“Regional smart specialization in Ukraine: JRC methodology applicability”

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REGIONAL SMART SPECIALIZATION IN UKRAINE: JRC METHODOLOGY APPLICABILITY

Abstract

Regional development is related to the effective management of disruptive industries on the local level. In the European Union, the innovation regional development policy is based on a smart specialization strategy, which neighboring countries try to apply as well. In their regional strategies, they notice the goals which are designed within the Joint Research Center methodology. It allows revealing the most efficient industries in the region, leading to a new level of regional competence on the global level. The study aims to identify smart specialization priorities based on JRC methodology in certain Ukrainian regions and assess its applicability in emerging markets (Ukrainian case) and develop the set of recommendations considering the specificity of the national economy.

The methodology is based on the static and dynamic analysis of economic (the indicators of the growth of average salaries and the number of employees indicators are calculated) and innovation (the indicators of productive, process, organizational, and marketing innovations are analyzed) potential of the region, which is examined in the article. It is revealed that the JRC methodology in identifying the smart specialization priorities has limited application in Ukraine. The restrictions related to the lack of data on innovations and other economic indicators. The analysis of certain regions shows what industries should be recommended as the priorities of smart specialization. However, discussions of the calculated results with the key stakeholders have differences which are not acceptable in the regional innovation policy development. As a result, the experts' opinions are recommended to consider the priorities of different regions in Ukraine and other developing countries, which are on the path of smart specialization during stakeholders' communication sessions.

Keywords innovative industries, regional development, smart specialization, global competence, economic potential, innovation potential

JEL Classification R11, R13, O14, O31, Q55

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INTRODUCTION

Implementing the smart specialization approach in regional strategies is considered a key factor in achieving a disruptive regional development. Smart specialization allows the region to be competitive on a global scale. The identification of the main priorities determining the direction of regional development is extremely important. The regional innovation policies cannot support all the industries for further development. Thus, the most perspective and the effective ones should be identified for their point stimulation through R&D, direction of financial support, engaging private stakeholders in innovation entrepreneurship, and other instruments. Accurate calculations based on reliable statistics can support this process, and the results should be a basis for certain regional strategy.

Moreover, the revealed smart specialization priorities play a crucial role in building a network between different regions, even those which

are placed far apart from each other and, at the same time, have much in common r to boost and stimulate regarded regions development.

This study provides an in-depth analysis of the regional economic potential based on smart specialization and innovative industries' effectiveness in the selected Ukrainian regions. Identifying the capacity of innovative industries is certainly challenging the performance of regional managers in the current economic situation.

The research seeks to address the following questions:

1) to apply the pure smart specialization methodology for selected Ukrainian regions to evaluate the economic and innovation potential of the region;

2) to identify the weaknesses of the application of smart specialization methodology in emerging markets and to develop the ways of its customization.

Determining the relevant priorities for smart specialization is important in the domain of regional development. The approbation of the methodology at the regional level in Ukraine was carried out to analyze both its positive aspects and vulnerabilities. A non-evidence-based approach could lead to unreasonable financial costs and irrational decisions regarding implementing the innovations and scientific developments.

The resulting calculations by region revealed several industries that are expected to form the basis of smart specialization. The general results of the study and recommendations can be used for other regions that focus on smart specialization priorities determination in Ukraine.

1. LITERATURE REVIEW

A great deal of previous research into smart specialization has focused on its importance in forming regional development policies in the EU and associated countries. Previous research has demonstrated how the smart specialization approach unites different European regions on the path to innovation development. As the smart specialization approach has been launched in certain countries, most papers are focused on comparative analysis of regional development indicators before and after smart specialization implementation. Further, there is an analysis of the most common approaches in smart specialization priorities assessment, which is the basis for smart specialization steps.

Fedeli et al. (2019), Polido et al. (2019), and Kroll (2019) explain what is smart specialization and claim that it is based on a policy approach and has certain difficulties in evaluation of its priority industries: social problems are not taken into account, low integration of smart specialization aims into sustainable development goals, need for strategy strengthening from the regional to the national level. Smart specialization priorities assessment is also considered through sustainable development on Poland's example (Murzyn, 2019), where the difficulties with EU funding are explored if the chosen industries are not identified within the common JRC methodology.

Santoalha (2019) draws attention that commonly recognized JRC methodology should be customized. In his mind, the concept of Northern regions is more efficient rather than Central and Southern ones. Other scholars believe that the JRC methodology for identifying smart specialization regional priorities should be considered within the cluster approach to increase regional competitiveness (Pronesti, 2018; Thissen et al., 2013; Kholiavko et al., 2020). A similar idea is described by Kopczynska and Ferreira (2018).

