

Leshchukh Iryna

PhD in economics,

scientific researcher of Department of spatial development

SI «Institute of Regional Research

Named after M.I. Dolishniy of the NAS of Ukraine»

4 Kozelnytska Str., Lviv, 79026, Ukraine

ira_leschukh@ukr.net**INNOVATIVE CAPACITY OF UKRAINIAN REGIONS**

Abstract: The paper analyzes the available in scientific literature approaches to evaluation of Ukrainian regions' innovative capacity.

The author's methodological approach to the evaluation of a region's innovative capacity is suggested. The approach is developed based on the following: in the first place, resources capacity is one of the main features of a region's innovative capacity, i.e. a region's innovative capacity is a set of certain types of recourses necessary to carry out the innovative activity; in the second place, in addition to resources component the innovative capacity of a region also contains an efficiency component; together they characterize the region's capacity to attract resources to generate, disseminate and use innovations; thirdly, an infrastructural framework for innovative activity is an important element of the region's innovative capacity.

Keywords: innovative potential, innovative development, innovative resources, innovative activity of the region, regional economy

JEL classification: O31, O33, P25

Introduction

In current conditions of growing competition between the regions for the attraction of resources, stimulation of innovative processes can become an important factor to improve competitiveness. However, compared to the leading countries, poor efficiency is peculiar to the current stage of Ukraine's innovative development. Despite a slight improvement in Global Innovation Index ranking in 2019 (47th place among 129 countries against 56th among 128 countries in 2016 and 64th among 141 countries in 2015), Ukraine still significantly lags

behind not only the leading countries but also most of the neighbors, namely Hungary, Slovakia, and Poland (Global Innovation Index, 2016; Global Innovation Index, 2019).

Ukraine has been ranked among the countries – modest innovators in the last few years by European Innovation Scoreboard – the most important aggregate index in Europe, having been the last among 36 analyzed countries.

Scientific literature nowadays provides numerous approaches to the evaluation of a region's innovative capacity. However, analysis of literature sources on the subject under research provides the main flaws peculiar to existing methodologies of the regions' innovative capacity evaluation:

- some methodologies are highly specialized, so they evaluate the level of impact of only a few factors on the region's innovative capacity, thus affecting the reliability of conclusions;
- some methodologies do not account an infrastructural factor of the region's innovative activity;
- indicators selected for analysis are not always weighted by the number of innovatively active enterprises, the region's population, etc.;
- some indicators selected for analysis are not related to the stages of an innovative process, and some of them aren't recorded in statistics.

Moreover, the regions' innovative capacity in scientific literature is evaluated and analyzed on the example of industrial enterprises, while the respective research for the entire set of economic activities is lacking.

Research results

The scientific paper suggests the author's methodological approach to the evaluation of a region's innovative capacity (Fig. 1). Its development is based on the following:

1. Resources capacity is one of the main features of a region’s innovative capacity, i.e. a region’s innovative capacity is a set of certain types of resources (institutional-organizational, informational, financial, staff, etc.) that forms an opportunity/capacity to perform research and development and experimental projects and to conduct innovative activity in the region.

2. In addition to the resources component, the region’s innovative capacity also contains an efficiency component. Together they characterize the region’s capacity to attract resources to generate, disseminate, and use innovations.

