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Changes in the social and technological innovation potential of the Visegrad (V4) regions (2001–2019)

For more than a century, technical progress and innovation have been at the forefront of economics. This is one of the reasons why the importance of innovation has been recognised by economic policy makers and the concept has become part of the public narrative. However, this does not mean that research has come to an end, which would in any case contradict Schumpeter's theory of the need for change and renewal. Despite the wealth of knowledge we have, we can state that there are a number of recurring (e.g. social and ethical aspects of innovation, etc.) and new (e.g. spill-over effects of innovation, the effectiveness of public intervention in supporting the development of innovation networks, etc.) questions that can be asked about innovation. In the aftermath of the financial crisis of 2008, the cyclical COVID crisis starting in 2019 and, not least, the Russian-Ukrainian war, the peripheral regions of the post-socialist countries of Europe are falling further behind. Research, development and innovation investment, already extremely low, has further declined and the economic outlook has worsened. Social innovation may therefore be of particular importance in these regions. Our study has two main parts. First, we briefly review the place and role of innovation in economic thinking and assess the definitions of social innovation; in the second part we analyse the differences in the NUTS2 regions of the Visegrad countries in terms of the ranking of technological and social innovation potential.

Key words: social innovation, good and bad innovation, Visegrad (V4) countries.
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1. The place and importance of technical progress and innovation in economic thinking

In Schumpeter's famous work, five points were created to summarise the essence of innovation: (1) the introduction of a new good – that is one with which consumers are not yet familiar – or of a new quality of a good; (2) the introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned; (3) opening of a new market, that is a market into which the particular branch of manufacture of the country of question has not previously entered, whether or not this market existed before; (4) conquest of a new source of supply of raw materials of half manufactured goods, again irrespective of whether this source already exists or it has first to be created; (5) carrying out of the new organisation of any industry (Schumpeter 1911, 66).
However, he did not address the impact of these on society, as 'good' innovation serves the public interest compared to that that causes physical, material or moral harm to smaller or larger communities. In other words, not all new combinations contribute to the survival and well-being of a society.
This not insignificant aspect was not included in the focus of the neoclassical thinking, which was the fundamental force of the twentieth-century's economic thought, when they focused only on the effects of broader technical progress on productivity and macroeconomic output.

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There is a further element of innovation – perhaps less spectacular, less measurable in GDP terms, but at least as important– when the new solution creates opportunities for improving employment, reducing unemployment, and improving the livelihoods of the person(s) concerned and their social inclusion. These are the conditions that social innovations are creating by new/novel combinations of solutions (possibly already known), recognising that economic, social and educational innovations are at least as important as the natural, technical and technological innovations in the Schumpeterian definition.
The position of each school of economics on innovation is closely linked to the mainstream theories of growth and development. The neoclassical approach has always tried to promote the so-called "innovation theory". It is therefore worth reviewing how this approach (which is still noticeable in its effects but increasingly criticised) has developed (Table 1).

Table 1: The role of innovation and technological progress in mainstream economics

model	key factors	source
exogenous	• The driving force of the economy is the entrepreneur, the entrepreneur's ability to innovate. • Progress is the result of new combinations.	Schumpeter, 1911
	• The evolution of the economy has been explosively influenced by major technological discoveries.	Kondratyev, 1928 Rostow, 1960 Aron, 1962 Gerschenkron, 1984
	• The amount of economic output is influenced by technical progress (technical and technological level).	Hicks, 1956
	• Technical progress (capital and labour efficiency are the same) is growth-neutral.	Harrod, 1939; 1973 Domar, 1946 Solow, 1956; 1957 Hicks, 1956 Uzawa, 1960
	• Monopolistic firms are less innovative than their competitive counterparts.	Arrow, 1962
endogenous	• Government policy has an impact on innovation and growth.	Kaldor, 1957 Romer, 1990 Rebelo, 1991 Lucas, 1993
	• Technological progress is not independent of the institutional system.	Aghion, 1998
evolutionary	• Innovation requires the existence of knowledge bases, and progress (development) is the result of changes in knowledge bases.	Nelson & Winter, 1977, 1982 Dosi, 1982 Stiglitz & Greenwald, 2016

Source: compiled by the authors

The classical school, which began with the work of Adam Smith, saw the economy as a circular process without development, moving along a given and unchanging path, repeating itself, where money only has a function in exchange (Smith 1776, 1959). Schumpeter (1911) made a fundamental break with this conception, not only incorporating change into this monotonically repetitive cycle, but considering it as essential for the whole model. The revolutionary element in Schumpeter's internationally respected paper is that he does not only consider economic growth by the amount of capital and the increase in the number of workers (population) (a necessary but insufficient condition for economic growth, which arguably supports development but does not necessarily ensure it), but also takes into account the

creative, new-creating activity of the entrepreneur. For our topic, it is important to stress that Schumpeter expects new ideas from entrepreneurs, who are the creators of innovation.

