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## The Measurement of Innovation and Development of Regions: The Framework for Quantification Based on Polish Voivodeships

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**Abstract:**

**Purpose:** The purpose of this study is to add a proposal of synthetic measurement, as well as to assess the current performance of the voivodeships in Poland, with respect to regional innovation and regional development investigated together.

**Design/Methodology/Approach:** Applied methodology was based on an aggregate measure including the set of indicators used to describe both innovation and development. The most current period available in STRATEG database was used to perform the analysis. To ensure the feasibility of international comparisons, the definition of region adopted in this study was coherent with the commonly used in EU regional policy NUTS 2 level, which in Polish case refers to sixteen existing voivodeships.

**Findings:** This empirical study contributes to the theoretical concept of examining the innovativeness and development of regions as multidimensional phenomenon. The current synthetic assessment of innovation and development for Polish regions indicated high differentiation and concentration of these phenomena appearance. Clear disparity in the development trajectories of individual voivodeships was observed. Identified inequalities should maintain the fields of further economic studies.

**Practical Implications:** The obtained results and conclusions allow to identify challenges for the quality and durability of the future development of Polish voivodeships, as well as in terms of practical implications related to regional cohesion policies in general.

**Originality/value:** To the best of my knowledge this is a unique study considering a synthetic measurement for regional innovation and development.

**Keywords:** Regional innovation, regional development, measurement.

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## 1. Introduction

Innovation is perceived as one of the factors contributing to the economic prosperity of countries and regions (Filipiak and Kogut-Jaworska, 2008). Furthermore, it is considered to be the most progressive driver of socio-economic development and growth in regional terms (Niedzielski and Jaźwiński, 2007). This is particularly important in the current reality of socio-economic challenges related to new technologies emergence (Brynjolfsson, 2016; Hémous and Morton, 2022) or climatic changes and dependence on non-renewable resources, affecting the majority of economies globally (World Economic Forum (a) 2023; World Economic Forum (b), 2023).

Development and innovation in regional dimension are the terms commonly used, however still ambiguously defined. Apart from treating both described economic categories separately and looking for similarities or differences between them, it is also worth to treat them together to analyze their combined value (Klóska, 2015; Markowska, 2012). Despite the complexity of both regional innovation and regional development, this approach seems additionally justified, as both of these multidimensional variables are expected to lead to positive changes in the qualitative progress.

The components of regional innovation and regional development seem to complement each other, in the same process of spatial socio-economic transformation. Furthermore, the empirical research concerning regional development and innovation can successfully use methods of multidimensional statistical analysis including the synthetic measures (Młodak, 2006; Strahl, 2006; Taylor *et al.*, 2015; Kadlubek *et al.*, 2022).

This article contributes to the discussion included in the studies concerning the growing role of innovation in the development of economies, as well as the challenges in measuring regional development (Czyżycki *et al.*, 2020; Klóska *et al.*, 2020; Szklarz, 2018). The dilemmas of measuring innovation and development are particularly visible among developing countries, where the progress of productivity performing during economic transformation was not based on innovation (the case of Poland and several Central and Eastern European economies).

In the described context, the purpose of this study is to add a proposal of synthetic measurement, as well as to assess the current performance of the voivodeships in Poland, with respect to regional innovation and regional development investigated together.

The outline of this paper is as follows. The first section provides theoretical background by reviewing the literature concerning both innovation and development in regional dimension. The second section presents the adopted methodology based on aggregate measurement, as well as the results of synthetic measures and the

ranking of Polish voivodeships. The final section presents the most important conclusions related to the conducted analysis, indicates limitations and identifies fields for further research areas mainly related to the future challenges of quantitative development and qualitative progress of regions.

## **2. Literature Review**

The evolution of approach to innovation presented in economic literature shows its interdisciplinary character and the unanimity in defining this concept (Godin, 2008). The classical Schumpeter's theory indicated, that innovation is the key aspect of economic development by transferring the system from one, to the next state of equilibrium via creative destruction (Schumpeter, 2017; Aghion and Howitt, 2014).

In this way new knowledge was originally recognized as primary important for shaping development potential, furthermore, the technological progress was related to acquiring knowledge through action (Arrow, 1962). The development of empirical studies concerning macroeconomic growth models empowered the perception of the key role of innovation for economic development (Fagerberg *et al.*, 2010; Thalassinos *et al.*, 2019; Pociovalisteanu and Thalassinos, 2009).

In this context, the individual components of progress such as technological advancement, knowledge and human capital empowering local linkages were further identified and emphasized (Lucas, 1988; Grossman and Helpman, 1994).

Irrespectively, the empirical studies mainly concerning developing countries, emphasized the internalization of economy and the role of foreign direct investments in innovation widespread (Filippetti *et al.*, 2013; Szklarz *et al.*, 2021). It was argued that internationally oriented enterprises are more likely to engage in higher levels of research and development and innovative activity (Rugman, 2009).

