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Assessment of Industrial and Financial Applications of Innovation Development

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***Abstract*: The purpose of this study is to make an analysis of indicators and methods used to calculate the Global Innovation Index (GII), which assesses the level of innovation development in a country. Within this index the shortcomings lead to overestimation for the developing countries. These indicators predominantly reflect not the achieved innovation development level, but the country's potential to achieve it.**

The GDP (less than the resource rent), calculated using the purchasing power parity and normalized per the number of people employed in a country, was chosen as baseline. In calculating the integral indicator (Ri), the baseline was adjusted for the country's competitiveness level and the Gini coefficient.

The integral indicator values were derived for the selected states of OECD and BRICS (total of 38 countries) and the countries were ranked respectively. To substantiate the validity of the suggested methodology and the objectiveness of the assessment, a comparison with the estimates using the GII was carried out. It is offered to estimate the achieved innovation level by the outcome indicators, namely, by the indicators reflecting the attained level of social and economic development on the premise that this level has been reached due to innovation and these indicators are invariant to the countries' development level.

The suggested methodology can be considered either separately in the process of assessing the innovation development level of a country or as a complementary to the assessment using the GII, which allows to analyze the country's prospects in terms of innovation proceeding from the 'attained level'.

***Keywords*: innovation development level, innovation index, rating, competitiveness, Gini coefficient, assessment methodology, level of social and economic development.**

I. INTRODUCTION

The changes in the world related to the increasing integration of countries in global economy demand alterations in the methods of calculating various indicators reflecting the place and role of a country in this process.

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However, the analysis of indicators and their calculation methods used for assessing such parameters of countries as competitiveness level, innovation development level, extent of participation in the value chain, etc., do not fully take into account the differences in the level of social and economic development of compared countries, which leads to distortion of estimates and decreasing credibility of the results received.

The nature of competition in the world is changing: it is increasingly more and more determined not by the output (goods, services), but by continuous updating or creation of new products. Due to globalization of economy, the created product has to withstand competition at international level, at that [4, 5].

Evidently, it is necessary to create an innovation-oriented environment, where innovations should take place continuously and they naturally become the key element in the whole product creation chain. Given the trend towards globally networked economy and Digital Revolution, the process of implementing innovation is also changing: researchers developing the products can be from various organizations around the world, same as participants of a temporary alliance of entities involved in the full cycle of production (Since 1990-s, the increasingly more widespread pattern in the developed countries has been the interaction of science, business and state based on the principle of equal participation in the alliance, which today is recognized as the optimal collaboration of these sectors for the innovation development [17, 18]. As a whole, such an alliance is called the National Innovation System, the functioning of which predetermines the effectiveness of innovation development in a country [31-33]. Thus, the innovation process is becoming more large-scale because of an across-the-board demand for it, more integrated in the economy and closely connected with the activity of other sectors [33]. Moreover, the results of this process in most cases cannot be estimated directly since the share of intellectual input is never explicitly expressed in the end product. Attempts carried out in some works [34, 35] directed at identifying it through the rate of return or other indicators of the innovation enterprise over the whole chain of value, which the product has as a result of its full life cycle, are limited to consideration of computer equipment, where the pricing of components, assembling cost, rate of return on the stages of promotion, distribution and retail sale are known. For other areas of production of goods and all the more of services, these data are either unavailable or their generalization is practically impossible because a plethora of affecting factors that vary from area to area need to be taken into account.

Most often, the added value on the stages of creation, production and sales is estimated qualitatively as is shown in Fig. 1 (suggested in 1992 by Stan Shih, founder of Acer Inc.). Later, such differentiation by added value share was confirmed as valid for other industries [26].

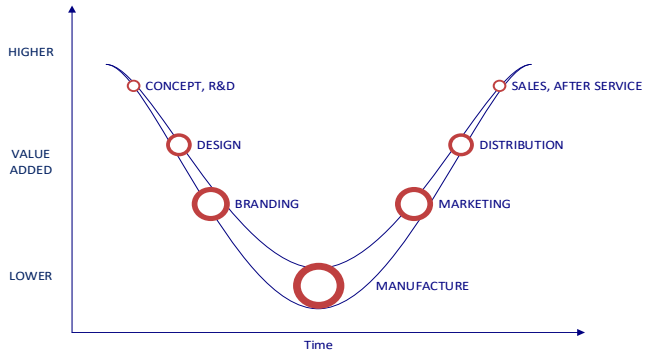

Fig. 1. Qualitative estimation of added value in a product on various stages of its life cycle

II. LITERATURE REVIEW

A. Definition of innovation

In the Proposed Guidelines for Collecting and Interpreting Technological Innovation Data (Oslo Manual). Joint publication of OECD and Eurostat, the following definition of innovation is suggested: 'Innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.

