Management Science Letters 10 (2020) 3173–3182

Contents lists available at GrowingScience

Management Science Letters

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Economy's innovative technological competitiveness: Decomposition, methodic of analysis and priorities of public policy

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C H R O N I C L E

Article history:
Received: March 3, 2020
Received in revised format: March 25 2020
Accepted: May 5, 2020
Available online: May 5, 2020

Keywords:
Competitiveness
Innovative technological
Integral index
Public policy
Ukrainian regions

A B S T R A C T

This research aims to improve a methodic for evaluation of economy's competitiveness through theoretical-methodological substantiation, forming and calculation of integral indices of innovative technological competitiveness across the regions of a country. The relevance and indispensability of reinforcement of economy's competitiveness on innovative technological foundations are also substantiated. Available methodical approaches in economic literature and competitiveness rankings and indices used by leading international economic organizations, namely in innovations and high technology domains, are generalized. Authors' methodic of calculation of integral index of economy's innovative technological competitiveness is suggested. Integral indicators of provision of innovative technological activity with resources, innovative technological activity and efficiency of innovative technological activity across regions (on the example of Ukraine) are calculated for 2009-2018; conclusions regarding the preconditions, capacity and availability of tendencies of innovative technological activity in oblasts (regions) of the country are made. The paper explains that each of the components of innovative technological competitiveness of the country's economy had almost equal input in forming of its integral index – provision with resources, capacity and efficiency of innovative technological activity. In the first place, it is an additional argument in favor of the model's reliability, and in the second place, it brings into the fore the importance of public policy in terms of improvement of resources maintenance of innovative and technologically active companies, boosting of innovative technological activity and increasing of its efficiency and contribution to general economic growth of the country. Strategic priorities of state policy of reinforcement of the economy's innovative technological competitiveness are substantiated.

1. Introduction

As it is mentioned in the U.S. National Security Strategy (The White House Washington, 2017), Japan's New Growth Strategy (Ministry of Foreign Affairs of Japan, 2017), strategic plans (Europe 2020), a strategy for smart sustainable and inclusive growth (European Commission, 2019) and the New High-Tech Strategy "Innovations for Germany" (Federal Government, 2014), forming of innovative technological competitive advantages of a country in modern world becomes an increasingly essential factor of securing the growth of productivity and efficiency of economy and improvement of a country's position in the system of international labor division. It proves the need for implementation of public policy of support and boosting of innovative technological activity, digitalization and creation and introduction of advanced technologies, digital production and results of scientific-research and intellectual creative activity in order to secure sustainable competitiveness of national

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doi: 10.5267/j.msl.2020.5.004

economy. Meanwhile, in the course of forming and further implementation of public policy of maintenance of innovative technological competitiveness it is necessary to clearly understand its nature, factors and components that create it and to have the modern methodic of analysis that can show the comprehensive picture of condition, level, tendencies and structural features of maintenance of economy's innovative technological competitiveness. Application of integral approaches to analysis that also include the system of indicators across the regions of a country is of special importance. It helps complex evaluation of the condition of economy's innovative technological competitiveness and detecting of interregional differentiations and misbalances.

2. Literature review

Theoretical and methodological basis of the evaluation methodic of economy's innovative technological competitiveness is defined by two aspects. The first one comprises intrinsic typological features of innovative technological competitiveness that outline the boundaries and directions of further methodic of the analysis, since they allow for decomposition into internal components and elements. The second one encompasses the available in economic literature economic approaches to analysis of innovative technological development of economy and maintenance of economy competitiveness. Regarding the first aspect, innovative technological competitiveness of economy is considered in economic literature, in the first place, from the viewpoint of creation and introduction of modern and advanced technologies (Edsand, 2019; Lisovska & Lushchak, 2010; Narula & Wakelin, 1995; Fedulova, 2010). It is the result of public policy of accumulation and use of intellectual capital and introduction of modern technologies that secures the growth of labor productivity and sustainability of production-technological and business processes and increases the level of added value in science-intensive economy sectors. However, the approach does not sufficiently take into account the role of business, innovative infrastructure, domestic developments and social effects of technologies introduction. Secondly, competitiveness is examined within the framework of industrial development and global challenges (Havlovska et al., 2019; Matyushenko, 2016). It is the capacity of industry to introduce and use advanced technologies for competition and solution of global problems (population decline, poverty, environment, new energy, social security). However, in this case the emphasis shifts from the development of national economy to global social level. The third research direction focuses on understanding of economy competitiveness as an ability to realize production-technological and export capacity on scientific and innovative grounds through introduction of advanced technologies, technical and technological modernization of basic industries, development of science-intensive and high tech production and use of institutional factors of structural changes and creative capacity of researchers (Missio & Gabriel, 2016; Munir & Phillips, 2002; Brown, 1994). Although the use of innovative technological factor as an instrument of structural changes is somewhat controversial.