Kondratyev's descriptive statistical studies (Kondratyev 1988), aimed at detecting so-called long-term (great) cycles, brought special colour to the study of the impact of innovation on the output of the economy. Analysing the causes, Kondratyev first of all emphasises that 'Before the beginning of the rising wave of each great cycle, and sometimes at the beginning of the waves themselves, a significant change in the basic conditions of economic life in society is observed. These changes are usually expressed in (various combinations of) profound changes in the techniques of production and exchange (preceded by major technical inventions and discoveries), changes in the conditions of monetary circulation, and the increasing role of new countries in the world economy' (Kondratyev 1988, 592). Kondratyev takes stock of the technical discoveries that triggered the first, second and third cycles, but also makes a strong reference to changes in the conditions of monetary circulation, which in themselves can be considered innovations.

In the study of economic growth (after a long pause), Solow and Swan's growth model shows technical progress as a substitute for capital and labour in the calculations (Solow 1956; Hicks 1956). In Solow's conception, technological progress not only increases output, but also eliminates earlier technologies (creative destruction). In the original Solow model, this technical progress is independent of investment, and the rate of technological progress is considered constant and exogenous. In a later paper (Solow 1957), however, he recognised that the rate of technological progress had to be influenced in order to increase economic output. Following in Solow's footsteps, a growing number of authors began to examine the impact of research and development on economic output.

Mansfield (1967) incorporated into the modified Cobb-Douglas production function the annual expenditure on research and development, as well as the annual rate of depreciation of the investment in research and development funds, and the rate of general technical progress that would have occurred even if the organisation's expenditure on research and development had been reduced to zero.

The 1970s saw another paradigm shift in research on innovation. The new, so-called evolutionary theory relates innovation to the results of corporate strategies (Nelson & Winter 1977) and fundamental technological change (Dosi 1982). It is characterised by gradual, systematic, conscious innovation, rather than explosive, revolutionary innovation (Wagner 2011).

Compared to the previous theories, the so-called endogenous growth theory represents a new approach to the analysis of the effects of technical and technological changes. The endogenous concept is based on the recognition that access to technological innovation varies among territories (which explains the different growth rates of countries and regions within countries and the lack of rapid convergence). Therefore, technical progress is not an exogenous variable that is available to all, but can be influenced by the amount of human capital and knowledge (Stiglitz & Greenwald 2016). The so-called new (endogenous) growth theory is of particular relevance for our topic because it argues that changes in the size and rate of output are a function not only of capital, labour and productivity, but also of human capital, initiatives, values and traditions (i.e. neoclassical economic factors) (Romer 1990).

From another perspective, innovation aims to increase productivity and gain a competitive advantage, which can lead to an increase in the level of economic development of countries and regions (Paas & Vaahi 2012; Iammarino et al. 2018). Analysing the relationship between innovation and economic growth, Lee and Rodríguez-Pose argue that 'innovation is a crucial driver of urban and regional economic success. Innovative cities and regions tend to grow faster and have higher average wages' (Lee & Rodríguez-Pose 2013, 1). This is due to higher levels of technology, more patent applications and more R&D (research and development) spending.

To sum up, innovation (science, technology, engineering) is treated with different forms of attention by all major schools of economics, while innovative responses to social problems are outside their horizon. This gap is to be filled by the new growth theory, which emphasises the initiatives of the local society.

2. The concept and drivers of social innovation

Studies of economic convergence and divergence at different levels now take into account (in contrast to the neoclassical school) the research, development and innovation (RDI) potential of a given region (e.g. Kocziszky 2004). However, innovations differ greatly in terms of their complexity, added value, social and historical importance. Innovation can affect the individuals (e.g. a particular workplace, the living environment, etc.) and small or large communities.
The technical and technological innovations resulting from Industry 4.0 will not substantially eliminate the disparities between social groups, and there is a real risk that some people will not benefit from the resulting advantages, or will benefit only to a limited extent. Therefore, the importance of social innovations generated by local communities (municipalities, religious communities, non-profit and for-profit organisations, etc.) will continue to grow, creating the potential for strengthening the value system based on work and knowledge, and transforming local initiatives into added value.
Social innovation as a concept first appeared in the work of Ogburn as a tool of improving the quality of life. In this context, Ogburn distinguishes between two complementary cultures: material and adaptive culture (Table 2). 'But frequently there is a delay in the changes thus caused, so that the old adaptive culture hangs over into the new material conditions. This lag in the adaptive culture produces a period of maladjustment, which is less harmonious as an adaptation than the period which precedes or follows.' (Ogburn 1923, 278).

