it has not, however, been widely applied for practical measurement of the nationwide IP and its comparison between the countries due to the lack of methodologies for IP comparative analysis.

In Romania, the components of the general national intellectual potential and its use in the economy were investigated. The influence of the intellectual product on the development of the production sector and trade in the context of European trends was investigated by V. Iancu (Iancu, 2014). The problems of intellectual property management in Romania are devoted to the works of Titu A., C. Oprean, A. Raulea, A. Simina (Titu et al., 2015). Sociological problems of national intellectual development under the influence of European factors were investigated by C. Schifirnet (Schifirnet, 2013).

Notable scientific achievements in adapting the world experience of IP research in the conditions of economic transformation, the formation of the knowledge economy and the influence of institutional features on its use have Ukrainian scientist school, in particular L. Fedulova (Fedulova, 2009), S. Shumska (Shumska, 2007) (school of Institute of Economics and Forecasting of NAS of Ukraine), V. Bazylevych (Bazylevych, 2008), A. Chukhno (Chukhno, 2007) (scientific school of Kyiv National University), V. Krublevskyi and Y. Kanygin (Ukrainian Society, 2005) (scientific school of Institute of Sociology of NAS of Ukraine), N. Gavkalova and N. Markova (Gavkalova and Markova, 2006) (scientific school of Kharkiv National Economic University).

Theoretical background of national intellectual potential

The national IP shows the possibility of implementing innovative development of the country's economy on the basis of rational use of intellectual resources. Intellectual resources, including human intelligence, artificial intelligence, and intellectual products, are the substantive basis of IP (see Fig. 1). Each of these types of the resources has many spheres of demonstration. In economy, which is based on the knowledge, the work of

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human intelligence is characterized by creative abilities shown in development of new knowledge and innovative products, as well as by entrepreneurial abilities, which are shown in commercialisation of the innovative products.

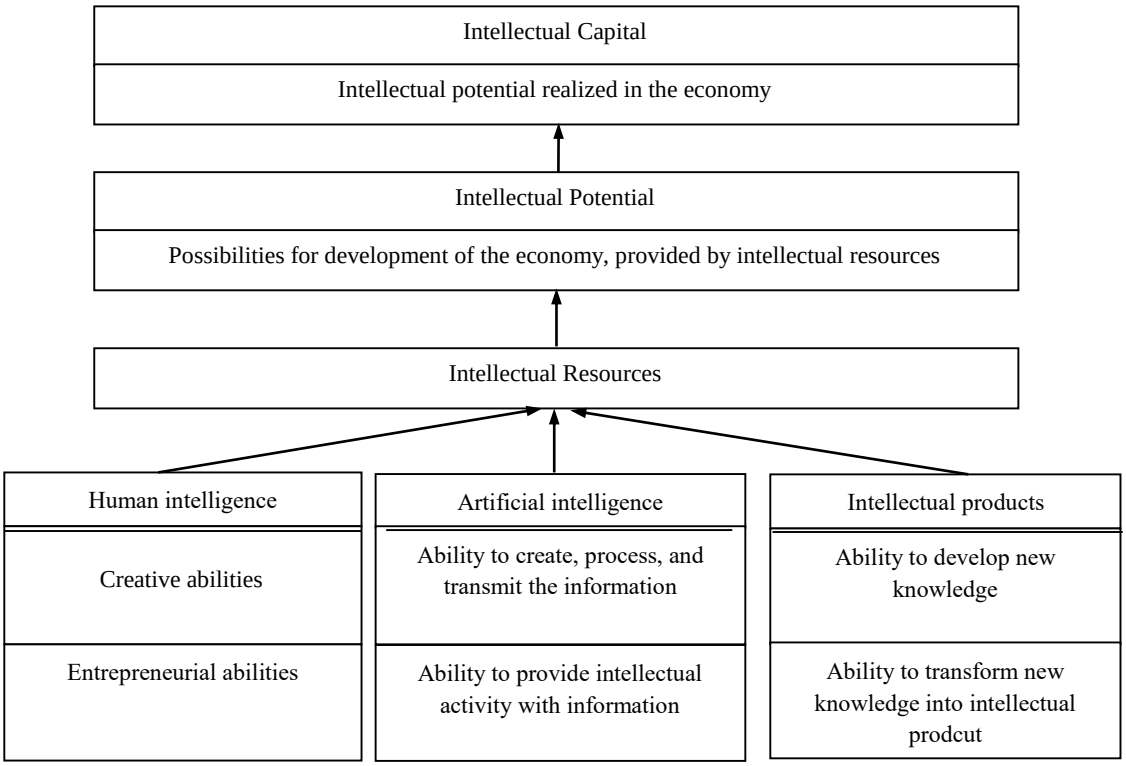

Figure 1. Structure and features of the components of nationwide IP

Source: Author's illustration

At the same time, features of the human capital, which we have defined here, turn up as function of several factors: mental capabilities, health condition, and education. Artificial intelligence is determined by the level of the software development, technical means for transmission and processing of information, and information databases. Intellectual products accumulated in the economy of a state can be defined by the range and quality of new knowledge, practical value of the created objects of industrial intellectual property and know-how.