Competitiveness is sometimes directly identified with innovative technological modernization of economy (Kindzerskyy, 2013; Buzhymska, 2011; Makri & Lane, 2007; Shults et al., 2017; Halchynskyy et al., 2004; Stehnei et al., 2018; Hrynkevych et al., 2020), arguing that it is the measure of introduction of new or improvement of competitive technologies and organizational-technical solutions in all areas of socio-economic system. However, in such a way the level of innovative activity and impact of innovative technological activity on quality and efficiency rather than ability to win in competition are in the center of attention. In the fifth place, innovative technological competitiveness is considered from the viewpoint of it being an element of a country's economic security (Ilyash et al., 2018; Vasyltsiv et al., 2017; Vlasiuk, 2016). Therefore, we can refer to the ability to guarantee high level of scientific-technological and investment-innovative security as important feature of environment and "warning" for business to conduct innovative technological modernization of production and to secure technological competitiveness of domestic production. In the sixth place, innovative technological competitiveness is considered as the leading factor of international competitiveness of a country (Kumar & Singh, 2019; Kirdina, 2011; Shnypko, 2011), which depends on the cost of production and the use of advanced technologies, quality of protectionism measures, support of export and import substitution and policy of forming and use of labor capacity. It secures the shift of focus from technological to other components of competitiveness and transition from economy to competitiveness of a country.

The synthesis and analysis, combination and critical contemplation of abovementioned approaches provide the grounds to conclude that *innovative technological competitiveness* is the leading element that forms competitive advantages of economy and is defined by the level of science and technology development, sector of digital economy, up-to-datedness and efficiency of used technologies, volumes of their penetration into the system of national economy and economic relations at all levels, availability of financial support and resources provision and efficiency of the use of innovative technological activity's results. Regarding the second aspect – methodical approaches to analysis of innovative technological development of economy and securing of economy's competitiveness – the methodology of research is mostly based on comparative, gnoseological, comprehensive, synergetic, dynamic and other methodical approaches; the methods of multivariate statistical analysis with a set of tools of integral evaluation of normalized indicators and rankings are most commonly used. Global Competitiveness Index of World Economic Forum is one of the most used in scientific and experts. It stipulates monitoring of 98 partial indicators settled in 12 groups of various weights, including the technological readiness and development of information and communication technologies (accessibility of advanced technologies, firm-level technology absorption, ICT legislation, foreign direct investment and technology transfer, network of the users of cellphones, personal computers, Internet) and innovative development (indicators of innovative capacity, quality of scientific and research institutes, company spending on research and development, university-industry collaboration, purchase of high tech products by a country, availability of

scientists and engineers, number of patents, intellectual property protection) (World Economic Forum, 2019). An alternative research provides the World Competitiveness Rankings of the International Institute for Management Development in Switzerland. The methodic covers 332 partial indices combined in 4 groups of competitiveness indicators (economic performance, government efficiency, business efficiency, infrastructure) (International Institute for Management Development, 2019). Experts of International Business School INSEAD (France) supported by World Intellectual Property Organization, Cornell University in the U.S. and other participants compound the Global Innovation Index formed by 7 groups of indicators: institutions, human capital and research, infrastructure, market sophistication, business sophistication, creative outputs, knowledge and technology outputs (Dutta et al., 2019). Innovation Capacity Index is a tool to evaluate the country's competitiveness by the level of innovative development, which consists of 5 sub-indices: human capital (education, social inclusion and equality), institutional environment (country policy, good governance), use of information and communication technologies (quality of the infrastructure, Internet, computers and TV, mobile cellular communications, etc.), research and development (R&D infrastructure, patents and trademarks), regulatory and legal framework (Yasmina & Augusto, 2010). Broad spectrum of innovative technological activity factors is outlined in annual reports of Bloomberg agency. The experts calculate the Bloomberg Innovation Index based on 7 equal groups of indicators (Bloomberg, 2019). The World Bank's Knowledge Economy Index is used to evaluate the decisive role of knowledge in forming of intellectual resource and creation of new technologies. It includes 109 indicators arranged in 4 groups: economic incentive and institutional regime, education and training, innovation and technological adoption, information and communication technologies infrastructure (The World Bank, 2019). In order to evaluate the capacity of European countries to create, develop and spread innovation and new technologies, the European Commission developed the methodic of calculation of Innovation Index of European Innovation Scoreboard, which has the system of input (resources of scientific and innovative activity) and output (efficiency of scientific-research and innovative technological domains) parameters with 4 groups of indicators: framework conditions (human resources, attractive research system, innovation-friendly environment), investments (R&D finance), innovation activities (level of companies' innovative activity, patents applications), impacts (employment and commercial activity in innovative industries) (European Commission, 2019).