3. The general institutional business environment in the country considerably impacts the innovative activity.

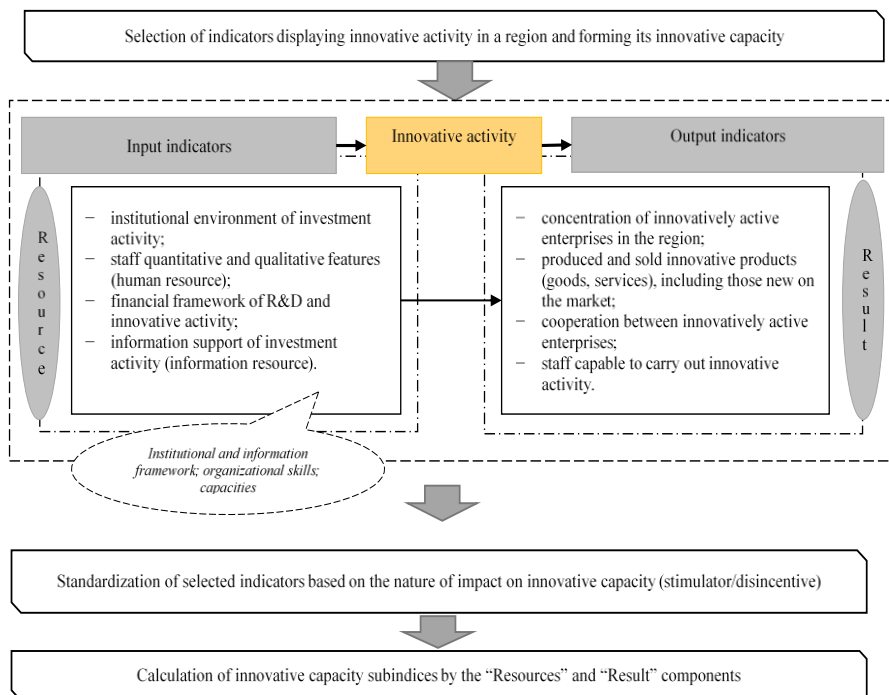


Figure1: Methodological approach to evaluation of a region’s innovative capacity

Moreover, the author’s methodological approach stipulates the following:

1) indicators for the analysis are selected based on their connection to an innovative process, i.e. they are the input and output indicators (in fact – resources and result respectively) of innovative activity;

2) with the view to secure the reliability of conclusions, the indicators selected for analysis are relative, i.e. they are weighted by certain parameters (number of innovatively active enterprises in the region; overall number of researchers; total number of scientific and research institutions, etc.).

The use of the abovementioned methodological approach, among other things, contributes to forming the regions' ranking based on the obtained results (their certain positioning) across “Resources” and “Result” sub-indices. This, in turn, will help evaluate the efficiency of the use of the region's innovative resources to achieve the result – the boosting/increase of the innovative activity in the region.

The indicators were selected for the analysis following the first stage of the suggested methodological approach to the evaluation of the regions' innovative capacity based on the conducted monitoring of available statistical information on innovative activity of Ukrainian regions (Table 1).

Table 1: Indicators of evaluation of Ukrainian regions' innovative capacity

№	Indicators for the evaluation of a region's innovative capacity	Measure
Input indicators; “Resources”		
1	Indicators that characterize the overall institutional business environment and innovative activity environment in particular:	
1.1	Position in the Regional Doing Business ranking	points
1.2	Region's position by Investment-Innovative Development and Foreign Economic Cooperation ranking calculated in the framework of Monitoring of Ukrainian Regions' Socio-Economic Development	points
1.3	Region's ranking by the Regional Human Development Index	points
1.4	Region's ranking by the Investment Efficiency Index	points

1.5	Value of the Aggregate Region's Innovations Index	%
2	Share of organizations carrying out R&D in the region	% to total number of organizations carrying out R&D in Ukraine
3	Share of employees carrying out R&D in the region	% to total number of employees carrying out R&D in Ukraine
4	Specific weight of researchers under 40 years of age	% to total number of researchers in the region
5	Share of expenditures on R&D in the region	% to total gross expenditures on R&D in Ukraine
6	Share of enterprises' expenditures on corporate R&D (technological innovations)	% to total enterprises' expenditures of the region
7	Share of enterprises' expenditures on external R&D (technological innovations)	% to total enterprises' expenditures of the region
8	Share of enterprises' expenditures on purchase of equipment and software (technological innovations)	% to total enterprises' expenditures on technological innovations
9	Share of enterprises with technological innovations subject to public financial assistance for innovative activity	% to total number of enterprises with technological innovations
10	Share of enterprises with technological innovations receiving information for innovative activity from corporate sources of information	% to total number of enterprises with technological innovations
11	Share of enterprises with technological innovations receiving information for innovative activity from the market sources of information (providers of equipment, materials, components, software; clients, customers, competitors)	% to total number of enterprises with technological innovations
12	Share of enterprises with technological innovations receiving information for innovative activity from the institutional sources of information (consultants, commercial labs, private R&D institutions; universities and other higher educational establishments; public R&D institutions)	% to total number of enterprises with technological innovations

