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FINANCING OF SMART GROWTH IN LESS DEVELOPED REGIONS ON THE EXAMPLE OF POLAND

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Abstract

The aim of this paper is twofold. First, the smart growth concept is examined with a focus on challenges associated with applying this concept in the less developed regions. Second, the impact of EU structural funds on smart growth in Poland is analyzed at the regional level with a view to contributing to the debate on public intervention in this area. The research questions are as follows: "Is the concept of smart growth, as postulated by the European Union, well suited to the less developed regions?" and "Whether and to what extent do EU funds contribute to achieving smart growth in Poland?"

Smart growth has accelerated after 2007, which could suggest a significant impact of EU structural funds, whose allocation to measures supporting innovative activity rose markedly after 2007. However, among the various factors influencing regional development processes, the impact of structural funds was not as strong as might be expected, which was confirmed by further analysis.

JEL classification: F36, O11, O30, R11
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Introduction

The importance of knowledge and innovation in explaining regional economic performance has gained increasing attention in both research and policy domains. Significant advances in economics in the last three decades (mainly in growth theory) have shown that creativity and innovation are critical to achieving lasting economic growth. The Europe 2020 agenda moves precisely in this direction by placing investment in knowledge creation at the core of a smart growth strategy. Smart growth means enhancing the role of knowledge and innovation as a driving force for economic development. Cohesion Policy, as the EU's main investment policy, is one of the most important tools in attaining the Europe 2020 goals, with Poland being by far the largest beneficiary among the member states (indeed the vast majority of the country's regional development funding comes from the EU budget). The EU's Cohesion Policy is probably the most extensive development program, with its objective being to promote the development of underprivileged regions, thus ensuring long-term convergence. Its effectiveness, however, has been scrutinized by scholars who have questioned its impact on growth.

The aim of this paper is twofold. First, the smart growth concept is examined with a focus on challenges associated with applying this concept in the less developed regions. Second, the impact of EU structural funds on smart growth in Poland is analyzed at the regional level with a view to contributing to the debate on public intervention in this area. The research questions are as follows: "Is the concept of smart growth, as postulated by the European Union, well suited to the less developed regions?" and "Whether and to what extent do EU funds contribute to achieving smart growth in Poland?"

From a methodological point of view, the level of smart growth of Polish regions and the impact of EU structural funds on it is estimated using statistical analysis such as linear ordering methods (Hellwig's and TOPSIS). Moreover, a regression discontinuity design (RDD) is used to analyze differences in progress before and after the influx of funding for smart growth.

Smart growth as one of the priorities of the Europe 2020 strategy

In June 2010, the European Council adopted "Europe 2020: A strategy for smart, sustainable and inclusive growth" (European Commission, 2010), which sets out a vision of Europe's social market economy for the 21st century. Europe 2020 was designed as an exit strategy from the global economic and financial crisis that started in 2008. It was to reinforce economic policy cooperation with a view to promoting sustainable growth in the EU. It succeeded the Lisbon Strategy (2000–2010), building on the objectives and toolbox of its 2005 revision focused on growth and jobs. Similarly to the latter, Europe 2020 is driven by international competitiveness concerns and the promotion of productivity, growth and sustainability. It also makes use of the same governance framework. The Europe 2020 strategy aims to transform the EU into a smart, sustainable and inclusive economy with high levels of employment, productivity and social cohesion, and to reinforce the EU as an actor in global governance.

The Europe 2020 Strategy is based on two strands. First, it identifies three priorities to clarify the nature of growth that the EU envisages: smart growth developing an economy based on knowledge and innovation, sustainable growth promoting a more efficient economy in terms of resource utilization which is more ecological and more competitive, and inclusive growth fostering an economy with high employment levels, which ensures social and territorial cohesion. These priorities are interrelated and mutually reinforcing. Second, there are five headline targets that serve as benchmarks for the EU in 2020 on employment, education, social inclusion, research and development, and climate and energy. Combining these two strands leads to a total of seven flagship initiatives that are to promote smart, sustainable, and inclusive growth and guide policymaking in the EU and the member states.

Smart growth is therefore one of the priorities of the strategy. It is aimed at enhancing outcomes in the areas of education (by encouraging learning and raising qualifications), research and innovation (by creating new products and services to boost economic growth and employment and helping to solve social problems), and digital society (by using information and communication technologies). At the heart of this development strategy is the belief that lower economic growth in Europe as compared to its main competitors largely results from differences in performance caused, in part, by lower investment in research and development and innovation,

insufficient use of information and communication technologies, and limited access to innovation for some social groups.

The concept of smart growth represents a new approach to economic development, but in the literature there is still little research on it, both at the national and regional levels. Moreover, the term "smart growth" is often used in the sense of "smart development" while the notions should be kept distinct as they are not identical. The terminology problem is further compounded by the fact that for many years now the concept of "smart growth" has also been associated with smart cities. In this article the term "smart growth" is used in the way the EU refers to it in the Europe 2020 strategy. This also means that despite the obvious differences between growth and development, the present author uses the term "smart growth" to describe both of these processes, as the EU does.