According to another widely used definition, 'innovation is an introduced marketable novelty ensuring a qualitative growth in process or product efficiency. It is the end result of intellectual activity of people, their imagination, creative process, discoveries, inventions and rationalization'.

Innovation is, actually, 'a fulfilled potential', the assessment of innovation by potential capacities for countries with various development level contains in itself a methodological mistake since potential in these countries is actualized differently, up to certain cases when it is not actualized at all.

B. Assessment of innovation using indexes

In view of difficulty of assessing innovation by end results, the Global Innovation Index (GII) has become widespread. The index determines the innovation development level in a country and its ranking in the world and is calculated using a weighted sum of indicators affecting the innovation process or characterizing it: level of institutional or infrastructure environment development, population's education level, various indicators of population's creative or scientific activity (number of registered patents, published articles, feature films released, videos downloaded to YouTube, etc.). Less popular is the Summary Innovation Index (SII) used by the EU to compare European countries by the level of capacity for innovation creation and degree of its implementation. Other indicators, such as level of country's competitiveness estimated using the Global Competitiveness Index (GCI), extent of the country's participation in global value chains (GVC), a number of direct indicators (payments for selling intellectual property, volume of supplied innovation products, etc.) provide an indirect estimation or assess only selected aspects of innovation activity.

However, the analysis of the calculation methodology for the most cited index, the GII, shows that it expresses rather the potential of the country and does not take into account the differences in the level of economic development. This results in such estimation reflecting predominantly not the achieved level of innovation development, but the achieved level of environment and conditions for its growth. It is furthermore assumed that there is direct dependence between the potential and the outcome, and that the level of innovation development can be estimated in this way. Though, for countries with different level of economic and social development this link can vary greatly, and the estimation done in such way is not objective, respectively.

Within the GII, however, patents, patent applications, utility models, research articles, citations (of research articles), expenditures for software, created industrial designs, annual quantity of Wikipedia edits, downloads of videos to YouTube are designated as output indicators used to calculate the resulting subindex, and they comprise the core part of the index. These indicators do not determine the achieved innovation development level since each of them is either not related to the implemented end product, or does not account for marketability, or does not reflect the impact on the growth in process or product efficiency. Essentially, these are indicators of the country's potential, which is, in particular, pointed out in research publications [24, 25].

And if for the developed countries it is logical to infer that this potential is actualized as relevant conditions have been created there, then in the developing countries or those with economies in transition such conditions, mostly, are not in place, and the summary estimate of innovation development (using the GII) presents a distorted picture – it turns out to be overstated. Besides, taking into consideration a large number of indicators (81 indicators were used to calculate the GII in 2017), the weights of which are determined by experts or accepted as equivalent, the result becomes even closer to average due to the offset of low values of some indicators by the high values of others, often assessing the level of innovation development in a country as satisfactory.

However, for these countries the averaging procedure is unacceptable: high values of some indicators will not offset the low values of others. As mentioned above, this is possible when the process of innovation implementation is generally well established and needs only optimization.

The problem in the developing countries lies in the absence of such working system. An example of a negative consequence of such innovation development assessment, which does not account for the country's level of social and economic development, is the demonstration of the GII growth caused solely by the growth of indicators of population's creative potential, whereas in present day globalized economy creative potential achieved in one country can be actualized in the form of innovation products created in another country.

The objective representation of this process should be the decline of the GII value reflecting the deterioration of the situation as the country is actually working for potential competitors.

An attempt to solve this problem in order to level the assessment was undertaken in the calculation method of the global competitiveness index, where countries are divided into five groups according to the development level and the weights for the indicators are different for each group.

Yet, the method to select the indicators is not different here – most of them reflect potential competitiveness; similarly, a large number of indicators is used for calculation (113 in 2017). That is to say, overall, the approach to assessment of competitiveness here is analogous, consequently it inherits the shortcomings of the GII calculation methodology. In calculating the European index SII, European countries are also divided into groups (Innovation Leaders, Strong Innovators, Moderate Innovators, Modest Innovators); however, this division is not considered when the integral indicator is calculated, countries are assessed according to groups.

In view of the above, a truly objective assessment of the achieved level of innovation development is possible only if it is measured by the outcome, which is expressed as economic or social effect achieved through innovation. Such approach, in terms of methodology, can provide more objective information and a more effective basis for further practical steps.

