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METHODOLOGICAL APPROACH OF INVESTMENT AND INNOVATION REGIONAL ENVIRONMENTAL POLICY USING THE SMART SPECIALIZATION AND QUINTUPLE HELIX MODELS

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ABSTRACT: The purpose of the study, therefore, is to form a methodological approach concerning the determination of dominants of investment and innovation regional environmental policy. The methodology bases on Smart Specialization and Quintuple Helix models. This research formulates the authorial vision for the combination of Quintuple Helix and Smart Specialization methodologies in order to determine the strategic priorities of investment and innovation policy of the national economy. It allows not only to define the dominants in nature but also to determine the uniqueness of regions based on scientific and technological potential, taking into account the priorities of individual Sustainable Development Goals. The presented research is an additional argument to existing official developments, as Guide on Research and Innovation Strategies for Smart Specialisation. A methodological approach has been developed, taking into account the methodology of "Smart Specialization" and in the context of existing European experience.

KEYWORDS: Quintuple Helix, Smart Specialization, Sustainable Development Goals, investment and innovation policy, natural resource potential

Introduction

In today's globalized and constantly changing world, is a prerequisite for resources and opportunities creation, on the basis of unique industrial and sectoral structures as well as a corresponding knowledge base. Effective use of public environmental investments and innovations, support of regions in the development of their innovation and investment potential, focusing limited human and financial resources on several competitive areas in order to promote the economic growth. This approach is the main direction of Quintuple Helix implementation (5 helix) methodology which adapted to modern needs of regional nature policy. It should be noted that modern researchers in the world consider innovation and investment policy at the macro, meso and micro levels through the prism of modern management models. One of the basic models of innovation and investment policy is the Triple Helix model (3 helix). The concept of interaction between the "University-Industry-Government" and "Triple Helix" was proposed in the 1990s by Professor Etzkowitz and his colleague Leydesdorff, which included the work of Lowe's predecessors and Sabato and Mackenzie. It describes the transition against the predominant industry-government dyad in industrial society to a more relevant triple interaction between universities, industry and government towards knowledge societies. Although at works of these and other researchers are used such names of the participants of this triad, in our opinion, more accurate to say about interactions "higher education institutions (HEIs) – business – government bodies t", and it's exactly what we'll use in the future.

Knowing that the Triple Helix can be considered as a heart, built into the Quadruple Helix (4 helix). Model 4 helix is conducive for successful implementation of the business process, stimulates intensive experimentation and invention, simultaneously intensifying the innovation activity. It can be used as an innovative architecture, an environment that allows you to simultaneously integrate four sectoral spaces based on dynamically balanced "from the top-down" and "from bottom to top" approaches: from the top-down – government, science, industry; from bottom to top – civil society. Inter- and intra-sectoral (as well as inter- and intra-regional) interfaces of knowledge and learning, built into the architecture of the quadro-spiral, determine its efficiency and stability. Campbell D.F.J. and others (2015) developed an innovative model into a five-pointed spiral, where the fifth constitutes the natural environment of society. Let's note that this methodology in combination with the ideologeme of Smart Specialization is actively considering in world science. This is the methodology with which the European Union has reviewed the rationale of the country's economic development. The Intelligent / Smart Specialization Platform (S3) was established by the European Commission in

June 2011 at the IPTS2 Joint Research Center in Seville, Spain. "Intelligent Specialization" (S3) is designed to assist EU Member States and regions in developing, implementing research and innovation strategies for Smart Specialization (RIS3). The Smart Specialization concept focuses on the development and implementation of innovative strategies that take into account regional characteristics, namely: economic structure, existing areas of excellence, clusters, research, research institutions, expansion of interregional and international networks of scientific and technical cooperation (Foray et al., 2012). Smart Specialization defines the interaction of economic sectors through the innovation and natural resource component, which creates sustainability between local economic entities. It is a combination of policy concepts, sectoral and cross-sectoral use of innovation and technology. Smart Specialization focused on 1) searching for dominant clusters of economic growth, areas with a small number of owners for simplified cooperation, 2) searching and reorganization of various specializations, 3) understanding the distribution of risks (Richardson, 2014).

This proposed methodology concerns not only developing new specializations in regions that have the potential to grow through local opportunities. It (so-called "Smart Specialization") is also the development of new specializations in regions that are unique in the world, more complex, that improve the local economy, in particular in the field of environmental management. The complexity of knowledge means the degree of sophistication and the number of opportunities required to develop new technology. Today, the regional policy of European countries is implemented together with the state innovation policy and policy to promote entrepreneurship, which creates conditions for the economic development of regions, effective use of existing potential (on approval of the State Strategy for Regional Development until 2020: Resolution of the Cabinet of Ministers of Ukraine of August 6, 2014 № 385. Official Gazette of Ukraine of 09.09.2014, № 70, p. 23, Article 1966, act code 73740/2014).

Analysis of recent studies and publications

Modern approaches to the management of innovation and investment systems in the world are gradually becoming transformed today. Note that at one time, leading international scientists (Carayannis, Campbell, 2012) formed the concept of the Quadruple Helix as a way to expand the triple spiral and open relatively closed processes of policymaking and innovation systems, thus making them more democratic. Early innovation systems, formed on the basis of the methodology of the so-called "Triple Helix", were based on

cooperation between universities, government and industry (Leydesdorff, Etzkowitz, 1996, 2000; Rubel, Zhykhareva, 2018). These systems were also to include the fourth spiral – the public and thus created the ideology of the quadruple model. The social capital and authorities of the regions are the glue that holds them together in the Quadruple Helix (4 helix spiral). The use of 4 helix for the intellectual interaction of regions implies a focus on the process of transforming the potential of business and communities for innovative and social learning (figure 1).