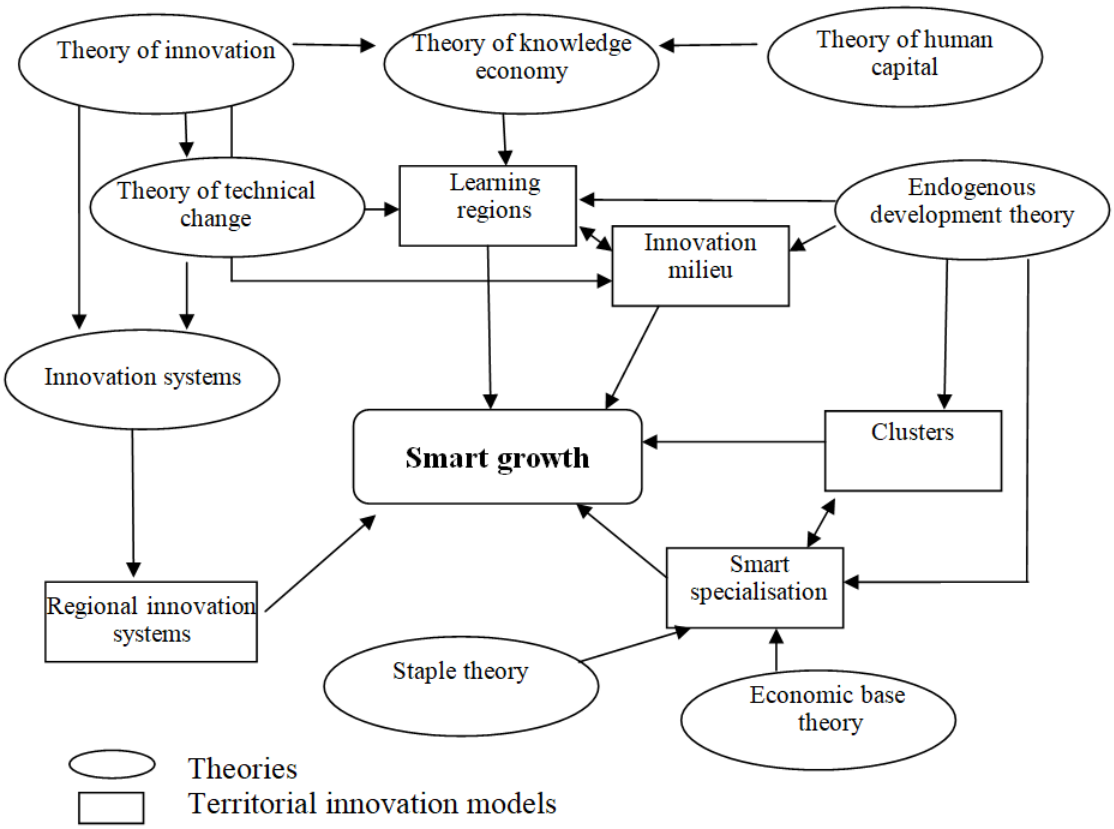
Smart growth is typically defined as economic development based on knowledge and innovation and founded on three pillars: research and innovation, education (training and upgrading), and digital society (using IT and communication technologies) (European Commission, 2010). Smart growth implies increasing the role of knowledge and innovation as the driving forces in economy. Modern economic development is to a considerable extent determined and driven by the emergence of the knowledge economy, which reflects trends in advanced countries towards greater dependence on knowledge, information and high skills levels, and an increasing need for ready access to all of these by the business and public sectors (OECD, 2005). Access to knowledge is generally recognized as a key condition for innovative activities in modern spatial management. Consequently, the creation and dissemination of knowledge may act as a crucial success factor for regional and national development.

The notion of a knowledge-based economy recognizes the structural changes that are taking place in modern economies. In the past, growth in the European Union was largely driven by the material-based economy (the manufacturing industries), while now it relies to a greater extent on the intangible sphere related to knowledge (Molle, 2011, p. 171). Modern economics has been interested in the importance of knowledge and the quality of human competence for a long time (Foray & Lundvall, 1996). Fritz Machlup focused on the economic aspects of knowledge (Machlup, 1962), and it was recognized as a source of productivity by Peter Drucker (1993). Knowledge is a multidimensional concept and the creation of knowledge is a complex process (Arrow, 1994). Moreover, effective knowledge distribution through formal and informal networks is essential for good economic performance (Lundvall, 1992; Nelson, 1993).

