EVALUATION OF HUMAN CAPITAL IN RELATION TO REGIONAL COMPETITIVENESS

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Abstract

Human capital refers to the knowledge, skills and attributes of an individual that help create personal, social and economic well-being. Measuring and analysing human capital is a prerequisite for prosperous and competitive regions. The development of knowledge, skills and competences as well as the capacity to innovate are key factors influencing the competitiveness and performance of regions. Regional competitiveness is the ability of a region to support and attract economic activity to the region in order to raise the living standards of its inhabitants. The aim of this paper is to assess the relationship between human capital and regional competitiveness at NUTS 2 level over a certain period of time. A regional composite indicator is constructed for human capital using multivariate statistical methods. Regional competitiveness is assessed by the officially published RCI index.

Key words: Human capital, Regional Competetiveness Index, Composite indicator,

JEL Code: C34, C52, R23

Introduction

The world economy has entered a phase of development described as the knowledge society or knowledge economy. In such an environment, human capital is becoming increasingly important and relevant. Rich and developed countries have gained their position by building, shaping, and exploiting the human capital of their people, employees in companies and other organisations. The goal of the economy is to sustainably grow performance in line with other requirements (e.g., the need for businesses to behave in an environmentally friendly manner and respect the natural environment) and to create a competitive advantage. This is the result of a systematic, well-thought-out, and well-designed approach to the use and development of human capital in the regions.

The competitiveness of the region is important for its development. Human capital is an important factor in economic growth and development, one of the sources of competitiveness and competitive advantage for individuals, enterprises, organisations, and international

integration groupings. The impact of human capital on the competitiveness of the regional economy (regional competitiveness) is now often assessed. This approach analyses the role and importance of human capital and focuses on different aspects of human capital in the light of the European Union's specialised measurement approach, the Regional Competitiveness Index (RCI). Its dimensions are closely related to human capital. Europe's competitiveness depends on a range of measures that can optimise the potential of its regions, as regions increasingly become the driving force of the economy. All regions have different opportunities for development - but this does not mean that they are competitive. To be competitive, regions need to make sufficient and effective use of these opportunities.

Quantification of human capital in each region is very important for the direction of regional policy in the country. The assessment of this phenomenon at the regional level is absent in the official indicators, only values at the level of the whole country are given. In this paper, a simple model for assessing the level of human capital of the regions using the aggregate composite indicator (CI) is presented. The value of this index is then compared with the officially reported value of the RCI, which characterises regional competitiveness in Slovakia at the NUTS-2 level.

1 Materials and methods

In general, human capital is an important component of the statistical model of economic growth and income disparities across countries (Jones, 2016). According to OECD (2001), the concept of human capital encompasses the knowledge, skills, competencies, and characteristics of individuals that facilitate the creation of personal, social and economic well-being. Investment in human capital, both private and public, is essential for the economic prosperity of a region. The penetration of the concept of human capital into the economic sphere has been influenced by the emergence and availability of relevant databases with empirical data. These databases contain data on different regions, and in addition to basic macroeconomic and demographic indicators, include data on education, health care, etc. Another factor has been the emergence of measures and studies that quantify the level of knowledge and skills of individuals, which has enabled empirical studies of the relationship between human capital and the economic success of individuals and entire economies.

The assessment of the level of human capital in a region is closely related to the competitiveness of the region. The trade-off between boosting EU member states competitiveness and reducing within-country regional inequalities is important but under

investigated relation in competitiveness and regional policy analyses. Tijanic (2015) examined the impact of regional inequality in human capital on competitiveness. Arnaut (2022) specified the contradiction between a particular territory competitiveness increase (the gross regional product, budget financing) and the population interest in implementing their qualitative and quantitative characteristics (human capital) on it.

1.1 Measurement of human capital

Human capital is knowledge, and knowledge is generally a non-rivalrous resource. Thus, it cannot be accounted in the same framework as rivalrous resources. However, managers, as they integrate the activities comprising the firm meld its rivalrous and non-rivalrous resources together (Spender et al., 2006). Quantifying human capital is a complex process. Evaluating and assessing its level is justified as human capital is a key indicator of the current and future potential of a country and its regions. There are two basic approaches to assessing and quantifying human capital: projects on monetary measures and projects based on the assessment of basic indicators. In the World Bank studies, human capital was not measured explicitly, but was included in the residual resulting from subtracting produced capital, natural capital, and net foreign assets from total national wealth, which was calculated as the present value of future consumption (World Bank, 2011). Some studies distinguish: Output-Based Approach, Cost-Based Approach, and Income-Based Approach. Currently, human capital is measured by applying the Lifetime Income Approach based on a database developed by the World Bank, The Changing Wealth of Nations (CWON) and Inclusive Wealth Report (IWR). Both CWON and IWR approaches estimate the per capita value of human capital. The IWR project calculates human capital for the entire population. CWON calculates human capital for those who have income from work. A detailed description of the methodology for quantifying human capital can be found in A Brief Introduction to Human Capital Measures (Liu et al., 2020). Projects based on the assessment of core indicators aggregate input data into a single index. The Human Capital Index (HCI) is an international metric that compares key components of human capital across countries. The HCI multiplicatively aggregates three dimensions: survival, education, health. New approaches to measuring human capital are based on realistic rates of return to education, which can vary significantly across countries (UNECE, 2016).