Elements that belong to the certain component of the intellectual potential are formed under the influence of the specific system of factors. The taxonomy of these factors is performed according to the forms and way of impact on the IP components and elements. The classification of factors that shape the components and elements of IP is given in the table 1.

According to the types of impact on IP, the factors are divided into factors of direct and mediate impacts. The factors of direct impact directly shape the elements of IP. Thus, they include, for instance, level, structure, and quality of education, that together determine intelligence of a person.

Table 1. Factors that shape nationwide IP

Composed IP	IP elements	Factors that shape IP elements
	Mental capabilities	Groups of factors: genetics, demography, sociocultural factors, history

Human intelligence	Health condition	Groups of factors: genetics, health, ecology, wealth
	Education	Level of education, structure of education, quality of education, compliance of education with the needs of the market, funding for education
Artificial intelligence	Software	Development of information communication, computer literacy, quality of education, software patenting
	Technical means for transmission and processing of information	Computerization of the population, development of information networks, competition at the market of the national operators of information networks
	Information databases	Development of library services, development of patent information databases, intensity of publications, popularization of Internet
Intellectual products	New knowledge	Advancement of education, advancement of science, recognition of schools of science, development of technologies, funding for science, social recognition of the scientific work
	Intellectual property	Demand for innovations, competition in the sphere of innovations, economic efficiency, protection of industrial intellectual property
	Know-how	Development of technologies, competition at the market of innovations, economic efficiency, protection of technologic secrecy

Source: Own computation

The mediate factors impact on IP elements trough another objects. As, for instance, funding for education is one of the main factors for complete advancement of this sphere, which, in its turn, will result in the level of education for the population of the whole country.

According to the ways of impact, the factors that shape IP, can be divided into three groups:

- factors for intellectual resources accumulation;
- factors for intellectual resources use;
- factors of renewal and development.

The first group includes the factors that form substantial structure of IP. The second group embraces factors of efficient interaction with external environment that affect the use of intellectual resources. Thus, this group includes: demand for innovations, competition at the market of innovations, state regulation of innovation activities. The third group contains the factors, which characterize the process of IP expanded reproduction: scientific and innovative activities, in the result of which the human intelligence is advanced; achievements of scientific and technical progress that give people new knowledge and put IP to the new higher level.

METHODOLOGY

The process of transformation of intellectual resources takes place due to the impact of the factors from the second group: at the first stage – IP formation, at the second – its mobilization as intellectual capital in the market economy (see Fig. 2). The similar position concerning the transformation of intellectual resource is held by Peter Drucker, who believes that "knowledge as itself is not useful in the business, it is effective only to the extent, when it produces benefits in the life outside the business – in the world of markets and consumers" (Drucker, 2006).

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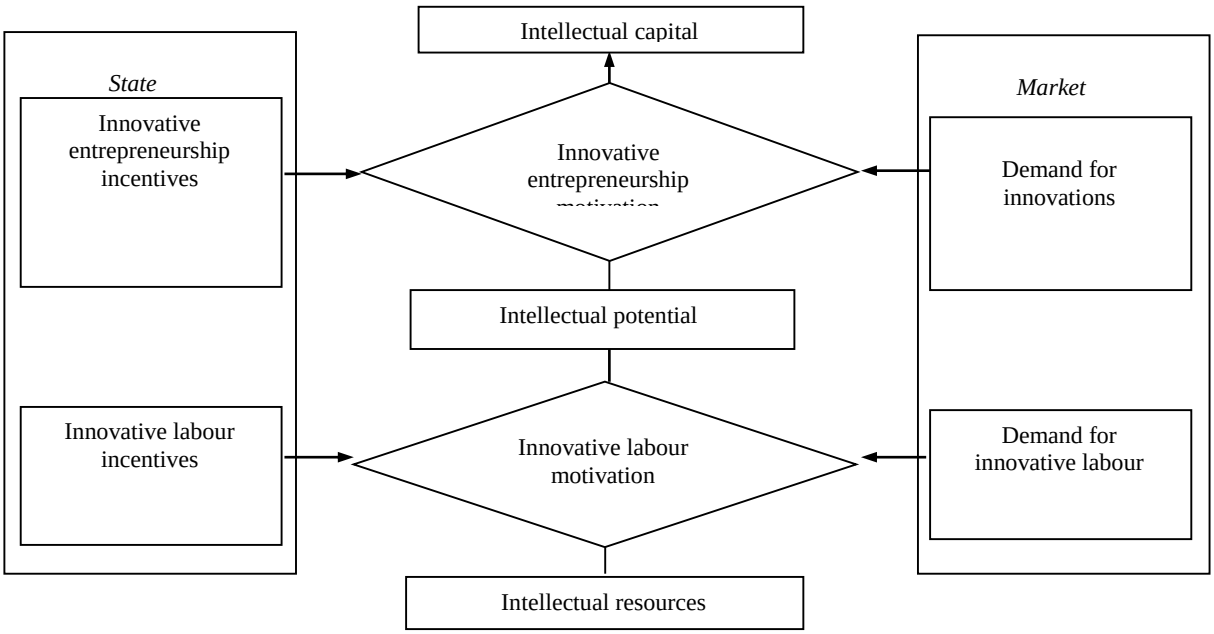