The concept of knowledge is related to the concept of human capital, introduced in the 1960s by T.W. Schultz and G.S. Becker. T. Schultz defined human capital as those qualities of a population that have value and can be enriched by appropriate investment (Schultz, 1961). G. Becker treated human capital as another factor of production (Becker, 1964). The 1980s saw the development of the concept of human capital in economic theory due to, among others, the work of A. Sen, the co-creator of human development theory. He pointed out that development is not limited to economic growth, but also encompasses human development, including civil liberties, health (life expectancy), equality, peace, social justice, and ecological issues (Sen, 1981). A. Sen's capability approach has emerged as a leading theoretical framework in the economics of welfare and development (Sen, 1985). With the incorporation of knowledge and skills in the general concept of human capital, it has become possible to fully meet the challenges posed by the fundamental questions of growth theory. The inclusion of human capital (resulting from investment) in addition to physical capital helps better explain technical progress and productivity growth.

In recent years, the role of innovation in growth processes has been emphasized and placed on an equal footing with knowledge (rather than below it, as was the case in the past), and an economy based on knowledge and innovation has increasingly become part of public discourse (Piech, 2009). Theory links the development of the knowledge base to innovation and economic growth (Lever, 2002). Also, the key relationship between knowledge and innovation and its centrality to firm performance has been explored (Masso & Vahter, 2008). The results of many investigations provide support for the relationship between innovation, quality upgrading, and market share of industries (Hashi & Stojcic, 2013). In the process of transformation of the modern economic model towards a knowledge-based economy, it is the ability to innovate that has become a major determinant of the success of individual countries in global competition. In

Figure 1: The theoretical basis for smart development and growth



Source: Own elaboration

other words, the competitiveness of an economy depends on its innovation performance with innovations resulting from knowledge. The level of innovation depends not only on the progress of new technologies, but also on knowledge and skills, or human capital (Klamut, 2011). Knowledge and innovation are of paramount importance in driving the development process. The ability to create and use knowledge for production and transfer it to innovation processes has become a major factor in market competitiveness. Of great importance to the advancement of these theories were also earlier contributions from Schumpeter (1934) and Porter (1990).

Therefore, smart growth means an increasing role of knowledge and innovation as drivers of economic development. Smart growth research is closely linked to regional development theory. Over the past several decades, a number of theoretical concepts and models have emerged, taking into account additional factors that have a significant impact on regional development processes. There is a clear shift from classical location theory to the social and institutional aspects of growth, including learning regions, innovation environments, and regional innovation systems.

Territorial innovation models (for more see Moulaert & Sekia, 2003), which are essential to the formation of the smart growth concept, include:

1) theory of regional innovation systems (Lundvall, 1992; Nelson, 1993; European Commission, 1998; Fornahl & Brenner, 2003),
2) theory of learning regions (Florida, 1995; Boekema et al., 2000),
3) innovative milieu concept (Maillat, 1995),
4) cluster theory (Porter, 1990),
5) smart specialization concept (Foray & Van Ark, 2007; Foray, 2015).

Smart growth is therefore a concept embedded in the study of a knowledge- and innovation-based economy and is founded on regional innovation models (Fig. 1). Measures designed to stimulate such development need to influence three areas: research and innovation, education (training and skills development), and digital society (using IT and communication technologies).

Smart growth in Poland

There are many strategic and programming documents at central and regional levels indicating the need to build an economy based on knowledge and innovation in Poland. In the 2017 European Innovation Scoreboard (European Commission, 2017a), Poland is classified as a moderate innovator, although it still ranks poorly in innovation statistics. The creation of innovations entails significant labor inputs and funding. However, the percentage share of R&D expenditure in GDP stands at approx. 1%, which represents less than 50% of the EU average. As compared to other EU member states, Poland is still characterized by a different structure of R&D spending, and especially a low share of private expenditure. There are significant and persistent differences in the innovative potential of individual regions – more than 50% of R&D outlays are concentrated in two Polish provinces: Mazowieckie and Małopolska, while expenditures in Świętokrzyskie, Opolskie, Podlaskie, Lubuskie, and Warmia-Mazury provinces are of minimal. According to the Regional Innovation Scoreboard (European Commission, 2017b), all Polish regions are classified at the lower end of the ranking (as modest and moderate innovators).

This situation is largely attributable to the legacy of the previous system and centrally-planned economy. As a result of systemic neglect under the old regime, regions are usually only weakly developed both in the administrative sense and as innovative milieux (Dyker, 2004, p. 270). The structural weaknesses of innovation systems common to all Central and Eastern European countries include (Piech & Radosevic, 2006, p. 47):

1) innovation activity restricted to a few large domestic enterprises that invest a relatively high percentage of their turnover in innovation,
2) a very small proportion of innovative SMEs, which represents the weakest part of innovation systems,
3) foreign firms investing in R&D and innovation more than domestic firms,
4) very weak linkages between large domestic enterprises and SMEs, and between FDI and domestic firms.