C. The choice of result indicators for assessing the level of innovation

The most difficult moment in the justification of this approach is the choice of result indicators of innovation activity. We will list the criteria that they must meet:

- indicators should evaluate the average level of innovation development for all areas of activity;
- the selected indicators should be applicable to all areas of activity, that is, be as versatile as possible, given the ubiquity of the use of innovations;
- the number of indicators should be minimal in order to minimize the influence of the subjective factor, which manifests itself, as a rule, in assigning weight coefficients and minimizing the effect of averaging, which inevitably manifests itself in using a large number of indicators;
- the indicators data should be presented in international statistical databases collected for most of the world' s countries in a relatively long period (about 10 years or more).

Of the most significant works on assessing the relationship of the level of development of innovation and indicators of socio-economic development one can distinguish the following ones [3, 8, 10, 11, 13, 14, 20, 21]. In the work of [30] the dependence of the level of development of innovations on GDP (gross domestic product) per capita and labor productivity was studied, where, according to the results of correlation and regression analysis, their direct dependence was found, although for an indicator of social efficiency (using the Gini coefficient as an example) dependence is defined as significant only for countries lagging behind in innovative development. The assessment of the actual level of development of innovations was not made there [29].

Based on the selected criteria and the analysis of early publications on this issue, the following indicators were determined, which characterize the result of innovation activity.

1. GDP calculated in US dollars at purchasing power parity (GDP, PPP (current international $) – as defined in the statistical database of World Bank), normalized to the number of people employed in the country (Labor force, total) (World Bank, International Comparison Program database);
2. The country's competitiveness (assessed according to the GCI index). (Global Competitiveness Report 2017–2018);
3. Resource rent (Total natural resources rents – as defined in the statistical database of the World Bank). (World Bank national accounts data, and OECD National Accounts data files);
4. The Gini coefficient [2, 27].

D. Basic indicator

A basic indicator is the normalized gross value of the produced product and services, which determines the effectiveness of the process of wealth creation. An integral indicator consists of the indicators of competitiveness, resource rent and the degree of uneven distribution of income.

The adjustment to the competitiveness index takes into account indirect contribution (not expressed in cash form and not generating added value directly) of innovations in non-production areas (health, education, culture, etc.) [28]. The adjustment for resource rent makes it possible to exclude from the added value the cost of resources, in the creation of which labor costs, and especially innovations, are absent (for example, natural resources – oil, gas, coal, metal, etc.).

The adjustment to the Gini index makes it possible to take into account the fact that a high degree of uneven distribution of income is present in countries where innovations are introduced only in a limited segment of the economy, so that relatively high values of normalized added value are achieved only in selected industries, while, in general, innovations are underdeveloped in the country. Why is the indicator of normalized gross value of the product and services, according to which the level of economic development or labor productivity in the country is traditionally assessed, chosen as the base one?

Firstly, as noted earlier, innovation is the end product of creative activity, which has been implemented and brings concrete results. Given the globalization of markets and increasing competition in the world, today almost every product or service can be attributed to an innovative product (noting that innovation accompanies every stage of its life cycle, from the initial idea and organization of production to promotion, implementation and maintenance). Considering the extreme case, without the innovation component a product simply will not enter the market, but in general, its "level of innovation" is expressed in gross value – a more successful product brings more added values.

Therefore, the indicators characterizing the level of development of innovations, which are now universally implemented in practical activity, should be expressed through result indicators of the creative or scientific process, that is, through the result or effect that was achieved through it. And here the indicator of added value, which expresses the completeness of the process of creating a new product and determines the degree of success of its implementation, just meets this requirement.

Secondly, this indicator, through the presence of GDP in the calculation formula, takes into account the level of welfare of the population, which is the main goal of innovation, and normalization of the number of employed population reflects the efficiency of the production of products and services, which is directly affected by the innovation process, a direct relationship between which is confirmed by several studies [22, 23]. Being imperfect, it is nevertheless optimal from the "best possible" point of view.

On the one hand, it has a sufficient degree of generalization from the point of view of the integral characteristic of the result of innovation, and greater detalization already leads to the need to involve a number of indicators, the inclusion of which, as noted earlier, "blurs" the assessment.

On the other hand, the degree of its generalization is not as great as in assessing innovations according to the level of well-being of the population, since the latter is more dependent on a much larger number of factors not related to innovations.

Finally, it is universal and applicable to take into account innovations in any area of activity, including non-production and exclusively creative ones. Thus, according to the World Bank data collection methodology, this indicator takes into account products and services of all fields of activity defined in the International Standard Industrial Classification of All Economic Activities (ISIC), including health, education, sports, creative and artistic areas.

The direct result of innovations (in the form of added value) in these areas is taken into account in the selected basic indicator, but the indirect one, not expressed in money, is "lost" (for example, increased life expectancy, increased cultural level, environmental improvement, etc.). In order to eliminate this drawback an adjustment of the base indicator by the value of the competitiveness index is introduced here.