Figure 2. Intellectual resources transformation in the market

Source: Author's illustration

Study of the international experience in IP measurement at the level of the countries, as well as of institutional concepts, presented by the Ukrainian researches (Dyachenko et al., 2018; Seitzhanov et al., 2020; Mushkudiani et al., 2020), allowed us to formulate methodological approaches, which, we believe, can be reasonably put to the basis of IP measurement model at the stage of shaping of national innovation system of Ukraine:

- nationwide intellectual resources are a substantial basis of country's IP;
- nationwide intellectual resources are a system, components of which are interrelated and interconnected and enable system to transform into IP;
- intellectual resources are composed of human intelligence, artificial intelligence, and intellectual products;
- mobilization of intellectual products is made on the basis of innovative labor motivation under the influence of the market and state.

According to the author's model, the impact of human intelligence factors should be measured with the help of relevant indices (see Fig. 3).

In this case we view the artificial intelligence as a process of machine reproduction of some human's functions related to the perception of information and the easiest functions of analysis and decision making. Intellectual products are provided by the development of the education, science, technologies, level of science funding, and protection of industrial intellectual properties (PIIP) in the country. Formation of the nationwide IP takes place under the influence of the demand for innovative labor, which is offered to be measured with the ratio of index of the number of the scientific and scientific-technical works executives with academic

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degrees to the general number of people with academic degrees. Impact of the state on IP is characterized by the indices of average monthly wage in the sphere of research and development and average monthly wage in the industrial sphere.

