
Specialization Integrated Strategy of Innovations: Effective Model for Emerging Regional Economy Development?

Submitted 12/02/20, 1st revision 13/03/20, 2nd revision 28/03/20, accepted 05/04/20

Krzysztof Malik¹, Łukasz Mach², Marzena Szewczuk-Śtepień³,
Piotr Bębenek⁴

Abstract:

Purpose: The purpose of our work is to propose a strategic model of smart specialization identification around the concept of regional knowledge and cognitive transfer (Double Helix Matrix, DHM).

Design/Methodology/Approach: While operationalization of smart specialization-oriented policy is still rather limited because of the lack of agreed development policy tools, we proposed the DHM model developed in order to provide the implementation of regional smart specialization oriented strategy. The model has been statistically verified by multidimensional comparative analysis on the example of a chosen weak innovative emerging region in Poland (Opolskie).

Findings: The proposed methodology let us to find the need of redefining the smart specialization concept as a part of regional innovation strategy.

Practical Implications: The new approach to the regional innovation policy has been proposed. The findings have been used to construct the regional policy directives for potential smart specializations development within 2027 perspective.

Originality/Value: The new model to conduct regional innovation strategy for smart specialization has been proposed and verified on the example of the weak innovation region.

Keywords: Emerging region, smart specialization identification, strategy for smart specialization, regional development policy, EU aids fund effectiveness.

JEL codes: O38, O47, P48.

Paper type: Research article.

¹Corresponding author, Opole University of Technology, Faculty of Economics and Management, Department of Economics, Finance and Regional Research k.malik@po.edu.pl

²Opole University of Technology, Faculty of Economics and Management, Department of Economics, Finance and Regional Research, l.mach@po.edu.pl

³Opole University of Technology, Faculty of Economics and Management, Department of Economics, Finance and Regional Research, m.szewczuk-stepien@po.edu.pl

⁴Opole University of Technology, Faculty of Economics and Management, Department of Organization and Management, p.bebenek@po.edu.pl

1. Introduction

1.1 Involvement in the Discussion on the EU Aids Fund Effectiveness on Regional Development Specializations

In the late 1980s, following the adoption of the Single European Act in 1986 and the publication of the Delors Report (1989), the EU's cohesion policy aimed to reduce disparities in the levels of development of different regions and to reduce the backwardness of the least-favoured regions (Single European Act, 1987). The structural funds, in particular the European Regional Development Fund (Article 130c), became the most important instrument of the EU cohesion policy. Since 1989, in the next financial perspectives, regional development has been pursued within the various objectives of the EU Regional Policy. For instance between 2007 and 2013, the EU regional policy consisted of three objectives: (1) Convergence, (2) Regional competitiveness and employment, and (3) European territorial cooperation. All the objectives reflected the cohesion policy mission of reducing disparities among EU regions.

The effectiveness and efficiency of foreign development aid from the point of reducing regional disparities criterion is being challenged in the literature of both neoclassical and behavioural schools of economics and political sciences. According to Hoppe (2001) “unearned income” in the form of public aid results in the acceptance of a financial advantage even though its beneficiaries have not produced more efficiently. This also results in reduction of productive-oriented activities and less autonomy for the beneficiaries of such aid.

Behaviourists, in turn, highlight the demotivating effect of external aid, which is to increase the reluctance to take risks and weaken the competitiveness, entrepreneurship and innovation activity of beneficiaries and entire regional economies (Beaulier and Caplan, 2007). The utilization of external aid as “an unearned income” may lead to dependency mentality of all types of beneficiaries. The indirect effect of absorbing unearned external aid within public sector is corruption (Economides, Kalyvitis and Philippopoulos, 2008).

On the other hand, it is emphasised that the main development barrier of European countries is the ever growing inequality in the level of development of individual regions and social groups (divergence). Despite the fact that the volume of the aggregated growth rates (e.g. GDP) are growing, while the differences in access between countries/regions/social groups to the allocation of benefits are increasing. Therefore, according to Stiglitz (2015), the principles of development policy should be reoriented towards stronger economic performance through:

- more investment in public goods;
- better corporate governance;
- antitrust anti-discrimination laws;

- better regulated financial and more progressive tax system;
- stronger workers' rights;
- transfer policies (Stiglitz, 2015).

From 1989 each EU nation has been carrying out periodic evaluations of regional policy (programmes). The European Commission concerns on evaluation effect of the EU regional funding which was spelled out in the reform of the Structural Funds in 1999. The way these are done expresses the EU's determination to make the regional policy contributes to the allocation efficiency. There are some econometric models used to evaluate EU funding efficiency at regional level like REMI, HELM, HERMIN, RHOMOLO, MaMoR2. But the public funding impact on regional policy (programme objectives) efficiency and effectiveness realization is still unclear (Malik, 2012). It is also unclear what is the European Regional Development Fund impact on the reduction in the regional economies inequalities (Rodokanakis, 2006).

The main purpose of the *Paris Declaration on Aid Effectiveness (2005) and the Accra Agenda for Action (2008)* was the improvement of economic performance of transfer policies. The *Paris Declaration* and *Accra Agenda for Action* are founded on five core principles, which have changed the foreign aid practice for the better. Now it is the rule of aid recipients to work out their own national/regional development strategies with their parliaments and electorates/stakeholders (ownership principle). As well as donors' role is to support these strategies (alignment principle) and work into streamline their efforts in-country (harmonization principle). Development strategies and programmes are to be focused to achieve clear goals and progress towards these goals has to be monitored (managing for results). Last but not least, donors and recipients are jointly responsible for achieving these goals (mutual accountability) (The Paris Declaration..., 2005).

In addition to the above principles, starting from the 2013-2020 perspective, the EU regional policy has implemented the overarching principle of the concentration of aid on endogenous regional development assets (smart specializations). From now on, the Research and Innovation Strategy for Smart Specializations (RIS3) is a first order condition for the region/country to obtain the assistance. This is enshrined in the most important strategic document, highlighting the importance of modern technologies and setting the EU innovation directions, such as the Strategy for *Smart, Sustainable and Inclusive Growth. Europe 2020 (Communication..., 2020 final)*. The European Commission stresses that the identification of *smart specializations* will be crucial for achieving *the smart growth* priority of *Europe 2020 Strategy*, i.e. the development of a knowledge-based economy, including innovations. As a part of this priority, at the level of action, the most importance of specialization-based development should be attributed to the flagship initiative of the Innovation Union.