Simultaneously, the theoretical background for regional development including the phenomena of innovation was developed. This concept occurred widely in the context of economy as a whole, with respect to both national and regional systems (Freeman, 1995). Many empirical studies concluded that innovation does not appear with equal intensity and is rather spatially or regionally concentrated (Redding, 2010; Adamopoulos and Thalassinos, 2020).

In spatial dimension, innovation was perceived as localized process by being the driving force of economies development in regional context (Korol, 2007; Gault, 2013; Adam, 2014; Pike *et al.*, 2017). Various theoretical and empirical frameworks have been developed to analyze spatial dimension of innovation in particular with respect to knowledge creation and spillovers (Audretsch and Feldman, 2004; Brenner, 2007).

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As the knowledge was not uniformly distributed across the sectors and space, the location of knowledge creation and the understanding of knowledge flows became the primary issue for economic growth generation. As the rate of technical progress, being the result of knowledge emergence, was treated as an internal factor determining economic growth, the evolution of new growth theories based on endogenous models have further operationalized the Schumpeter's concept (Romer, 1990).

In general, the theoretical basis for local and regional innovation emergence were reflected in the concepts of new industrial districts and innovative milieu. The concept of new industrial districts emphasized the dynamic relations between socio-cultural features of entrepreneurs to explain the local growth of productivity and innovativeness (Becattini, 2004).

It was argued, that the dynamic efficiency within new industrial districts appears in the form of additional innovation emergence. The second concept of innovative milieu was developed on the theoretical basis of endogenous growth theory. It involved dynamic factors related to cooperation, interpersonal synergies and collective learning in order to investigate innovation processes conducted at spatial level.

As the enterprises innovation processes were concerned, the synergies resulting from cooperation were further confirmed by the open innovation model paradigm (Chesbrough, 2006). The innovative milieu approach assumed that space is the matrix of economic development and that economic mechanisms transform the space (Crevoisier, 2004).

It is currently argued, that in spatial context, the models of knowledge creation and innovation emergence seem to be more accurately explained by regional interactions. Furthermore, the region has been defined as a space, where new economic knowledge can be created and commercialized into innovations (Malecki, 2021; Kijek *et al.*, 2023).

As a result, the innovativeness of regions becomes a determinant of further regional development and plays a leading role in the process of continuous socio-economic changes (Janger *et al.*, 2017; Silva *et al.*, 2020; Teirlinck and Spithoven, 2023).

In the described context, the research gap could be recognized as the constant need of assessment of both categories: innovation and development in regional dimension, in particular with the use of synthetic taxonomic measures. Thus, regional innovation and regional development considered in combined approach seem to constitute additional information value.

### **3. Methods and Results**

Applied methodology was based on a synthetic measure including the set of indicators (variables) used to describe both individual criteria: regional innovation and regional development. The most current available data for 2021 published in STRATEG database and up-dated as for 30.08.2023 was used to perform the analysis. STRATEG is a public Polish database which supports the process of monitoring development and evaluating the effects of actions conducted to enhance social cohesion.

To ensure the feasibility of international comparisons, the database also provides fundamental indicators for the EU member states, as well as individual regions at the NUTS 2 level. The definition of region adopted in this study was therefore coherent with the commonly used in EU regional policy NUTS 2 level, which in Polish case refers to sixteen existing voivodeships.

The adopted list of indicators (diagnostic variables) consisted of eight aligned to regional innovation and nine aligned to regional development, together combined into one set of seventeen features. The applied indicators representing innovation were related to the areas of potential, business activity and results. These were:

- (1) expenditure on innovative activity in enterprises in relation to GDP [%];
- (2) percentage of people aged 15-89 with higher education [%];
- (3) internal expenditures on R&D activity in relation to GDP [%];
- (4) percentage of industrial enterprises that cooperated in the field of innovative activities [%];
- (5) share of innovative enterprises in total industrial enterprises [%];
- (6) share of innovative enterprises in total enterprises from the service sector [%];
- (7) share of people working in R&D in the economically active population [%];
- (8) share of net revenues from the sale of products of entities classified as high and medium-high technology [%].

The applied indicators representing development were related to both economic and social dimensions. These were:

- (1) gross domestic product per capita [PLN/per capita];
- (2) percentage of the unemployed with higher education [%];
- (3) number of newly registered entities of the national economy private sector per 1,000 people of working age [per 1.000 people of working age];
- (4) master's degree graduates per 1.000 people of working age [per 1.000 people of working age];
- (5) average monthly disposable household income [PLN/per person];
- (6) physicians working by primary place of work per 10.000 population [person/per 10 thousand people];
- (7) population per bed in hospitals [person/bed];