Several studies are focused on the industrial component of smart specialization assessment;

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for instance, the need for smart specialization priorities of water and wastewater economy is explored (Machnik-Slomka, 2018). Another example is raising the competitiveness of rural territories via smart specialization support (Šipilova et al., 2017). It has been assumed that diversification, transition, radical foundation, and modernization are the main models of smart specialization launching (Piirainen et al., 2017).

Some scholars emphasize the importance of stakeholders' cooperation at each phase of smart specialization as a part of methodology (Gedminaitė-Raudonė et al., 2019; Giggord & McKelvey, 2019; Höglund & Linton, 2018; Pirnau et al., 2018; Lundström & Mäenpää, 2017).

Female entrepreneurs may also have the potential to impact regional development if they have the relationships with the diaspora in a country of their business performance (Ratten & Pollegrini, 2019), developing a wide network abroad. Therefore, such non-economic factors should also be taken into account while smart specialization priorities are defined. A similar position is in another paper where the importance of the network in the context of smart specialization performance has highlighted the assessment of economic impact (Varga et al., 2018). Vittoria and Napolitano (2016) stress the culture networks, which should be considered within smart specialization priorities.

Foray (2016) relates smart specialization strategies to development, industrial, and innovation policies. Therefore, he emphasizes the importance of industrial and innovation indicators should be considered in smart specialization priorities assessment. The importance of innovation policy concept and readiness to implement regional smart specialization in certain countries is examined by Balland et al. (2018), Gebhardt and Stanovnik (2016), Smolinski et al. (2015), Prause (2014). Some scholars offer to apply a smart specialization approach to cities' sustainable development (Serbanica & Constantin, 2017; Lobanova et al., 2020). In our opinion, cities' smart specialization priorities should be revised because, in pure view, it seems to have many inaccuracies.

To improve the smart specialization assessment priorities methodology, Szerb et al. (2020) offer to launch the Regional Entrepreneurship and Development Index (REDI) to optimize local entrepreneurial discovery processes. One more approach is developed by Varga et al. (2020), where they adjusted traditional smart specialization methodology and designed GRM-Hungary for evaluation of entrepreneurship and innovation network policies.

A relatively small body of literature is concerned with quantitative tools for identifying smart specialization priorities. Few studies are devoted to discussing issues of chosen smart specialization priorities due to traditional methodology, which is contentious. At the same time, these studies deserve attention.

For instance, the index-based method is also used for exploring smart economic development, using data from six Central and Eastern countries (Dagilienė et al., 2020). Poponi et al. (2020) offer to use the cascade system in a multi-stakeholder perspective in the policy development cycle to prioritize brunches instead of commonly recognized methodology. This approach is worth attention; however, there is an issue related to EU regional policy and funding innovative projects.

In conclusion, these studies show that almost all countries that entered the smart specialization have issues customizing the commonly recognized methodology of the JRC. For instance, it is only quantitative and does not include national specifics (what is appropriate for one region that is not always good for the other), international communication development, the part of rural territories and level of its development, etc. Therefore, there is a need to reveal on this phase what problems can face Ukrainian regional local authorities assessing smart specialization of priorities in each region.

2. AIMS

Thus, the research aims to identify smart specialization priorities based on JRC methodology and assess its applicability in emerging markets (Ukrainian case).

3. METHODOLOGY AND DATA

3.1. Data

According to CEA, the research is based on economic data published by the State Statistics Committee annually at the three and four-digit industry level[1] for 2013–2017.

European Commission recommends using the JRC methodology of detecting smart specialization priorities (Navarro et al., 2014). Despite the critical assessments of other scholars on the possibility of fully applying this methodology, it is considered necessary to test the methodology, identifying priority areas for the smart specialization of two regions – Cherkasy and Ivano-Frankivsk regions. This will allow us to either confirm or reject previous researchers' views on the problems of applying this technique in individual developing countries.

To determine regional Smart Specialization strategy (S3), the local coefficients (LQ) method was used. This approach identifies each sector value in the regional economy compared to the national one.

The calculation is based on two groups of indicators: economic potential and innovation potential in static and dynamic dimensions.

The description of the applied 3-step methodology is given further (details are given in Appendix B).

Step 1. Determination of economic potential of the sector based on static and dynamic analysis techniques

Static analysis indicates the industry's contribution to regional development at a certain date (2018), while dynamic analysis indicates industry development potential (from 2014 to 2018).

For static analysis, such indicators were used:

- number of employees – shows the potential of the workforce to ensure the development of a particular industry (main criterion);
- wages level – an indicator of the attractiveness of the industry for employees (auxiliary criterion).

The industry's potential for the implementation of SMART specialization is determined by the coefficient of local specialization of each industry (both for the regional and national levels) (see Appendix B).