The range of other rating indicators are used in global practice, according to which the aspects of innovative technological development and economy competitiveness are evaluated. Therefore, currently there is a considerable and diversified basis of methodical approaches and methods of evaluation of economy's competitiveness and its innovative technological component. However, most of them provide the external comparison of countries by certain components of competitive advantages, opportunities and development (in particular in innovation, advanced technologies, digitalization, etc.). There are also the methodic of internal (within the economy of a certain country, region, companies) analysis, although they do not fully correspond to the nature of evaluation of innovative technological competitiveness, because they take into account other (non-technological) aspects. It is also reasonable to develop further the methodic in terms of decomposition of innovative technological competitiveness into separate components (provision of innovative activity with resources, innovative activity, efficiency of innovative activity) with their further more profound analysis. Many of the suggested approaches have some weaknesses related to omission of the weight of researched indicators in forming of integral index or to taking into account only the multivariate average values. Moreover, permanent technological dynamism and global impact of leading technologies on the development of national and regional economies stipulate the need for occasional adjustment of scientific methodic by the change of the list of estimated indicators, increasing reliability of data sources, providing of complete primary information and improvement of an algorithm of outcome indicator's calculation.

3. Materials and Methods

The authors' methodic stipulates calculation of integral index of economy's innovative technological competitiveness (on the example of Ukraine). The methodic consists of seven stages:

1) forming of indicators of innovative technological activity across Ukrainian regions in the defined time period (10 years – from 2009 till 2018) by three groups:

- group 1 – provision of innovative technological activity with resources;
- group 2 – innovative technological activity;
- group 3 – efficiency of innovative technological activity;

2) normalization of indicators;
3) determining of indicators' weight in the group;
4) calculation of weighted indices of the groups of indicators;
5) determining of weight for each group of indicators;
6) calculation of integral indices by competitiveness groups;
7) construction of integral index.

The values of indicators of innovative technological activity across Ukrainian regions in 2009-2018 selected according to indicators of structural-functional model of innovative technological competitiveness (ITC) serve as an information basis of the analysis:

$$ITC = F\begin{Bmatrix} RP\uparrow\left(I_C\uparrow; P_I\uparrow; I_P\uparrow; I_I\uparrow\right) \\ IA\uparrow\left(IAE_Q\uparrow; ITE_Q\uparrow; AIEQ\uparrow; NTP_N\uparrow\right) \\ IE\uparrow\left(RC_E\uparrow; RIP_E\uparrow; IP\uparrow; IP_Q\uparrow\right) \end{Bmatrix}, \quad (1)$$

where RP – index of provision of innovative technological activity with resources; I_C – volumes of spending on innovation per one innovatively active industrial enterprise; P_I – number of employers involved in R&D per one innovatively active industrial enterprise; I_P – shares of companies with technological innovations that have the partner for innovative cooperation; I_I – share of companies with technological innovations that use the most important sources of information for innovative activity; IA – index of innovative technological activity; IAE_Q – share of innovatively active industrial enterprises; ITE_Q – share of innovatively active companies by the types of innovations; AIE_Q – share of industrial enterprises that introduce innovations; NTP_N – number of introduced new technological processes per 100 industrial enterprises;
IE – index of efficiency of innovative technological activity; RC_E – coefficient of efficiency (volumes of realized innovative products to spending on innovation) of R&D spending of industrial enterprises; RIP_E – volumes of realized innovative products per one innovatively active industrial enterprise; IP – labor productivity (volumes of realized innovative products per one employee involved in innovative activity of industrial enterprises); IP_Q – share of the volume of realized innovative products (goods, services) in economy. Normalizing is carried out according to the Eq. (2):

$$z^s_{ij} = \frac{x_{ij}}{x_{\max j}}, \quad (2)$$

where z^s_{ij} – standardized values of i indicator in j time period ($i = 1,...,n; j = 1,..., m$); x_{ij} – output values of indicators ($i = 1,...,n; j = 1,..., m$); $x_{\min j}$, $x_{\max j}$ – minimum and maximum value of i indicator in j time period ($i = 1,...,n; j = 1,..., m$). Indicators normalizing leads to forming of normalized series of indicators (z_{ij}) for each group. Weight of indicators is defined by construction of correlation matrix (pairwise correlation comparisons) (formula 3) for each group of indicators separately. Indicators' weights are constant in the period under research.

$$\begin{vmatrix} r_{11}r_{12}r_{13}r_{14}.... & r_{1n} \\ r_{21}r_{22}r_{23}r_{24}... & r_{2n} \\ .... & \\ r_{n1}r_{n2}r_{n3}r_{n4}....r_{nn} & \end{vmatrix}, \quad a_t = \begin{pmatrix} r_{11}+r_{12}+r_{13}+r_{14}+....+r_{1n} \\ r_{21}+r_{22}+r_{23}+r_{24}+...+r_{2n} \\ r_{31}+r_{32}+r_{33}+r_{34}+...+r_{3n} \\ ..... \\ r_{n1}+r_{n2}+r_{n3}+r_{n4}+...+r_{nn} \end{pmatrix} = \begin{pmatrix} a_1 \\ a_2 \\ a_3 \\ ... \\ a_n \end{pmatrix}, a_t = \Sigma a_n, \quad (3)$$

where r_{ni} – coefficient of pairwise correlation of n indicators in k *group*; a_n – the sum of elements of n row of correlation matrix.