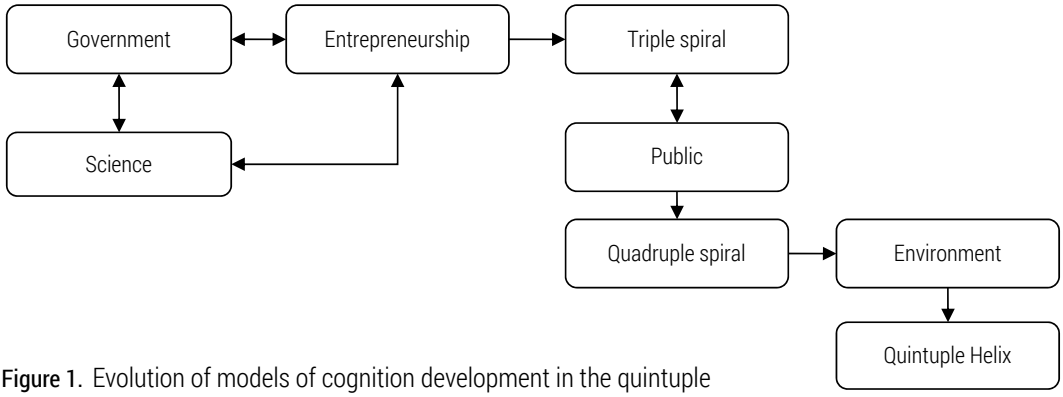

Figure 1. Evolution of models of cognition development in the quintuple spiral

Source: author's work based on Carayannis, Campbell, 2012.

Modern world researchers (Carayannis, Campbell, 2012) point to the importance of broadening the existing definition of democracy through the inclusion of not only political and civil law, but also the ideology of sustainable development. In this context, they have refined the concept of the triple innovation spiral from a regional point of view, considering it not only through the quadruple system of spirals, but also the quadruple, where the fifth spiral is a natural feature of a particular region. Thus, the expansion of the former innovation system includes the prospects of both democracy and environmental issues. Carayannis, E. G. etc. considered the model of the pentagonal spiral as a way of emphasizing the transformation of society and the modern economic system into an international paradigm of sustainable development. According to Carayannis, E. G., the quadruple spiral model consists of five spirals: the economic system, the environment, the media and culture, the public and the political system (Grundel, Dahlström, 2016) (figure 2).

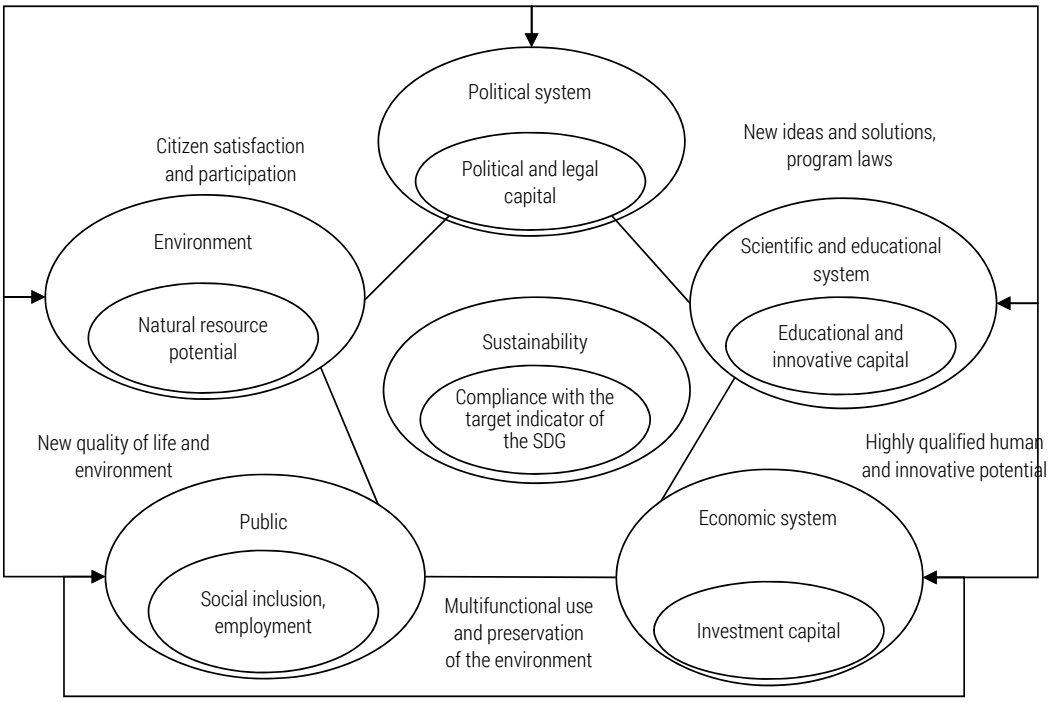

Figure 2. Effects of investment and innovation Quintuple Helix policy development
Source: author's work based on Carayannis, Campbell, 2012.

Note that the modern view of Quintuple Helix (5 helix) involves a combination of different approaches to implementation, including the use of Smart approach. In regional science, the result of the innovation process is closely related to the geographical (in this case, spatial or regional) context and institutional features (Doloreux, Parto, 2005). Different data sources require comprehensive use, but Smart-assessment does not always use complete and correct global and domestic scientific approaches to determine the nature of this process (table 1).

In 2018, the Resolution of the Cabinet of Ministers of November 14, 2018, № 959 came into force in Ukraine, according to which all regions within the regional development strategy must determine at least one strategic goal based on the European methodology of Smart Specialization. The Ministry of Economic Development, Trade and Agriculture planned to allocate UAH 6.75 billion in 2021-2023 for Smart Specialization of Regions. Strategic guidelines for regional development for 2021-2027 aimed at solving the tasks of the previous period, which was characterized by the financing of projects aimed at the development of funds, ignoring the creation of new jobs and increasing

budget revenues (Regional Development Strategies 2021-2027). Requirements for Smart Specialization are approved at the state level by the relevant resolutions of the Cabinet of Ministers of Ukraine "On approval of the Procedure for developing the State Strategy for Regional Development of Ukraine and action plan for its implementation, as well as monitoring and evaluating the implementation of this Strategy and Action Plan."