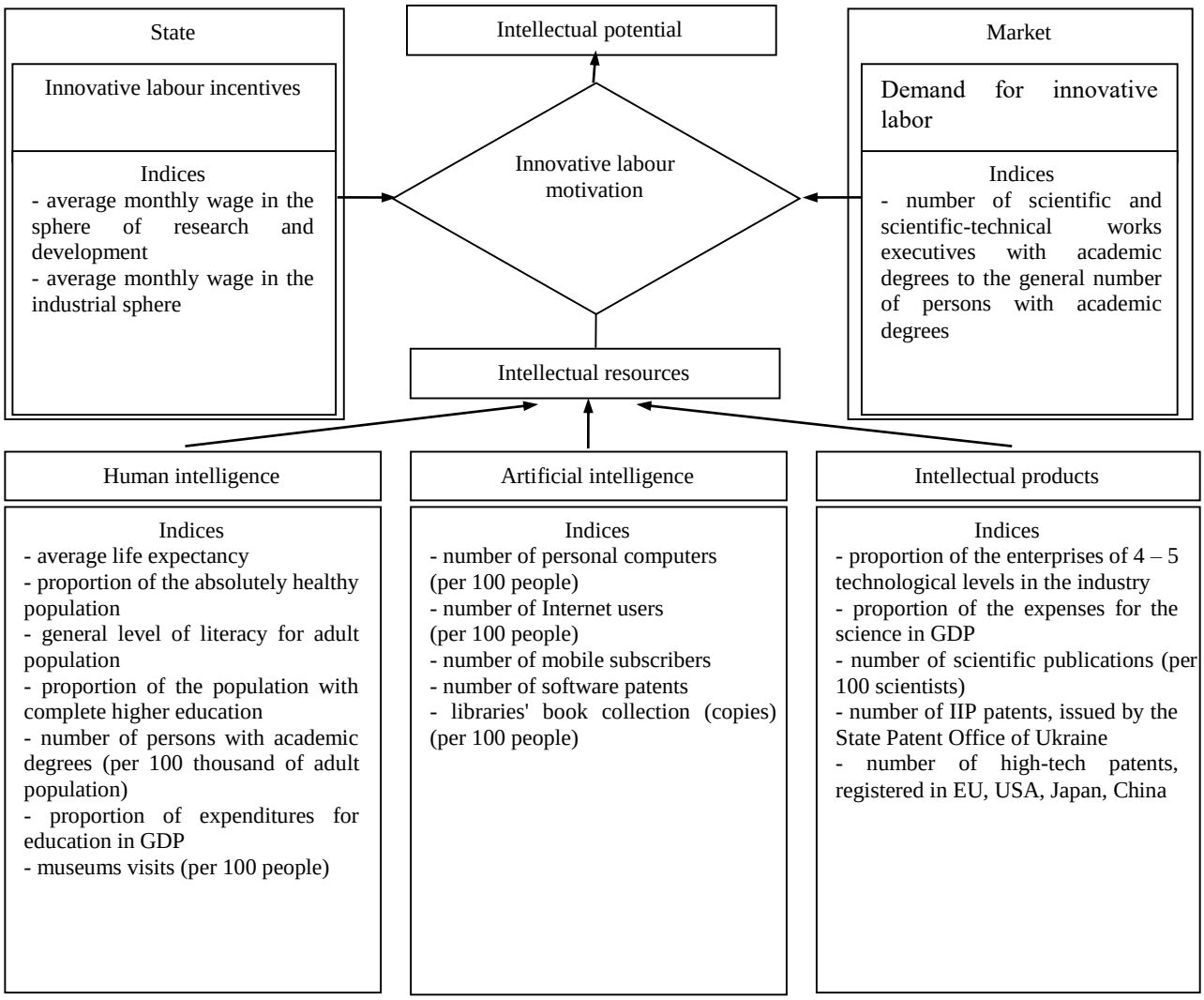

Figure 3. Measurement model for nationwide IP

Source: Author's illustration

We believe that the offered system of indicators for nationwide IP measurement includes minimal and sufficient set of indices, information for calculation of which is given in the statistics periodicals and special publications of Ukraine, EU countries, USA, Japan, China, and other developed countries, thus allowing to make comparative analysis between the countries.

Methodology for nationwide IP measurement should define main parameters of the object and measuring instrument: IP indicators research period, which will allow us to make conclusions about certain consistent trends of intellectual potential, effectiveness of state regulation for its development and mobilization, as well as impact of the market; Indicators' value that should be accepted as a basic value for comparison, which will allow us to make a qualitative estimation of the reached level and make comparative analysis of IP in Ukraine

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and other countries; Operating instrument (algorithm), with the help of which we may define the IP tendencies of Ukraine and basic factors of their formation, as well as compare the nationwide IP between the countries.

We believe that the process of IP formation in Ukraine shall be studied in terms of two factors:

- first, specification of the strategy for economic and social development;
- second, modernization of the state regulation of the innovative activities.

With regard to the first factor, the fundamental changes occurred in 2014 due to the with the signing and ratification of the "Association Agreement between Ukraine and the European Union" (Verkhovna Rada of Ukraine, 2014), in which the development of human and, in particular, IP, is defined as a strategic goal in line with European values. In the second direction, such changes should be considered approval by the Cabinet of Ministers of Ukraine in October 2017 "Action Plan for the implementation of the Association Agreement between Ukraine (Cabinet of Ministers of Ukraine, 2017), on the one hand, and the European Union, the European Atomic Energy Community and their Member States, on the other hand" and reports on the implementation of the "Association Agreement between Ukraine, on the one hand, and the European Union for 2014-2018, according to which a number of laws and regulations were developed and adopted, which now determine the state scientific and innovation policy of Ukraine.

Thus, the most representative for the study of trends in the development of national IP in Ukraine in the new period, taking into account the available official statistical information of Ukraine and Romania, is 2016 – 2018 (State Statistics Committee of Ukraine, 2016-2018; National Institute of Statistic, 2016-2018). At the same time, 2013 will present information on the magnitude of indicators in the year preceding the signing of the Agreement. For comparative inter-country analysis of IP of individual indicators of national intellectual potential, the time interval of the study can be chosen much smaller, for example, within one year, taking into account the different conditions for the formation and use of IP of comparable countries.

The scientific literature about the theory of economic analysis considers comparison as one of the most important methods. It is widely used in researches concerning the tendencies of socio-economical process development. General and specific economic phenomena are defined with the help of comparison. Also, it helps to outline the established patterns of development and the reasons causing it. However, the authors do not always specify the methodology or do not always follow such methodology in their publications dedicated to the IP measurement of the countries. They compare the indicators' values not taking into account their compatibility, which in such way lead to subjective, erroneous conclusions.

According to the purpose of our research, the following types of comparison will be used:

- Analysis of dynamics of nationwide IP in Ukraine and its components shall be made relying on the comparison with the indicators' values for the basic (2013 year), taking into consideration that the impact of inflation on the cost parameters that form the basis of the relevant indices;
- When analysing the long-term trends for the IP components, the comparison shall be made with the relevant indicators of the year 1990, taking into consideration the social, political, and economical differences;

- Comparison of IP indices in the analysed year with the indices of the previous years (taking into consideration the level of inflation);
- Comparison of nationwide IP indices and its components with the relevant indices in the regions of Ukraine;
- Comparison of the indicators' values of the nationwide IP in Ukraine and its components with the same indicators in other countries (with the corresponding recalculation of the cost indices to the general base);
- Comparison of the dynamic ranges of indices and their components for identification of interrelation between the studied values (phenomena and processes);
- Comparison of nationwide IP indices before and after any indicator has been measured for estimation of its impact.