$$w_{ki} = \frac{a_t}{\sum\limits_{n=1}^{i} r_{ni}}, \Sigma w_{ki} = 1, w_{ki} > 0, \quad (4)$$

where w_{ki} – value of the weight of i indicator in k group (i=1,…,n; k=1,…,5). Weighted indices of each group of indicators are calculated by the formula (5):

$$I_{kj} = \sum_{j=1}^{m} w_k \times z_{ij}, \quad (5)$$

where I_{kj} – weighted index of k group of indicators in j time period (k=1,…,5; j=1,…,m). Weights of indicators groups same as weights of indicators in a group are determined by construction of correlation matrix consisting of pairwise correlation comparisons of calculated weighted indices of indicator groups. Integral index of economy's innovative technological competitiveness (Y_J) is calculated by formula (6):

$$Y_j = \sum_{j=1}^{m} w_k \times I_{kj}. \quad (6)$$

4. Results and discussion

Based on the suggested methodic the average values of integral indices of provision of innovative technological activity with resources in Ukraine are identified (Table 1). Thus, the rate across the regions in 2018 was within 0.174 (the lowest value was in Hmelnytska oblast) – 0.662 (the highest value was in Zaporizka oblast). Moreover, in 2009-2018 integral values of provision of innovative technological activity with resources in most oblasts of Ukraine has deteriorated, which is a negative point and testifies to weakening resources capacity in the domain. The exceptions were Zaporizka, Luhanska, Lvivska, Mykolayivska, Odeska, Ternopilska, Harkivska, Hersonska, Chernivetska and Chernihivska oblasts. Meanwhile, in dynamics the situation was much better with innovative technological activity at regional level. Integral index of innovative technological activity is established to have increased in 2009-2018 in most oblasts of the country (Table 2). Decline was peculiar only to Vinnytska, Rivnenska, Hmelnytska, Chernivetska and Chernihivska oblasts. Overall innovative technological activity in the

regions of Ukraine was higher compared to provision with resources. For example, the lowest rate in 2018 was in Hmelnytska oblast (0.324), the highest – in Kyivska oblast (0.906).

Table 1
Integral indices of provision of innovative technological activity with resources across Ukrainian regions, 2009-2018

Administrative oblasts	Years 2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Deviation 2018-2009
Vinnytska	0.609	0.309	0.446	0.331	0.439	0.301	0.799	0.562	0.742	0.514	-0.094
Volynska	0.489	0.171	0.371	0.170	0.310	0.122	0.534	0.336	0.749	0.262	-0.227
Dnipropetrovska	0.636	0.374	0.598	0.391	0.367	0.193	0.588	0.521	0.747	0.282	-0.354
Donetska	0.545	0.394	0.688	0.447	0.502	0.355	0.767	0.358	0.774	0.514	-0.032
Zhytomyrska	0.426	0.119	0.657	0.126	0.279	0.098	0.506	0.195	0.504	0.278	-0.148
Zakarpatska	0.270	0.281	0.281	0.252	0.432	0.172	0.719	0.374	0.735	0.208	-0.062
Zaporizka	0.621	0.435	0.446	0.213	0.351	0.173	0.547	0.331	0.612	0.662	0.041
Ivano-Frankivska	0.347	0.528	0.433	0.282	0.473	0.096	0.783	0.329	0.628	0.305	-0.042
Kyivska	0.606	0.407	0.483	0.318	0.339	0.179	0.568	0.492	0.791	0.471	-0.134
Kirovohradska	0.360	0.197	0.374	0.232	0.235	0.118	0.391	0.450	0.936	0.278	-0.082
Luhanska	0.422	0.411	0.455	0.470	0.554	0.315	0.633	0.472	0.826	0.465	0.043
Lvivska	0.424	0.235	0.401	0.271	0.366	0.164	0.697	0.423	0.875	0.587	0.163
Mykolayivska	0.345	0.186	0.264	0.163	0.291	0.182	0.503	0.497	0.758	0.490	0.145
Odeska	0.364	0.214	0.405	0.470	0.316	0.199	0.579	0.321	0.693	0.457	0.094
Poltavska	0.427	0.283	0.601	0.391	0.480	0.377	0.546	0.420	0.639	0.305	-0.122
Rivnenska	0.452	0.368	0.573	0.295	0.302	0.065	0.622	0.317	0.786	0.301	-0.151
Sumska	0.444	0.308	0.632	0.369	0.481	0.299	0.557	0.509	0.909	0.561	0.117
Ternopilska	0.290	0.140	0.296	0.239	0.269	0.123	0.549	0.223	0.706	0.320	0.031
Harkivska	0.624	0.364	0.675	0.382	0.441	0.257	0.690	0.514	0.857	0.493	-0.131
Hersonska	0.650	0.318	0.508	0.410	0.605	0.242	0.805	0.488	0.946	0.655	0.006
Hmelnytska	0.542	0.152	0.274	0.102	0.284	0.108	0.499	0.195	0.713	0.174	-0.368
Cherkaska	0.388	0.276	0.388	0.231	0.418	0.123	0.987	0.189	0.465	0.228	-0.161
Chernivetska	0.426	0.215	0.446	0.214	0.375	0.234	0.835	0.411	0.637	0.548	0.122
Chernihivska	0.328	0.119	0.435	0.376	0.323	0.221	0.580	0.358	0.945	0.469	0.141
Kyiv	0.542	0.434	0.595	0.454	0.566	0.286	0.855	0.570	0.891	0.495	-0.048