Output indicators; “Result”		
1	Share of enterprises carrying out innovative activity	% to total number of examined enterprises
2	Share of employed at innovatively active enterprises	% to total number of employed at the examined enterprises
3	Share of enterprises carrying out staff training for innovative activity	% to total number of enterprises with technological innovations
4	Share of products (goods, services) sold by innovatively active enterprises	% to total volumes of products (goods, services) sold by enterprises of the region
5	Share of sold innovative products (goods, services) that are new on the market	% to total volumes of products (goods, services) sold by enterprises of the region
6	Share of innovatively active enterprises involved in innovative cooperation	% to total number of enterprises with technological innovations
7	Share of enterprises introducing innovative products (goods, services) and/or technological processes on their own	% to total number of innovatively active enterprises in the region
8	Share of applications for inventions (national applicants)	% to total number of applications for inventions in Ukraine
9	Share of patents for inventions (national applicants)	% to total number of patents for inventions in Ukraine

10	Share of applications for utility models from national applicants	% to total number of applications for utility models from national applicants in Ukraine
11	Share of patents for utility models (national applicants)	% to total number of patents for utility models in Ukraine

*developed by the author

Taking into account the fact that indicators provided in Table 1 are heterogeneous, i.e. they are not subject to comparison and contain slight intraregional fluctuations, it is essential to carry out the process of their standardization to secure compatibility and comparability of the formed information basis (Leshchukh, 2019).

All the indicators selected for analysis are stimulators (i.e. the growth of their value positively impacts the overall level of a region's innovative capacity). Therefore, the standardization should be conducted by the formula (1):

$$N_i = \frac{p_i - p_{min}}{p_{max} - p_{min}} \quad (1)$$

where N_i – the standardized value of the i indicator of innovative activity in a region in the examined period; p_i – the value of the i indicator of innovative activity in the region in the examined period; p_{max} – maximum value of the i indicator of innovative activity in the region in the examined period; p_{min} – minimum value of the i indicator of innovative activity in the region in the examined period.

Standardization of primary indicators by the formula (1) brings their value within the range [0:1].

On condition that indicators by all components of innovative capacity have a relatively equal impact, the “Resources” ($SI_{resources}$) and “Result”

(SI_{result}) sub-indices are calculated based on the additive model by formulas (2) and (3):

$$SI_{resources} = \frac{\sum_{i=1}^n N_{resources\ i}}{n}, \quad (2)$$

where $SI_{resources}$ – the value of the region’s investment capacity by the “Resources” subindex; $N_{resources\ i}$ – standardized value of the i indicator (output indicator) of innovative activity in the region in the examined period; n – number of indicators.

$$SI_{result} = \frac{\sum_{i=1}^n N_{result\ i}}{n}, \quad (3)$$

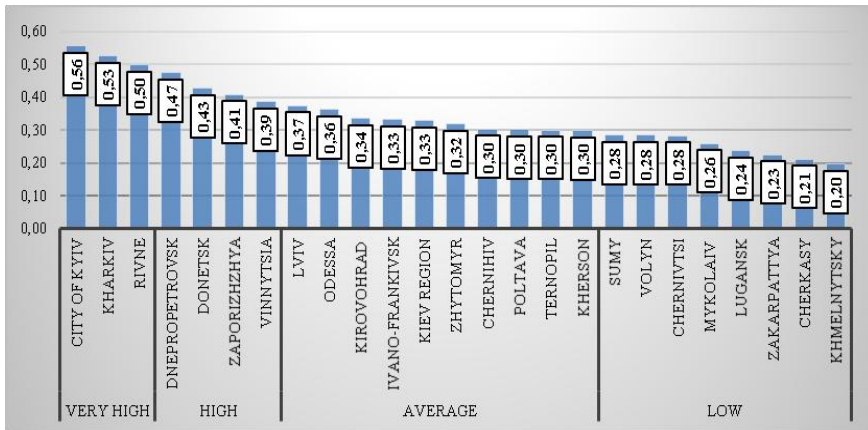
Where SI – the value of the region’s investment capacity by the “Result” subindex; $N_{result\ i}$ – standardized value of the i indicator (output indicator) of innovative activity in the region in the examined period; n – number of indicators.

The conducted evaluation of the components of Ukrainian regions’ innovative capacity based on the abovementioned methodology contributed to arranging the regions into groups by the ranking points across input and output indicators, i.e. by the “Resources” and “Result” sub-indices.