Table 2: Typology of innovation

innovation		
aim	character	name
the creation of a new/novel product, technology, sales format, structure	material	technical/ technological innovation
solving a social problem	material	social innovation
improving knowledge levels, absorption capacity, new regulatory environment	immaterial	

Source: compiled by the author

The two cultures have different speeds of absorption. From this, Ogburn derived the cultural lag thesis: that is, technical and technological innovations are adopted more quickly, as opposed to immaterial culture, which needs time to catch up. The evolutionary capacity of individuals and groups with lower skills and knowledge to absorb technical and technological innovations is more modest, as evidenced by numerous examples.
Nevertheless, it was only in the late 1970s and early 1980s that the issue of social innovation came to the forefront again (and, as is usual in such cases), complementary and more precise definitions were created. The fundamental reason for this is the openness of the concept, which allows for a diversity of interpretations.
One of the most complex and brief definitions of social innovation is that of Mulgan (2007, 4), who defines social innovation as 'new ideas that address unmet social needs'.

‘Social innovation can be defined as new ideas that both meet societal needs and create new social relationships or collaborations. So not only does the individual benefit from it, but it also helps to increase society's capacity to act’ (Wendt 2016. 10).
‘Social innovation constitutes new way to attain goals’ (Zapf 1989, 177).
‘There is a one-way dependency relationship between technical and social innovations; technical innovations lead to social change and draw social innovations after them.’ (Gillwald 2000, 38).
According to Pelka and Terstriep (2016), there are seven basic types of innovation, one of which is social innovation. The other types are product, service, organisation, governance, system and marketing.
Another formulation is that social innovation is about shaping social practices to respond to societal challenges, thereby leading to increased social welfare, and this necessarily implies a greater degree of social responsibility of civil society actors than before (Garcia et al. 2015; Lombardi et al. 2020). Jastrzebska's (2017) interpretation builds on similar keywords, but more broadly formulates the character of social innovation. According to her, the main character of social innovation is that it is mainly implemented through bottom-up initiatives, has a novelty content, covers the full range of innovations from idea to implementation, and its main objective is to meet societal needs and increase efficiency, through which it improves society's capacity to act.
According to the OECD (2016, 82), social innovation differs from technical innovation in the classical sense in that "the social innovation is not about introducing new types of production or exploiting new markets in itself but is about satisfying new needs not provided by the market or creating new, more satisfactory ways of insertion in terms of giving people a place and a role in production." In their view, five main areas of impact can be identified which fundamentally determine the process of social innovation at national level. These are: unemployment, demographic challenges, poverty, environment and education.
As can be seen from the above definitions, there are simpler and more complex interpretations of the concept. Any differences in perceptions are not only due to differences of perception but also to differences of definition. Some authors, for example, have focused their analysis of the topic only on business organisations (e.g. Zapf 1994), while others have focused on larger social groups (e.g. Benedek et al. 2018). Some definitions thus emphasise the characteristic of social innovations that they satisfy needs in a novel way that the market cannot (e.g. Mulgan 2007), others focus on increasing efficiency (Phills et al. 2008; Lombardi et al. 2020), while others emphasise that social innovation can help in solving problems caused by market and governance failures (Rehfeld et al. 2015).
For an innovation to be useful, it needs to be able to be adopted or produced by a narrow or broader group in society. This requires adequate knowledge and expertise. The lack of such knowledge and skills is an obstacle to the diffusion of technical and technological innovations.