Source: own research

Table 2
Integral indices of innovative technological activity across Ukrainian regions, 2009-2018

Administrative oblasts	Years 2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Deviation 2018-2009
Vinnytska	0.833	0.755	0.716	0.753	0.818	0.623	0.747	0.820	0.603	0.641	-0.192
Volynska	0.523	0.715	0.647	0.685	0.662	0.465	0.738	0.762	0.775	0.602	0.079
Dnipropetrovska	0.376	0.598	0.418	0.663	0.489	0.548	0.705	0.873	0.706	0.888	0.512
Donetska	0.649	0.646	0.679	0.716	0.665	0.520	0.542	0.835	0.863	0.804	0.156
Zhytomyrska	0.495	0.526	0.765	0.630	0.833	0.423	0.777	0.961	0.677	0.615	0.120
Zakarpatska	0.764	0.758	0.635	0.486	0.466	0.327	0.632	0.791	0.691	0.849	0.085
Zaporizka	0.237	0.281	0.948	0.648	0.777	0.530	0.673	0.719	0.640	0.524	0.287
Ivano-Frankivska	0.659	0.434	0.786	0.650	0.720	0.557	0.901	0.681	0.743	0.736	0.077
Kyivska	0.466	0.457	0.532	0.520	0.585	0.468	0.630	0.820	0.564	0.906	0.440
Kirovohradska	0.362	0.349	0.482	0.405	0.513	0.349	0.705	0.775	0.641	0.872	0.510
Luhanska	0.572	0.593	0.680	0.640	0.691	0.449	0.663	0.623	0.509	0.639	0.067
Lvivska	0.558	0.513	0.551	0.541	0.650	0.471	0.787	0.972	0.654	0.621	0.063
Mykolayivska	0.405	0.386	0.602	0.510	0.498	0.390	0.738	0.741	0.747	0.478	0.073
Odeska	0.590	0.651	0.589	0.695	0.560	0.470	0.756	0.940	0.697	0.673	0.083
Poltavska	0.638	0.602	0.394	0.482	0.427	0.351	0.986	0.863	0.665	0.827	0.189
Rivnenska	0.577	0.507	0.583	0.712	0.714	0.607	0.640	0.954	0.271	0.417	-0.160
Sumska	0.614	0.703	0.711	0.620	0.543	0.486	0.921	0.939	0.927	0.803	0.189
Ternopilska	0.485	0.447	0.704	0.489	0.437	0.465	0.609	0.913	0.982	0.680	0.195
Harkivska	0.653	0.634	0.689	0.728	0.699	0.486	0.797	0.839	0.811	0.812	0.159
Hersonska	0.416	0.519	0.747	0.633	0.782	0.750	0.779	0.751	0.608	0.640	0.224
Hmelnytska	0.381	0.730	0.953	0.828	0.698	0.324	0.501	0.644	0.356	0.336	-0.045
Cherkaska	0.557	0.703	0.676	0.711	0.557	0.371	0.696	0.677	0.972	0.726	0.169
Chernivetska	0.649	0.467	0.602	0.595	0.521	0.439	0.764	0.760	0.618	0.473	-0.176
Chernihivska	0.745	0.505	0.567	0.759	0.700	0.424	0.646	0.834	0.645	0.576	-0.169
Kyiv	0.645	0.737	0.617	0.704	0.556	0.557	0.546	0.892	0.586	0.688	0.042

Source: own research

Innovative activity certainly is an important feature of innovative technological competitiveness, however efficiency of innovative technological activity is of somewhat higher practical value, because it shows the values of realized innovative products, efficiency of the use of funds attracted in the form of spending on innovation, efficiency of the use of labor to create and introduce innovations, share of the volume of realized innovative products (goods, services) in economy. From this viewpoint, it is a positive fact that the range of Ukrainian regions is characterized by high values of integral index of efficiency of innovative technological activity. They are, for example, Kyiv (0.901) and Odeska (0.851), Harkivska (0.795), Lvivska (0.745), Kyivska (0.728), Hersonska (0.726), Zaporizka (0.649) oblasts (Table 3).