To determine the future development potential of industries, a dynamic analysis of the following indicators was used:

- change in the industry employment share from 2013 to 2017 (year to year and for the whole period concerning the region and the national economy);
- change in the industry wages in the region from 2013 to 2017 (year to year and for the whole period concerning the region and the national economy).

Step 2. Definition of innovation potential

To determine innovation potential, such indicators were used:

- the share of companies that have introduced product innovations;
- the share of companies that have introduced process innovations;
- the share of companies that have introduced organizational innovations;
- the share of companies that have introduced marketing innovations.

The selection of industries by innovation potential considers two criteria of specialization: for the region and the whole economy (see Appendix B for details).

Industries that meet all the above criteria have the innovative potential to be part of the region's smart specialization.

1 CEA – Code of Economic Activity.

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Source: Formed by the authors based on Navarro et al. (2014), Iacobucci (2012), Gianelle et al. (2016), Gulc (2015), Soltys and Kamrowska-Zaluska (2016).

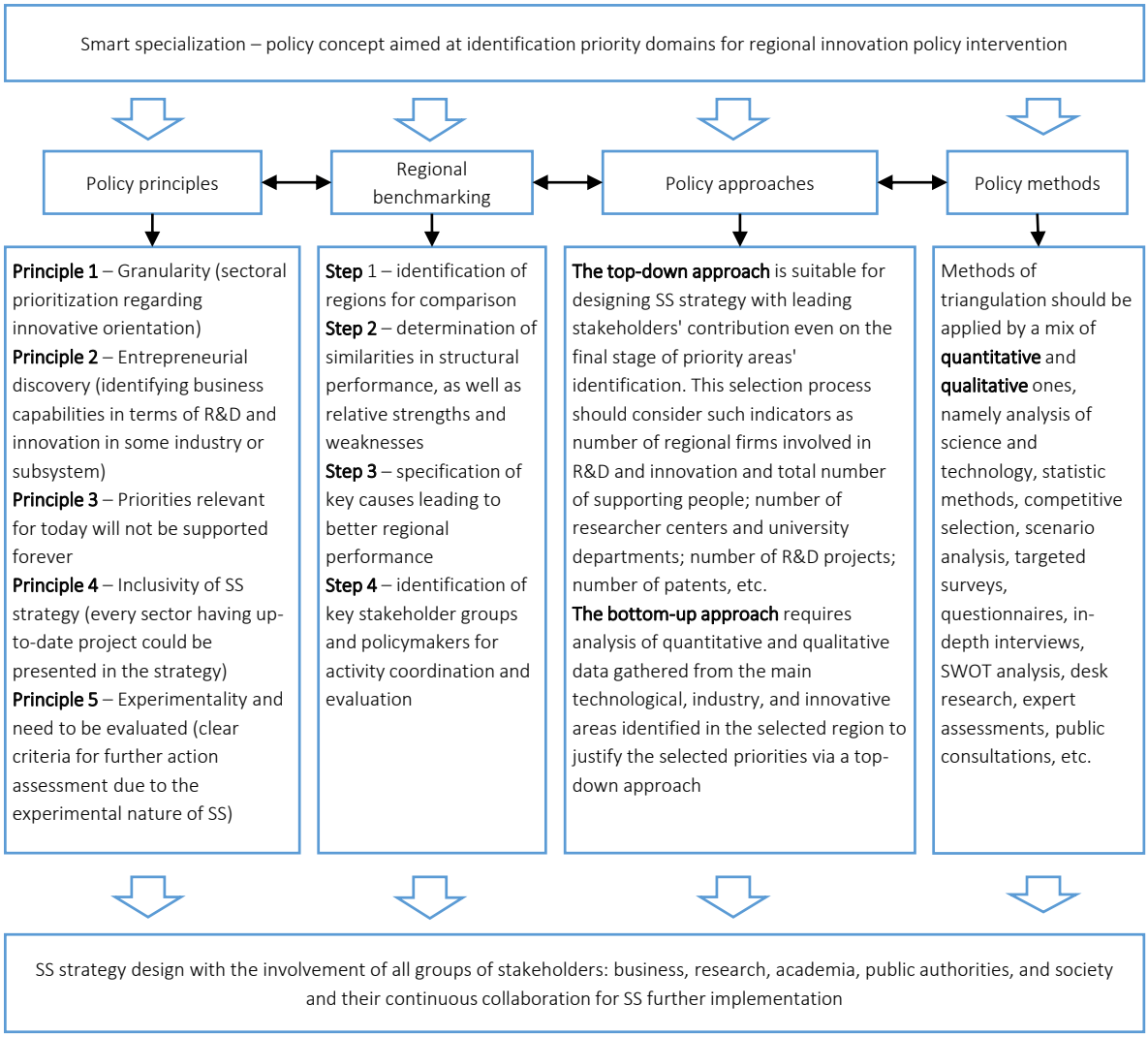

Figure 1. Approaches for priority industries' selection in regions within the smart specialization framework

Step 3. Industry selection and analysis according to both types of potential

At the final stage, the selection of industries with economic and innovation potential was made. 4 industries were identified for the Ivano-Frankivsk region, and 3 for the Cherkasy region.