E. Competitiveness index

If the added value expresses the efficiency of the process (which directly reflects the result of innovation), then its qualitative characteristics are expressed in the competitiveness index, since it is logical to conclude that the product created with a greater investment of intellectual work, by more cultured and healthy people, based on a better basic scientific foundation, has a greater potential to be in demand longer and maintain competitiveness with the appearance of analogs, etc.

It can be argued that the quality of innovation is higher here. And the quality of innovations (in this sense), expressed quantitatively through the competitiveness index, most adequately and integrally reflects the maturity of these non-production spheres, while according to the accepted methodology, the assessment is determined precisely by the achieved result (competitiveness level).

In order to justify the implementation of adjustment to the competitiveness indicator, we will assess the level of innovation development by using the example of education sector. The rendered paid services are directly taken into account in added value. The fact that paid services are provided can be attributed to innovations, because if this paid service is in demand, it is demanded by the market, and competition on the market assumes the supply of novelty products. The provision of services in education by means of budget funds does not generate profit, but is aimed at improving the educational potential of the population.

The process of learning and acquiring new knowledge in general is in itself an innovation process that has a positive integral effect. In the competitiveness index, indicators characterizing the field of education include, respectively, the value of development, and when adjusted for the competitiveness index, the value of the added value will change in proportion to the level of development of this sphere.

Similar reasoning can be applied to health care, sports and other non-productive areas. That is, for non-production spheres, the direct effect can always be expressed as a contribution to the created added value, and the indirect one – taking into account the competitiveness index.

F. Rent adjustment

In the added value the contribution of innovations in each country is different, since the cost of the product or service sold is different for each country (the share of added value that comes from the cost of resources available to the country). In terms of the impact on the added value there are 3 most significant types of rent: resource, climate and favorable location. The resource rent is associated with natural resources, the climate one — with the conditions for the production of agricultural products, the rent of favorable location — with a good climate for tourism [6, 7].

The analysis of GDP structures of the selected countries shows (Table 1) that the share of the added value of agricultural products in them is on average 3.74% of the total GDP with a standard deviation of 3.6%.

The small share of this product in GDP and its dispersion make it possible to neglect the allowance for this rent. The situation with tourism income is similar. According to the World Bank, the indicator of "Income from international tourism" as a percentage of total exports is on average about 6.69% for the world (International tourism, receipts (% of total exports), while the value attributable to rent is a share of it. In this regard, the adjustment of GDP for tourism rents in the studied countries can also be neglected.

Table 1. The share of agricultural income in GDP of the world countries; %
(World Bank national accounts data, and OECD National Accounts data files; World Development Indicators)

Country	2010	2011	2012	2013	2014	2015	2016	On average
Argentina	8.50	8.33	6.89	7.21	8.00	6.04	7.56	7.51
Australia	2.38	2.46	2.44	2.47	2.40	2.56	2.61	2.47
Austria	1.42	1.57	1.52	1.41	1.35	1.25	1.24	1.39
Belgium	0.85	0.72	0.88	0.77	0.73	0.76	0.69	0.77
Brazil	4.84	5.11	4.90	5.28	5.03	4.97	5.45	5.08
Canada	1.42	1.71	1.76	1.84	1.52	..	..	1.65
Chile	3.93	4.00	3.61	3.70	4.28	4.31	4.30	4.02
China	9.53	9.43	9.42	9.30	9.06	8.83	8.56	9.16
Czech Republic	1.68	2.38	2.61	2.69	2.74	2.48	2.45	2.43
Denmark	1.39	1.52	1.92	1.51	1.59	0.93	0.92	1.40
Estonia	3.19	3.88	3.65	3.41	3.50	3.14	2.57	3.34
Finland	2.73	2.73	2.73	2.98	2.79	2.58	2.69	2.75
France	1.78	1.84	1.82	1.63	1.74	1.76	1.64	1.74
Germany	0.72	0.82	0.78	0.98	0.77	0.62	0.61	0.76
Greece	3.27	3.36	3.66	3.62	3.84	4.24	3.97	3.71
Iceland	7.50	7.76	7.73	6.93	6.19	6.34	5.90	6.91
Iran, Islamic Rep.	6.56	5.47	7.68	9.84	10.01	10.75	9.96	8.61
Iraq	5.16	4.56	4.12	4.77	4.90	4.75	5.10	4.77
Ireland	1.06	1.33	1.09	1.22	1.40	0.96	1.00	1.15
Israel	1.69	1.71	1.36	1.34	1.28	1.31	1.30	1.43
Italy	1.97	2.10	2.19	2.33	2.16	2.25	2.11	2.16
Japan	1.10	1.08	1.15	1.11	1.06	1.12	1.16	1.11
Korea, Rep.	2.47	2.52	2.46	2.34	2.33	2.29	2.20	2.37
Netherlands	1.91	1.67	1.75	1.90	1.84	1.81	1.83	1.82
New Zealand	9.38	8.90	7.91	9.37	6.80	..	..	8.47
Norway	1.76	1.50	1.26	1.47	1.61	1.72	2.41	1.68
Poland	2.92	3.22	3.01	3.24	2.95	2.48	2.69	2.93
Portugal	2.19	2.08	2.18	2.37	2.32	2.35	2.18	2.24
Russian Federation	3.87	3.92	3.70	3.62	4.07	4.56	4.74	4.07
Spain	2.55	2.48	2.52	2.75	2.67	2.78	2.77	2.65
Sweden	1.62	1.63	1.49	1.39	1.34	1.36	1.30	1.45
Switzerland	0.73	0.72	0.68	0.72	0.75	0.67	0.67	0.71
Turkey	10.27	9.36	8.78	7.68	7.45	7.83	7.02	8.34
United Kingdom	0.73	0.68	0.68	0.73	0.72	0.66	0.60	0.69
United States	1.17	1.37	1.24	1.43	1.25	1.05	..	1.25