Socio-economic phenomena in IP countries are complicated in their structure and in factors causing such phenomena. Therefore, indicators of different types may be used for these phenomena measurement. The general classification of indicators is given in the table 2.

Table 2. Classification of the nationwide IP indicators

Criteria of classification	Types of indicators	Characteristics
Unit of measurement	Absolute	Natural or monetary units of measurement
	Relative	Natural or monetary units of measurement with a view to the value of another indicator (for instance, population – per 1000 people)
	Structural	Proportion of the part to the whole
Time period	Static	The indicator value calculated by the point in time (for instance, average life expectancy)
	Dynamic	Changes of value during certain period of time (for instance, growth, indices (pace) of growth, indices (pace) of growth of the average life expectancy
In comparison with other phenomena, processes	Unitary	Calculated according to the value of indicator of the certain phenomenon (process) that is being measured
	Comparative	Calculated according to the value of indicator of the certain phenomenon (process) that is being measured in comparison to another similar phenomenon (process)
	Limiting	Growth of the indicator's value that is being measured in comparison with the growth per unit value of another indicator

Source: Own computation

The formula of the standardized index is used for the calculation of indices at dynamic analysis of IP in Ukraine:

$$I_i = \frac{X_{iUkr} - \min\left(X_{iUkr}\right)}{\max\left(X_{iUkr}\right) - \min\left(X_{iUkr}\right)}, \quad (1)$$

where X_i – is an actual value for i indicator in Ukraine;

min (X_{iUkr}) – is a minimum value for i indicator in Ukraine;

max (X_{iUkr}) – is a maximum value for i indicator in Ukraine.

The important methodological problem for applying the formula of the standardized index is defining the maximum and minimum values for the indicator. The study of actual values of indicator used in the offered methodology confirms certain range of changes in their values, as during continuation of the analysed period of time (2013 – 2018), so in classification groups of the phenomena characterized by indicators.

For instance, the average life expectancy in Ukraine has been changing during the years 2013 – 2018 from 71,3 years (2013 – 2014) to 72.3 years (2017) (State Statistics Committee of Ukraine, 2017), but at the same period of time in the Ukraine's regions it has been changing from 69.5 years (for instance, Chernihiv oblast) to 72.7 years (city of Kiev) (State Statistics Committee of Ukraine, 2018). Justification of the need for keeping of the records for this indicator in social and economic researches is given in the annual reports "Human Development Report", which are published by the Human Development Department of United Nations Organization (Bounfour, 2003).

Thus, the range of changes for this indicator for its two features (time, regions) creates certain area in three-dimensional space, within the frames of which the maximum and minimum value of indicators will be defined (see Fig. 4).

When there is a bigger number of classification (group) features the range of changes of indicator's value is changed to the area in n-dimensional space.

RESULTS

When comparing IP between the countries, the actual value for i indicator in the comparing country shall be used as a maximum value for the formula of the standardized index (1). In this case it is necessary to keep the range of changes of this indicator for the countries that are compared at the same level. It may be reached by setting common for the both countries maximum and minimum valued of the indicator. Comparative analysis between the countries involves comparison of nationwide IP indices in the countries that are compared:

$$I_k = \frac{I_{iUkraine}}{2_{^3 countreofcomparisio\,n}}, \qquad (2)$$

When the range of changes of i indicator is common for both countries, denominators in indices $I_{i\ of\ Ukraine}$ and $I_{i\ country\ of\ comparison}$ shall be canceled.

Thus, the formula of the standardized index for the comparative analysis between the countries will be as following:

$$I_i = \frac{X_{iUkr} - \min\left(X_{iUC}\right)}{\max\left(X_{i\,countre\,of\ comparison}\right) - \min\left(X_{iUC}\right)}, \qquad (3)$$

where X_{iUkr} – is an actual valued for i indicator in Ukraine; $\min(X_{iUC})$ – is a minimum valued for i indicator, taking into consideration Ukraine and the country that is compared; max (X_i country of comparison) – is an actual value for i indicator in the country that is compared.