4. RESULTS

4.1. Analysis of the applied approach to smart specialization identification in Ukraine

4.1.1. Concept of industry selection within the smart specialization framework

The key principle of smart specialization identification is to select priority industries on a regional basis taking into account the level of economic and innovation potential in the direct region.

Because regional policy in Ukraine is under the reformation processes based on smart specialization framework implementation principles, the importance of relevant industry selection in every region via proper quantitative and qualitative measures is the key issue on the mentioned stage (Figure 1).

The proposed concept for priority industry selection (see Figure 1) holding the policy principles, regional benchmarking features, policy approaches, and methods could be a useful tool for key stakeholder groups on the stage of key industries' identification in a particular region.

The approaches for priority industry selection within smart specialization framework are presented in Figure 1, and at regional benchmarking, Frankivsk and Cherkasy regions were chosen as ones that have similarities in regional economic and innovation potential using static and dynamic indicators (it is described in more detail in subsection 3.1.2).

4.1.2. Regional benchmarking: cases of Ivano-Frankivsk and Cherkasy regions

Tables A1 and A2 (see Appendix A) summarize the results of assessing the Ivano-Frankivsk and Cherkasy regions' economic potential. The threshold values can also be changed to select more or fewer industries. The initial selection included 201 industries for the Ivano-Frankivsk region and 153 industries for the Cherkasy region (without taking into account the threshold value); 74 and 68 industries passed at least one of 4 selection criteria in Ivano-Frankivsk and Cherkasy regions, respectively (employment, average wages, change in employment, change in average wages).

Based on static analysis, 30 and 32 industries were identified in Ivano-Frankivsk and Cherkasy regions using data "the number of employees", which is 44.4% and 54.5% of total employment in each region. Using data "average wages", 30 and 29 industries were identified, representing 24.8% and 47.8% of total employment in each region. Combining the results of these two criteria has been matched in 13 and 16 industries, accounting 18.6% and 47.8% of total employment in Ivano-Frankivsk and Cherkasy regions, respectively.

The dynamic analysis revealed 27 and 31 industries using changes in the number of employees, amounted to 17.1% and 35.5% of total employment in Ivano-Frankivsk and Cherkasy regions. Using data on changes in the average wages, 22 and 16 industries were identified, constituted 16.3% and 8.7% of total employment for each region. According to these two criteria, the combination of results has coincided in 5 and 8 industries, which is 3.2% and 4.1% of total employment in Ivano-Frankivsk and Cherkasy regions, respectively. Only 1 industry in each region passes both static and dynamic thresholds, employing 2.2% and 1% in Ivano-Frankivsk and Cherkasy regions (more detailed information of selected industries is shown here)[2], which shows the defined industries for each category.

The combination of certain industries accounts for 21.8% and 49.5% of total employment in the Ivano-Frankivsk and Cherkasy regions. Only 1 industry was identified in selected regions, using both the criteria of static and dynamic analysis:

- 49.4 freight road transport, provision of transportation services (for Ivano-Frankivsk region);
- 47.3 retail sale of automotive fuel in specialized stores (for Cherkasy region).

Tables A3 and A4 (see Appendix A) generalize the innovative potential assessment results for Ivano-Frankivsk and Cherkasy regions. In 2016, 23 and 18 industries had innovative potential in Ivano-Frankivsk and Cherkasy regions, respectively, 27 and 10 industries had innovative potential in the country's total industry, 22 and 10 industries had innovative potential according to both criteria in each region. In 2018, 29 and 21 industries had innovative potential accordingly in Ivano-Frankivsk and Cherkasy regions, 28 and 11 industries had innovative potential in the country's total industry, and 26 and 11 industries had innovative potential, according to two criteria in the selected regions. Combining results of 2016 and 2018 for Ivano-Frankivsk region, 13 industries have innovative potential over these years, which is 9.1% of total employment in the region and, at the same time, Cherkasy region has 3 industries with innovative potential, amounted to 1.7% of the total number of employees in the region.

2 https://drive.google.com/file/d/1xWp00PAq_ep7JVuPFcEM33FLjy_hSj1n/view

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Using the alternative, selecting industries that passed at least 3 of the 4 criteria in 2016 and 2018, it was revealed 16 and 6 industries for Ivano-Frankivsk and Cherkasy regions, accounting for 14% and 3.2 % of total employment in each region (more detailed information about industries with innovative potential is shown here)[3].