Table 3
Integral indices of efficiency of innovative technological activity across Ukrainian regions, 2009-2018

Administrative oblasts	Years 2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Deviation 2018-2009
Vinnytska	0.124	0.454	0.679	0.362	0.567	0.668	0.216	0.318	0.647	0.478	0.354
Volynska	0.117	0.520	0.813	0.256	0.421	0.508	0.688	0.364	0.085	0.599	0.483
Dnipropetrovska	0.472	0.348	0.294	0.425	1.000	0.417	0.234	0.137	0.077	0.290	-0.182
Donetska	0.610	0.257	0.216	0.250	0.385	0.163	0.531	0.671	0.507	0.165	-0.445
Zhytomyrska	0.120	0.289	0.507	0.877	0.939	0.343	0.532	0.348	0.428	0.279	0.159
Zakarpatska	0.306	0.508	0.585	0.705	1.000	0.692	0.358	0.288	0.246	0.460	0.153
Zaporizka	0.711	0.736	0.414	0.367	0.356	0.298	0.649	0.640	0.648	0.638	-0.073
Ivano-Frankivska	0.494	0.170	0.688	0.955	0.571	0.765	0.272	0.224	0.106	0.498	0.004
Kyivska	0.480	0.544	0.659	0.470	0.721	0.699	0.416	0.342	0.441	0.728	0.248
Kirovohradska	0.558	0.423	0.460	0.229	0.741	0.452	0.321	0.329	0.298	0.638	0.080
Luhanska	0.960	0.841	0.297	0.317	0.191	0.023	0.263	0.138	0.013	0.053	-0.906
Lvivska	0.609	0.374	0.398	0.473	0.657	0.559	0.712	0.588	0.504	0.745	0.136
Mykolayivska	0.376	1.000	0.481	0.149	0.436	0.261	0.063	0.199	0.405	0.160	-0.216
Odeska	0.094	0.170	0.418	0.589	0.851	0.522	0.542	0.238	0.122	0.656	0.562
Poltavska	0.301	0.535	0.369	0.898	0.377	0.565	0.160	0.096	0.031	0.076	-0.225
Rivnenska	0.539	0.446	0.652	0.413	0.621	0.815	0.554	0.211	0.090	0.567	0.028
Sumska	0.582	0.468	0.687	0.739	0.801	0.791	0.708	0.400	0.212	0.252	-0.331
Ternopilska	0.750	0.566	0.575	0.576	0.254	0.194	0.387	0.221	0.137	0.512	-0.238
Harkivska	0.682	0.461	0.354	0.747	0.795	0.657	0.748	0.661	0.633	0.780	0.099
Hersonska	0.406	0.782	0.625	0.679	0.495	0.864	0.298	0.349	0.457	0.726	0.321
Hmelnytska	0.197	0.079	0.654	0.804	0.739	0.474	0.563	0.401	0.261	0.245	0.048
Cherkaska	0.537	0.825	0.389	0.125	0.241	0.238	0.093	0.210	0.244	0.576	0.039
Chernivetska	0.803	0.675	0.764	0.647	0.537	0.398	0.701	0.499	0.319	0.268	-0.535
Chernihivska	0.331	0.941	0.166	0.123	0.075	0.103	0.078	0.151	0.283	0.596	0.265
Kyiv	0.488	0.901	0.732	0.638	0.738	0.387	0.389	0.359	0.400	0.652	0.164

Source: own research

However, essentially low values of integral index of efficiency of innovative technological activity were peculiar to a range of Ukrainian oblasts, for example for Poltavska (0.031), Luhanska (0.053), Mykolayivska (0.160) and Donetska (0.163) oblasts. Therefore, a considerable gap between the regions with much more efficient innovative activity and regions with its substantially lower level has emerged in the country. It is a negative point and it does not contribute to implementation of balanced approach to securing of innovative technological competitiveness of Ukrainian economy. Calculations show that all three groups – components of innovative technological competitiveness of economy – are of almost equal importance in the structure of integral index (Fig. 1). The weights of efficiency (33.7 %) and provision of innovative technological activity with resources (33.5 %) are somewhat higher, of innovative technological activity – somewhat lower (32.8 %), yet the weight of all three groups is high. Therefore, all these aspects should be sufficiently taken into account in forming and implementation of state policy of maintenance of economy's innovative technological competitiveness.

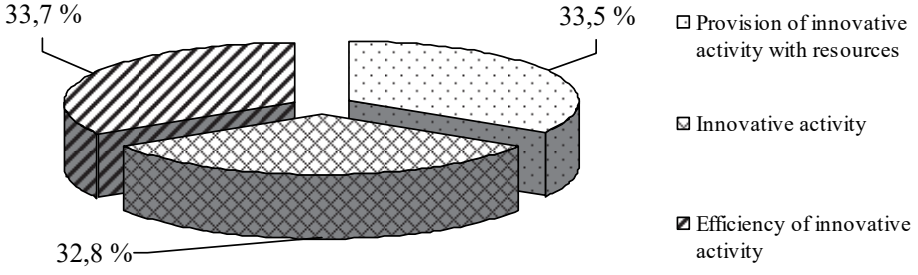

Fig. 1. Weights of the groups of Ukrainian economy's innovative technological competitiveness integral index.
Source: own research