According to the adopted rules, each region should have a regional innovation

strategy for smart specialization (RIS3). The aim of this strategy is to build a sustainable future based on long-term planning, which creates more jobs and ensures a higher standard of living. At the same time, the regions – mainly through the commercialization of innovation will improve their competitiveness. The *Europe 2020 Strategy* identifies a number of mechanisms to increase the efficiency of development policy after 2013, which were included in the legislative package for the Cohesion Policy 2014-2020:

- thematic concentration of the funds;
- based on results, including the strengthening of monitoring and evaluation;
- conditionality principle;
- integrated approach to development.

The thematic concentration of financial resources in a limited number of intervention areas, i.e. the thematic objectives, and within the quantitative number of measurable targets, is one of the most important elements of ensuring the effectiveness of cohesion policy after 2013. Thematic concentration of measures is reflected in the concept of strategic development management adopted in EU countries, which will be the basis for the development planning and programming of EU funds in 2014-2020. One of the objectives of the new development management concept is to focus investment on areas of strategic intervention. The thematic concentration of measures in the new programming period will be linked to the strengthening of existing planning, monitoring and evaluation tools, in particular the modification of the cohesion policy intervention effectiveness testing system. The territorial dimension of the European Union's regional policy has not yet been emphasized in its implementation.

As indicated in the *Green Paper on Territorial Cohesion*, development policy at regional level should respond in an integrated manner to development challenges and take advantage of the complementarity and synergies of the investments made (CEC, 2008). The concept of territorial cohesion allows for the building of a bridge between economic efficiency, social cohesion and environmental sustainability, putting sustainable development at the heart of its objectives as a paradigm of development policy. In a regional context, combining a sectoral and territorial approach will maximize synergies of the results of investments. Since 2013, the strategies of national/regional innovation for smart specialization (RIS3) have been the most important document in the area of R&D development policies and the commercialization of innovative solutions. They are an integrated local economic transformation programme aimed at achieving five important objectives:

1. Targeting policy and investment support towards key national regional challenges and needs to ensure knowledge-based development.
2. Exploiting the strengths, competitive advantages and potential of excellence of each country/region.
3. Promoting technological and practical innovation and striving to stimulate

- investment in the private sector.
4. Fully engage partners and encourage innovation and experimentation.
 5. The strategies are fact-based and include appropriate monitoring systems and evaluation (*Research and Innovation Strategies...*, 2014).

Supporting national and regional specialization should contribute to improving the efficient use of EU funds and improve coordination and synergies between initiatives at national and regional level (Grima and Thalassinos, 2020). When identifying development potentials, it is particularly important to define the methodology for the selection of priority support areas (smart specializations) and the course of the public consultation. As part of the 2013-2020 financial perspective, the European Commission has proposed that smart specialization should become an integral part of *ex-ante* conditionality. The identification of national and regional specialization should be carried out on a bottom-up approach with key innovation partners (in cooperation between entrepreneurs, universities and research centers) who are best versed in the development needs of the region.

Several valuable proposals have been concluded while analyzing an innovative policy that takes into account smart specializations for emerging regions in Poland (Kamrowska-Zaluska and Soltys, 2016). Similar studies, in Europe (Thalassinos *et al.*, 2015) and in other countries, were presented the process of identifying smart specializations for Romania (Sandu, 2012; Dodescu and Chirilă, 2012), for Lithuania (Paliokaitė, Martinaitis and Sarpong, 2016) and for Slovakia (Borseková, Vaňová and Vitálišová, 2017). It should also be noted the interesting studies conducted on the role of smart specialization in less-developed countries (Krammer, 2017), as well as the research on smart specialization policies as a support for the sustainable development policy in the face of new global challenges (Rusu, 2013). It has been presented foresight methods as a toolkit for smart specialization (Gheorghiu, Andreescu and Curaj, 2016), while some authors described regional foresight and smart specializations as the basis for creating pro-developmental diversifications of the structure of the economy (Pirainen, Tanner and Alkærsg, 2017). As there are some interested examples of smart specialization innovation policy of different territories, there is no agreed operational methodology of smart identification in this regard.

1.2 Original Economic Theories for Objective Identification on Regional Development Specializations

Original theories relating directly or indirectly to the development of the region and the policy of such development, in the context of the specialization of development based on endogenous potentials, we can refer to: the Perroux, Boudeville and Lasuen poles of growth theory, the location theory of von Thünen and Weber, the Sombart's economic base theory, the spatial innovation diffusion model of Hägerstrand, and the Friedman's endogenous development theory (Malik, 2011). Each of these original development theories have been created through attempts to

adapt an innovation-based development model. An example is the so-called polarization theories, which develop the concept of growth poles and often refers to the classic theory of cyclical economic development.

According to Perroux (1950), growth is manifested with varying intensity in the form of growth poles, spreading across channels and with varying effects for the entire economy of a particular territory. The region's most developed companies or groups of companies, industries and entire sectors whose clusters are the poles of growth are the flybys of economic growth. The dominant impact of growth poles on economic development is called sectoral (branch) polarization. This concept takes into account the impact of growth poles on changes in the structure of the economy, without explicitly referring to the development of a specific geographical territory. The task of public authorities is to strengthen the existing growth poles and to create new ones, as well as to develop a communication network between metropolies and their surroundings in order to spread development processes (Perroux, 1950).

Lasuen (1969) presented the concept of growth poles with a spatial aspect. An important objective of this model is to recognize the imitation of innovation as a driver of economic growth and to assume that development processes are taking place in the main branches of regional industry through innovation and subsequent diffusion into sectors and areas (Lasuen, 1969). It should be emphasized that the concept of sectoral polarization by Perroux (1950) and, taking into account the territorial aspect of development, Lasuen's (1969) theory strongly emphasizes innovation and entrepreneurship as key growth factors, directly referring to the theory of Schumpeter's real economic cycle. According to Schumpeter, technological innovation sparking the same or better quality goods at lower costs than competitors offer is becoming the flywheel of the economy, accelerating the growth phase economic situation and at the same time shortening the crisis phase in the development of cyclical economy (Schumpeter, 1934).