Tables A5 and A6 (see Appendix A) summarize the results of economic and innovation potential for CEA B-E sectors in columns 3 and 6. Column 7 shows whether the sector has economic and innovation potential, and column 8 shows the share of employment in this area. The main performance indicators for each of these industries are included in Tables A5 and A6 (see Appendix A). The criterion by which the industry passed the critical value is highlighted in blue if it has passed all static or dynamic economic evaluation criteria in bold. If the innovation criterion has been passed, all evaluations for this year are highlighted.

Finally, 4 sectors in CEA B-E in the Ivano-Frankivsk region match both criteria of economic and innovation potential, which is 7.6% of total employment in the region:

- Manufacture of other textiles (CEA 13.9) has been identified based on economic potential in terms of employment and wages. The innovative potential is explained mainly by the relatively high share of product and process innovations in 2016 and 2018.
- Manufacture of articles of wood, cork, straw, and plaiting materials (CEA 16.2) was determined based on current strong specialization and average wages per employee. The innovative potential is mainly according to the relatively high share of innovation in 2018.
- Production of basic chemical products, fertilizers, and nitrogen compounds, plastics, and synthetic rubber in primary forms (CEA 20.1) has been defined based on economic growth potential. The innovative potential is explained mainly by the relatively high share of product and process innovations in 2016 and 2018.
- Production of cement, lime, and gypsum mixtures (CEA 23.5) has been identified based on economic potential. The innovative potential is mainly due to the relatively high share of innovations in 2016 and 2018.

In addition to the mentioned 4 industries identified in the analysis, the following activities have a high level of innovation:

- manufacture of beverages (CEA 11);
- manufacture of electric motors, generators, transformers, electrical distribution, and control equipment (CEA 27.1);
- manufacture of games and toys (CEA 32.4).

A smart specialization for this region can also be a symbiosis of the production of games and toys (CEA 32.4) and the manufacture of wood, cork, straw, and plant materials for weaving (CEA 16.2) for the manufacture of environmentally friendly wooden toys.

In the Cherkasy region, 3 sectors in CEA B-E meets both terms of economic and innovation potential, which is 1.5% of total employment in the region:

- Manufacture of instruments and appliances for measuring, testing, and navigation; watches and clocks (CEA 26.5) has been determined based on economic growth potential. The innovation potential is mainly due to the relatively high share of innovations in 2016 and 2018.
- Manufacture of optical instruments and photographic equipment (CEA 26.7) was defined according to current strong specialization and average wages per employee. The innovation potential is explained mainly by the high share of product and process innovations, marketing innovations in 2016, and product and process innovations in 2018.
- Manufacture of other general-purpose machinery (CEA 28.2) has been specified based

3 https://drive.google.com/file/d/1xWp00PAq_ep7JVuPFcEM33FLjy_hSj1n/view

on economic potential in wages per employee. The innovation potential is mainly due to the relatively high share of product innovations and marketing innovations in 2016 and 2018.

In addition to 3 industries identified in the analysis, the following activities have a high level of innovation:

- processing and preserving of fish, crustaceans, and mollusks (CEA 10.2);
- manufacture of beverages (CEA 11).

5. DISCUSSION

The applied methodology allowed quantifying both the economic and innovation potential of each regional sector of the economy. Thus, the design of a smart specialization strategy for a particular region is based on a data-driven approach. Moreover, the use of unified methodology allows comparing the study results of different Ukrainian regions and increases the smart specialization approach's effectiveness at the national level.

However, some specific features of the methodology should also be addressed. First, access to data is difficult: the State Statistics Committee's information is not always up-to-date and complete. The risk of incomplete information can be mitigated by obtaining data provided by regional stakeholders directly. Second, the methodology does not take into account shadow employment and income received by self-employed individuals. Third, the results of the analysis largely depend on the threshold values of the local quotient coefficients. To eliminate the shortcomings mentioned above in smart specialization strategy design and the use of quantitative methods, it is recommended to attract local experts and adjust the methodology according to unique regional features. Further research will focus on developing qualitative methodology (specifically structured interviews and focus groups in particular regions) to take into account all mentioned above shortcomings.

CONCLUSION

The JRC methodology for Ukrainian regions (Ivano-Frankivsk and Cherkasy) indicates priority industries based on existing regional economic and innovation potential. As a result of assessing the economic potential according to JRC methodology, only one industry meets the criteria of static and dynamic analysis in both analyzed regions. For innovation analysis, indicators of 13 industries in the Ivano-Frankivsk region and 3 industries in the Cherkasy region represent the innovation potential over the analyzed period from 2016 to 2018. Combining the results of economic and innovation potential assessment, 4 industries of Ivano-Frankivsk region and 3 industries of Cherkasy region meet both criteria (amounted 7.6% and 1.5% of total employment in each region). The obtained results of industry analysis could be included in regional development strategies in the context of smart specialization.