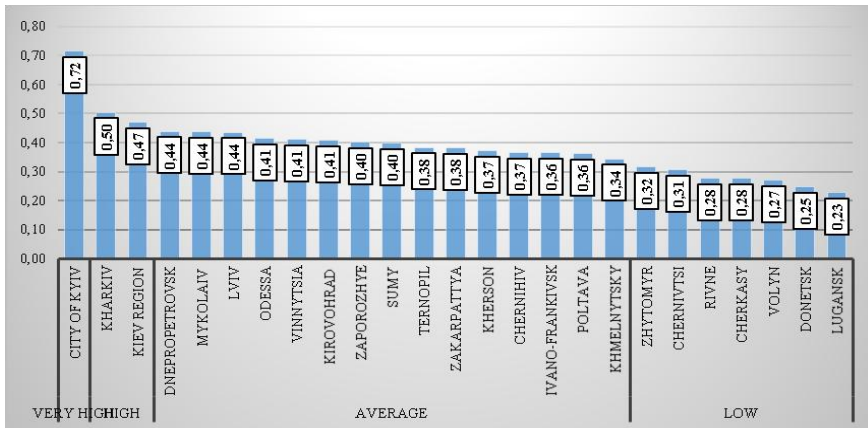
The given ranking of Ukrainian regions by the “Resources” sub/index (Fig. 2) shows the general objectively existing preconditions and the innovative activity environment in the region.

Thus, Kyiv has the most favorable institutional business environment as an important component of innovative capacity input indicators described by investment-innovative development, investment efficiency, foreign economic cooperation of the region, and features of regional human development. Moreover, the capital has remained the leader by the number of organizations carrying out R&D and the number of employees carrying out R&D during the entire period un-

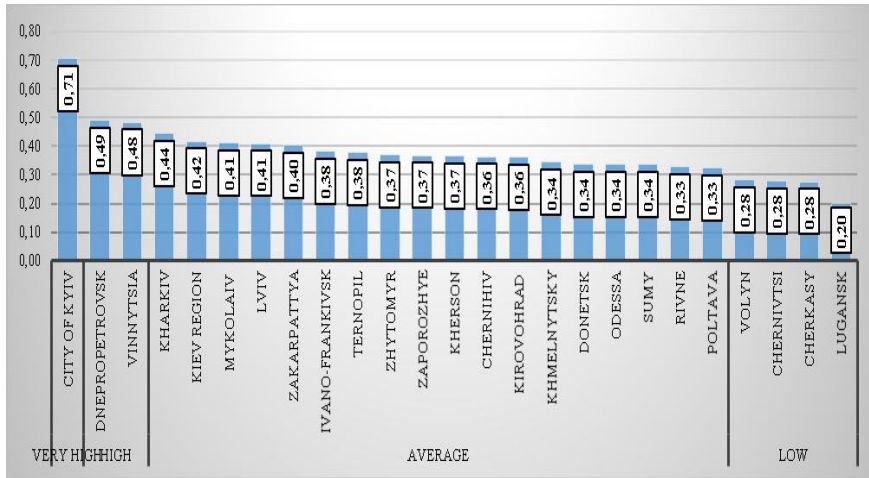
der research. As a result, it secured Kyiv the leading position among Ukrainian regions by the “Resources” sub-index.



(a)



(b)



(c)

Figure 2. **Ranking of Ukrainian regions by the level of investment capacity by the “Resources” sub-index (input indicators) in 2008-2010 |2014-2016 (b) and 2016-2018 (c)**

*calculated and developed by the author according to the data (Scientific and innovative activity of Ukraine, 2010; Scientific and innovative activity of Ukraine, 2016; Scientific and innovative activity of Ukraine, 2018)

Kharkiv area, having been the powerful center of innovative activity concentration during the entire period under research (in particular, the region is leading in Ukraine by Aggregate Innovations Index), couldn’t manage to increase its innovative capacity by the “Resources” sub-index. Moreover, having been among the regions with a very high level of investment capacity by the sub-index in 2008-2010, the area lost its positions in 2014-2016 and found itself among the regions with a high and in 2016-2018 with an average level of investment capacity. The situation was caused, in particular, by political instability in the country, a certain decline of the region’s investment efficiency (-46 points in 2018 compared to 2016 by Investment Efficiency Index for Ukrainian regions), as well as the outflow of employed in innovative activity sector (the share of employed at in-

novatively active enterprises in the total number of employed at the oblast's enterprises decreased by 7.9 p.p. in 2016-2018 compared to 2014-2016).