2.1 Opportunities and dilemmas for social innovation

The application of social innovation (despite its many definitions and nearly forty years of existence) has been slow to gain traction in practice (Benedek et al. 2015). There are several reasons for this, which are worth taking into account.

a) In the past decades, the literature and economic policy have mainly focused on linear innovation processes (R&D-manufacturing-marketing). Following the financial crisis of 2008, the Europe 2020 strategy (EC 2020) has put more emphasis on these ideas than ever before. One of the EU's priorities is to strengthen social innovation activity in the Member States, with a number of projects being supported, but measuring this at regional level remains a major problem. Over the last 10 years, a number of analyses have been carried out to measure the

social innovation potential of a given region (country, regional or local level), but there is still no uniformly agreed methodology and indicator structure for the calculations.
b) Social problems are complex, usually with cumulative effects (Figure 1). The reason for this complexity is that most social problems are rooted in values problems. This has spill-over effects on social coexistence, unemployment, environmental pressures, low levels of education, poor housing conditions, segregation, etc.

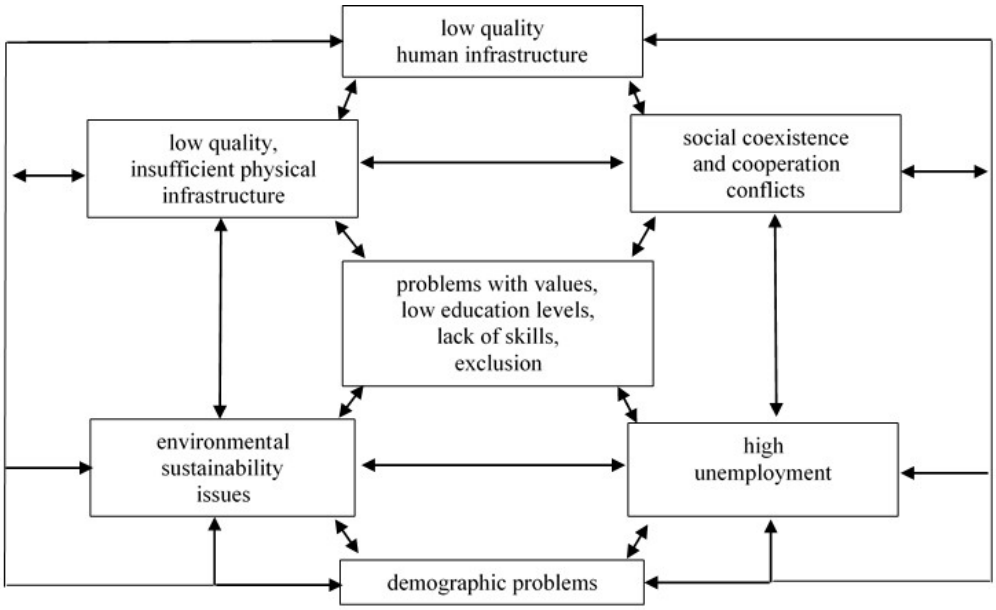

Figure 1. Typical social problems
Source: compiled by author

As social innovation generally tries to meet social needs that the market cannot, it can also be an alternative solution for catching the periphery up to the core areas (Benedek et al. 2015; Szörényiné 2015; Kocziszky et al. 2017; Kocziszky & Szendi 2018; Lombardi et al. 2020). Indeed, the problems of disadvantaged and peripheral regions (e.g. low educational attainment, low activity rates, high unemployment, low human development index, poverty, etc.) cannot be solved by technological innovation due to their low innovation potential (absorptive capacity).
c) Knowledge, the need to acquire new knowledge, individual and community values also play a prominent role in social innovation. There are significant differences in the learning, skills and knowledge levels of individual communities, municipalities and regions, which are reflected in their capacity to innovate and ultimately in their income levels and development.
d) The state has a key role not only in generating and ensuring the sustainability of innovation and R&D in science and technology, but also in social innovation processes.

3. Technological vs. social innovation potential in the NUTS2 regions of the V4

As an effect of the prolonged COVID-19 pandemic, followed by the Russian-Ukrainian war that broke out in February 2022, the socio-economic risks have increased in the Visegrad countries (Poland, the Czech Republic, Slovakia, Hungary), including inflation, increase in

budget and public deficits, increase in commodity price and, emergence of a demand rather than a supply market.

As the economy slows down, social innovation based on local initiatives will become more valuable. In the following, we examine how the technological and social innovation potential has changed in the NUTS2 regions of the four Visegrad countries between 2001 and 2019.

We analyse the similarities and differences in the distribution of the technological and social innovation indices, and the impact of the two dimensions on territorial development (whether high technological innovation performance attracts high social innovation capacity and vice versa).

In both cases, a complex analysis was carried out with the application of several indicators. In the case of technological innovation performance, R&D expenditure, the number of R&D personnel and the regional distribution of patent applications generated were considered as the main indicators of classical technological innovation.