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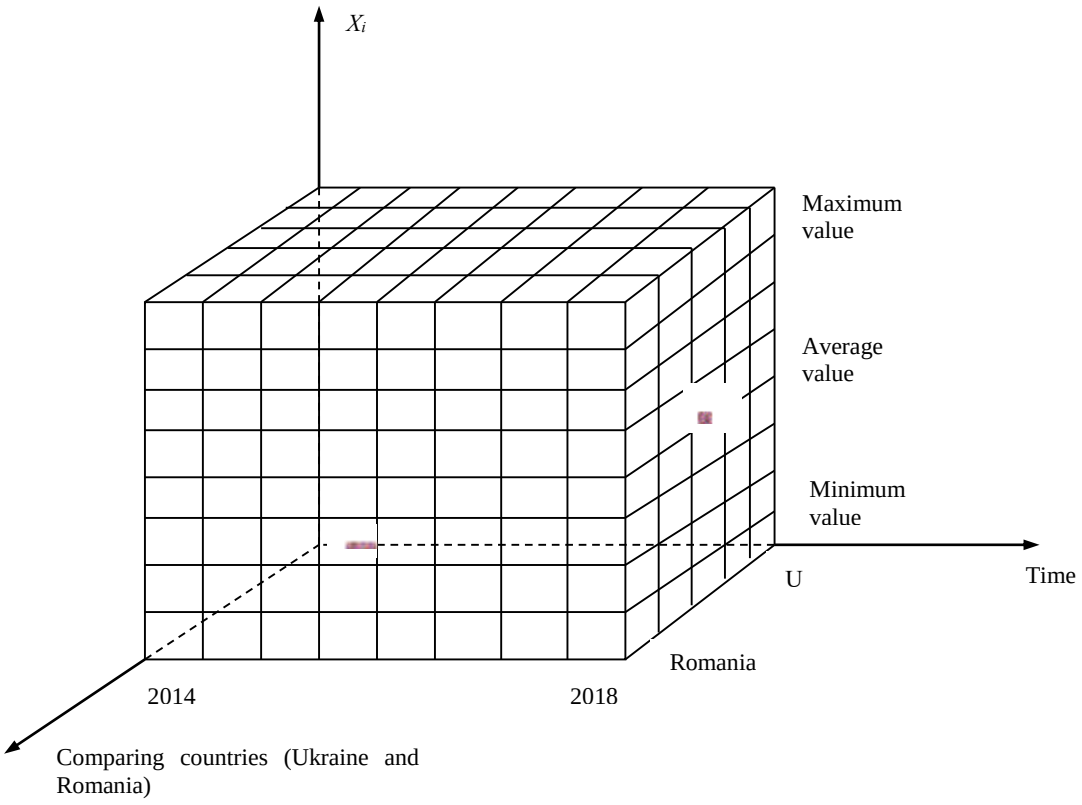

Figure 4. Range of changes of the average life expectancy in Ukraine and Romania

Source: Author's illustration

Aggregate index of nationwide human intelligence (Il) is calculated according to the formula:

$$I_l = \frac{r_{l1} \cdot I_{l1} + r_{l2} \cdot I_{l2} + r_{l3} \cdot I_{l3} + r_{l4} \cdot I_{l4} + r_{l5} \cdot I_{l5} + r_{l6} \cdot I_{l6} + r_{l7} \cdot I_{l7}}{7}, \quad (4)$$

where $r_{l1},\ldots r_{l7}$ – are the weight numbers of i indicator impact on the value of nationwide human intelligence; $I_{l1},\ldots I_{l7}$ – are the indicators indices for human intelligence (respectively see Fig. 3).

Aggregate index of nationwide artificial intelligence (Fs) is calculated according to the formula:

$$F_s = \frac{r_{s1} \cdot F_{s1} + r_{s2} \cdot F_{s2} + r_{s3} \cdot F_{s3} + r_{s4} \cdot F_{s4} + r_{s5} \cdot F_{s5}}{5}, \quad (5)$$

where $r_{s1},\ldots r_{s5}$ – are the weight numbers of i indicator impact on the value of nationwide artificial intelligence; $F_{s1},\ldots F_{s5}$ – are the indicators indices for artificial intelligence.

Aggregate index of collective intellectual product (Hp) is calculated according to the formula:

$$H_p = \frac{r_{p1} \cdot H_{p1} + r_{p2} \cdot H_{p2} + r_{p3} \cdot H_{p3} + r_{p4} \cdot H_{p4} + r_{p5} \cdot H_{p5}}{5}, \quad (6)$$

where $r_{p1},\ldots r_{p5}$ – are the weight numbers of i indicator impact on the value of collective intellectual product; $H_{p1},\ldots H_{p5}$ – are the indicators indices for collective intellectual product.

Aggregate index of intellectual resources (Ir) is calculated according to the formula:

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$$I_r = \frac{I_l + F_s + H_p}{3}, \quad (7)$$

where I_l, F_s, H_p – are respectively the aggregate indices of nationwide human intelligence, nationwide artificial intelligence, collective intellectual product.

Aggregate index of state's impact on mobilization of nationwide IP (G_v) is calculated according to the formula:

$$G_v = \frac{G_1 + G_2}{2}, \quad (8)$$

where G_1 – is an index of average monthly wage in the field of research and development; G_2 – is an index of average monthly wage in the field of industry.

Index of market's impact on formation of the nationwide IP (M) is calculated according to the formula:

$$M = \frac{M_1 + M_2}{2}, \quad (9)$$

where M_i – is an index of demand for academic staff (is defined on the basis of the performers of the scientific and scientific-technical works with academic degrees to the general number of people with academic degrees).

General IP index (I) is calculated according to the formula:

$$I = \frac{I_r + r_v \cdot G_v + r_m \cdot M}{3}, \quad (10)$$

Value of general IP index (I) calculated in accordance with the offered method of comparative measurement shows how many times IP index of Ukraine is greater or smaller than in the country of comparison.