However, the mentioned methodology is not purely applicable for emerging economies and Ukraine in particular due to the high level of the shadow economy, information asymmetry among potential stakeholders, and lack of transparent and reliable data. Insufficient statistical data are an additional reason for such a limited number of industries, because individual entrepreneurs are not included in the statistical database according to JRC methodology and untransparent wages payments (e.g., envelop wages).

It should be emphasized that the presented methodology does not consider the concentration of chosen industry companies in the regional economy, suggesting high levels of the economic and innovative potential of the industry can be provided by only one large enterprise. Besides, the companies of the chosen industry can be located in one particular area of the region. Therefore, the industry input in smart specialization development can be limited.

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Only quantitative analysis is not sufficient for achieving sustainable regional development and improving the regional innovation ecosystem. However, it is reasonable to supplement the assessment by qualitative methods with stakeholders' groups' involvement exemplified as regional policymakers, business, academia, and public society activists. The expert opinions gathering by conducting in-depth interviews, focus groups, online surveys, etc., among potential stakeholders, namely business representatives of key regional industries, individual entrepreneurs, academic society, NGOs, and regional authorities, could be considered the effective instrument for industry selection within the smart specialization. Thus, regional experts' involvement is essential in evaluating the industry capacity to become a part of smart specialization, which could be performed within the next stage of assessment, based on qualitative methods.

To sum up, the JRC methodology is a generalizing tool for regional authorities who are well aware of the specifics of regional development, but this methodology in Ukrainian regions should be applied only in complex of quantitative and qualitative methods to select the industries, which contributed the most to the regional ecosystem in terms of economic and innovation development.

AUTHOR CONTRIBUTIONS

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Writing – original draft: Alla Ivashchenko, Anna Kornyliuk, Yevheniia Polishchuk, Tetiana Romanchenko.
Writing – review & editing: Yevheniia Polishchuk, Tetiana Romanchenko.

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APPENDIX A

Table A1. Reflection of economic potential: results of Ivano-Frankivsk region

Criterion	Threshold value	Number of selected industries	Share of regional employment
The initial number of industries included in the analysis	–	201	–
Static analysis – employment			
Degree of specialization	1.5	46	–
Critical mass	0.25%	67	–
Both criteria	–	30	44.4%
Static analysis – average wages			
Regarding the region	0.8	77	–
Regarding the aggregate industry	0.9	35	–
Both criteria	–	30	24.8%
Employment and average wages	–	13	18.6%
Dynamic analysis – change in employment			
Regarding the region	3 out of 5 years	35	–
Regarding the aggregate industry	3 out of 5 years	53	–
Both criteria	–	27	17.1%
Dynamic analysis – change in average wages			
Regarding the region	3 out of 5 years	24	–
Regarding the aggregate industry	3 out of 5 years	42	–
Both criteria	–	22	16.3%
Change in employment and change in average wages	–	5	3.2%
Static and dynamic analysis	–	1	2.2%

Table A2. Reflection of economic potential: results of Cherkasy region

Criterion	Threshold value	Number of selected industries	Share of regional employment
The initial number of industries included in the analysis	–	153	–
Static analysis – employment			
Degree of specialization	1.5	38	–
Critical mass	0.25%	66	–
Both criteria	–	32	54.6%
Static analysis – average wages			
Regarding the region	0.9	52	–
Regarding the aggregate industry	0.9	38	–
Both criteria	–	29	47.8%
Employment and average wages	–	16	41.8%
Dynamic analysis – change in employment			
Regarding the region	3 out of 5 years	48	–
Regarding the aggregate industry	3 out of 5 years	47	–
Both criteria	–	31	17.1%
Dynamic analysis – change in average salary			
Regarding the region	3 out of 5 years	28	–
Regarding the aggregate industry	3 out of 5 years	27	–
Both criteria	–	16	8.7%
Change in employment and change in average wages	–	8	4.1%
Static and dynamic analysis	–	1	1.0%

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Table A3. Reflection of innovation potential: results of Ivano-Frankivsk region

Criterion	Threshold value	Number of selected industries	Share of regional employment
The initial number of industries included in the analysis	–	201	–
2016			
Innovative potential in the region	LQ above 1.1 in 2 types of innovations	23	–
Innovative potential for aggregate industry	LQ above 1.1 in 2 types of innovations	27	–
Both criteria		22	–
2018			
Innovative potential in the region	LQ above 1.1 in 2 types of innovations	29	–
Innovative potential for aggregate industry	LQ above 1.1 in 2 types of innovations	28	–
Both criteria		26	–
2016 and 2018	All criteria for 2016 and 2018	13	9.1%
2016 and 2018 – alternative	At least 3 of 4 criteria in 2016 and 2018	16	14%