A number of recommendations have been formulated in the literature (e.g. Krlev et al. 2014; Economist Intelligence Unit 2016; Castro Spila et al. 2016) to examine/measure social innovation performance, among which also three indicators (number of social enterprises, number of non-profit organisations, number of self-employed) have been analysed. As the primary objective of social entrepreneurship is not only to maximise profit but, like social innovation, to address social problems at the local level (e.g. labour market, equal opportunities, health, culture, etc.) (Popoli 2016; Piac & Profit 2017), social sensitivity and responsibility may be stronger in regions with more social enterprises. Self-employed people are creative actors who have innovative ideas and/or venture capital to implement new ideas and even create start-ups.

In the complex technological innovation index, the capital regions of the Visegrad countries are at the top of the list in both periods investigated. Prague is the best performing region in both 2001 and 2019 (although it has lost its top position in the number of research developers), ahead of Közép-Magyarország (Central Hungary) and the region of Bratislava. The Polish regions are found at the bottom the ranking (bottom 10) in terms of technological innovation factors.

Table 3: Ranking of top and bottom ranking NUTS2 regions in the Visegrad countries by technological innovation index and components (2001, 2019)

No	Region	2001				No	Region	2019			
		1.	2.	3.	Total			1.	2.	3.	Total
1.	Prague (CZ)	1	1	2	4	1.	Prague (CZ)	1	2	2	5
2.	Central-Hungary (HU)	3	3	1	7	2.	Central-Hungary (HU)	5	1	1	7
3.	Bratislava Region (SK)	5	2	3	10	3.	Bratislava Region (SK)	2	4	4	10
4.	Mazovian Voivodeship (PL)	4	4	10	18	4.	Mazovian Voivodeship (PL)	6	3	6	15
5.	Southeast (CZ)	6	5	7	18	5.	Lesser Poland (PL)	7	6	5	18
6.	Central Bohemia (CZ)	2	13	11	26	6.	Southeast (CZ)	4	5	9	18
7.	Southern Transdanubia (HU)	17	8	5	30	7.	Central Bohemia (CZ)	3	14	3	20
8.	Lesser Poland (PL)	9	6	16	31	8.	Central Moravia (CZ)	9	8	8	25
9.	Northeast (CZ)	7	16	9	32	9.	Pomeranian (PL)	11	9	7	27
10.	Lower Silesian (PL)	12	7	18	37	10.	Lower Silesian (PL)	12	7	11	30
…						…					
26.	Northern Hungary (HU)	33	28	15	76	26.	Central Slovakia (SK)	23	24	33	80
27.	Podlachian (PL)	22	29	27	78	27.	Podlachian (PL)	25	21	34	80
28.	Kuyavian-Pomeranian (PL)	26	24	31	81	28.	Northern Hungary (HU)	30	32	21	83
29.	Northwest (CZ)	27	35	20	82	29.	Opole (PL)	31	31	23	85

30.	West Pomeranian (PL)	30	22	35	87	30.	Eastern Slovakia (SK)	32	28	26	86
31.	Subcarpathian (PL)	28	30	30	88	31.	West Pomeranian (PL)	29	27	31	87
32.	Lubusz (PL)	34	33	24	91	32.	Warmian-Masurian (PL)	27	30	35	92
33.	Opole (PL)	31	31	32	94	33.	Lubusz (PL)	34	34	27	95
34.	Warmian-Masurian (PL)	32	32	33	97	34.	Northwest (CZ)	33	35	28	96
35.	Swietokrzyskie (PL)	35	34	34	103	35.	Swietokrzyskie (PL)	35	33	30	98

Source: compiled by author

Note: 1. R&D expenditure per capita (euro); 2. Number of R&D personnel per 100 inhabitants; 3. Number of patents per million inhabitants

The Prague region also tops the ranking in terms of the components of the social innovation index, but the dominance of the capital regions is less pronounced in this comparison. The list is dominated by Czech regions, but their position in the ranking has changed minimally over the period of 2001 to 2019. In the case of the social innovation index, the Hungarian regions are among the worst ranked, partly due to the low self-employment rate, but also because they are in the bottom third of the list for the other two indicators. The situation is similar in the Slovak regions.