Table 4 shows the results of calculation of Ukrainian economy's innovative technological competitiveness integral index in 2009-2018. It is possible to conclude that its condition is insufficient across the country's regions. In 2018, the value was the highest in Harkivska oblast – 0.776. The obtained value corresponds to average level by the scale of Harrington's desirability function (0.64-0.80). Only the following oblasts have the value of integral index at this level: Hersonska (0.679), Kyivska (0.678), Lvivska (0.678). It is worth paying attention to the values of oblasts, where the values of integral index of innovative technological competitiveness are extremely low, weakening the innovative technological competitiveness of Ukrainian economy in general, namely Hmelnytska (0.256), Luhanska (0.369), Poltavska (0.386) and Mykolayivska (0.290) oblasts. It should also be noted that in 2009-2018 the value of integral index of innovative technological competitiveness has improved in most regions of the country, which is a positive thing. Decline of the value was recorded only in Dnipropetrovska, Donetska, Luhanska, Poltavska, Rivnenska, Sumska, Hmelnytska and Chernivetska oblasts. Index decline was especially critical in Luhanska, Donetska and Chernivetska oblasts. On the other hand, the greatest improvements were peculiar to Kyivska, Odeska, Hersonska and Kirovohradska oblasts. Table 5 shows the dynamics of the change of the country's regions by the

values of integral indices of innovative technological competitiveness. We can observe that 2014 was characterized by substantial decline of integral index of innovative technological competitiveness in Ukrainian oblasts.

Table 4
Values of integral index of innovative technological competitiveness of Ukrainian economy, 2009-2018

Administrative oblasts	Years 2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Deviation 2018-2009
Vinnytska	0.489	0.512	0.627	0.482	0.615	0.553	0.550	0.549	0.659	0.541	0.052
Volynska	0.387	0.449	0.593	0.360	0.456	0.348	0.646	0.480	0.557	0.472	0.085
Dnipropetrovska	0.491	0.436	0.426	0.491	0.644	0.392	0.493	0.490	0.482	0.480	-0.010
Donetska	0.602	0.426	0.515	0.462	0.512	0.339	0.610	0.624	0.707	0.482	-0.120
Zhytomyrska	0.352	0.327	0.649	0.560	0.702	0.300	0.616	0.532	0.544	0.405	0.053
Zakarpatska	0.451	0.530	0.519	0.507	0.664	0.427	0.549	0.482	0.530	0.523	0.072
Zaporizka	0.541	0.503	0.582	0.399	0.479	0.325	0.623	0.562	0.634	0.612	0.071
Ivano-Frankivska	0.483	0.388	0.615	0.600	0.575	0.440	0.656	0.397	0.496	0.490	0.007
Kyivska	0.524	0.468	0.557	0.425	0.538	0.438	0.532	0.528	0.608	0.678	0.153
Kirovohradska	0.424	0.321	0.438	0.289	0.490	0.302	0.474	0.520	0.533	0.588	0.164
Luhanska	0.657	0.617	0.464	0.465	0.465	0.250	0.510	0.397	0.445	0.369	-0.288
Lvivska	0.530	0.375	0.451	0.429	0.558	0.398	0.733	0.664	0.678	0.650	0.120
Mykolayivska	0.388	0.528	0.466	0.290	0.422	0.289	0.463	0.506	0.665	0.395	0.007
Odeska	0.364	0.362	0.477	0.589	0.571	0.398	0.633	0.524	0.519	0.598	0.234
Poltavska	0.446	0.489	0.440	0.623	0.422	0.443	0.537	0.437	0.405	0.386	-0.060
Rivnenska	0.517	0.434	0.601	0.457	0.526	0.463	0.606	0.475	0.413	0.419	-0.098
Sumska	0.548	0.496	0.677	0.577	0.608	0.525	0.732	0.621	0.686	0.542	-0.006
Ternopilska	0.501	0.381	0.529	0.432	0.325	0.268	0.521	0.472	0.631	0.509	0.008
Harkivska	0.651	0.492	0.589	0.614	0.637	0.455	0.746	0.677	0.776	0.693	0.042
Hersonska	0.499	0.545	0.611	0.567	0.606	0.605	0.604	0.499	0.676	0.679	0.180
Hmelnytska	0.369	0.336	0.645	0.597	0.585	0.308	0.521	0.425	0.434	0.256	-0.113
Cherkaska	0.487	0.580	0.477	0.344	0.405	0.235	0.616	0.345	0.551	0.490	0.003
Chernivetska	0.620	0.444	0.597	0.484	0.477	0.359	0.769	0.569	0.538	0.439	-0.181
Chernihivska	0.469	0.536	0.385	0.416	0.363	0.248	0.427	0.445	0.613	0.550	0.080
Kyiv	0.556	0.678	0.646	0.590	0.619	0.401	0.609	0.599	0.638	0.604	0.049

Source: own research

Table 5
Positions of Ukrainian regions on the scale of Harrington's desirability function by integral index of innovative technological competitiveness in 2009, 2014 and 2018