According to the new approach after Schumpeter theory of real business cycle, smart specialization does not mean only supporting of existing assets and strengths of the regions but rather finding the new possibilities of their development (Foray, 2015).

In the light of those theories of development, the concentration of public intervention (state or foreign) is a recommendation addressing growth factors – their identification and optimization from the point of effectiveness improvement and efficiency of the public aid support. As there is a strong theory based explanation for focusing aids on a few endogenous specializations of the territory, there is no agreed methodology in this regard.

Our research objective is to develop a formal model of identifying smart specializations for the emerging region economies in order to create an effective development policy.

2. Materials and Methods

The identification of regional industries and their classification according to the innovation potentials was carried out in six research steps. The whole was preceded by a desk research in both theoretical and practical conditioning for contemporary innovation development policy (Introduction – parts 1.1 and 1.2). In section two, the concept of smart specializations was operationalized based on the knowledge transfer process through a novel model of Double Helix Matrix. In section 3, the different levels of regional specializations have been recognized. In the two sections ahead, using multidimensional statistical data, analysis tools, groups of technologies have been classified as part of regional performing specializations and smart (potential) specializations further and closer. In the last, sixth section of the study, a discussion of the received results was conducted and recommendations have been made for development policy support for the specializations as drivers in regional development.

2.1 Materials and Methods: What do the Weak Innovator Regions Need? A Case of Opolskie, Poland

The Member States of the European Union have been divided into four performance groups from the point of view of their innovation potential. The studies shall relate to the average results obtained according to a specific rate counted for countries and regions. This indicator is called the Summary Innovation Index. Countries such as Sweden, Finland, Denmark and the Netherlands are among the *innovation leaders* with innovation far outstripping the EU average. Luxembourg, the United Kingdom, Germany, Belgium, Austria, Ireland, France and, Estonia are *strong innovators* with results above or near the EU average. The results of Croatia, Cyprus, the Czech Republic, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Slovakia, Slovenia and Spain are below the EU average and are called *moderate innovators*.

There are 239 EU regions valued on Regional Innovation Scoreboard and Opolskie has been ranked as 222 (*Regional Innovation Scoreboard*, 2019). The Regional Innovation Scoreboard is a detailed complement to the European Innovation Scoreboard report. Presented once a year, the document provides a comparative assessment of the innovation position of the 25 countries and their regions that are members of the European Union. RIS 2019 presents the magnitude of indicators that are monitored in each country and, in addition, regional data from the Community Innovation Survey (CIS). The aggregate innovation rate is the result of an assessment of the effectiveness of all indicators used in RIS 2019. In taking stock of the data presented from the RIS report, it is necessary to indicate the weakening level of innovation in the Opolskie region in the period 2009-2019. The results from individual regions show that this downward trend affects not only the Opolskie, but all regions in Poland as well. Against the background of the regions of the European Union, Poland does not fall out as a significant player, which can be classified as

"moderate innovators" but rather as "modest innovators". In carrying out a detailed analysis of the innovation indicators presented in the regional innovation report and also included in the CIS report, they show and confirm that the Opolskie region is one of the *modest innovators* (Community Innovation Survey, 2014). In the Polish innovation survey carried out by Millennium Bank this result has also its confirmation (Millennium Bank, 2019). In all cases, the indicators presented for the Opolskie region fall below the average for Poland and the EU. Underfunding of the R&D sphere is evident both in the public and in private sectors expenditure.

The determinants of the level of innovation are primarily human capital and innovation policy. Systemic solutions, operationalized strategies and programmes mainly on the financing mechanism are therefore necessary. In order to improve the regional knowledge transfer and effectively implementation of the RIS3 it is necessary to create an objective tool for identifying regional development specializations.

2.2 Materials and Methods: Double Helix Matrix and Statistical Identification of Regional Specializations

In order to identify the region's development specializations, including Smart Specializations, the original method of logical matrix based on the criteria for the evaluation of the knowledge transfer and cognitive process was adopted (Table 1). The regional specialization identification process, including Smart Specialization, shall be analyzed via regional knowledge transfer. Knowledge transfer is one of the elements of knowledge management, and it covers a set of processes which facilitate (1) B&R production, (2) use – transmission to the economy, and (3) dissemination – creation of competitive advantage. On the basis of the knowledge transfer process consisting of three phases, a Double Helix Matrix (DHM) has been created as a research tool for research and analysis, allowing the identification of regional specializations, including Smart Specializations (Table 1). Simultaneously, for the identification of Smart Specializations, it was assumed that they occur if a specific technology is present within each of the three phases of the regional knowledge transfer. Therefore Smart Specializations are present in the region if, simultaneously, specific innovations are or become:

- 1) the object of the research study in the regional R&D sector (centers, laboratories, and universities located in the region);
- 2) the subject matter of the pilot implementation projects in an enterprise located in the region;
- 3) the subject of the sale and purchase transaction on the regional and transregional market.

Smart Specializations appear when innovations go through all the three stages of transferring knowledge: from R&D, usage in production and finally extending within the regional and trans-regional market.

A methodological DHM contains Cartesian products of the two parallel transfer processes of knowledge and expertise, each of which goes through three levels of the analysis. Therefore, the DHM consists of nine fields. Each field of the matrix is the result of research and corresponds to the scope of the regional specialization' identification. The cognitive process is aimed to determine a short list of technology groups which were a significant validity measure for the conducted research on existing sources, quantitative and qualitative (expert) studies. The matrix of the logical conjunction of results on the knowledge transfer and cognitive process leads to the identification of the Smart Specializations (Table 1).