Table 4: Ranking of NUTS2 regions in Visegrad countries by social innovation index and components (2001, 2019)

No.	Region	2001				No.	Region	2019			
		1.	2.	3.	Total			1.	2.	3.	Total
1.	Prague (CZ)	12	1	3	16	1.	Prague (CZ)	6	2	2	10
2.	Central Bohemia (CZ)	16	4	5	25	2.	Central Bohemia (CZ)	5	4	7	16
3.	Southwest (CZ)	22	6	2	30	3.	Southwest (CZ)	19	6	3	28
4.	Southeast (CZ)	19	5	7	31	4.	Southeast (CZ)	14	9	5	28
5.	Northeast (CZ)	21	7	4	32	5.	Northeast (CZ)	18	8	4	30
6.	Lesser Poland (PL)	4	21	12	37	6.	Northwest (CZ)	15	12	8	35
7.	Central-Hungary (HU)	17	3	17	37	7.	Lesser Poland (PL)	7	21	11	39
8.	Greater Poland (PL)	7	16	15	38	8.	Mazovian Voivodeship (PL)	4	34	1	39
9.	Mazovian Voivodeship (PL)	8	30	1	39	9.	Pomeranian (PL)	12	15	14	41
10.	Central Moravia (CZ)	23	8	8	39	10.	Greater Poland (PL)	10	17	15	42
…						…					
26.	Subcarpathian (PL)	5	35	25	65	26.	Central-Transdanubia (HU)	32	11	23	66
27.	Silesian (PL)	29	27	11	67	27.	Lubusz (PL)	18	28	24	70
28.	Central-Transdanubia (HU)	28	12	28	68	28.	Subcarpathian (PL)	11	33	27	71
29.	Warmian-Masurian (PL)	14	28	26	68	29.	Warmian-Masurian (PL)	14	29	29	72
30.	Bratislava Region (SK)	31	2	35	68	30.	Central Slovakia (SK)	20	20	33	73
31.	Northern Great Plain (HU)	27	18	31	76	31.	Eastern Slovakia (SK)	13	27	34	74
32.	Northern-Hungary (HU)	30	20	30	80	32.	Southern Great Plain (HU)	30	19	26	75
33.	Central Slovakia (SK)	33	23	32	88	33.	Western Slovakia (SK)	26	14	35	75
34.	Western Slovakia (SK)	34	22	34	90	34.	Northern Great Plain (HU)	34	22	28	84
35.	Eastern Slovakia (SK)	35	29	33	97	35.	Northern-Hungary (HU)	35	24	25	84

Source: compiled by author

Note: 1. Self-employed as % of total employment; 2. Number of social enterprises per 1000 inhabitants; 3. Number of non-profit organisations per 1000 inhabitants

When analysing the components together, it can be said that there are substantial differences and changes in the classification of both social and technological innovation potential between 2001 and 2019. Six categories were formed through the analyses:

above average scores & position has not changed;
above average scores & position improved between 2001-2019;
above average scores & position declined between 2001 and 2019;

below average scores & position has not changed;
below average scores & but performance improved between 2001 and 2019;
below average scores & position declined between 2001 and 2019.

Between 2001 and 2019, the main differences in the clusters of technological and social innovation factors are mainly due to the different positions of the metropolitan areas. In the case of the metropolitan areas, the Central Hungary region is part of the cluster, with above-average results in terms of technological and social innovation cluster performance, with a stable position. The technological innovation potential of the Prague region has deteriorated, while its social innovation potential has improved. For Warsaw, the trends show improving technological innovation capacity and deteriorating social innovation capacity. The case of Bratislava is the most contrasting: above average in technological innovation potential but below average in social innovation.

Looking at the patterns, it can be seen that in some regions at least one of the potentials is favourable, while in other regions (e.g. eastern Poland), both classifications are in the less favourable cluster. In other words, high technological innovation potential is not necessarily going hand-in-hand with high social innovation activity. On the other hand, the social innovation potential in peripheral regions is still significant, even in the absence of technological innovation (Figure 2).