Measurement of innovation processes is difficult (but possible and needed) due to the fact that innovations result from interactions between cooperating actors, and so it is difficult to predict their occurrence or effects. A set of four headline indicators has been defined to enhance monitoring of the Europe 2020 smart growth objectives. The strategy contains three headline targets concerning research and development, employment, and education, which are to be achieved by 2020. In support of these targets, the member states were encouraged to set national targets in their National Reform Programs, and

Table 1: EU and Polish targets for smart growth and headline indicators

EU targets for smart growth	National targets - Poland	Headline indicators	The level of indicator in 2016 in Poland
Combined public and private investment levels to reach 3% of EU's GDP as well as better conditions for R&D and Innovation.	1.7%	Gross domestic expenditure on R&D (% of GDP)	0.97%
75% employment rate for women and men aged 20-64 by 2020– achieved by getting more people into work, especially women, the young, older and low-skilled people and legal migrants.	71%	Employment rate, age group 20-64, total (% of population)	69.3%
Better educational attainment – in particular: – reducing school drop-out rates below 10% – at least 40% of 30-34–year-olds with third level education (or equivalent)	4.5% 45%	Early leavers from education and training, total (% of the population aged 18-24 with at most lower secondary education and not in further education or training) Tertiary educational attainment, total (% of population aged 30-34)	5.2% 44.6%

Source: Own elaboration based on European Commission and Eurostat data

Poland followed suit (Tab. 1). The strategy is underpinned by concrete actions at EU and national levels.

The current indicators suggest that Poland is generally on track to meet the targets, which vary in terms of the degree of their implementation. Undoubtedly, the greatest challenge is to achieve suitable R&D investment levels. Current R&D spending in Poland is far below the 3% target set forth in the Europe 2020 strategy and only slightly closer to Poland's own target of 1.7%.

Ward's classification was performed to compare the progress made by Poland and other EU countries towards each target. At the beginning of analysis, the original value of each indicator was divided by the national target value, indicating the expected level of the indicator after the adoption of the Europe 2020 strategy. The classes obtained by means of this classification group the countries implementing the Europe 2020 strategy according to similarities in progress made. The greater the progress in a given category, the lower the number of the class to which the country was assigned. Tab. 2 presents a classification of 27 member states in terms of smart growth advances. Analysis was performed for each variable separately.

Poland has a relatively high standing as regards progress in employment of people aged 20–64, the proportion of people with tertiary education in the 30–34 age group, and GERD. On the other hand, Poland is in the group of worst performers as regards reduction in the percentage of early school leavers. Given that the classification is based on changes in indicators rather than their absolute values, it should be noted that countries placed higher in this ranking are not necessarily closer to achieving the targets. However, analysis shows that the progress made by Poland in reaching the GERD target is significant compared to other EU countries.

Regardless of progress towards achieving the goals of the Europe 2020 strategy, the level of innovation (and smart growth) in Poland remains low and requires stimulation. Cohesion Policy, as the EU's main investment policy, is one of the most important tools in achieving the Europe 2020 goals, and Poland is by far the largest beneficiary of Cohesion Policy funds among the member states. The promotion of innovation was a central feature in the 2007–2013 Cohesion Policy programs, where about €86.4 billion or nearly 25% of the total allocations went to innovation in a broad sense of the word. This commitment is further strengthened in the 2014–2020 programming period, where 30% of the total allocations are going to be deployed for innovation (European Commission, http…).

EU Cohesion Policy for smart growth in Poland

While it is the regions which are mainly responsible for RTDI policy, due to their limited financial resources, the structural funds are the predominant sources of funding for innovation-stimulating measures. Poland is expected to receive another €72.9 billion in structural funds in the 2014–2020 EU financial perspective, which represents approx. 2 percent of the country's GDP per year. Efficient spending of these new EU funds will be key to ensuring long-term and sustainable socioeconomic transformation and continued convergence with the more developed regions and countries.

Investment in research, innovation, and human capital is crucial for all regions, but regions start with different endowments and capabilities. The less

Table 2: EU and Polish targets for smart growth and headline indicators

grade	Employment rate	GERD	Early leavers from education and training	Tertiary educational attainment
1	HU, MT	CZ	PT	CZ, LV, GR, AT
2	*CZ, LT, DE, PL*	SK	MT, GR, ES	LT, RO
3	RO, EE, LU, SK, AT, SE	*BG, SI, BE, GR, HU, PL*	LV, IE, CY	*PL, PT, SI, HU, HR, SK*
4	LV, BE, FR	DE, DK, IE, NL, AT, CY, LT, EE, IT, MT	DK, HR, LU	EE, IT, DK, SE, LU, MT
5	BG, IE, FI, NL, DK, IT	FR, LV	DE, BE, EE, FR, NL, LT, IT, AT	DE, IE, NL, BG, CY
6	PT, SI, ES, HR	HR, RO, PT, ES, SE	BG, FI, SI, SE	BE, FR, ES, FI
7	GR, CY	LU, FI	*HU, PL, SK, CZ, RO*	_