The quality and quantity of human resource that characterizes organizational skills and opportunities of innovative activity is an important component of innovative capacity increase on the way to the development of the knowledge economy. Thus, the research contributed to establishing the leaders in Ukraine by the share of employees carrying out R&D – city Kyiv and Kharkiv area (45.5% and 16.1% of the total number of employees carrying out R&D in Ukraine respectively). Moreover, the gap from the closest competitor by the indicator is 6.3 p.p. However, what is interesting is that the specific weight of researchers under 40 years of age to the total number of researchers in the mentioned regions is one of the lowest in Ukraine.

Funding of innovative activity is the material basis of investment introduction as well as improvement of production technologies and stimulation of innovative growth. Thus, Kyiv as well as Kharkiv and Dnipropetrovska area have been the leaders in the country by the volumes of expenditures on R&D during the entire period and accounted for almost 80% of the total gross expenditures on R&D in Ukraine.

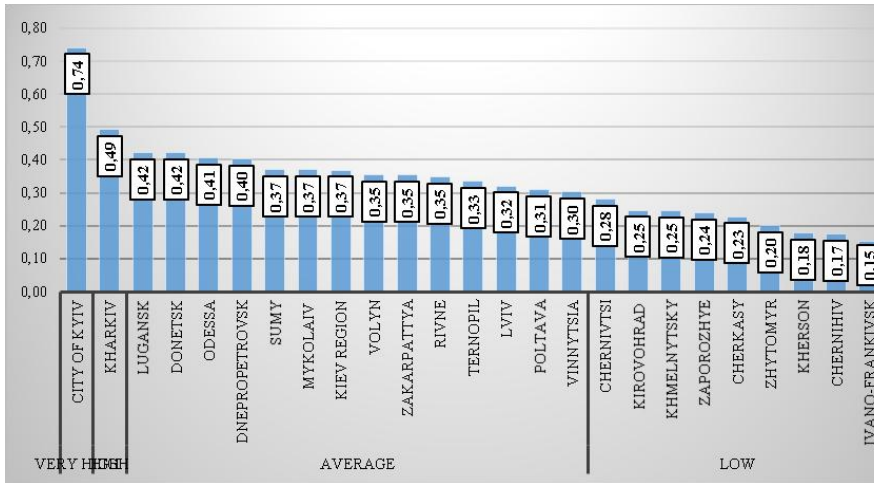
The purchase of equipment and software was the major direction of innovative expenditures in the period under research in all regions. Its share in the structure of innovative enterprises' expenditures on technological innovations in 2016-2018 ranged from 22.1% in Luhanska area up to 98.3% in Ivano-Frankivska area (average rate in the country was 52.2%).

Moreover, a low level of cooperation between innovative businesses and various institutions like commercial laboratories, public and private scientific and research institutes, and higher educational establishments is peculiar to Ukrainian regions (in 2016-2018, on average, 4.7% of enterprises with technological innovations in

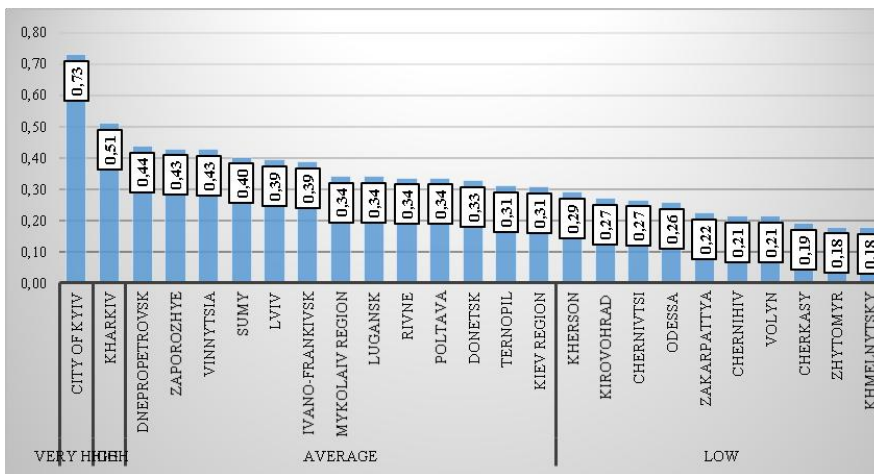
Ukraine). Corporate and market (suppliers, clients, customers, competitors) sources remain to be the major source of information for enterprises' innovative activity. Therefore, the functioning of innovative infrastructure facilities in the regions is very important: scientific parks, technology transfer centers, or innovative clusters, etc.