In view of the above, the value of gross added value without a big loss of accuracy can only be adjusted for the rent of natural resources.Therefore, an integral indicator that determines the level of development of innovations in the country can be the indicator of the normalized gross added value of the produced products and services adjusted to the amount of rent, the level of competitiveness and the index of unevenness of income distribution. [36].

Despite the fact that the assessment is conducted by indirect indicators, it more objectively characterizes the achieved level of innovation development in the country, because it is tied to the final, effective indicators covering not only the initial phase of the process of creating a new product or service, but the entire life cycle of the product from the initial idea to its sale, and methodologically linked to the evaluation of innovations in terms of their contribution to the growth of efficiency of production and non-production spheres, and ultimately to the growth of well-being of people.

III. METHODOLOGY

A. The method of cross-country comparison of the level of innovation

In general, the methodological cross-country comparison is made according to the values of relative rating. The relative rating is the normalized value of the integral index calculated by the formula:

$$R = \frac{X_{abs} - X_{\min}}{X_{\max 0} - X_{\min}} \times 100 \quad (1)$$

where X_{abs} – the value of the integral index expressed in absolute value; X_{max}, X_{min} – the maximum and minimum absolute value of the integral indicator among the considered countries.

Therefore, the value of the rating calculated by formula (1) is in the range of 0–100, where “0” corresponds to the worst position, and “100” corresponds to the best one. In the case of the Gini index, where big absolute values reflect the worst result, the relative rating is calculated by using the following formula:

$$R_{Gini} = 100 - R \quad (2)$$

where the value R is calculated by the formula (1).

Therefore, all indicators – the normalized gross added value (taking into account the rent), the level of competitiveness – are calculated by formula (1), the Gini index – by formulas (1, 2), and the integral normalized value for each country is calculated as their weighted sum by the following formula:

$$R_i = K_{av\,i} * R_{av\,i} + K_{c\,i} * R_{c\,i} + K_{Gini\,i} * R_{Gini\,i} \quad (3)$$

where $R_{av\ i}$ ($R_{c\ i}$, $R_{Gini\ i}$) – the relative rating of the normalized value of gross added value (the level of competitiveness, the level of inequality in income distribution) of the *i-th* country, calculated by formula (1), where X_{abs} (X_{min}, X_{max}) are the *absolute* values of the considered indicators;$K_{av\ i}$ ($K_{c\ i}$, $K_{Gini\ i}$) are coefficients that take into account the weight of the relative rating $R_{av\ i}$ ($R_{c\ i}$, $R_{Gini\ i}$). The weights' values are in the range of 0–1, and their values are linked by formula $K_{av\ i} + K_{c\ I} + K_{Gini\ I} = 1$.

The absolute value of the normalized gross added value is calculated by the following formula:

$$AV_r = \frac{GDP_r}{Numb_{25-64}} \quad (4)$$

where AV_r is a normalized value of gross added value adjusted for the influence of the size of rent created by the country in the reporting year, US dollars; $Numb_{25\text{-}64}$ – the number of working populations aged from 25 to 64 years; GDP_r is the size of GDP adjusted for rent in US dollars, calculated by the following formula:

$$GDP_r = GDP_{ppp} * (1 - R) \quad (5)$$

where GDP_{ppp} – the gross domestic product at purchasing power parity, US dollars; R – the share of rent in GDP, %.