Source: Own elaboration

developed ones have a relatively greater need to allocate spending to innovation, but also, as acknowledged by the paradox of regional innovations of Oughton, Landabaso and Morgan (2002), have a relatively lesser ability to absorb public funds earmarked for the promotion of innovation and investment in innovation activities as compared with the more developed ones. Moreover, the less developed regions face additional development problems because they are spatially and historically locked into their existing paths (Martin & Sunley, 2006). K. Pylak (2015) came to similar conclusions showing that the less developed regions fall within a low-tech "primary-sector-based manufacturing" model and struggle to advance to higher-tech models. Indeed, breaking out of a negative path dependency represents a major challenge. Research suggests that factors enabling growth are model-specific. Therefore, when aiming to transition to a new innovation process model, regional policies should be tailored accordingly.

R. Camagni and R. Capello (2013) call for "smart innovation policies" defined as policies which can increase the innovation capability of an area and enhance local expertise in knowledge production and use, acting on local specificities and on the characteristics, strengths, and weaknesses of existing innovation patterns in each region. Regional diversity favors different routes to growth through innovation and specialization, and challenges policy-makers to develop the right policy mix adjusted to regional potentials and needs. Therefore, to receive funds for innovation in the EU financial perspective 2014–2020, Poland had to develop an innovation framework. This included Research and Innovation Strategies (RIS3s) and was aimed at setting national and regional innovation development priorities. The framework should be consistent with the new "smart specialization" concept developed by the European Commission. "Smart specialization" is a development strategy that builds on existing competitive advantages to increase the impact of research and innovation policies on economic growth in EU member states.

There are potentially large gains from strategies that exploit an original, globally competitive specialization niche and strengthen it over time. Such smart specialization strategies can ensure that research and innovation resources reach a critical mass and are supported by targeted interventions in human resources, knowledge infrastructure, and suitable framework conditions for businesses. Smart specialization strategies have been designed by all Polish provinces (voivodships). The basis for development based on smart specialization is a policy embedded in place-based innovation policy, that is, a policy focused territorially with particular emphasis on innovation in the development process. However, in Poland the implementation of this concept encounters difficulties. Renewed or new regional innovation strategies, although they contain smart specializations, do not respect the principles and mechanisms of the choice and shape of innovation policy (Szostak, 2015).

Under Cohesion Policy, European funds are the main financial catalysts for the implementation of Poland's pro-innovation policy and smart specialization strategies. The Smart Growth Operational Program 2014–2020 is particularly important in this context. The program aims to boost the innovativeness and competitiveness of the Polish economy by increasing business expenditure on research and development (R&D) and by improving co-operation between all stakeholders in the innovation lifecycle. The support is linked to the smart specializations of all regions. Ultimately, the program should galvanize the ongoing transition of the Polish economic model towards an innovation-based one, enabling it to better compete in a globalized world. The program will continue until 2022, but in order to estimate how such support contributes to the smart growth of Polish regions, it is worth looking at the effects achieved to date. The predecessor of the Smart Growth OP was the 2007–2013 Innovative Economy Program. Co-financing from the European Union enabled the creation of an array of innovative solutions in various fields, such as medicine, ICT, transport, tourism, and others.

The aim of the present analysis is to assess the impact of EU structural funds on the smart growth of Polish regions in 2007–2013. The study is composed of three principal steps. In step one, the smart growth of Polish regions is analyzed (on basis of values corresponding to Europe 2020 indicators) using two methods: Hellwig's and TOPSIS. The results of both methods are compared by Spearman's correlation coefficients. Then, a regression discontinuity design is used to compare differences in progress before and after the influx of funding. In step two, based on analysis of all operational programs implemented in Poland in 2007–2013, the amount of EU funds allocated to areas directly related to smart growth and obtained by all the regions is estimated. Finally, in the

third stage of the study, correlations between changes in the regions' smart growth ranking (from 2007 to 2014) and the amount of EU funds in areas related to smart growth obtained in 2007–2014 are analyzed. The scope of analysis is primarily determined by the availability of statistics. The study uses data from Poland's Office for National Statistics made available via Local Data Banks, as well as Eurostat data. Analysis applies to the years of 2007–2014.

Linear ordering methods are very useful in measuring regional development (Obrębalski, 2006), with some of the best ones being Hellwig's method and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution). The first was proposed by Z. Hellwig (1968) for economic applications (taxonomy), while the second by C.L. Hwang and K. Yoon (1981) within the framework of decision theory (multi-criterion decision-making). In fact, TOPSIS can be treated as a modification of Hellwig's method with the difference being the way the synthetic criterion value is evaluated. In TOPSIS, the formula takes into account, in addition to the distance of the object assessed, also the distance from non-pattern development. These methods produce a synthetic indicator of development, built on the basis of partial measures reflecting its different aspects. This facilitates analysis of similarities of the studied objects and their linear systematization.