Table 1. Review of the literature on the disclosure of the essence of the methodology used in the coverage of Smart Specialization

Author	The essence of the methodology
(Ortega A.R., McCann, P., Perianez-Forte, I., Cervantes, M., Larosse, J., & Sanchez, L., 2013)	The use of methods for forecasting and diagnosing regional features to identify new activities, possible synergies and complementarities that may arise in the regional context.
(Sugimoto, C.R., Robinson-Garcia, N. and Costas, R., 2016)	Use of scientific publications on conducting diachronic network analysis to identify patterns of mobility among the location of the region.
(Bakhshi, H. and Mateos-Garcia, J., 2016)	Use of unstructured data to identify areas of technological and economic activity in a more accurate way by methods of information analysis.
Internet resources, public interactions	Use public feedback and increase the accountability of all stakeholders in the RIS3 process. Use of data and technologies of social media, online tools.
(Delaney, K. and Osborne, L., 2013)	Involvement of RIS3 beneficiaries and users, public consultations, expert recommendations, submission through web tools.

Source: aurhor's work.

In the process of Smart Specialization, zoning takes place by combining areas in science and education, areas of industrial production and areas not focused on science and technology, within which there are different subcategories. These categories reflect the main activities and interactions of knowledge, innovation and regional specificities in the EU. Today Ukraine is an industrial-agrarian country, but some experts emphasize the return of our state to the agrarian-industrial model. In this context, the provision of rational nature management in the regional policy will be of special importance. Ukrainian agricultural exports – grain, oil, livestock and poultry products, goods of processing industries – are almost international. Accordingly, for further effective development and taking into account the rich natural resource potential of our country, it is necessary to identify areas with a specific focus on nature management.

Research methods

A number of methods were used to analyze the regional context of innovation-investment and natural resource potential: comparison, tabular and graphical methods, rating evaluation methods, expert method, modelling method (figure 3).

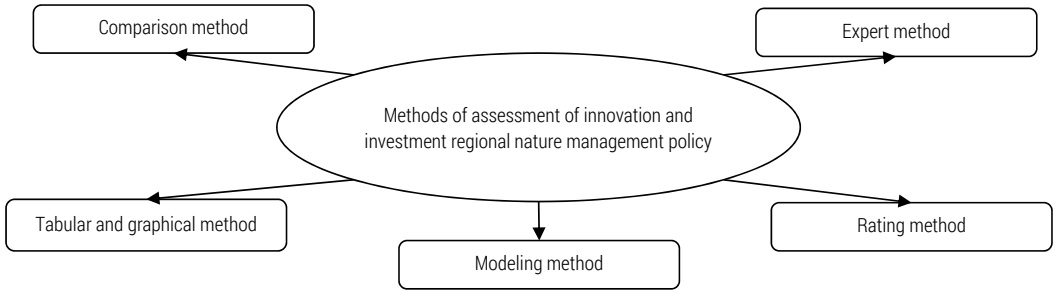

Figure 3. Methods of evaluation of investment and innovation regional nature management policy taking into account Smart Specialization

Source: author's work based on Рябоволик, Т.Ф., 2017, p. 71.

Using the comparison method, the evaluation was performed in comparison with the best analogues. Design issues for a method-comparison study include the selection of the measurement methods, number of measurements and the range of conditions over which the measurements are made (Hanneman, 2008). Expert methods provided an opportunity to assess phenomena and processes for which there are no statistics. The method by means of which obtained results are based on the opinions and assessments of competent experts is called expertise, an expert's opinion or the method of expert assessment (Iriste, Katane, 2018). This is an advantage of the methodological provisions in terms of transforming the structure of existing Ministries and Offices, as well as reducing the sources of primary information in the state. As a result of the reform of the Ministry of Ecology and Natural Resources to the Ministry of Energy and Environmental Protection, and then to the Ministry of Environmental Protection and Natural Resources of Ukraine, there is no single standard for regions on statistical reporting, as well as the latest data on some objects. In this regard, the methodological provisions use the rating method of research, the order of items by making judgements of absolute value, using a numerical scale (McGraw-Hill Dictionary of Scientific & Technical Terms, 6E., 2003). It reflects the ranking of the region by a group of indicators rating method of assessment. The method of comparison allowed

not only to determine the dominants of investment and innovation policy of nature management but also to present a comprehensive economic and environmental assessment of regional development. Note that when making management decisions in the field of environmental management is an essential and necessary tool of the analytical stage is the involvement of external experts.

Modelling method used in creating a comprehensive assessment of the priority of implementation of Smart-projects in the field of nature management. With the modelling method, every problem is solved by creating a model or, more often, adapting a known model to the specifications of the problem. The modelling method may facilitate the solution of textbook problems by providing deeper physical insight. But it also supports a deemphasis on textbook problems (Hestenes et al., 1995). With tabular and graphical method have designed all calculations and research schemes. Tabular method a set of qualitative data can be summarized by constructing a frequency distribution. The graphical method used to visually describe data from a sample (Descriptive Stats: Tabular & Graphical Methods, 2020).

Results of the research

The study proposes a methodological approach to a comprehensive assessment of the dominants of investment and innovation regional environmental policy, taking into account European practices, based on the philosophy of the Quintuple Helix (5 helix) model of the international paradigm of sustainable development, the methodology for assessing innovation and investment and resource potential. smart specialization of regions taking into account their resource-ecological base.