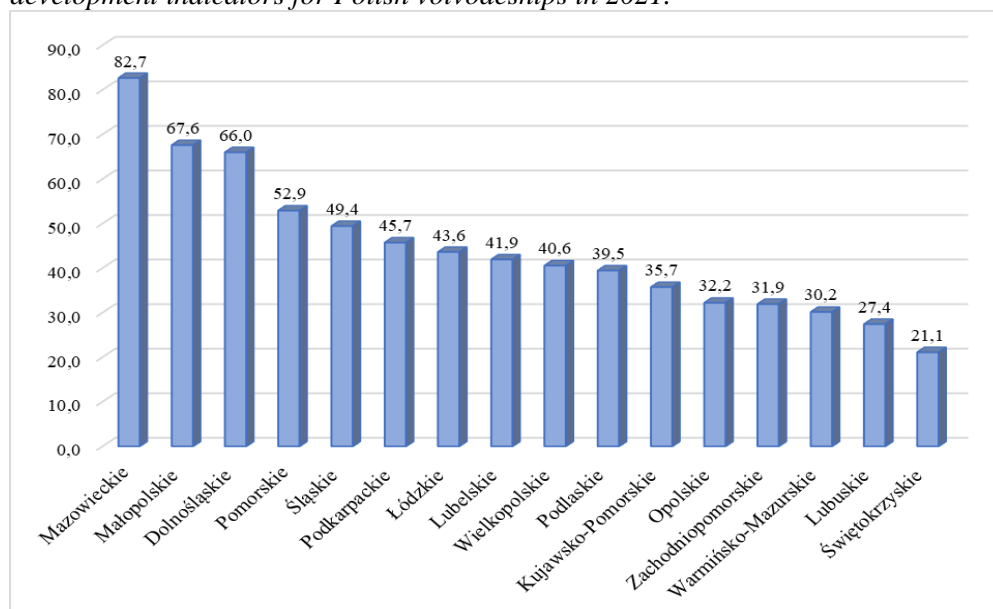
- (8) beneficiaries of community social assistance per 10.000 population [person/10 thousand people];  
 (9) natural increase per 1000 population [per 1000 population].

The nature of variables remained unchanged: high values of all of these adopted to regional innovation and the most of these adopted to regional development were desirable (stimulants), whereas three variables adopted to regional development were de-stimulants: (2), (7) and (8). Due to the absence of a clear and universally accepted procedure for weighing the variables, equal importance was aligned to each feature, therefore equal weights were further used.

As a result of the adopted approach, the final set of seventeen diagnostic variables eventually allowed to characterize the innovation development of regions in Poland as for 2021. To further organize the voivodeships in Poland with adopted criteria, an aggregate formula similar to the one used in EU innovation member states studies was applied (European Innovation Scoreboard Methodology Report, 2022).

Methodologically, this involved dividing the sum of diagnostic variables reduced to comparability through unitarization zeroed by the number of variables and multiplying the resulting arithmetic mean by one hundred. The achieved values of described aggregate formula (presented in Figure 1) enabled to rank the voivodeships in Poland basing on innovative regional development in 2021.

**Figure 1.** The values of synthetic formula aggregating both innovation and development indicators for Polish voivodeships in 2021.



**Source:** Own calculations based on STRATEG database and retrieved from: [www.strateg.stat.gov.pl](http://www.strateg.stat.gov.pl) as for 30.09.2023.

The obtained results of synthetic measures for Polish regions were visibly diversified. Only six out of sixteen regions achieved the score above the average for all analyzed voivodeships which amounted to 44,3. Furthermore, the three leaders achieved the scores from ca. 148% to 186% of the average level. The remaining ten regions achieved the aggregate scores below the average level. Moreover, five voivodeships with the lowest results achieved the scores below 75% of average level.

#### **4. Conclusions**

This study was directed to add a proposal of synthetic measurement, as well as to assess the current performance of the voivodeships in Poland, with respect to regional innovation and regional development investigated together. Adopted aggregate measure involved both described categories, which were represented by seventeen detailed indicators involving different perspectives: potential, business activity and results for innovation, as well as social and economic variables related to development.

The most current available data for 2021 was used to perform the analysis. The definition of region adopted in this study was coherent with the commonly used in EU regional policy NUTS 2 level.

The obtained results of synthetic measures for Polish regions were clearly diversified. Only six out of sixteen regions achieved the scores above the average for all analyzed voivodeships, whereas the scores of three leaders clearly distinguished from the rest.

On the contrary, the majority of regions achieved the scores below the average level, whereas the voivodeships with the lowest assessment achieved the scores much below this level. The value of the adopted aggregate measure for the frontrunner was nearly fourfold that of the lowest-ranked region.

The multidimensional nature of regional development means that its issues can be examined from various perspectives. This article emphasized the role of innovation in the development of regions. The considerations supported by the empirical study results led to several conclusions.

The aggregate current assessment of innovation and development for Polish regions indicated high differentiation and concentration of these phenomena appearance. Clear disparity in the development trajectories of individual voivodeships in Poland was observed.

Additionally, the described study conclusions allow to identify challenges for the quality and durability of the future development for at least one third of Polish

voivodeships, as well as in terms of practical implications related to regional cohesion policies in general.

Furthermore, Poland in general view seems not to be an exception among EU member states in this respect. These inequalities, as well as their determinants, should therefore maintain the fields of further economic studies. Ultimately, limitations of the conducted research should be recognized, mainly deriving from limited current database, in particular with respect to various indicators related to new technologies emergence or circular economy.

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