In general, the evaluation of Ukrainian regions by the level of innovative capacity by the “Resources” sub-index shows the reduced by half number of regions with low innovative capacity level by the input indicators and the growing from 10 to 19 number of regions with average innovative capacity level by the output indicators. The positioning of Ukrainian regions by the innovative capacity level by the “Results” sub-index is the opposite matter. Thus, the number of oblasts belonging to the regions with low innovative capacity level by the output indicators has increased one and a half times in the period under research, while the number of oblasts with average innovative capacity level has reduced twice (Fig. 3). The positive aspect of the growing number of regions with high innovative capacity levels from one (Kharkiv area) to three (Kharkiv, Dnipropetrovska, and Zaporizka area) should also be emphasized. Kyiv remains the consistent leader by the “Results” sub-index. Its innovative capacity level by the output indicators increased by 0.03 p.p. in 2016-2018 compared to 2008-2010.

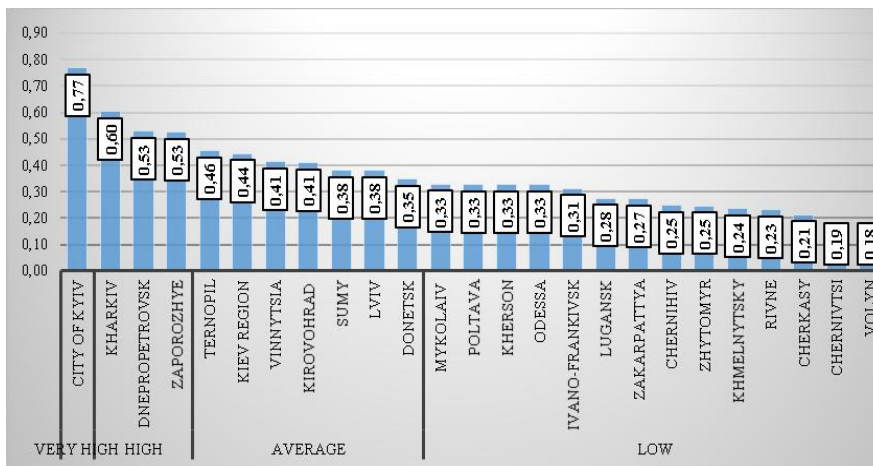
While the input indicators provide an estimation of favorability of general objectively existing conditions of innovative activity, the output indicators show the real results achieved in this conditions.



(a)



(b)



(c)

Fig. 3. Ranking of Ukrainian regions by the level of investment capacity by the “Results” sub-index (output indicators) in 2008-2010 (a), 2014-2016 (b) and 2016-2018 (c)

*calculated and developed by the author according to the data (Scientific and innovative activity of Ukraine, 2010; Scientific and innovative activity of Ukraine, 2016; Scientific and innovative activity of Ukraine, 2018)

The growing share of innovative enterprises in the total number of enterprises is one of the important features of an institutional business environment favorable for carrying out the innovative activity. The conducted research establishes that the abovementioned indicator increased in two-third of Ukrainian regions in the reporting year compared to the base one. Zaporizka area (the share of innovative enterprises in the total number of enterprises increased by 19.2 p.p.), Ivano-Frankivska (+16.5 p.p.), Kirovohradska (+15.6 p.p.), Lvivska (+11.3 p.p.), Khersonska (+10.7 p.p.) area and Kyiv (+11.5 p.p.) were the leaders by the processes.

Large cities are the centers of innovations in Ukrainian regions where the main productive, intellectual, and scientific capacity is concentrated. Thus, in 2017, from 21.4% (Ivano-Frankivsk) up to 80.0% (Mykolayiv) of innovatively active enterprises of respective

regions were concentrated in the cities – oblast centers. Moreover, in 2017, only 16.2% of industrial enterprises carried out an innovative activity on average in the country, while in Mykolayiv 38.5% of industrial enterprises were innovatively active, in Ternopil – 33.3%, in Kharkiv – 31.2%, in Kyiv – 20.7%. Such spatial concentration of innovatively active industrial enterprises is caused by a range of factors, in the first place by:

- 1) proximity of a large number of sellers and buyers that allows the fast and flexible reaction to the market condition;
- 2) availability of local labor force funds with a concentration of specific skills;
- 3) extended opportunities to attract transnational stakeholders;
- 4) availability of institutional and transport infrastructure, etc. (Leshchukh, 2019).