Under the *investment and innovation policy of nature management of the regions*, the authors understand the activities of state and regional bodies aimed at creating favourable institutional and economic conditions to stimulate the implementation of environmentally oriented investments and innovations in economic activities of regional regions, taking into account the available natural resource potential. *Assessment of innovation and investment regional nature management policy* is a process of the systematic study of the results of economic and environmental interactions and environmental consequences of management at the regional level, which is based on a comprehensive analysis of relevant areas of planned investment and innovation activities. *Natural resource potential* is a set of identified and usable natural resources at a given level of production (in the world, country, region, local level). It is the most important part of the national wealth of the country

(region) and ensures their raw materials and fuel independence and security. *Dominant positioning of the region* is an economic concept used in investment and innovation policy in determining the fact of the dominant regional market position.

The key role in maintaining the competitiveness of economic systems belongs to the innovative specialization of economic activity, which diversifies economic activity. The lack of a clear innovation-oriented specialization of production and the trend towards the concentration of innovation-oriented services indicates the necessary development of relevant clusters (Бакушевич, Гощинська, Мартиняк, 2019, p. 240). Unlike traditional ones, they should include so-called institutions of knowledge and attracting talents to the place of concentration of resources and financing of their efficient and rational use. In Ukraine, systemic obstacles that hinder the formation of "Smart Specialization" are associated with the centralized and universal nature of strategic planning of economic development, which does not take into account the conditions and needs of specific regions. Regions (table 2).

Table 2. Dynamics of the rating of some countries according to the Innovation Efficiency Index for 2010-2018

Country	2010	2012	2014	2015	2016	2017	2018
Ukraine	54	14	14	15	12	11	5
Kazakhstan	77	131	118	124	108	116	111
China	14	1	2	6	7	3	3
USA	63	70	57	33	25	21	22
Germany	56	11	19	13	9	7	9
Poland	85	80	76	93	66	48	42
India	101	2	31	31	63	53	49
Japan	18	88	88	78	65	49	44
Switzerland	15	5	6	2	5	2	1
Luxembourg	5	8	9	3	1	1	2

Source: author's work based on The Global Innovation Index 2010-2018.

Analysis of the financing of existing priority areas of innovation is carried out in Ukraine on the basis of the Law of Ukraine "On Priority Areas of Innovation in Ukraine", which defines seven strategic priority areas of innovation, and the Cabinet of Ministers of Ukraine dated 28.12.2016 №1056, which strategic priorities identified 41 medium-term priority areas of innovation at the national level (On priority areas of innovation in Ukraine № 3715-VI).

The number of enterprises that have implemented environmental innovations is characterized by uniformity between regions, but the highest level is occupied by the Rivne region, Vinnytsia and Poltava.

Smart Specialization (S3) focuses on the role of universities and university research as a key driver of innovation and regional development. This is seen as providing the necessary cohort of skilled knowledgeable professionals who can conduct research, commercialize intellectual property and catalyze the adoption of research.

The business process will be different in each region according to the density of innovators and entrepreneurs in some regions and low population, a small number of sectors and large dominant organizations, but with few external links – in others. In accordance with the Procedure for evaluation of regional development projects that can be implemented at the expense of the state budget received from the European Union (On amendments to the Procedure for evaluation of regional development projects that can be implemented at the expense of the state budget received from the European Union On 165), the expected result is to increase the competitiveness of regions through the development of regional and local economies based on the effective use of existing potential, existing competitive advantages, creating a favourable investment environment, modernization of the real sector of the economy, growth of export potential, creating conditions for innovation processes taking into account the principles of Smart Specialization. Preservation and restoration of natural areas have found their place in the areas of rural and tourist development of the regions.

The territory of Ukraine is rich in natural resources that need to preserve and improve their ecological condition, overcome the consequences of irrational use of nature and take measures to prevent further depletion of natural resources. Carrying out appropriate measures and solving environmental problems by greening enterprises and institutions require increased investment in environmental protection.

Given the existing trends in world science on the active implementation of the Quintuple Helix (5 helix) model in the domestic economy, which is adapted to modern needs of sustainable development and regional environmental policy, it is important to define methods, formulations, procedures and indicators of its implementation in practice. Note that the modern vision of this approach in the regional dimension is just being formed. This scientific direction in the world community is primarily associated with the combination of the methodology of Smart Specialization and individual Sustainable Development Goals.

Monitoring and evaluation of the effectiveness of the implementation of investment and innovation regional policy are carried out in order to moni-

tor the process of its implementation, identify problems of regional development and the reasons for their occurrence, increase the effectiveness of management decisions. It provides for periodic monitoring of relevant indicators on the basis of available official statistics and information.

Monitoring the implementation of regional policy is carried out by determining the list of relevant indicators, tracking their dynamics, preparation and publication of the results of such monitoring and includes: monitoring the implementation of indicators of the objectives of documents defining regional policy (in this scientific work – determination of optimal values of indicators of resource and ecological productivity according to SDG by regions of Ukraine); monitoring of socio-economic development (in this scientific work – innovation and investment regional nature management). The synergy of investment and innovation is an integral part of the country's economic development. To succeed in an innovative project, there is a need for a ratio between the initial investment and financial return. After all, any innovative project is an investment, as a result of the fact that companies face the most important financial goal – to maximize profits. One of the main features of the Smart Specialization approach is that the region must make strategic decisions taking into account its position in interaction with other regions. The region must determine its competitive advantages by systematically comparing with other regions, comparing national and international contexts for effective benchmarking. The region should be able to identify relevant links in trade, services and knowledge, thus identifying possible integration models and schemes with partner regions. This is especially important for less developed regions. The position of the regional business sector in the framework of international industrial interactions (value chain), in this regard, is the most important element (A Guide to Research and Innovation Strategy for Smart Specializations).

Implementation of the Smart Specialization Strategy, which will provide a combination of the above components will provide an opportunity to determine the approach to the formation and implementation of state regional policy. The search for a dominant position of the regions is aimed at preventing the growth of disparities that hinder the development of regions and should be ensured through a coherent policy to stimulate the development of "growth points" and support economically less developed and depressed areas.