In calculating the relative rating of the level of the country's competitiveness the value $R_{c\ i}$ was subjected to adjustment. In the description of the methodology for calculating the competitiveness index [19, 22] countries were divided into 5 groups according to per capita GDP taking into account the resource rent, where the weights for 3 subindices for the countries in each group were different.

The data of the 3rd sub-index characterize the following aspects of competitiveness.

1. Basic requirements, which include the indicators for assessing the level of development of institutional, infrastructural and macroeconomic environment, health care and primary education.
2. Efficiency enhancers, which include the indicators for assessing the level of higher education and skills development, product market efficiency, labor market efficiency, financial market development, technology readiness, market size.
3. Innovation and sophistication factors, which include the indicators for assessing the level of readiness of the business environment and indicators of research and development.

The analysis of these subindixes shows that the assessment of the potential component of innovation includes the first 2 subindixes, and, accordingly, their total weight can act as a corrective value $R_{c\ i}$. According to the report, the weights for each of the 5 groups of countries in calculating the competitiveness index for this pair of sub-index ranged from 0.7 to 0.95, where 0.7 was used to calculate the integral value for developed countries with a high value of per capita GDP, 0.95 – to the least developed ones (with the lowest per capita GDP).

For the purposes of this study it is logical to apply an inverse gradation, that is, to assign the value of 0.95 to the coefficient $K_{c\ i}$ for countries from the most developed group based on the assumption that their potential possibilities have a greater chance of being realized, the value of 0.7 – for countries from the least developed group, and for countries from intermediate groups to assign uniformly increasing values – 0.76, 0.83 and 0.89. Therefore, the value of $R_{c\ i}$ in formula (3) was adjusted to the selected weights.

IV. RESULT AND DISCUSSION

A. The comparation of countries

The study examined 3 variants of assessment, which differ in the weights of indicators.

$$K_{av\,i} = 1, \quad K_{c\,i} = K_{Gini\,i} = 0. \quad (6)$$

The gross added value was adjusted only to the size of rent, which corresponded to the variant, where the achieved level of innovations was evaluated solely by the gross added value.

$$K_{av\,i} = 0.75, \quad K_{c\,i} = 0.25, \quad K_{Gini\,i} = 0. \quad (7)$$

In this case the value of the gross added value was adjusted only to the level of competitiveness, which corresponded to the variant, where the achieved level of innovation was assessed mainly by the gross added value, but taking into account the level of development of non-production spheres.

$$K_{av\,i} = 0.5, \quad K_{c\,i} = 0.25, \quad K_{Gini\,i} = 0.25. \quad (8)$$

In this variant the influence of all considered indicators was taken into account. The study examined 38 countries, mostly from the OECD group, that is, the most developed ones, as well as the BRICS countries. For each variant the countries were ranked and compared with other countries in the rating based on the GII index, as well as the ratings of countries according to the development of institutional environment and output subindex (both indicators are taken from the GII index).The institutional environment was considered as an indicator characterizing the country's existing opportunities in terms of conditions created for innovations, that is, the opportunities whose potential (in terms of creating an environment for innovation growth) has already been realized (and will definitely be realized later).The output subindex was considered as an indicator characterizing the potential for growth of innovations in the near future.

Therefore, the analysis of the obtained results of the value Ri, (that is, relative to the rating of the country according to the level of innovation) is based on actual data, the dynamics of their changes depending on the weight of potential factors, on comparison with the GII index and its sample composite indicators. A direct comparison of countries in the ranking regarding the values Ri and GII should reflect the difference between the assessment of the actual results of the implemented innovations (Ri value) and the assessment of the level of innovations in terms of indicators characterizing the potential capabilities of countries (GII index). The comparison of Ri with the rating of institutional environment makes it possible to assess the potential capabilities of the environment (mainly how they worked in the past). The comparison of Ri with the output subindex made it possible to assess the immediate prospects of the country in terms of the growth of innovations.

The comparison of the ranks of countries identified according to the GII index and Ri value is presented in Tables 2–4. The ratings are compiled according to the average values of the corresponding indices for the period from 2009 to 2016.