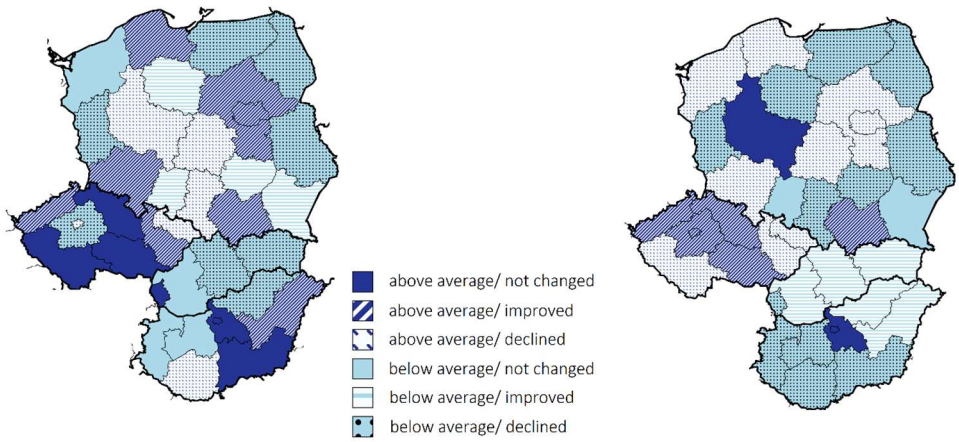

Figure 2. Technological (left) and social (right) innovation index clusters in the Visegrad regions (2001-2019)
Source: compiled by author

By examining the correlation and regression relationships within each cluster and for the region, the following conclusions can be drawn.

There is a significant, moderately strong, positive correlation between technological and social innovation potential at the 1% level in both 2001 and 2019 (2001: 0.463**; 2019: 0.578**), which has strengthened over time. In other words, high technological innovation potential is associated with higher social innovation potential for regions.

The strength of the relationship is also confirmed by regression analyses, where we have reviewed the regression indicators for the region as a whole and within each cluster (Table 5). The spatial relationships show an improvement/strengthening in both their closeness and significance over the period under study, but the analysis of the clusters shows greater disparities.

Table 5: Regression relationships between the technological and social innovation potential of NUTS2 regions in the Visegrad countries

	2001		**2019**	
cluster1	y = -0.3236x + 50.742	R^2 = 0.1127	y = -0.202x + 48.254	R^2 = 0.0332
cluster2	y = 0.7063x + 17.246	R^2 = 0.2032	y = 0.7959x + 16.217	R^2 = 0.5852
cluster3	y = 0.2422x + 33.301	R^2 = 0.1985	y = 0.2507x + 34.423	R^2 = 0.2247
cluster4	y = -0.3257x + 89.036	R^2 = 0.1172	y = -0.4814x + 99.273	R^2 = 0.2594
cluster5	y = -0.4073x + 106.3	R^2 = 0.276	y = -0.0676x + 76.905	R^2 = 0.0074
cluster6	y = -0.0467x + 67.744	R^2 = 0.0066	y = -0.0877x + 71.648	R^2 = 0.0466
Total V4	**y = 0.3235x + 37.75**	**R^2 = 0.2139**	**y = 0.3664x + 35.45**	**R^2 = 0.3344**

Source: compiled by author

For the first cluster (above average scores/position unchanged), there is a negative relationship between the two indices, i.e. a higher technological innovation index is not necessarily associated with a strong social innovation potential, and vice versa. In clusters 2 and 3, other regions with above average scores, the relationship between the two indices is positive, and has been strongly strengthened in cluster 2. The regions with below average initial values (cluster 4-6) show a negative trend, with a weak relationship between the two indicators.
Another result of the study is that there were shifts between 2001 and 2019 in the ranking of both technological and social innovation potential across regions, as evidenced by gamma convergence (Boyle & McCarthy 1997), which measures a change in ranking.

$$\gamma = \left(\frac{\mathrm{var}(indic_{\mathrm{ti}} + indic_{\mathrm{t0}})}{\mathrm{var}(\mathrm{indic}_{\mathrm{t0}} * 2)}\right),$$

where $var(indic)$ indicates the variance of the indicator's ranking, while t_i is the current year under study and t_0 is the base year.
The analysis of gamma convergence shows that between 2001 and 2019 there was a shift in the ranking of both indicators, with a downward trend, i.e. a gamma convergence is being achieved. For the technological innovation index, the value of the indicator has decreased from 2.197 in 2001 to 2.183, indicating a shift in the ranking of regions, while for the social innovation index, the decrease is minimal (from 2.212 to 2.211) but noticeable. The analysis of gamma convergence also shows that the changes in the ranking of the technological innovation index over almost 20 years are more pronounced than in the social innovation ranking.
A detailed review of the ranking changes reveals more significant shifts in some regions, such as those indicated in Figure 3 below. In the case of the Central Bohemia region, there has been a significant improvement along both dimensions, with the region's overall score in technological innovation potential improving by six points from 2001 to 2019 to stand at 20, while in social innovation potential there has been a nine-point improvement. In the case of the technological innovation index, the Pomeranian region has shown one of the most outstanding cases of progress, improving its score by 17 points over the period, while losing one point in the social innovation index. The Northern Great Plain region of Hungary suffered a significant drop in the technological dimension (30 points, the largest loss in the region), while it improved by two points in the social innovation dimension. The performance of the Northern Hungary region was also complex over the period, with a seven-point decline in the technological innovation potential and a five-point improvement in the social innovation potential.