Hellwig's synthetic measure is constructed as follows (after Bąk, 2016):

a) normalization of variables (standardization):
$$z_{ij} = \frac{x_{ij} - \overline{x}_j}{s_j},$$

where: z_{ij} – standardized value of the *j*-th variable in the *i*-th object, x_{ij} – observation of the *j*-th variable for the *i*-th object, $\overline{x_j}$ – arithmetic mean of the *j*-th variable, s_j – standard deviation of the *j*-th variable;

b) coordinates of the pattern:
$$z_{oj} = \begin{cases} \max_i \{z_{ij}\} & \text{for stimulant variables} \\ \min_i \{z_{ij}\} & \text{for destimulant variables} \end{cases}$$

c) distance of objects from the pattern:
$$d_{i0} = \sqrt{\sum_{j=1}^{m} (z_{ij} - z_{0j})^2}$$

d) values of the synthetic variable: $q_i = 1 - \frac{d_{i0}}{d_0}$, $q_i \in [0;1]$; $\max_i\{q_i\}$ – the best object; $\min_i\{q_i\}$ – the worst object; $d_0 = \overline{d}_0 + 2S_d$; $\overline{d}_0 = \frac{1}{n}\sum_{i=1}^{n} d_{i0}$; $S_d = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(d_{i0} - \overline{d}_0)^2}$.

The construction of TOPSIS synthetic measure is as follows:

a) normalization of variables (quotient conversion):
$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}},$$

b) coordinates of the pattern (positive ideal solution):
$$z_{0j}^{+} = \begin{cases} \max_i \{z_{ij}\} & \text{for stimulant variables} \\ \min_i \{z_{ij}\} & \text{for destimulant variables} \end{cases}$$

c) coordinates of the anti-pattern (negative-ideal solution):
$$z_{0j}^{-} = \begin{cases} \min_i \{z_{ij}\} & \text{for stimulant variables} \\ \max_i \{z_{ij}\} & \text{for destimulant variables} \end{cases}$$

d) distance of objects from the pattern:
$$d_{i0}^{+} = \sqrt{\sum_{j=1}^{m} (z_{ij} - z_{0j}^{+})^2};$$

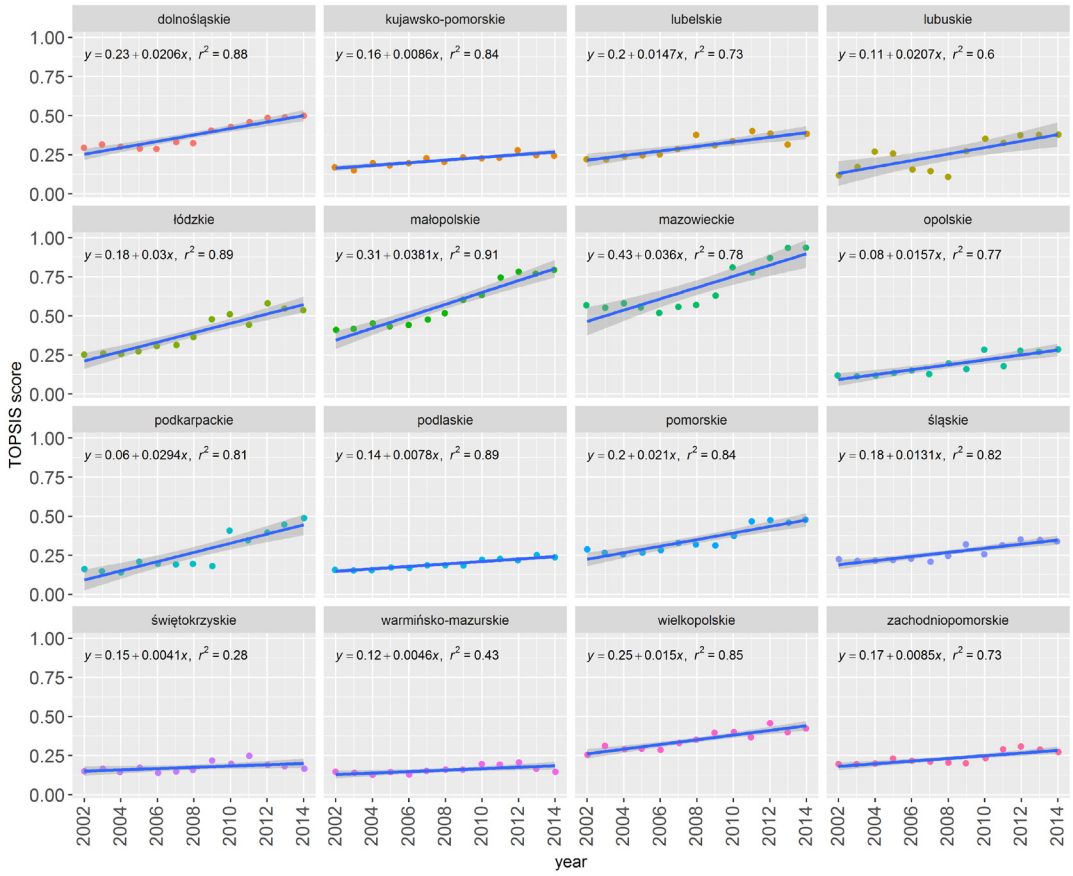
e) distance of objects from the anti-pattern:
$$d_{i0}^{-} = \sqrt{\sum_{j=1}^{m} (z_{ij} - z_{0j}^{-})^2};$$