Table 1. *Regional specialization identification matrix model (view of the double processes)*

Phases of the processes	Phases of the knowledge transfer process						
Phases of the cognitive process	Production-Creation of potential innovations in R&D sector	^	Use-Transmission of R&D products to be spread in the economy	^	Dissemination - Creation of trans-regional competitive advantages	=	Regional Specializations
Foresight and other regional research sources	Involved resources based on knowledge (R&D) that can be used for innovation	^	Production processes and structures	^	Trans-regional sales and distribution channels	=	Logical conjunction by areas of the economy
Quantitative research	Identifying indicators for this phase by the PCA section	^	Identifying indicators for this phase by the PCA section	^	Identifying indicators for this phase by the PCA section	=	Logical conjunction by the PCA section
Quantitative and expert research study	Identification of technology (detailed listing of sections and areas)	^	Identification of technology (detailed listing of sections and areas)	^	Identification of technology (detailed listing of sections and areas)	=	Logical conjunction by groups of the technology
Cartesian product rankings of RSI priorities	Regional Specialization areas ranked by the production phase	^	Regional Specialization areas ranked by the use phase	^	Regional Specialization areas ranked by the dissemination phase	=	Logical sum of regional Specializations = Performance Specialization, Key Enabling Technologies

Source: *Authors' calculations.*

In cases where technology meets all three criteria (which means it is present in all stages of regional knowledge transfer), it is considered as *regional performance*

smart specialization. In cases of meeting two criteria, they are identified as a *potential smart specialization*. Fulfilling one of the criteria classifies technology to *farther potential smart specialization* (production or use). In cases where the performed analysis indicates that the technology available in the region is not present in any of the regional knowledge transfer phases, then regional specialization does not occur.

The starting point in the statistical identification of regional specializations was the collection of diagnostic data. In view of the fact that the data collected is multidimensional, i.e. data of different scales, the procedure for uniting the collected data was carried out in step two. The synthetic indicators on the basis of which the classification of regional specializations were carried out and then calculated. The effect of the first calculation part is the diagnostic variables (Table 2). The transcript ionized variables are presented in matrix form, which are input data for calculations.

Table 2. Diagnostic variables – input (unconverted)

Technology Group	Creating of potential innovations	R&D products transmission to the economy	Dissemination: Creation of competitive advantages
X_1	$\begin{bmatrix} K_{11}^{x_1} & K_{21}^{x_1} & \dots & K_{m1}^{x_1} \\ K_{12}^{x_1} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ K_{1n}^{x_1} & \dots & \dots & K_{mn}^{x_1} \end{bmatrix}$	$\begin{bmatrix} T_{11}^{x_1} & T_{21}^{x_1} & \dots & T_{m1}^{x_1} \\ T_{12}^{x_1} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ T_{1n}^{x_1} & \dots & \dots & T_{mn}^{x_1} \end{bmatrix}$	$\begin{bmatrix} P_{11}^{x_1} & P_{21}^{x_1} & \dots & P_{m1}^{x_1} \\ P_{12}^{x_1} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ P_{1n}^{x_1} & \dots & \dots & P_{mn}^{x_1} \end{bmatrix}$
X_2	$\begin{bmatrix} K_{11}^{x_2} & K_{21}^{x_2} & \dots & K_{m1}^{x_2} \\ K_{12}^{x_2} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ K_{1n}^{x_2} & \dots & \dots & K_{mn}^{x_2} \end{bmatrix}$	$\begin{bmatrix} T_{11}^{x_2} & T_{21}^{x_2} & \dots & T_{m1}^{x_2} \\ T_{12}^{x_2} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ T_{1n}^{x_2} & \dots & \dots & T_{mn}^{x_2} \end{bmatrix}$	$\begin{bmatrix} P_{11}^{x_2} & P_{21}^{x_2} & \dots & P_{m1}^{x_2} \\ P_{12}^{x_2} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ P_{1n}^{x_2} & \dots & \dots & P_{mn}^{x_2} \end{bmatrix}$
...
X_z	$\begin{bmatrix} K_{11}^{x_{10}} & K_{21}^{x_{10}} & \dots & K_{m1}^{x_{10}} \\ K_{12}^{x_{10}} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ K_{1n}^{x_{10}} & \dots & \dots & K_{mn}^{x_{10}} \end{bmatrix}$	$\begin{bmatrix} T_{11}^{x_{10}} & T_{21}^{x_{10}} & \dots & T_{m1}^{x_{10}} \\ T_{12}^{x_{10}} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ T_{1n}^{x_{10}} & \dots & \dots & T_{mn}^{x_{10}} \end{bmatrix}$	$\begin{bmatrix} P_{11}^{x_{10}} & P_{21}^{x_{10}} & \dots & P_{m1}^{x_{10}} \\ P_{12}^{x_{10}} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ P_{1n}^{x_{10}} & \dots & \dots & P_{mn}^{x_{10}} \end{bmatrix}$

Where X_1, \dots, X_z are identified technology groups, $K_{mn}^{x_1}$ are diagnostic variables for the first group of technologies collected for the knowledge transfer stage called: Creating innovation potential; $T_{mn}^{x_1}$ are diagnostic variables for the first group of technologies collected for the knowledge transfer stage called: Transmission of products to the economy; $P_{mn}^{x_1}$ are diagnostic variables for the first group of technologies collected for the knowledge transfer stage called: Create transregional competitive advantages.

Similar markings were adopted for other groups of technologies, i.e. for variables X_2, \dots, X_z . With the data collected in matrix terms (Table 2), in the second stage called zero unitarization, calculation transformations were carried out to:

1. deprivation of the names in which the characteristics are expressed;
2. bringing the order of variable sizing to a comparability state;
3. the equality of the length of the volatility ranges of the value of all standardized characteristics (stretch constancy) and the equality of the lower and upper limits of their volatility range;
4. the possibility of standardizing the characteristics of taking positive and negative or negative values;
5. the possibility of standardizing characteristics that take a value equal to zero;
6. non-negative value of standardized characteristics;
7. the existence of simple formulas– within a given standardization formula – to harmonize the nature of variables.