Weight numbers of i indicator's impact on the value of the nationwide IP component, same as a component of its independent summaries, shall be defined with the use of group expert evaluation method, particularly, the Delphi method, in two stages together with the correlation analysis methods.

When the methodology of comparative measurement of IP between the countries is practically applied, there could arise a problem of choice of the country for comparison. The subject matter of the comparative analysis, in contrast to the traditional analysis, is that the country chosen for comparison should act as a certain principle, standard, value of indicator of IP development and use, which Ukraine aims to reach in the nearest future. Eastern European countries – Romania may be of a special interest in this case. Our studies of economic potential indices for the mentioned group of countries, macroeconomic indicators, scale of national innovation systems gave us grounds to conclude that Romania is the most significant country for comparison with the mentioned criteria. Although, we should keep in mind that now Romania is well ahead of Ukraine in a number of indicators important for IP measurement (see Table 3).

Results of aggregate IP index calculation in accordance with the comparative methodology show that in 2016 the IP of Ukraine 1.14, and in Romania 1.43; in 2017 in Ukraine 1.18, and in Romania 1.36; in 2018 in Ukraine 1.04, and in Romania 1.61. This is due to a significant excess in Romania of the following indicators:

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average life expectancy (75.9 years in Romania versus 71.8 years in Ukraine), the level of ICT use (31.7% in Ukraine, in Romania (55.9%), a significant excess of indicators of registration of property rights to industrial intellectual property, the share of high- and medium-sized technological industries in industry, in the field of education and science. It is when converted in hryvnia more than 2.5 times. In addition, in Romania in recent years there has been an intensification of demand for researchers and developers of innovative products, while in Ukraine this indicator is almost stable in the analyzed period.

DISCUSSION

The debatable issues of this study, in our opinion, include the following:

- what is the practical value of conducting a comparative analysis of the IP of the two countries?
- which country can be chosen as the base for comparison?
- what are the directions of improvement of the methodology of comparative analysis of IP proposed by the authors?

The practical value of the methodological approaches of the authors presented in the article lies in the fact that these approaches make it possible to identify the reasons that affect the innovative competitiveness of countries. Such an analysis becomes possible due to the assessment of the structural components of the national intellectual potential of the country (IP), in particular, the application of a "motivational approach" to the study of the process of transformation of intellectual resources in individual entrepreneurs (see Fig. 3). This is achieved due to the fact that the authors associate the motivation of innovative work (to which, according to the author's concept, partly the field of academic science and the entire sphere of applied scientific activity belongs) with the influence of the market on the demand for innovative labour and the influence of the government on the formation of incentives for this work. Without the use of comparative analysis, it is impossible to determine the factors that influence the fact that certain countries are ahead in innovation competitiveness, while others are lagging behind. In Ukraine, such a reason, in our opinion, was the insufficient monetary motivation of specialists engaged in innovative activities, compared to Romania. The reliability of the results of the comparative analysis of individual entrepreneurs is ensured by the objectivity of the official statistical information of the countries and the publication of the results of analytical studies of international organizations in the field of intellectual property and innovation.

As for the choice of country for comparison, it should be noted that any comparative analysis, including those proposed by the authors, can provide a reliable assessment of the results only if the countries are comparable by factors that affect the value of the IP indirectly, for example, the historical conditions for the formation of the education system, science and innovation. Therefore, it would be incorrect to compare the IP of Ukraine, in which the above-mentioned institutional conditions have been formed over the past 30 years, with the UK or Sweden, in which the systems of education, science and innovation in market conditions have been formed over 300 years. These considerations suggest that for comparison it is necessary to choose a country that in the past belonged to the socialist camp and has macroeconomic indicators close to Ukraine (in

conditions of restrictions related to the Covid-19 pandemic and the pre-war state of Ukraine's economy). This is what led to the choice of Romania as a country for comparison and the time period of comparison between 2016 and 2018.

The range of discussion issues also includes methods for determining the weighting coefficients of influence of the i-th indicator on the value of the IP in the formulas 5,6,10. In this example of the study, their value was taken the same for both Ukraine and Romania, at the unit level, which makes it possible to compare these countries. Although we assume that they may be different and in this case be determined by the methods of correlation analysis. Directions for improving the methodology of comparative analysis of IP proposed by the authors can be: first, the study of the list and classification of IP indicators; secondly, the determination of the weighting coefficients of the influence of each of the indicators on the value of the IP.

CONCLUSION

According to the results of the study established, that the European Commission pays considerable attention to the comparative analysis of IP of the EU member states and other countries with which there are close cultural, scientific, technical and other countries with which there are close cultural, scientific, technical and economic relations.