Table 2. The comparison of the countries' ranking (K_{av} = 1, K_c = K_{Gini}= 0)

The ranking of countries according to GII index		The ranking of countries according to R_i	
Rank	**Country**	**Rank**	**Country**
1	Switzerland	1	Ireland
2	Sweden	2	United States
3	United States	3	Switzerland
4	United Kingdom	4	Norway
5	Finland	5	Belgium
6	Netherlands	6	Austria
7	Denmark	7	Netherlands
8	Germany	8	Italy
9	Canada	9	Denmark
10	Iceland	10	Sweden
11	Ireland	11	Germany
12	Korea, Rep.	12	France
13	Norway	13	Finland
14	New Zealand	14	Australia
15	Japan	15	Canada
16	Israel	16	United Kingdom
17	Australia	17	Japan
18	Austria	18	Iceland
19	France	19	Israel
20	Belgium	20	Spain
21	Estonia	21	New Zealand
22	Czech Republic	22	Korea, Rep.
23	Spain	23	Czech Republic
24	China	24	Greece
25	Italy	25	Turkey
26	Portugal	26	Portugal
27	Chile	27	Estonia
28	Poland	28	Poland
29	Croatia	29	Croatia
30	Greece	30	Iran
31	South Africa	31	Argentina
32	Russian Federation	32	Russian Federation
33	Turkey	33	Chile
34	Brazil	34	South Africa
35	Argentina	35	Brazil
36	India	36	China
37	Ukraine	37	Ukraine
38	Iran	38	India

Table 3. The comparison of the countries' ranking (K_{av} = 0.75 K_c = 0.25 K_{Gini} = 0)

The ranking of countries according to GII index		The ranking of countries according to R_i	
Rank	**Country**	**Rank**	**Country**
1	Switzerland	1	Switzerland
2	Sweden	2	United States
3	United States	3	Ireland
4	United Kingdom	4	Norway
5	Finland	5	Belgium
6	Netherlands	6	Netherlands
7	Denmark	7	Sweden
8	Germany	8	Austria
9	Canada	9	Germany
10	Iceland	10	Denmark
11	Ireland	11	Finland
12	Korea, Rep.	12	France
13	Norway	13	United Kingdom
14	New Zealand	14	Canada
15	Japan	15	Japan
16	Israel	16	Australia
17	Australia	17	Italy
18	Austria	18	Israel
19	France	19	Iceland
20	Belgium	20	New Zealand
21	Estonia	21	Korea, Rep.
22	Czech Republic	22	Spain
23	Spain	23	Czech Republic
24	China	24	Turkey
25	Italy	25	Portugal
26	Portugal	26	Estonia
27	Chile	27	Greece
28	Poland	28	Poland
29	Croatia	29	Croatia
30	Greece	30	Chile
31	South Africa	31	Iran
32	Russian Federation	32	Russian Federation
33	Turkey	33	Argentina
34	Brazil	34	South Africa
35	Argentina	35	Brazil
36	India	36	China
37	Ukraine	37	India
38	Iran	38	Ukraine

Table 4. The comparison of the countries' ranking (K_{av} = 0.5 K_c = 0.25 K_{Gini} = 0.25)

The ranking of countries according to GII index		The ranking of countries according to R_i	
Rank	**Country**	**Rank**	**Country**
1	Switzerland	1	Switzerland
2	Sweden	2	Norway
3	United States	3	Belgium
4	United Kingdom	4	United States
5	Finland	5	Netherlands
6	Netherlands	6	Ireland
7	Denmark	7	Sweden
8	Germany	8	Denmark
9	Canada	9	Finland
10	Iceland	10	Germany
11	Ireland	11	Austria
12	Korea, Rep.	12	France
13	Norway	13	United Kingdom
14	New Zealand	14	Canada
15	Japan	15	Australia
16	Israel	16	Iceland
17	Australia	17	Italy
18	Austria	18	Korea, Rep.
19	France	19	Israel
20	Belgium	20	Czech Republic
21	Estonia	21	Spain
22	Czech Republic	22	Japan
23	Spain	23	Estonia
24	China	24	Portugal
25	Italy	25	Poland
26	Portugal	26	Turkey
27	Chile	27	Greece
28	Poland	28	New Zealand
29	Croatia	29	Croatia
30	Greece	30	Iran
31	South Africa	31	Russian Federation
32	Russian Federation	32	Chile
33	Turkey	33	Argentina
34	Brazil	34	Ukraine
35	Argentina	35	China
36	India	36	India
37	Ukraine	37	Brazil
38	Iran	38	South Africa

The analysis of the data in Tables 2–4 shows the following.

The ranking of countries with a big value of normalized gross margin (Ri value) is higher than their rank determined by the GII index, which indicates that the level of achieved innovations is higher than the GII index. This is most clearly demonstrated by the difference in the ranking of Switzerland and Belgium. In the GII ranking Switzerland has a rank of 1 and Belgium – 20. In the Ri ranking their ranks are 3 and 5 respectively (Table 2). In the assessment according to Ri, their ranks are close because normalized values of added value are also close. In 2016 this value for Switzerland was $109,400/person, for Belgium – $105,121/person (these values were also close in the previous years). A similar picture can be observed in countries whose rank in the Ri rating is lower, for example, in Finland and Sweden, since the achieved level of well-being of the population is lower compared to the countries with a higher rank [12, 15, 16].