In addition to the abovementioned, evaluation of Ukrainian regions by the innovative capacity level by the “Results” sub-index (output indicators) leads to a range of other conclusions:

firstly, despite the growing share of innovative enterprises in the total number of enterprises in 2016-2018, the share of employed at innovatively active enterprises in the total number of employed reduced in half of the country’s regions. The process was the most dynamic in Luhanska, Odeska, Chernivetska, and Zakarpatska area;

secondly, the share of products (goods, services) sold by innovatively active enterprises in the total volume of sold products (goods, services) by enterprises in the respective region in the reporting year ranged from 27.3% in Chernivetska oblast to 68.9% – in Zaporizka area.

However, extremely low level of sold innovative products (goods, services) new on the market (in the total volumes of sold products (goods, services)) is peculiar to Ukrainian regions. In 2016-2018, it ranged from 0.1% in Donetska, Zhytomyrska, Mykolayivska, Chernihivska, and Poltavaska area to 1% in Zaporizka, Kirovohradska, and

Kharkiv areas. Meanwhile, innovative enterprises of Volynska, Zakarpatska, Ivano-Frankivska, Rivnenska, Khmelnytska, and Chernivetska areas didn't sell any fundamentally new innovative products at all. This testifies to the fact that businesses focus in innovative production on their own needs rather than the market;

thirdly, despite the fact that the share of innovatively active enterprises engaged in innovative cooperation has grown in the period under research, yet it remains rather insignificant (for example, only the fourth part of innovatively active enterprises in Ivano-Frankivska area);

fourthly, Kyiv as well as Kharkiv and Dnipropetrovsk areas have been the leaders in Ukraine by industrial property protection (patenting of inventions, utility models, etc.) during the entire period under research.

Therefore, both input and output indicators are the basis for the evaluation of an administrative unit's innovative capacity. Their comparison contributes to the analysis of the efficiency of the use of available innovative resources, opportunities and institutional business environment in the region in terms of achievement of the respective result (Fig. 4). Thus, the higher indices of the innovative activity results correspond to the higher level of existing input conditions (in Fig. 4, the regions will be located along the main diagonal; blue columns).

Indicators		Result			
		Low 0,18-0,33	Average 0,34-0,48	High 0,49-0,63	Very high 0,64-0,78
Resource	Low 0,2-0,32	Volyn, Chernivtsi, Charkasy, Rivne, Poltava, Lugansk			
	Average 0,33-0,45	Zhytomyr, Zakarpattia, Ivano-Frankivsk, Chernihiv, Khmelnytsky*, Kherson*, Odessa*, Mykolaiv*	Vinnytsia, Donetsk, Ternopil, Sumy, Lviv, Kirovograd, Kiev region	Kharkiv, Zaporizhzhia	
	High 0,46-0,59			Dnipropetrovsk	
	Very high 0,6-0,72				city Kyiv

Figure 4: Ranking of Ukrainian regions by the groups of input and output indicators of the innovative capacity evaluation

*at the average level of innovative capacity by input indicators, the regions were characterized by the low level of investment capacity by output indicators, however, the results of their innovative activity were

as close to the efficient ratio “resources-result” as possible;

**calculated and developed by the author

The regions located to the left from the main diagonal are characterized by the inefficient ratio between input and output indicators of innovative capacity. Thus, in 2008-2010, Zhytomyrska, Zaporizka, and Rivnenska areas had the worst ratio.

In general, if in the base year the share of regions characterized by efficient ratio between input and output indicators of innovative capacity (blue columns) had accounted for 36% of the total number of regions under research, in 2016-2018, the rate increased up to 60%.

The positioning of Harkivska, Zaporizka, and Dnipropetrovska areas in Fig. 4 is interesting. Thus, the regions managed to accumulate their innovative resources in the period under research and upscale them to achieve high innovative activity results.

Kyiv is a consistent leader in Ukraine by the level of innovative capacity both by output and input indicators characterized by efficient ratio between the input conditions and the result of innovative activity.

In general, arranging Ukrainian regions into groups by input and output indicators of investment capacity evaluation can become the basis for the regions’ clustering by the types of innovative capacity.

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