Zero uniting was made taking into account equation 1:

$$x'_{ij} = \frac{x_{ij} - \min_i \{x_{ij}\}}{\max_i \{x_{ij}\} - \min_i \{x_{ij}\}} \tag{1}$$

In Table 3 it was presented a matrix of diagnostic data that has been united.

Table 3. *Diagnostic variables subjected to the unitization process*

Techno-logy Group	Creating innovative potential	Product transmission to the economy	Dissemination: Creation of competitive advantages
X_1	$\begin{bmatrix} UK_{11}^{x_1} & UK_{21}^{x_1} & \dots & UK_{m1}^{x_1} \\ UK_{12}^{x_1} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ UK_{1n}^{x_1} & \dots & \dots & UK_{mn}^{x_1} \end{bmatrix}$	$\begin{bmatrix} UT_{11}^{x_1} & UT_{21}^{x_1} & \dots & UT_{m1}^{x_1} \\ UT_{12}^{x_1} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ UT_{1n}^{x_1} & \dots & \dots & UT_{mn}^{x_1} \end{bmatrix}$	$\begin{bmatrix} UP_{11}^{x_1} & UP_{21}^{x_1} & \dots & UP_{m1}^{x_1} \\ UP_{12}^{x_1} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ UP_{1n}^{x_1} & \dots & \dots & UP_{mn}^{x_1} \end{bmatrix}$
X_2	$\begin{bmatrix} UK_{11}^{x_2} & UK_{21}^{x_2} & \dots & UK_{m1}^{x_2} \\ UK_{12}^{x_2} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ UK_{1n}^{x_2} & \dots & \dots & UK_{mn}^{x_2} \end{bmatrix}$	$\begin{bmatrix} UT_{11}^{x_2} & UT_{21}^{x_2} & \dots & UT_{m1}^{x_2} \\ UT_{12}^{x_2} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ UT_{1n}^{x_2} & \dots & \dots & UT_{mn}^{x_2} \end{bmatrix}$	$\begin{bmatrix} UP_{11}^{x_2} & UP_{21}^{x_2} & \dots & UP_{m1}^{x_2} \\ UP_{12}^{x_2} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ UP_{1n}^{x_2} & \dots & \dots & UP_{mn}^{x_2} \end{bmatrix}$
X_z	$\begin{bmatrix} UK_{11}^{x_{10}} & UK_{21}^{x_{10}} & \dots & UK_{m1}^{x_{10}} \\ UK_{12}^{x_{10}} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ UK_{1n}^{x_{10}} & \dots & \dots & UK_{mn}^{x_{10}} \end{bmatrix}$	$\begin{bmatrix} UT_{11}^{x_{10}} & UT_{21}^{x_{10}} & \dots & UT_{m1}^{x_{10}} \\ UT_{12}^{x_{10}} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ UT_{1n}^{x_{10}} & \dots & \dots & UT_{mn}^{x_{10}} \end{bmatrix}$	$\begin{bmatrix} UP_{11}^{x_{10}} & UP_{21}^{x_{10}} & \dots & UP_{m1}^{x_{10}} \\ UP_{12}^{x_{10}} & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ UP_{1n}^{x_{10}} & \dots & \dots & UP_{mn}^{x_{10}} \end{bmatrix}$

Source: Authors's calculations.

Where: X_1, \dots, X_z - identified technology groups, $UK_{mn}^{x_1}$ - united diagnostic variables for the first group of technologies collected for the knowledge transfer stage called: Creating innovation potential; $UT_{mn}^{x_1}$ - unitarized diagnostic variables for the first group of technologies collected for the knowledge transfer stage called: Transmission of products to the economy; $UP_{mn}^{x_1}$ - Unitarized diagnostic variables for the first group of technologies collected for the knowledge transfer stage called: Create transregional competitive advantages. Similar markings were adopted for other groups of technologies, i.e. for variables X_2, \dots, X_{10}

The next stage, after zero uniting, was the calculation of synthetic indicators. Table 3 provides a symbolic record of calculated synthetic indicators, calculated for detailed technologies, in each of the technology groups, in each of the three stages of knowledge transfer. Multidimensional benchmarking (WAP) methodology (cf. figure 2, 3, and 4) was used for the calculation. The measure obtained on the basis of calculated indicators is the basis for the classification of possible innovative activities in the category significantly affecting the development of the Opolskie region.

$$UK_{1\dots n}^{x_k} = \left[\sum_{i=1}^m UK_{m1}^{x_1} \right] * 100, \tag{2}$$

$$UT_{1\dots n}^{x_k} = \left[\sum_{i=1}^m UT_{m1}^{x_1} \right] * 100, \tag{3}$$

$$UP_{1\dots n}^{x_k} = \left[\sum_{i=1}^m UP_{m1}^{x_1} \right] * 100, \tag{4}$$

where: $k=1,2,3,\dots,10$, n - number of specific technologies and m - number of innovative activities during the test stage of knowledge transfer.

Table 4. Synthetic indicators calculated by multidimensional comparative analysis methodology

Technology Group	Creating innovative potential	Product transmission to the economy	Dissemination: Creation of competitive advantages
X_1	$\begin{bmatrix} UK_1^{x_1} \\ \dots \\ UK_n^{x_1} \end{bmatrix}$	$\begin{bmatrix} UT_1^{x_1} \\ \dots \\ UT_n^{x_1} \end{bmatrix}$	$\begin{bmatrix} UP_1^{x_1} \\ \dots \\ UP_n^{x_1} \end{bmatrix}$
X_2	$\begin{bmatrix} UK_1^{x_2} \\ \dots \\ UK_n^{x_2} \end{bmatrix}$	$\begin{bmatrix} UT_1^{x_2} \\ \dots \\ UT_n^{x_2} \end{bmatrix}$	$\begin{bmatrix} UP_1^{x_2} \\ \dots \\ UP_n^{x_2} \end{bmatrix}$
...
X_z	$\begin{bmatrix} UK_1^{x_{10}} \\ \dots \\ UK_n^{x_{10}} \end{bmatrix}$	$\begin{bmatrix} UT_1^{x_{10}} \\ \dots \\ UT_n^{x_{10}} \end{bmatrix}$	$\begin{bmatrix} UP_1^{x_{10}} \\ \dots \\ UP_n^{x_{10}} \end{bmatrix}$

Source: Authors' calculations.