f) values of the synthetic variable: $q_i = \frac{d_{i0}^{-}}{d_{i0}^{+} + d_{i0}^{-}}$, $q_i \in [0;1]$; $\max_i\{q_i\}$ – the best object; $\min_i\{q_i\}$ – the worst object.

For research purposes, a limited set of measures substantively related to the analyzed complex phenomenon (smart growth), were proposed. These are[1]: X1 – gross domestic expenditure on R&D (GERD) [% of GDP]; X2 – industrial companies which invest in innovative activity [%]; X3 – patent applications to the European patent office (EPO) [per million inhabitants]; X4 – share of people employed in R&D in total employment [%]; X5 – employment rate, age group 18–64 [%]; X6 – high school students aged 19–24 [per 10 thousands inhabitants]; X7 – tertiary educational attainment by sex, age group 30–34. The included specific variables are relative rather than absolute, which made it possible to reduce the impact of interferences associated with objects exhibiting certain features confounding the analysis (e.g., much greater population than the other objects). The limited number of indicators is used to keep the concept of smart growth as close as possible to its meaning defined in the Europe 2020 strategy and to focus on areas directly affected by EU structural funds. Indicators represent a consensus between the requirements presented in EU strategic documents and databases providing regional information

1 Due to a lack of data available at the regional level, none of the proposed measures are related to a digital economy. However, such measures are also absent among the headline indicators of the EU 2020 strategy, and it should be noted that the present article attempts to measure smart growth rather than development.

Figure 2: Linear regression models for smart growth (TOPSIS score) of Polish regions



Source: Own elaboration

at NUTS2 level.

The smart growth of Polish regions was analyzed on the basis of those indicators using two different methods: Hellwig's and TOPSIS. Analysis was conducted for the years 2002–2014, separately for each year. The results of both methods were compared by Spearman's correlation coefficients. Hellwig and TOPSIS scores were strongly correlated (Spearman's rho=0.89, p<0.001). A strong monotonic relationship was found between both sets of results, which implies high ranking similarity. Mazowieckie Province was the best region every year. The positions of Polish regions in terms of smart growth and changes in this respect for 2002–2014 are presented in Fig. 2.

Regression discontinuity design was used to determine whether there was a significant change in the values of indexes between the years preceding the influx of EU funds and subsequent years (2002–2014). The cut-off point was set at 2007.5[2]. Analysis was performed for each province separately and for all regions together (tab. 3, tab. 4, tab. 5). Regression discontinuity design (RDD), introduced by Thistlethwaite and Campbell (1960), is a non-experimental group comparison strategy where participants are assigned to a 'treatment' depending on whether an observed 'forcing variable' is below (or above) a known cut-off point. The rationale is that units just above (below) the cut-off point, not receiving the treatment, can be compared with those just below (above) the cut-off – receiving the treatment. Any discontinuity in the conditional expectation of the outcome at the cut-off point can be interpreted as evidence of a causal effect of the treatment. The RDD is well suited for evaluating public policies (Lee & Lemieux, 2010), when it is important to isolate their impact from other factors affecting the outcome under analysis. However, in this paper it is used only to assess changes in smart growth (before and after the influx of significant external funds supporting smart growth) rather than to directly evaluate the impact of Cohesion Policy.

2 Poland has been benefiting from EU structural funds since 2004. EU Cohesion Policy has supported innovative solutions for years, but its commitment to smart growth has grown considerably since 2007, with the renewed Lisbon strategy.