As the weights of coefficients in the calculation formula Ri change (as the weights of the potential factors increase) the ranks of the countries converge for both indices. Thus, the sum of differences in the absolute values of rankings in Table 2 (the weight of potential factors is zero) was 56 units, in Table 3 (the weight of potential factors is 0.25) – 43, in Table 4 (the weight of potential factors is 0.5) – 38. This shows the relationship between Ri and GII – an increase in the weight of potential factors (estimated through indirect indicators – the level of competitiveness and the Gini index) in calculating Ri, which leads to the convergence of its values with GII (which, in terms of output data, is estimated through the number of articles, citation index and similar indicators).

It can be seen that the Ri index logically reflects the achieved level of innovation. As it includes potential indicators it approaches the GII index, which confirms the previously made preliminary conclusion that the GII index reflects the potential possibilities of the country in terms of innovation, rather than their achieved level. According to the dynamics of changes in the rankings of countries (Tables 2–4), where potential factors are taken into account in the data of the subsequent tables, it is clear that countries, whose innovations have been actively developing in recent years, are moving upwards in the Ri rating [1, 9].

For example, Finland rises from 13th to 9th place, Sweden – from 10th to 7th place, which reflects the fact that innovations in these countries are currently being actively developed, but at an earlier time the level of their development was lower than in the countries ranked higher on the rating scale. In turn, countries that have a high rank with a low estimate of the current potential are lowered in the ranking, which reflects the dynamics of changes in the ranking according to Ri values, for example, for Belgium or Ireland. Therefore, the comparison of the Ri and GII indices is productive, which makes it possible to evaluate both the achieved level (the development of innovations) and the prospects for further development.

Additional information for the analysis gives a comparison of the rankings of countries determined according to the Ri value, the level of development of institutional environment and output subindex (Table 5).

For better clarity, Table 5 presents only countries whose difference in relative ratings between the Ri and GII indices is essential (more than 20%). On average the ratings are compiled according to the values of the corresponding indices for the period from 2009 to 2016. We will analyze the obtained values of the ratings using the example of individual countries.

Table 5. Countries whose relative ratings according to the Ri and GII indices differ by more than 20%

Country	K_{av} = 1, K_c=K_{Gini}=0.	K_{av} = 0.75, K_c=0.25, K_{Gini}=0.	K_{av} = 0.5, K_c=0.25, K_{Gini}=0.25.	Average
The difference between the relative ratings of institutional environment and the rating according to R_i				
Belgium	–7	–4.5	–9.1	–6.9
China	9.7	2.7	–0.3	4
Iran	–17.9	–11.5	–11.3	–13.5
Italy	–24.2	–13.2	–11.2	–16.2
New Zealand	44.3	40.9	61.5	48.9
Norway	3.7	4.8	–1.4	2.4
The difference between the relative ratings of output indicators and the rating according to R_i				
Belgium	–45.6	–43	–47.6	–45.4
China	37.9	30.9	27.9	32.2
Iran	–4.3	2.1	2.2	0
Italy	–46.7	–35.7	–33.7	–38.7
New Zealand	–6.2	–9.5	11	–1.5
Norway	–43.8	–42.6	–48.8	–45.1

Note. The values in the table are presented as a difference between the values of the relative rating of the indicator according to the GII index on a scale 0–100 minus the value of the relative rating of the indicator according to the index Ri on a scale 0-100. A negative value indicates that the score according to GII turned out to be lower than the score according to Ri and vice versa, with the absolute value reflecting the degree of the difference in evaluation.

V. CONCLUSION

The article offered and tested a method for assessing the achieved level of the country's innovation through the indicators reflecting the level of its socio-economic development. The methodology takes into account the indicators of rent and inequalities in income distribution, which make it possible to reduce the influence of factors not related to innovation on the determination of the level of socio-economic development. The article also considers the indirect impact of innovation in non-production spheres.

The testing of the method based on selected indicators is built on the comparison of data obtained with the GII index data. It shows that the obtained estimates do not contradict each other. A comparative analysis of the obtained research results with the GII index data confirms the initial assumption about the potential nature of the evaluation of innovations according to the GII index, whereas the evaluation according to the final result of innovations reflects the actually achieved level.

In general, the rating of countries determined by taking into account different potential factors contributing to innovations makes it possible to carry out an objective assessment of the level of innovations, to identify the trends in their development and to predict the dynamics of their changes in the future, while the comparison of the obtained data with GII data provides an additional useful information for analysis.

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