The next step calculates integrated synthetic indicators that have been calculated for technology groups. Calculations were made according to dependencies 5-7, while the data in the symbolic entry is shown in Table 5.

$$UK_k = [\sum_{i=1}^n UK_n^k] * 100, \tag{5}$$

$$UT_k = [\sum_{i=1}^n UT_n^k] * 100, \tag{6}$$

$$UP_k = [\sum_{i=1}^n UP_n^k] * 100. \tag{7}$$

where: k = 1..z, n are numbers of specific technology groups.

Table 5. *Integrated synthetic indicators calculated by multidimensional comparative analysis methodology*

Technology Group	Creating innovative potential	Product transmission to the economy	Dissemination: Creation of competitive advantages
X_1	UK_1	UT_1	UP_1
X_2	UK_2	UT_2	UP_2
...
X_z	UK_z	UT_z	UP_z

The next step in the calculation engineering used was to classify the identified specialization. The calculation uses the median value as a criterion for classifying identified innovation activity in the region as significant. Median value calculations have been performed for each stage of knowledge transfer ($Me(UK)$, $Me(UT)$, $Me(UP)$), using formulas 8-10.

$$Me(UK) = \begin{cases} UK_{\frac{n+1}{2}}, & \text{when } UK \text{ is even number,} \\ \frac{1}{2} (UK_{\frac{n}{2}} + UK_{\frac{n}{1}+1}) & \text{when } UK \text{ is an odd number.} \end{cases} \tag{8}$$

$$Me(UT) = \begin{cases} UT_{\frac{n+1}{2}}, & \text{when } UT \text{ is even number,} \\ \frac{1}{2} (UT_{\frac{n}{2}} + UT_{\frac{n}{1}+1}) & \text{when } UT \text{ is an odd number.} \end{cases} \tag{9}$$

$$Me(UP) = \begin{cases} UP_{\frac{n+1}{2}}, & \text{when } UP \text{ is even number,} \\ \frac{1}{2} (UP_{\frac{n}{2}} + UP_{\frac{n}{1}+1}) & \text{when } UP \text{ is an odd number.} \end{cases} \tag{10}$$

The identification of significant activity of innovative activities in the different stages of knowledge transfer occurs when:

$$UK_i > Me(UK) \tag{11}$$

$$UT_i > Me(UT) \tag{12}$$

$$UP_i > Me(UK) \quad (13)$$

It occurs when more than half of the indications for the specific technology in the technology group have received a value greater than or equal to the median value set for the knowledge transfer stage.

3. Results-Regional Smarts Identified, Methodology Model Verification: The Case of Opolskie, Poland

The regional Research and Innovation Strategy for Smart Specialization (RIS3) has become a part of a comprehensive system for programming the development of UE countries and regions. The system of such programming was presented for the example of Poland in the field of innovation and knowledge transfer within the weak innovative region of Opolskie (Figure 1). The preparation of the *document of the Regional Innovation Strategy of the Opolskie Voivodeship until 2027* involved the need to develop a diagnosis of the state, conduct strategic analysis and prepare the postulated part. Conceptual work (mainly on methodology), analytical and diagnostic work (collection and analysis of data on the state of the region's economy, innovation potential and knowledge transfer) and editorial work was provided by the expert group. In order to ensure the participatory nature of document creation, strategic workshops and consultation meetings were organized. The particular role of stakeholders was to support the process of identifying the regional potential of the economy with a view to identifying market niches that could be new regional specialisations. In total, the number of participants in the work on *the Strategy* covered about 90 stakeholders.

Potential smart specializations were identified in two stages. In the first stage, on the basis of pre-drafted documents of the current RSIWO2020, as well as on the basis of the work of the expert group, proposals were prepared for product and process technology groups. Step two statistically verified the presence of the tested technologies at the different stages of knowledge transfer using diagnostic variables UK, UT, UP (Table 2) taking into account: (1) creating innovation potential, (2) the transmission of innovative products to the economy and (3) creating transregional competitive advantages.

A matrix approach was used in which integrated synthetic indicators were defined in one dimension, while in the other, a group of technologies, for which more than half of the indications for the specific technology within the technology group have received a value greater than or equal to the median value set for the knowledge transfer stage (8, 9, 10 formulas). Thus, the intensity of the impact of the industries on the development of the innovation of the Opole region was determined. On the basis of the work of stakeholders and experts, identified technologies of products and processes have been detailed. For example, the chemical technologies group included: technologies of polymers, plastics and rubber, technologies of organic chemicals, technologies of household chemicals, hybrid materials and structures,

including those made on the basis of renewable raw materials and technologies of raw materials and assumed durability materials. Using the methodology set out in Part 2.2, two groups of technologies were identified: (1) performance regional specialisations and (2) potential smart specialisations. It is reasonable to highlight closer and further specializations in the potential (smart) specialisations group of technologies (Table 6). The approach adopted, following the example of model verification in the Opolskie region, shows the positive result of the concept used.

Figure 1. Main strategic and operational documents in Poland with regard to knowledge transfer programming



Identified in the participatory-expert process, the technology groups correspond with the research carried out so far on the state of innovation of the economy of the region (diagnosing key areas of development - regional foresight (Malik, 2008), forecasting development trends - companies of tomorrow (Malik, 2010), building an innovation system - effective knowledge transfer (Malik and Dymek, 2015) and set out a consistent direction for specializing the innovative development of the region.