Tests of the offered methodology allowed us to find out its advantages in comparison with other methods of nationwide IP measurement: indicators system provides record of institutional peculiarities of innovation sphere in Ukraine; estimation of IP components indices gives a possibility to determine the impact of the marker and state on formation and mobilization of IP in Ukraine; offered methodology includes comparative measurement and analysis as of the general IP index (I), so the value of each IP indicator in Ukraine, with the value of the corresponding indicator in the country of comparison; comparative indices method allows comparison of dynamic ranges of indices for comparative analysis of IP development in Ukraine and other countries, and comparison of the tendencies of indicators' values allows to define the factors that have the most impact on IP formation in these countries.

During the sampling period of study, the index of national intellectual potential in the Romanian economy exceeds the level of this indicator in Ukraine. Although until 2015 this trend was reversed. By 2014-2015, Ukraine was ahead of Romania in all indicators (possibly, except for information awareness of the population), 2016 - 2018 - the situation changed to the opposite. In 2019-2021, the main focus was on the defense industry (no data). Therefore, the trial period was limited to 2014-2018 in order to obtain reliable data. A prospective direction for further research is the improvement of the method for calculating the weights of indicators of individual entrepreneurs and its testing on statistical data of Ukraine and the European Union.

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Table 3. Feed data for comparative measurement of IP of Ukraine and Romania

Index	Indicator	Unit of measur.	Ukraine					Romania				
			2016	2017	2018	max	min	2016	2017	2018	max	min
Aggregate index of nationwide human intelligence (I_I)	Average life expectancy	years	71,7	71,9	71,8	78,0	70,0	75,5	75,7	75,9	78,0	75,0
	Proportion of the absolutely healthy population [1]	%	28,2	29,1	30,3	32,0	25,0	25,7	28,2	30,1	32,0	25,0
	Tertiary education											
	Knowledge-intensive employment	% gross	47,1	47,1	45,2	48,0	40,0	41,1	41.9	42,9	48,0	40,0
	Expenditure on education	%										
	Museums visits (per 100 people)	% GDP people	33,7	37,6	37,3	38,0	21,0	21,5	22,7	23,4	38,0	21,0
			6,7	6,0	5,9	7,0	2,0	3,0	2,9	3,1	7,0	2,0
			37,0	39,0	36,0	92,0	35,0	72,0	81,4	90,4	92,0	35,0
Aggregate index of nationwide artificial intelligence (F_S)	ICT access	%	62,7	64,8	66,0	70,0	60,0	66,9	69,0	69,8	70,0	60,0
	ICT use	%	21,7	25,7	31,7	60,0	20,0	44,8	50,8	55,9	60,0	20,0
	Governments online service	%	41,7	58,7	58,7	60,0	40,0	44,1	45,7	45,7	60,0	40,0
	E-participation	%	43,1	74,6	74,6	75,0	40,0	47,1	62,7	62,7	75,0	40,0
	Patent applications (per billion US$ PPP constant 2017)	pieces	2,74	2,79	2,54	3,00	1,00	1,26	1,45	1,50	3,00	1,00
	Trademark registrations (per billion US$ PPP constant 2017)	pieces	58,3	66,2	69,3	90,0	55,0	78,2	83,6	88,9	90,0	55,0
	Industrial design applications (per billion US$ PPP constant 2017)	pieces	13,6	11,4	7,51	20,0	7,00	9,76	17,4	12,5	20,0	7,00
	Existing volumes of libraries (thousand volumes per 1 thousand people)	volumes	5,82	5,47	5,50	9,0	5,0	8,35	8,33	8,35	9,0	5,0
Aggregate index of collective intellectual product (H_P)	High and medium-high-tech manufacturing	%	26,5	23,1	19,8	40,0	15,0	34,9	36,7	38,6	40,0	15,0
	Gross expenditure on R&D	% GDP										
	Science & technical articles	pieces	0,7	0,6	0,5	1,0	0,4	0,4	0,5	0,6	1,0	0,4
	(bn PPP$ GDP)		12,6	12,2	10,2	20,0	10,0	17,6	16,5	11,5	20,0	10,0
	Intellectual property payments	% total trads	0,8	0,,7	0,7	1,5	0,5	1,1	1,1	1,2	1,5	0,5
	Hight-tech net export	% total trads	2,9	3,1	3,1	7,0	2,5	5,2	6,0	6,7	7,0	2,5
Aggregate index of state's impact (G_V)	Average monthly wage in R&D[2]	th. UAH	6,12	8,21	13,5	30,0	5,0	17,2	24,1	26,3	30,0	5,0
	Average monthly wage in the industry[2]	th. UAH	5,90	7,63	10,6	30,0	5,0	24,3	27,7	29,4	30,0	5,0
Aggregate index of market's impact (M)	Researchers, FTE	mn pon	1165	1006	1037	1300	850	921,5	894,8	912,4	1300	850
	Graduates in science & engineering	%	25,5	25,5	26,7	30,0	25,0	25,5	25,5	28,8	30,0	25,0

Source: Own representation based on SSCU, 2010; SSCU, 2018; NIS, 2019; Eurostat, 2019