In Ukraine, the largest number of higher education institutions is concentrated in Kharkiv, Dnipropetrovsk, Lviv and Odesa regions. Most higher education institutions are subordinated to the Ministry of Education and Science of Ukraine. The Ministry of Agrarian Policy and Food of Ukraine and the State Agency of Forest Resources of Ukraine, which primarily train specialists in

natural sciences, occupy the middle link in the ranking of universities by number in the country. The training of nature specialists in universities and colleges is more common in the agricultural sciences. Innovative literature tends to exaggerate the role and effectiveness of university-based research and development, emphasizes the creation of knowledge rather than the dissemination and exploitation of knowledge, and prioritizes research universities over other types of educational institutions and opportunities.

There is a lack of good strategic intelligence or forecasting models, and often a commitment within education, especially higher education, that it should not be too closely aligned with business and economics. Despite the average level of provision of the country with higher education institutions with the predominance of environmental sciences, employment in this area is characterized by negative dynamics in recent years. Priorities are usually set by the institution based on the competencies of teachers/academics, interests and priorities, which are not always well aligned with the (changing) socio-economic context and do not change easily due to contractual issues. There are also no mechanisms through which the vision of the region can be discussed, agreed and implemented. In this context, it is very important to strengthen the environmental component in the scientific and educational spheres in order to further implement the borrowed knowledge in the formation of investment and innovation policy of nature in certain regions.

A comprehensive assessment of investment and innovation policy of the region in the proposed methodological approach is carried out on four groups of factors, namely:

- economic activity and investment potential of environmental protection of the regions of Ukraine (factor 1: GRP, UAH million; capital investments for environmental protection, UAH million; capital investments for environmental protection at the expense of own funds of enterprises, UAH million),
- the scientific and innovative potential in the field of nature management of the regions of Ukraine (factor 2: scientific and innovative activity of Ukraine; employment in the field of nature management; universities of I-IV levels of accreditation; the number of students),
- resource and environmental productivity according to the SDG by regions of Ukraine (factor 3: carbon productivity of GRP; GRP energy consumption; water capacity of GRP; waste productivity GRP),
- natural resource status of regions (factor 4: provision with average long-term river runoff; drinking and technical groundwater reserves; underground mineral water reserves; area of nature reserve fund; forests and other wooded areas; afforestation area; agricultural land; combustible natural gas; oil, brown, coal, peat; metallic minerals).

Table 3. Analysis of the group of indicators of economic activity and investment potential of the environmental orientation of the regions of Ukraine

Region	GRP, UAH million	Cap. invest. for environmental protection, UAH million	Cap.invest. for environmental protection at the expense of own funds of enterprises, UAH million	The sum of points for assessing strengths and weaknesses
Vinnytsia region	++	+	+	4
Volyn region	+	+	+	3
Dnepropetrovsk region	++++	++++	++++	12
Zhytomyr region	+	+	+	3
Transcarpathian region	+	+	+	3
Zaporozhzhia region	++	++	++	6
Ivano-Frankivsk region	+	+	+	3
Kyiv region	++	+++	+	6
Kirovograd region	+	+	+	3
Lviv region	++	+	+	4
Mykolayivska region	+	+	+	3
Odesa region	+	+	+	3
Poltava region	++	+	+	4
Rivne region	+	+	+	3
Sumy region	+	+	+	3
Ternopil region	+	+	+	3
Kharkiv region	+++	+	+	5
Kherson region	+	+	+	3
Khmelnytsky region	+	+	+	3
Cherkasy region	+	+	+	3
Chernivtsi region	+	+	+	3
Chernihiv region	+	+	+	3

Source: author's work.

The first stage is the analysis of the first group of indicators of economic activity and investment potential of environmental orientation *(factor 1)*, which was formed from indicators (table 3): gross regional product; state capital investments in environmental protection; capital investments in environmental protection at the expense of own means of the enterprise, the

organizations, establishments. For the analysis of *factor 1,* the maximum values on each indicator of the group with equal to 10 points are defined. In this case: the calculated score for all regions according to the highest score; the expert assessment (by highly qualified experts – scientists of the Institute of Market Problems and Economic&Ecological Research of the National Academy of Sciences of Ukraine, dealing with Smart Specialization and environmental economics) was evaluated according to the formula: (where B – score according to the value of each indicator in the group, K – the weighting factor of each indicator in the group); identified strong 9-10 (++++), moderate 6-8 (+++), neutral 3-5 (++) and weak 0-2 (+) sides; calculated the number of points for determining the dominants and a comprehensive assessment of the priority of implementation of Smart-projects in the field of nature management.

At the second stage, the *second factor* of assessment of scientific and innovative potential in the field of nature management *(factor 2)* (table 4) was determined by indicators:

- scientific and innovative activity of Ukraine,
- employment of the population in the field of nature management,
- number of higher bulk institutions of I-IV levels of accreditation by regions,
- number of students.

Table 4. Analysis of the group of indicators of economic activity and investment potential of the environmental orientation of the regions of Ukraine

Region	Scientific and innovative activity of Ukraine	Employment in the field of nature management	Universities of I-IV levels of accreditation	Number of students	The sum of points for assessing strengths and weaknesses
Vinnytsia region	+++	++++	++	+	10
Volyn region	++	++	+	+	6
Dnepropetrovsk region	+++	++	+++	+++	11
Zhytomyr region	++	++	++	+	7
Transcarpathian region	++	+++	+	+	7
Zaporozhzhia region	++	+++	++	++	9
Ivano-Frankivsk region	++	+++	+	+	7
Kyiv region	+++	+	++	++	8
Kirovograd region	++	++	+	+	6
Lviv region	++	++++	+++	+++	12

Region	Scientific and innovative activity of Ukraine	Employment in the field of nature management	Universities of I-IV levels of accredita-tion	Number of students	The sum of points for assessing strengths and weaknesses
Mykolayivska region	++	+++	+	+	7
Odesa region	++	+++	+++	+++	11
Poltava region	+++	+++	++	++	10
Rivne region	++++	++++	+	+	10
Sumy region	++	++	+	+	6
Ternopil region	++	+++	++	+	8
Kharkiv region	++	+++	++++	++++	13
Kherson region	+++	+++	++	+	9
Khmelnytsky region	++	+++	++	+	8
Cherkasy region	+	+++	+	+	6
Chernivtsi region	++	++	+	+	6
Chernihiv region	+++	++	+	+	7

Source: author's work.