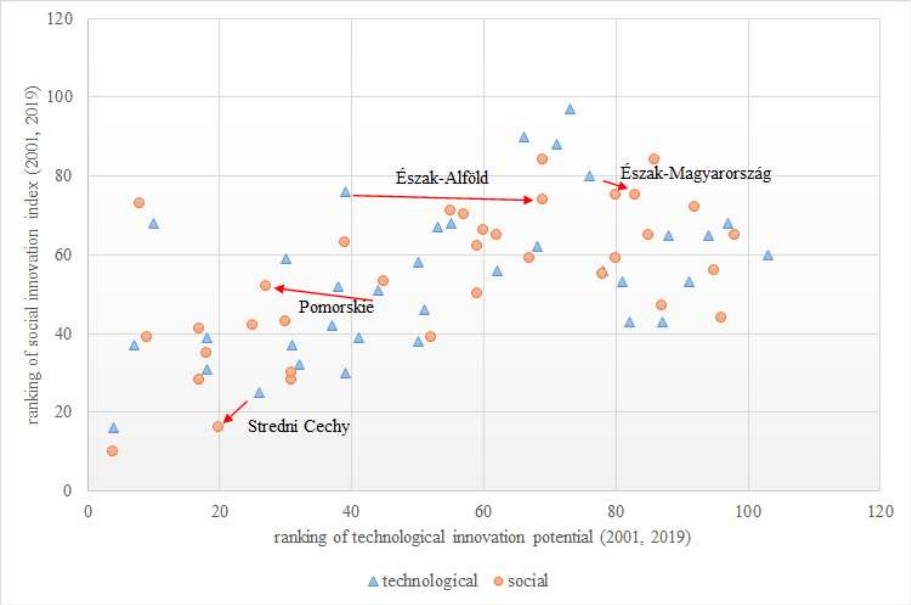

Figure 3. Changes in the technological and social innovation index in the Visegrad countries' regions (2001-2019)
Source: compiled by author

The largest positive changes in technological innovation potential were in Subcarpathian (PL), Pomeranian (PL) and Central Moravia (CZ), with improvements of 28, 17 and 16 points respectively, while the largest decreases in overall ranking scores were in the Northern Great Plain region (30 points), Western Slovakia (14 points) and Eastern Slovakia (13 points). The social innovation ranking has seen smaller shifts. Central Slovakia and Eastern Slovakia improved their position most significantly (by 13 points), while Central Bohemia (CZ) improved by 9 points. Significant declines were recorded in Swietokrzyskie (PL) and Bratislava Region (SK) (5 points), followed by five regions (including Southern Transdanubia and Southern Great Plain) which also suffered a decline of 4points.

4. Summary

Not a single society can do without economic and social renewal and development, the driving force of which is innovation, aimed at creating new or novel products, services, capabilities, tangible and intangible assets. In addition to technological innovation in the traditional sense, theories and research on social innovation are increasingly popular in the literature. Social innovation aims at solving the problems of a given community, large or small, and at improving the communities' well-being. Social innovation is a new, non-linear process (a chain of conscious activities starting from scientific research and ending with the commercialisation of a given product or service), but a complex one, which gives all members of society the opportunity to participate in the innovation process.
The "learning by doing" approach, first formulated by Arrow (1962), also applies to social innovation. Social innovation is viable if it is endogenous; its pace is determined by the learning process through the application. This suggests that the sustainability of social innovations is not only influenced by the initial skill level, but also by the process of learning, knowledge acquisition and value formation.

Technological innovation and social innovation are not mutually exclusive. On the contrary, they should be mutually reinforcing and cumulative. There is therefore no relationship of subordination, even if the added value of one is much greater than that of the other.
Social innovation alone cannot solve the problems of the centre-periphery, but in the longer term, it can contribute to higher added value innovations. High technological innovation potential and performance does not go hand in hand with high social innovation activity, which is also a sign that there is hope for high social innovation performance in peripheral regions, even in the absence of technological innovation.
Today, social innovation research has a history of almost forty years, but it is continues to expand. There are still many more topics to be developed by researchers (e.g. measuring it, generating innovations, studying its social sustainability, building its network, monitoring its impact, etc.).

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