Table 3: RDD model for smart growth in Polish regions, summary of RDD procedure

	Bandwidth	Observations	Estimate	Std. Error	z value	Pr(>|z|)
LATE	2.762	96	-0.01272	0.0581	-0.219	0.8267
Half-BW	1.381	32	0.01341	0.04425	0.3031	0.7618
Double-BW	5.525	192	0.0009131	0.04187	0.02181	0.9826

Table 4: RDD model for smart growth in Polish regions, summary of discontinuous linear model – coefficients

	Estimate	Std. Error	t value	Pr(>|t|)
Tr (intercept, after 2007)	0.0009131	0.03418	0.02671	0.9787
Xl (slope, 2002-2007)	0.006309	0.01083	0.5828	0.5607
Xr (slope, 2008-2014)	0.03429	0.01083	3.168	0.001793
(Intercept)	0.264	0.02417	10.92	0.00000000000000000008189

Tab. 5. RDD model for smart growth in Polish regions, summary of discontinuous linear model for TOPSIS score

Observations	Residual Std. Error	R^2	Adjusted R^2
192	0.009629	0.121	0.107

The model can be presented as follows:

$$\hat{y} = \begin{cases} 0.006309 \cdot year + 0.264, & year = 2002, \ldots, 2007 \\ 0.03429 \cdot year + 0.264 + 0.0009131, & year = 2008, \ldots, 2014 \end{cases}$$

The model reveals that smart growth was increasing both before and after 2007, but at a higher rate after 2007. The model can explain about 11% of the variability of the growth rate. However, smart growth rates for individual regions varied. After 2007, smart growth was the fastest in Mazowieckie, Małopolskie, and Podkarpackie, and the slowest in Wielkopolskie, Lubelskie, Opolskie, and Świętokrzyskie. However, it should be remembered that the explanatory power of the regressive models presented here is limited, which indicates that development processes are multifaceted, with the contribution of EU funds being neither conclusive nor clear. This indicates the need for further optimization of financial flows under development policy (Churski & Perdał, 2016).

In the next step, the level of EU funding in fields directly related to smart growth was estimated for all regions. Analysis was based on data from KSI SIMIK 2007–2013 (an electronic record system for applications for co-financing from EU funds, as of 2016.12.31). Consequently, the following programs and priorities were taken into account: Operational Program (OP) Innovative Economy, OP Human Capital, some priorities of regional operational programs, OP Development of Eastern Poland, and OP Infrastructure and Environment. The calculated value of the funds raised in a given region was then divided by the number of its inhabitants.

Finally, analysis included changes in the ranks of regions in terms of smart growth (from 2007 to 2014) and correlations between them and the amount of EU funding in fields related to smart growth in 2007–2014. The Wilcoxon test showed no significant difference between TOPSIS scores in 2007 and 2014 for all regions. Spearman's correlations between region rank change (from 2007 to 2014) and the amount of EU funding in areas related to smart growth in 2007–2016 were calculated, but the results were not statistically significant (Spearman's rho=-0.12, p-value=0.652). Podkarpackie province was remarkable in that it saw one of the most dramatic changes in smart growth while it obtained the largest EU funding per capita in this area. To complement the analysis, the regions were divided into two groups (as it turned out – equinumerous) depending on whether the change in TOPSIS score was less than (-) or greater than (+) 0. The groups were compared using the Mann–Whitney U test, but no significant results were obtained.

Conclusions

Smart growth, as one of the priorities of the Europe 2020 strategy, is a concept based on the theory of regional development and is focused on enhancing knowledge and innovation as drivers of economic development. It is particularly challenging to implement smart growth in the less developed regions. On the one hand, these regions

are less advanced in terms of innovation (which is crucial for smart growth), while on the other hand they also have less financing available to change this situation. Therefore, Cohesion Policy funds are targeted mainly at such regions. Poland is a good example for the effectiveness of such policy intervention, being by far the largest beneficiary of cohesion policy funding among the member states, with the vast majority of the country's regional development funds coming from EU sources. Poland can be seen as one of the most interesting "laboratories" for regional development in the EU and beyond (OECD, 2008, p. 2).

The analysis presented in this article shows that while the smart growth of Polish regions is on an increase, the degree and rate of change differs between them. Interestingly, smart growth accelerated after 2007, which could suggest a significant impact of EU structural funds, whose allocation to measures supporting innovative activity rose markedly after 2007. However, among the various factors influencing regional development processes, the impact of structural funds was not as strong as might be expected, which was confirmed by further analysis.

This proves that spending on innovation alone has little effect on its growth. For example, companies often use funding to finance investment in machinery and equipment for production based on the absorption of existing technologies without creative development. Capello and Lenzi (2016), who assessed the relevance and utility of research, technological development, and innovation policies taking into account alternative regional innovation contexts, suggest that research, technological development, and innovation funds are in general relevant to stimulating innovation. However, they also warn that such initiatives may not translate into socio-economic growth in regions lacking internal scientific research and technological activity.

Smart specialization strategies are well poised to meet these challenges, at least to some extent. Regional diversity favors different routes to growth through innovation and specialization and challenges policy-makers to develop the right policy mix adjusted to regional potentials and needs. Smart specialization policies may be able to increase the innovation capacity of a region and to enhance local expertise in knowledge production and use, acting on local specificities and on the characteristics, strengths, and weaknesses of existing regional innovation patterns. However, further research is needed to assess their implementation in the less developed regions.

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