The third stage was calculated resource and environmental productivity according to the SDG by region *(factor 3)* (table 5), by indicators:

- carbon productivity (environmental productivity),
- GRP energy intensity (resource productivity),
- GRP water capacity (resource productivity),
- waste GRP (environmental productivity).

Table 5. Analysis of the group of indicators of resource and environmental productivity according to the SDG by regions of Ukraine

Region	Carbon product GRP	Energy intensity of GRP	Water capacity GRP	Waste product GRP	The sum of points for assessing strengths and weaknesses
Vinnytsia region	+	++	+++	+	7
Volyn region	++	+	++	+	6
Dnepropetrovsk region	+	+++	+	++++	9
Zhytomyr region	++	++	+++	+	8
Transcarpathian region	++	+	+++	+	7
Zaporizhzhia region	+	+++	+	+	6
Ivano-Frankivsk region	+	++++	++	+	8
Kyiv region	++	++	++	+	7
Kirovograd region	++	+	+++	+	7
Lviv region	+	++	+++	+	7
Mykolayivska region	+	++	+	+	5
Odesa region	+	++	+	+	5
Poltava region	+	++	++++	+	8
Rivne region	+	+++	++	+	7
Sumy region	+	++	++	+	6
Ternopil region	++	+	+++	+	7
Kharkiv region	+	++	++	+	6
Kherson region	+++	++	+	+	7
Khmelnytsky region	+	++	++	+	6
Cherkasy region	+	++	++	+	6
Chernivtsi region	++++	++	++	+	9
Chernihiv region	+	++	++	+	6

Source: author's work.

The fourth stage is the assessment of the natural resource status of the regions *(factor 4)* (table 6) by indicators:

- provision of average long-term river runoff,
- drinking and technical groundwater reserves,
- underground mineral water reserves,
- area of the nature reserve fund,

- forests and other wooded areas,
- afforestation areas,
- areas of agricultural land,
- combustible minerals (combustible natural gas, oil, lignite and peat, peat),
- metallic minerals.

Table 6. Analysis of the group of indicators of natural resource status of the regions of Ukraine

Region	1	2	3	The sum of points for assessing strengths and weaknesses
Vinnytsia region	++	+++	+	6
Volyn region	+	++++	+	6
Dnepropetrovsk region	+++	+++	+	7
Zhytomyr region	+	++++	++	7
Transcarpathian region	++	+++	+	6
Zaporozhzhia region	+++	++++	+	7
Ivano-Frankivsk region	++	+++	++	7
Kyiv region	++	+++	+	6
Kirovograd region	++	+++	+	6
Lviv region	++++	+++	+	8
Mykolayivska region	+	++	+	4
Odesa region	++	+++	+	6
Poltava region	++	++++	++	8
Rivne region	+	+++	+	5
Sumy region	++	++++	+	7
Ternopil region	++	+++	+	6
Kharkiv region	+++	+++	+++	9
Kherson region	+	++++	+	6
Khmelnytsky region	++	++++	+	7
Cherkasy region	++	++	+	5
Chernivtsi region	+	+++	+	5
Chernihiv region	++	++++	+	7

Source: author's work.

At the fifth stage, the sum of points on four factors was calculated to determine the dominants of investment and innovation policy of the regions and to form a priority rating for the implementation of Smart-projects in the field of nature management (figures 4, 5).

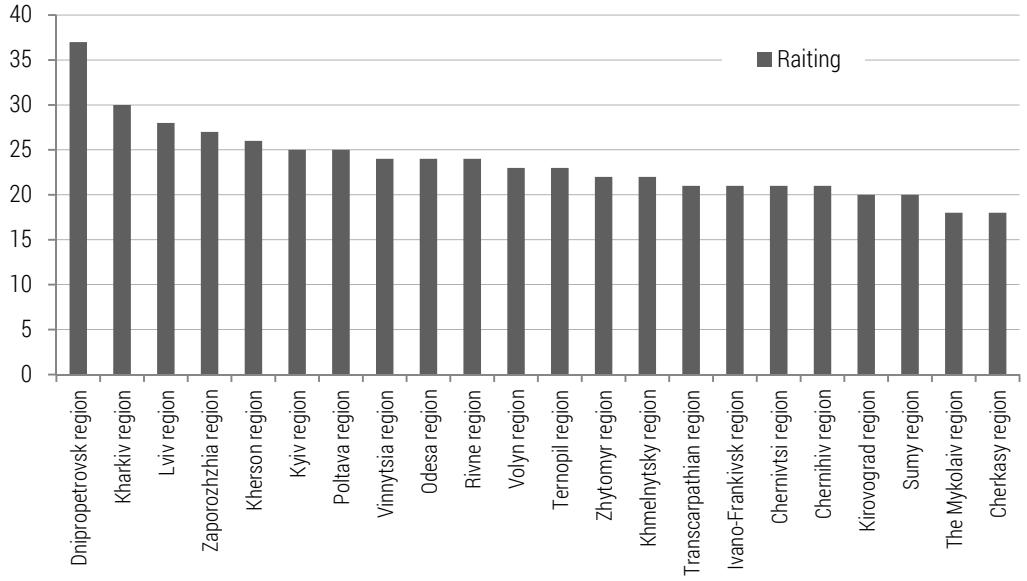

Figure 4. Rating of development of investment and innovation regional policy of nature management of regions by groups of indicators of Smart Specialization

Source: author's work.

To substantiate the group of indicators of natural resource status of the regions of Ukraine, three subgroups of indicators were outlined and systematized.