Table A4. Reflection of innovation potential: results of Cherkasy region

Criterion	Threshold value	Number of selected industries	Share of regional employment
The initial number of industries included in the analysis	–	153	–
2016			
Innovative potential in the region	LQ above 1.1 in 2 types of innovations	18	–
Innovative potential for aggregate industry	LQ above 1.1 in 2 types of innovations	10	–
Both criteria		10	–
2018			
Innovative potential in the region	LQ above 1.1 in 2 types of innovations	21	–
Innovative potential for aggregate industry	LQ above 1.1 in 2 types of innovations	11	–
Both criteria		11	–
2016 and 2018	All criteria for 2016 and 2018	3	1.7%
2016 and 2018 – alternative	At least 3 of the 4 criteria in 2016 and 2018	6	3.2%

Table A5. Main efficiency indicators for industries with economic and innovation potential of Ivano-Frankivsk region

CEA	Industry	Degree of specialization, average for 2012–2018	Share of regional employment; average for 2012–2018	Salary per employee in the region, the average for 2012–2018	Salary per employee in industry in the country, the average for 2012–2018	Change in employment in the region, 2012–2017 (positive for # years)	Change in employment in industry in the country, 2012–2017 (positive for # years)	Change in salary per employee in relation to the region, 2012–2017 (positive for # years)	Change in salary per employee for industry in the country, 2012–2017 (positive for # years)	Innovations, degree of specialization in the region, 2016				Innovations, degree of specialization in industry in the country, 2016				Innovations, degree of specialization in the field, 2018				Innovations, degree of specialization in industry in the country, 2018			
										Product innovations	Processing innovations	Organizational innovations	Marketing innovations	Product innovations	Processing innovations	Organizational innovations	Marketing innovations	Product innovations	Processing innovations	Organizational innovations	Marketing innovations	Product innovations	Processing innovations	Organizational innovations	Marketing innovations
13.9	Manufacture of other textiles	2.986	0.6%	145.2	160.9	0 (1)	0 (0)	0 (1)	0 (1)	1.06	1.27	5.24	4.74	1.92	1.22	5.96	3.35	0.00	2.08	0.00	2.32	0.00	2.19	0.00	1.98
16.2	Manufacture of wood, cork, straw and plaiting materials	5.659	2.3%	123.8	119.6	13.5% (3)	7.7% (2)	25.5% (2)	15.8% (2)	0.91	0.55	1.12	0	3.71	1.37	1.73	0.0	1.99	1.38	1.91	1.03	2.69	1.6	1.60	0.92
20.1	Manufacture of basic chemical products, fertilizers and nitrogen compounds, plastics and synthetic rubber in primary forms	3.464	2.9%	155.7	92.0	–8.9% (1)	9.7% (2)	–102.7% (2)	–32.1% (2)	**1.82**	**3.28**	4.49	4.07	3.64	2.85	4.86	3.36	3.41	3.56	1.63	1.33	2.86	2.57	1.26	1.26
23.5	Production of cement, lime and gypsum mixtures	13.822	1.8%	184.9	90.4	3.6% (2)	22.9% (4)	24.6% (4)	33.2% (4)	2.12	2.55	5.24	4.74	3.22	1.93	4.83	3.22	0.0	0.00	5.72	4.64	–	0.00	3.83	1.92

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Table A6. Main efficiency indicators for industries with economic and innovation potential of Cherkasy region

CEA	Industry	Degree of specialization, average for 2012-2018	Share of regional employment; average for 2012-2018	Salary per employee in the region, the average for 2012-2018	Salary per employee in industry in the country, the average for 2012-2018	Change in employment in the region, 2012-2017 (positive for # years)	Change in employment in industry in the country, 2012-2017 (positive for # years)	Change in salary per employee in relation to the region, 2012-2017 (positive for # years)	Change in salary per employee for industry in the country, 2012-2017 (positive for # years)	Innovations, degree of specialization in the region, 2016	Innovations, degree of specialization in industry in the country, 2016	Innovations, degree of specialization in the field, 2018	Innovations, degree of specialization in industry in the country, 2018
										Product innovations			
										Processing innovations			
										Organizational innovations			
										Marketing innovations			
											Product innovations		
											Processing innovations		
											Organizational innovations		
											Marketing innovations		
												Product innovations	
												Processing innovations	
												Organizational innovations	
												Marketing innovations	
26.5	Manufacture of instruments and appliances for measuring, testing and navigation, watches and clocks	2.592	0.7%	94.6	70.9	35.7% (2)	39.7% (3)	32.1% (3)	−68.1% (2)	7.22	0.00	8.90	3.25	0.00	0.00	5.26	2.96	0.00	0.00	2.37	1.23	0.00	0.00
26.7	Manufacture of optical instruments and photographic equipment	14.348	0.7%	123.7	118.1	9.8% (3)	30.7% (2)	4.0% (2)	−160.8% (2)	10.83	8.42	0.00	13.36	2.17	3.25	–	3.25	14.03	7.89	0.00	0.00	3.56	3.57	1.47	1.22	0.00	0.00
28.2	Manufacture of other general-purpose machinery	0.305	0.1%	122.2	104.4	30.1% (3)	42.0% (3)	−19.9% (2)	−18.0% (2)	5.41	0.00	0.00	8.90	3.33	0.00	0.00	4.67	4.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.79