Values	Performance	Years 2009	2014	2018
0.81-1.00	High	-	-	-
0.64-0.80	Sufficient	Luhanska (0.66) **Harkivska** (0.65)	-	**Harkivska** (0.69) ↑ **Kyivska** (0.68) ↑ **Hersonska** (0.68) ↑ **Lvivska** (0.65) ↑
0.38-0.63	Average	Chernivetska (0.62) Donetska (0.60) Kyiv (0.56) Sumska (0.55) **Lvivska** (0.53) **Kyivska** (0.52) Rivnenska (0.52) Zaporizka (0.54) Ternopilska (0.50) **Hersonska** (0.50) Vinnytska (0.49) Dnipropetrovska (0.49) Cherkaska (0.49) Ivano-Frankivska (0.48) Chernihivska (0.47) Zakarpatska (0.45) Poltavska (0.45) Kirovohradska (0.42) Mykolayivska (0.39) Volynska (0.38)	**Hersonska** (0.60) ↑ Vinnytska (0.55) ↑ Sumska (0.53) ↓ **Harkivska** (0.46) ↓ Rivnenska (0.46) ↑ **Kyivska** (0.44) ↓ Ivano-Frankivska (0.44) ↑ Poltavska (0.44) ↓ Zakarpatska (0.43) ↓ Kyiv (0.40) ↓ **Lvivska** (0.40) ↓ Odeska (0.40) ↑ Dnipropetrovska (0.39)↓	Zaporizka (0.61) ↑ Kyiv (0.60) ↑ Odeska (0.60) ↑ Kirovohradska (0.58) ↑ Chernihivska (0.55) ↑ Vinnytska (0.54) ↓ Sumska (0.54) ↑ Zakarpatska (0.52) ↑ Ternopilska (0.51) ↑ Ivano-Frankivska (0.49)↑ Cherkaska (0.49) ↑ Dnipropetrovska (0.48) ↑ Donetska (0.48) ↑ Volynska (0.47) ↑ Chernivetska (0.44) ↑ Rivnenska (0.42) ↓ Zhytomyrska (0.40) ↑ Mykolayivska (0.39) ↑ Poltavska (0.39)
0.21-0.37	Low	Hmelnytska (0.37) Odeska (0.36) Zhytomyrska (0.35)	Chernivetska (0.36) ↓ Volynska (0.35) ↓ Donetska (0.34) ↓ Zaporizka (0.33) ↓ Hmelnytska (0.31) ↓ Zhytomyrska (0.30) ↓ Kirovohradska (0.3) ↓ Mykolayivska (0.29) ↓ Ternopilska (0.27) ↓ Chernihivska (0.26) ↓ Luhanska (0.25) ↓ Cherkaska (0.23) ↓	Luhanska (0.37) ↑ Hmelnytska (0.26) ↑
0.00-0.20	Extremely low	-	-	-

Source: own research

Therefore, none of the oblasts entered the group with favourable level of competitiveness, and only Hersonska, Vinnytska, Rivnenska, Ivano-Frankivska and Odeska oblasts had higher values of integral index compared to 2009. However, a positive thing is that integral indices of economy's innovative technological competitiveness in the country's regions improved in 2018. Harkivska, Kyivska, Lvivska and Hersonska oblasts remain to be the leaders. Moreover, the regions had comparatively higher levels of competitiveness integral index in the whole analyzed period (2009-2018). Furthermore, Lvivska oblast achieved the highest growth paces, having increased the value of integral index of innovative technological competitiveness from 0.40 to 0.65 in 2014-2018. Lower values of integral index of economy's innovative technological competitiveness are peculiar to the rest of the country's regions; conditions in Luhanska and Hmelnytska oblasts are extremely threatening, requiring more efficient public policy of innovative technological development and strengthening of economy's competitiveness. Creation of new facilities for high technology production, introduction of innovations of higher technology mode in industry, boosting of innovative activity in basic economy sectors, establishment of export-oriented technology intensive domestic production, creation and expansion of the activity volumes of integrated trade-production and scientific-technological systems are of priority importance in the context of strengthening of innovative technological competitiveness of Ukrainian economy on the grounds of technological modernization (Fig. 2).

Fig. 2. Strategic priorities of strengthening of innovative-technological competitiveness of Ukrainian economy on the grounds of technological modernization
Source: own research

5. Conclusion

Based on the suggested analysis methodic the integral indices of innovative-technological competitiveness of economy across Ukrainian regions were evaluated. The paper has determined the average and low values of integral index peculiar to the

majority of country's regions, boosting the need to improve state policy of maintaining the reinforcement of innovative technological competitiveness of economy. Iinnovative technological modernization of existing and forming of new industries of the real economy sector as the basis of national economy competitiveness should become the strategic goal of state policy. Implementation of state policy is secured by the formed basic conditions and their harmonization with further strategic priorities: creation of new production in technology intensive industries with available resources capacity; increase of the share of production based on the use of technologies of the fifth and sixth technological modes; increase of the share of industrial production in basic economy sectors due to creation of new production with technological innovations; increase of the share of industrial enterprises that introduce innovative products and technologies; increase of the volumes and share of production and realization of innovative products (services); increase of export of technology intensive products; increase of the number of integrated entities that produce and sell technology intensive products (services) with participation of industrial enterprises and entities of IT, innovation, investment and R&D sectors.

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