The first (1) included: provision of average long-term river runoff; drinking and technical groundwater reserves; underground mineral water reserves.

To the second (2) group: Nature reserve fund areas; forests and other wooded areas; afforestation areas; agricultural land.

To the third (3) group: combustible natural gas; oil, brown, coal, peat; metallic minerals.

Strengths and weaknesses were determined by calculating the sum of the scores of the subgroup, namely: strong 20-18 (++++), moderate 17-12 (+++), neutral 11-6 (++) and weak 0-5 (+) sides.

The analysis of economic activity and investment potential of the environmental orientation of the regions of Ukraine allowed us to determine that

in most regions the production of the gross regional product is a strong point of development. The volumes of investments actually disbursed in the reporting period at the expense of the state budget of Ukraine and local budgets for environmental protection are characterized by growing dynamics but are generally not a strong point of regional development.

The EU's Smart Specialization platform provides both information and expert and financial support using the resources of the European Structural and Investment Funds. The pilot regions will receive individual support from the European Union to quickly remove investment barriers and innovate. In addition, we are talking about the automation of production, the transition to alternative energy sources – depending on the Smart Specialization of a particular region. Today, only three regions of Ukraine have been selected as participants in the EU's Smart Specialization platform: Odesa, Kharkiv and Zaporizhzhia (Odesa region was chosen to participate in the EU project "SMART-specialization").

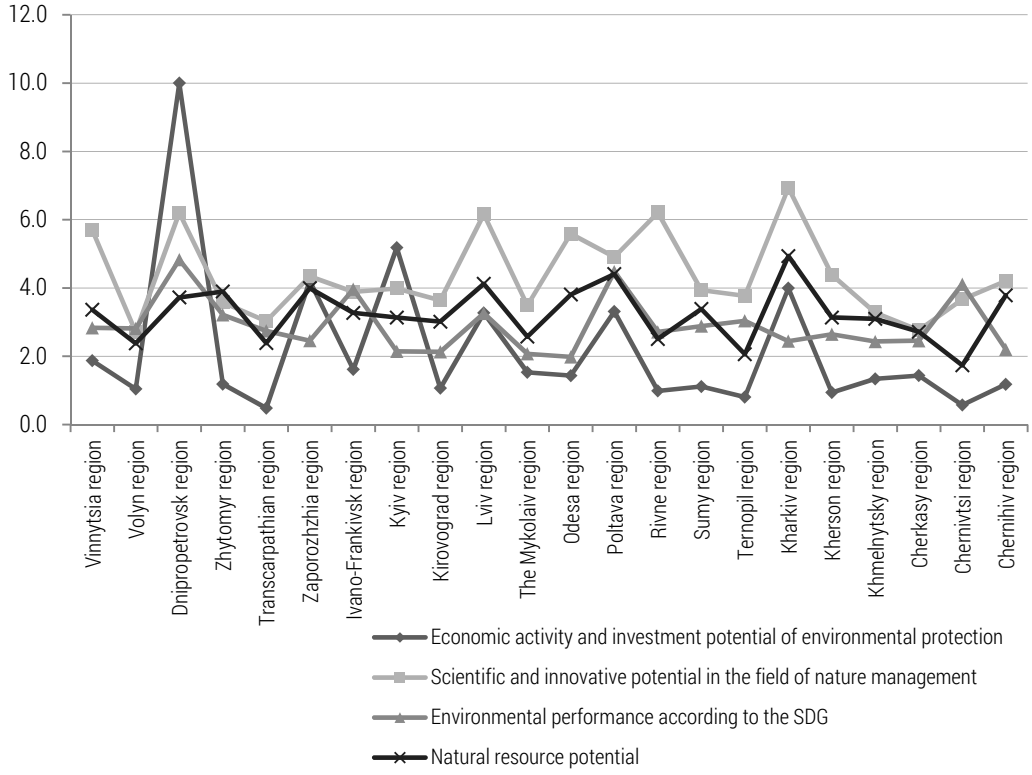

Figure 5. Comprehensive assessment of the priority of implementation of Smart-projects in the field of nature management

Source: author's work.

The scientific and innovative potential of the regions of Ukraine is the strongest component of the development of Smart Specialization. Only in a few areas does it need significant support and cooperation. Employment in the field of nature management is characterized by an almost equal distribution among the regions. The location of higher education institutions is the weakest component of the group, as is the concentration of students (talents). Achieving the Sustainable Development Goals is presented by the best results in fulfilling the task of increasing water capacity. The field of waste productivity is characterized by a low level of development among almost all areas. Energy intensity productivity is in second place among the goals achieved by the regions, carbon productivity – the penultimate. The natural resource potential of the regions is determined by the highest indicators of development of forest and nature reserves. Provision of supplies of drinking, technical, groundwater and river runoff as well as rational and efficient use of agricultural land is the primary tasks at the present stage of development of Ukraine's economy. Gaps in the use of natural resource potential are minerals, combustible and metallic. However, this is more about their natural occurrence than organizational and economic issues.

Conclusions

Modern approaches to the management of innovation and investment systems in the world are gradually being transformed today. The presented scientific article substantiates the methodological approach for determining the dominants of investment and innovation policy at the regional level through a comprehensive combination of concepts Quintuple helix, Smart Specialization and Sustainable Development Goals. The institutional essence of investment and innovation policy of nature management at the regional level as a modern model of Quintuple helix is determined. The study analyzes the compliance of the priorities of investment and innovation policy of the region with the Sustainable Development Goals.

The Quintuple Helix model is a way of emphasizing the transformation of society and the modern economic system into an international paradigm of sustainable development. Note that the modern view of Quintuple helix involves a combination of different approaches to implementation, including the use of Smart approach. The expansion of the former innovation system should include the prospects for both democracy and environmental issues.