APPENDIX B

Methodology description of detection smart specialization priorities

Step 1. Determination of economic potential of the sector based on static and dynamic analysis techniques

1.1. Static analysis

The coefficient of local specialization by the criterion of labor is determined as follows:

$$LQEi = \left(ei / e\right) / \left(Ei / E\right),$$

where *LQEi* – local coefficient of specialization of the industry *i* at the regional level by the criterion of labor, *ei* – number of industry *i* employees at the regional level, *e* – total number of employees at the region, *Ei* – number of industry *i* employees at the national level, *E* – total number of employees at the national level.

The threshold for *LQEi* is > 1.5.

If *LQEi* > 1, it means that at the level of a particular region, the share of employees in the industry is greater than in the country as a whole, which may indicate the specialization of the region in a particular industry. If *LQEi* < 1 – the share of industry *i* employees is less compared to the national level.

In this study, the threshold value for *LQEi* is > 1.5.

To exclude too small and, accordingly, not influential at the regional level, industries, an additional coefficient of critical mass was calculated:

$$cmi = ei/e,$$

where *cmi* – indicator of the relative size of the industry *i* in the regional economy, *ei* – number of employees in industry *i* on regional level, *e* – total number of employees in the regional economy.

The threshold of the coefficient is > 0.25.

As mentioned above, the wages level was used as an auxiliary selection criterion, for which the following indicators were calculated:

- average wages in the industry at the regional level (awi);
- average wages in the region (aw);
- average wages in a particular industry at the state level (awi).

The following thresholds were set for the selection of industries:

1) the size of the average wages in the industry at the regional level (awi) must be at least 80% of the average wages in the region (awi);
2) the size of the average wages in the industry at the regional level (awi) must be at least 90% of the average wages in the industry at the national level (awi).

Accordingly, only those sectors that meet the above criteria were selected for further analysis.

1.2. Dynamic analysis

To be selected through dynamic analysis industries must meet the following requirements.

Employment criterion:

1) the growth rate of employees' share is positive for the whole region in 2018 compared to 2014 and the annual growth rate employees in the region is positive for at least 3 out of 5 years;
2) the growth rate of employment in the industry on the national level is positive and the annual growth rate of employment in the he industry on the national level is positive for at least 3 out of 5 years.

Wages criterion:

1) the growth rate of the average wages is positive for the whole region in 2018 compared to 2014

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CEA[1] and the annual growth rate in average wages is positive for at least 3 out of 5 years;

2) the growth rate of average wages in the industry on the national level is positive and the annual growth rate of average wages in the industry on the national level is positive for at least 3 out of 5 years.

Industries that meet all the above criteria are considered to have economic potential for the implementation of smart specialization.

Step 2. Definition of innovation potential

Specialization in relation to the region shows the contribution of a particular industry to the innovative development of the region and is determined by the following formula:

$$LQIir = (\%in_xi)/(\%in_x),$$

where *LQIir* – local coefficient of specialization of the industry *i* at the regional level, *%in_xi* – the share of x-type innovations in industry *i*, *%in_x* – the share of type x innovations in the regional economy, x – type of innovation.

Specialization in relation to the country reflects the innovative potential of a particular industry in the region in relation to the entire industry of the country and is determined by the formula:

$$LQIic = (\%in_xi)/(\%IN_xi),$$

where *LQIic* – local coefficient of specialization of industry *i* in the economy, *%in_xi* – the share of x-type innovations in industry *i*, *%IN_xi* – the share of type x innovations in industry across the country, x – type of innovation.

In order for an industry to be selected for further study, the following thresholds were set:

3. coefficients of specialization of the industry both in relation to the region and the total industry must be higher than 1.1;

4. coefficients must be above the threshold for at least two types of innovation out of four possible.

Step 3. Industry selection according to the above mentioned criterions

1 CEA – Code of Economic Activity.