Table 6. Identification of technology groups according to a specific type of regional specialization

	TECHNOLOGY GROUPS	Creating innovative potential	Transmission to the economy	Dissemination: Creation of competitive advantages	Specialisations
1	Chemical technologies (sustainable)				performance regional specialisations
2	Sustainable construction and timber technologies				
3	Machinery and metal technologies				
4	Agri-food technologies				
5	ICT sector				potential smart specialisations: closer
6	Health processes, products and services and the quality of life				
7	Intelligent mobility management systems				
8	Energy industry technologies including renewable energy sources				
9	Circular economy				
10	Knowledge-based education on new technologies and innovations				

4. Discussion and Recommendations

The proposed model assumes that the process of identifying specialization should be provided continuously and include ongoing monitoring of the closer and further environment in order to adapt the specificities to the changes taking place. In this way, it will be possible to verify the up-to-date of RIS3 (forecasts and trends) shaping the development processes of the region. The identification of regional smart specialisations (whether technology groups, industries, sectors or business areas are identified) should ultimately serve to concentrate regional development policy support for those areas that create competitive advantages, on the one hand, and sustainable development on the other. It should be stressed that the *potential smart specialisations* identified have a statistically significant capacity to develop innovation and that support should be dedicated to them in this phase of regional knowledge transfer, in which they have not yet been sufficiently developed.

Innovation requires, on the one hand, to have creative and imagination skills, on the other hand, entrepreneurship and the ability to use innovative solutions in business practice (Tidd, Bessant and Pavitt, 2006). Ultimately, the economic effects of innovation in the form of higher productivity and added value are of great importance. The process of transforming expenditure into these economically tangible effects of innovation (development efficiency) is therefore crucial.

The barrier to innovative action continues to be with an individualized approach to creating and implementing innovation – a lack of tradition of cooperation, reluctance

to cooperate, mostly due to fear of taking over or even stealing the new inventions. Cooperation is most often a leaven for change, and the role of cooperation is particularly emphasized in RIS3 documents (Szewczuk-Stępień and Klemens, 2019). It is necessary to clustering and mutual understanding of the needs of all actors involved in the knowledge transfer as a whole, but also throughout the innovation process.

Economic effects and financial support as well as cooperation and trust should therefore be the drivers of regional knowledge transfer. The two last elements are rarely highlighted and even overlooked in the discussion of innovation, as they are difficult to parameterize and measure effectively. Nevertheless, without trust, it is difficult to build the foundations of an innovative economy. How important this aspect can be in the context of innovation suggests the results of the European Social Survey. The question set in the study "Would most people try to use you or do they act fairly" the largest percentage of responses aimed at trusting the other party's intentions were given by the people of Finland (nearly 80% of those surveyed), Sweden (75%) and Switzerland (68%).

If we put the results of Bloomberg's innovation ranking on this data (Community Innovation Survey, 2018) Regional Innovation Scoreboard 2019 and Community Innovation Survey – CIS, this will turn out to be at the same time the countries at the forefront of the largest innovators. It has been known for over a dozen years that this is not the case. Trust triggers initiative, opens up new ideas and solutions, facilitates cooperation, reduces costs, saves time, fosters a culture of innovation.

Innovation requires a large financial outlay, they are fraught with a significant degree of risk and therefore require support for the institutional, economic and scientific environment. Therefore, small and medium-sized enterprises are mostly not able to cover the costs of innovation activities by their own means. In practice, but also in discussions about innovation focuses mainly on R&D expenditure, research, inventions or patenting. An important link in the implementation of innovation in enterprises should be business environment institutions.

The existing of performance smart specializations has a huge impact on the development of innovative solutions within the region. However, from a sustainability point of view it is important to support *potential smart specializations* because many authors argue that relatedness and the new knowledge transfers are key building elements of the place-based smart specialization policy, in which regions aim at renewing and upgrading their economy structure by building on their existing and future capabilities (Boschma, 2014). From a point of view the regional knowledge transfer process, the types of potential smart specializations have been highlighted: closer and further. Support for (institutional and financial) relatedness technologies and potential smart specializations will be a key factor in the success of the region's development policy and is now the most important investment in the development capital of the region. For closer potential smart specialization, these

investments are short-term and, in the case of further smart specialization, long-term. However, both of these types of investments in regional development capital are needed and complementary.

References:

- Beaulier, S., Caplan, B. 2007. Behavioral Economics and Perverse Effects of the Welfare State. *Kyklos*, 60, 485-507. doi:10.1111/j.1467-6435.2007.00382.x.
- Bloomberg. 2019. Innovation Index. <https://www.bloomberg.com/news/articles/2020-01-18/germany-breaks-korea-s-six-year-streak-as-most-innovative-nation>.
- Borseková, K., Vaňová, A., Vitálišová, K. 2017. Smart Specialization for Smart Spatial Development: Innovative Strategies for Building Competitive Advantages in Tourism in Slovakia. *Socio-Economic Planning Sciences*, 58, 39-50. <https://doi.org/10.1016/j.seps.2016.10.004>.
- Boschma, R., 2014. Towards an evolutionary perspective on regional resilience, *Papers in Innovation Studies 2014/14*, Lund University, CIRCLE - Center for Innovation, Research and Competences in the Learning Economy.
- CEC. 2008. Turning Territorial Diversity into Strength. Green Paper on Territorial Cohesion, Luxembourg, Office for Official Publications of European Communities, Commission of the European Communities.
- Communication from the Commission. Europe 2020. A strategy for smart, sustainable and inclusive growth. Brussels, 3.3.2010 COM(2010) 2020 final.
- Community Innovation Survey – CIS. <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20190312-1>.
- Dodescu, A., Chirilă, L.F. 2012. Regional Innovation Governance in the Context of European Integration and Multi-level Governance Challenges. A Case Study of North-West Region of Romania. *Procedia Economics and Finance*, 3(12), 1177-1184. [https://doi.org/10.1016/s2212-5671\(12\)00293-6](https://doi.org/10.1016/s2212-5671(12)00293-6).
- Economides, G., Kalyvitis, S., Philippopoulos, A. 2008. Does foreign aid distort incentives and hurt growth? Theory and evidence from 75 aid-recipient countries. *Public Choice* 134, 463-488. <https://doi.org/10.1007/s11127-007-9239-9>.
- European Innovation Scoreboard 2019. https://ec.europa.eu/growth/industry/policy/innovation/scoreboards_en
- European Social Survey 2018. https://www.europeansocialsurvey.org/docs/round9/fieldwork/poland/ESS9_interviewer_and_fieldwork_instructions_PL.pdf.
- Foray, D. 2015. Smart Specialisation. Opportunities and challenges for regional innovation policy. Routledge. London.
- Gheorghiu, R., Andreescu, L., Curaj, A. 2016. A foresight toolkit for smart specialization and entrepreneurial discovery. *Futures*, 80, 33-44. <https://doi.org/10.1016/j.futures.2016.04.001>.
- Grima, S., Thalassinos, I.E. 2020. Financial Derivatives: A Blessing or a Curse? Emerald Publishing Co., London UK, ISBN: 9781789732467. <https://books.emeraldinsight.com/page/detail/Financial-Derivatives/?k=9781789732467>.
- Hoppe, H.H. 2001. Democracy: The God That Failed. Transaction Publishers, Rutgers, N.J. https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards/index_en.htm.