The authors formed a categorical-conceptual apparatus and proposed a methodological approach to determine the dominants of investment and innovation policy, which is based on a step-by-step study: monitoring the

implementation of indicators (indicators) of documents that determine regional policy (determining optimal values of resource and environmental productivity of regions of Ukraine); monitoring of the innovation and investment regional sphere of nature management.

The proposed methodological approach allows not only to outline the dominants in the field of nature management but also to determine the uniqueness of the regions, based on scientific and technical potential, taking into account the priorities of the Sustainable Development Goals. Note that the proposed research is an additional argument to existing official developments, as Guide on Research and Innovation Strategies for Smart Specialisation. The study found that the number of enterprises that have implemented environmental innovations is characterized by uniformity between regions, but the highest level is occupied by the Rivne region, Vinnytsia and Poltava. The concentration of higher education institutions in Ukraine is concentrated in Kharkiv, Dnipropetrovsk, Lviv and Odesa regions. The training of specialists in nature management among universities and colleges is more numerous in the agricultural sciences. The Ministry of Agrarian Policy and Food of Ukraine and the State Agency of Forest Resources of Ukraine, which primarily train specialists in natural sciences, occupy the middle link in the ranking of universities by number in the country. Employment in the field of nature management is characterized by negative dynamics in recent years.

The authors assess the investment potential of the regions, which justifies the prospects of such regions as Dnipropetrovsk, Kharkiv and Kyiv. The indicators of Zaporizhia, Lviv and Poltava regions are quite close. The dynamics of capital investment in environmental protection by type of environmental protection measures over the years is defined as positive. According to the analysis of capital investments developed by enterprises and organizations for environmental protection measures, the largest share of developed investments was in Kyiv region, now the first places are taken by Odesa, Dnipropetrovsk and Zaporizhia regions. The dynamics of implementation of environmental measures and solving environmental problems represents that in Rivne, Vinnytsia and Odesa regions the indicators of financing the implementation of environmental measures have reached the greatest importance, in Kyiv – large-scale financing of greening and solving environmental problems.

The authors prove that the dynamics of reducing the total amount of emissions of pollutants into the atmosphere from stationary sources is characterized in Volyn, Zhytomyr, Ternopil, Kherson, Chernivtsi regions as positive. The assessment of energy deviation indicates the presence of a significant number of regions that do not increase energy intensity in accordance with the Sustainable Development Goals, namely Vinnytsia, Dnipropetrovsk,

Zaporizhia, Ivano-Frankivsk, Odesa, Poltava, Rivne, Cherkasy, Chernivtsi, Chernihiv regions. The water content in two oblasts, Zaporizhia and Kherson regions, significantly exceeds the target. The goal of reducing the volume of waste generation and increasing the volume of their processing and reuse on the basis of innovative technologies and industries in Zakarpattia, Kyiv, Kharkiv and Kherson regions has been practically fulfilled.

The authors, when studying the natural resource state of the country in terms of regions according to the statistical database, found that the dynamics of growth of areas of nature reserves is characterized by relative stability. Forest lands are mainly located in Zhytomyr, Rivne, Chernihiv and Zakarpattia regions. Afforestation is characterized by unstable dynamics, the largest areas were in the Kherson region those are now the Vinnytsia region. The highest share of arable land is in steppe areas and forest-steppe zone. The increase in Ukraine's energy potential is also associated with the possibility of using minerals in the Dnipropetrovsk region. The leading place among the territories of groups of combustible minerals was taken by the Volyn region, in the second place – Kharkiv, Lviv. Dnipropetrovsk, Zaporizhia and Poltava regions predominate among the reserves of metallic minerals.

According to the results of the research, the principles of Smart-specialization of regional development of Ukraine are determined. In particular, today only three regions of Ukraine have been selected as participants in the EU's Smart-Specialization platform: Odesa, Kharkiv and Zaporizhia.

In most regions, the production of the gross regional product is a strong point of development. Investment volumes are characterized by growing dynamics but are generally not a strong point of regional development. Volumes of investments mastered at the expense of own funds of enterprises are positively reflected in Dnipropetrovsk and Zaporizhia regions. The scientific and innovative potential of the regions of Ukraine is the strongest component of the development of smart specialization.

Achieving the Sustainable Development Goals is represented by the best results in fulfilling the task of increasing energy intensity. The field of waste productivity is characterized by a low level of development among almost all areas. Carbon productivity is in second place among the achieved goals by the regions, water capacity – the penultimate. The natural resource potential of the regions is determined by the highest indicators of development of forest areas and nature reserves.

Involvement in innovation processes of educational institutions, companies, government agencies and users of innovations will be a driver of talent mobilization to meet the capabilities and needs of strong regions. The development of environmental investments and innovations requires the delineation of priorities based on strengths, avoidance of duplication and fragmen-

tation of the concentration of funding sources. The use and preservation of natural resource potential require the development of specialized clusters and the provision of space for intersectoral relations within the region and abroad, which contributes to technological diversification.

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The contribution of the authors

Natalya Andryeyeva – 38% (substantiated methodical provisions on the combination of Quintuple helix methodology, Smart-specialization and Sustainable Development Goals; defined the institutional essence of investment and innovation policy of nature management at the regional level as a modern model Quintuple helix).

Hanna Tiutiunnyk – 38% (conducted an assessment of the innovation potential of the regions as a component of investment and innovation policy of nature management; analyzed the dynamics of implementation of environmental innovations by enterprises of Ukraine, the concentration of higher education institutions of I-IV levels of accreditation in terms of regions, in particular, subordinate government agencies; determine the number of students, specialists in higher education institutions majoring in natural sciences, employment in the field of nature management).

Borys Burkynskyi – 12% (comparative characteristics of statistical data Ukraine – EU countries).

Nina Khumarova – 6% (studied the natural resource potential of the country in terms of regions according to the statistical database).

Larysa Kupinets – 6% (established that it is very important to strengthen the environmental component in the scientific and educational spheres in order to further implement the borrowed knowledge in the formation of investment and innovation policy of nature management of individual regions).

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