-
- Kamrowska-Zaluska, D., Soltys, J. 2016. Process of Emergence of Smart Specialisation in Pomeranian Voivodeship in Poland. *Procedia Engineering*, 161, 1987-1995. <https://doi.org/10.1016/j.proeng.2016.08.791>.
- Krammer, S.M.S. 2017. Science, technology, and innovation for economic competitiveness: The role of smart specialization in less-developed countries. *Technological Forecasting and Social Change*, 123(June), 95-107. <https://doi.org/10.1016/j.techfore.2017.06.028>.
- Lasuen, J.R. 1969. On Growth Poles. *Urban Studies*, 6(2), 137-161. <https://doi.org/10.1080/00420986920080231>
- Malik, K. 2011. Evaluation of Regional Development Policy: Methods, Contexts and Dimensions of Sustainable Development. *Studia KPZK PAN*, tom CXXXV, Warszawa. ISBN: 978-83-89693-67-9.
- Malik, K. 2012. The Effectiveness and Efficiency of Regional Development Policy [in:] Günter Hofbauer & Hauke Haensel (Hrsg.), *Challenges, Research and Perspectives – Herausforderungen, Forschung und Perspektiven*. European Research and Working Group. Berlin: uni-edition GmbH, Berlin, 287-300. ISBN 978-3-942171-86-1
- Malik, K. 2010. (ed.), *Kierunki rozwoju przedsiębiorstw województwa opolskiego. Podsumowanie wyników badań. (Development Trends of Regional Companies: Final Findings for Opolskie Region)*, Opole.
- Malik, K. 2008 (ed.), *Województwo opolskie regionem zrównoważonego rozwoju – foresight regionalny do 2020 roku. Kluczowe obszary badawcze i opisy scenariuszowe. Opolskie Voivodeship as Sustainable Development Region: 2020 Regional Foresight*. Politechnika Opolska, Opole.
- Malik, K., Dymek Ł. 2015 (eds.), *Effective Transfer of Knowledge from Science to Industry in the Opolskie Voivodeship: Requirements for an Effective Cooperation*. Difin, Warsaw.
- Millennium Bank 2019. *Indeks Millennium 2019: Potencjał Innowacyjności Regionów*. <https://www.bankmillennium.pl/documents/10184/27565853/Indeks+Millennium+2019.pdf>.
- Paliokaitė, A., Martinaitis, Ž., Sarpong, D. 2016. Implementing smart specialisation roadmaps in Lithuania: Lost in translation? *Technological Forecasting and Social Change*, 110(2016), 143-152. <https://doi.org/10.1016/j.techfore.2016.01.005jak>.
- Perroux, F. 1950. Economic Space: Theory and Applications. *The Quarterly Journal of Economics*, Volume 64, Issue 1, 89-104, <https://doi.org/10.2307/1881960>.
- Piirainen, K.A., Tanner, A.N., Alkærsg, L. 2017. Regional foresight and dynamics of smart specialization: A typology of regional diversification patterns. *Technological Forecasting and Social Change*, 115, 289-300. <https://doi.org/10.1016/j.techfore.2016.06.027>.
- Regional Innovation Scoreboard 2019. <https://www.clustercollaboration.eu/news/regional-innovation-scoreboard-2019>.
- Research and Innovation Strategies for Smart Specialization, Cohesion Policy 2014-2020, Fact sheet of the European Commission. http://ec.europa.eu/regional_policy/sources/docgener/informat/2014/smart_specialization_pl.pdf.
- Rodokanakis, S. 2006. How Effective are the Regional Policies of Convergence in the EU? *European Research Studies Journal*, Volume IX, Issue 3-4, 59-74.

-
- Rusu, M. 2013. Smart Specialization a Possible Solution to the New Global Challenges. *Procedia Economics and Finance*, 6(13), 128-136. [https://doi.org/10.1016/s2212-5671\(13\)00124-x](https://doi.org/10.1016/s2212-5671(13)00124-x).
- Sandu, S. 2012. Smart Specialization Concept and the Status of Its Implementation in Romania. *Procedia Economics and Finance*, 3(12), 236-242. [https://doi.org/10.1016/s2212-5671\(12\)00146-3](https://doi.org/10.1016/s2212-5671(12)00146-3).
- Schumpeter, J.A. 2008. The theory of economic development. Social science classis series. Translation of: *Theorie der wirtschaftlichen Entwicklung*. Reprint. Originally published: Cambridge, Mass., Harvard University, 1934. *Harvard Economics Studies* v. 46.
- Single European Act, 1987: 1-28.
- Stiglitz, J.E. 2015. Inequality and economic growth. *Polit Q*, 86(S1),134-155.
- Szewczuk-Stępień M., Klemens, B. 2019. Essence and role of co-operation in regional development. RIS3 study. In *Quality-Access to Success*, 20 (SI), Romania, Petrosani.
- Thalassinos, I.E., Thalassinos, E.P., Venedictova, B., Yordanov, V. 2015. Currency Board Arrangement Capital Structure Macro-Financial Diagnostic. SSRN-id2624333.pdf.
- The Paris Declaration on Aid Effectiveness and the Accra Agenda for Action. <https://www.oecd.org/dac/effectiveness/34428351.pdf>.
- Tidd, J., Bessant, J., Pavitt, K. 2006. *Managing innovation. Integrating technological, market and organizational change*, Chichester, John Wiley&Sons, Ltd.