Currently, three metrics are recommended for assessing human capital using an aggregate index: the World Bank's Human Capital Index (WB HCI), the United Nation's Human Development Index (UN HDI) and the United Nations Development Programme (UNDP). Liu (2020) compares some of the indices assessing human capital. International

Labour Office (ILO) tends to utilize the similar index considering the quality aspects such as the Key Indicators of the Labour Market (KILM). The link between human capital and productivity is analysed in Botev et al. (2019).

All the approaches to human capital measurement mentioned above are based on country-wide data. For regional policy, it is necessary to be able to estimate the level of a region in terms of human capital. In this case, there is no single methodology on how to measure human capital at the regional level. When assessing it, it is necessary to keep in mind the purpose, the choice of the method and its correct application, and the choice of input indicators. The key role is played by the way they are integrated into a single indicator, a composite indicator, and its correct interpretation. The indicator must be significant, relevant, understandable, transparent, analytical, complete, internally, and externally comparable.

Using multivariate statistical methods, the optimal number of input indicators can be identified (cluster and correlation analysis, principal component analysis), normalized (z-scores, Min-Max, Distance to a reference), weighted (Equal weighting, Principal component analysis, Benefit of the doubt) and aggregated into a single, dimensionless number. For aggregation, Nardo et al. (2005) list several basic methods. According to the way the input indicators are included in the calculation, the methods are divided into linear, geometric and multicriteria. While the linear aggregation method is useful when all individual indicators have the same measurement unit, provided that some mathematical properties are respected. Geometric aggregations are better suited if the modeller wants some degree of non compensability between individual indicators or dimensions.

OECD (2008) methodologically described the ten-step process of creating a classical composite indicator. Handbook discussed the following steps in the construction of composite indicators: theoretical framework, data selection, imputation of missing data, multivariate analysis, normalisation, weighting and aggregation, robustness and sensitivity, back to real data, links to other variables, presentation and visualisation. In each step, suitable statistical methods are described, including the conditions of their application. The input indicators are aggregated into a single index for each region according to the relationship

$$\mathrm{CI}(\mathbf{x}_i, \mathbf{w}) = \sum_{j=1}^{m} y_{ij} w_j, \qquad (1)$$

where vector $\mathbf{y}_i = [y_{ij}, \dots, y_{im}]$ is the normalised form of the vector of input indicators $\mathbf{x}_i = [x_{ij}, \dots, x_{im}]$ for region i and indicators j, the weight w_j is specified for each dimension j, such that $w_j \geq 0$ for all $j \in J$ and $\sum_{j=1}^{m} w_j = 1$.

Mazziata and Pareto (2020) present new approach to the use of the composite index. Instead of one number, they recommend constructing an interval, which they called ´performance interval´. The one-number description approach is called the compensatory approach. In the case of a description of reality, the ´performance interval´ would refer to the non-compensatory approach. Additive methods can be used for aggregation, in the case of a compensatory approach. Otherwise, it is recommended to use non-linear functions, such as the geometric mean (OECD, 2008). If the composite index to be constructed is ´positive´, for instance socio-economic development, a downward penalization must be used. Therefore, increasing values of the index correspond to an improvement of the examined phenomenon. It is recommended partially compensatory approach an aggregation function is geometric mean.

$$\mathrm{CI}(\mathbf{x}_i, \mathbf{w}) = \prod_{j=1}^{m} y_{ij}{}^{w_j}. \qquad (2)$$

Based on these facts, it is recommended to construct ´performance interval´ of CI, rather than a single value. This interval is bounded by a lower (LB) and upper (UB) boundary. It is constructed depending on the level of compensability of individual indicators. Formula for ´positive´ performance interval is

$$(\mathrm{LB}; \mathrm{UB}) = \left(\min_j (y_{ij}) \, ; \, \sum_{j=1}^{m} y_{ij} w_j \right), \qquad (3)$$

and for ´negative´ performance interval is

$$(\mathrm{LB}; \mathrm{UB}) = \left(\sum_{j=1}^{m} y_{ij} w_j \, ; \max_j (y_{ij}) \, ; \right). \qquad (4)$$

The longer the length of this interval, the greater the imbalance between the input indicators. If an object has all the indicators rated the best, compared to other objects, the interval is narrowed to one number. The interval does not depend on how the original values are normalized.

1.2 Measurement of regional competitiveness

Regional competitiveness is a characteristic related to the comparison of their performance and development prerequisites. Regional competitiveness can be understood as the result of a concerted effort to make the most productive use of internal development resources in interaction with the use of external resources and development opportunities, targeted at a sustainable increase in the productive potential of regions (Viturka, 2007). The ability to compete with other regions is thus understood as the ability to be economically active. This brings regional disparities and uneven development of the country's regions into sharp focus.

The competitiveness of a region is defined both by the indicators that determine the region's ability to compete with other regions and by the outcomes that regional competitiveness has produced.

The Regional Competitiveness Index (RCI) is currently used to compare the regional competitiveness of EU countries. Official RCI values have been published since 2010. RCI 2019 tracks the performance of 268 regions at NUTS-2 level across 28 EU Member States. It measures 11 dimensions of competitiveness capturing concepts that are relevant to productivity and long-term development. The RCI provides a comparable and multifaceted picture of the level of competitiveness for all EU regions. RCI 2019 follows the same framework as previous editions: the indicators are grouped into 11 pillars which, in turn, are organised into three sub-indexes: basic, efficiency and innovation factors of competitiveness (Annoni et al., 2019).

2. Results and discussion

To assess the relationship between the level of human capital and regional competitiveness, at the NUTS-2 regional level, the evolution of two aggregate indices was considered. Human capital was quantified by constructing a composite indicator. Considering the official availability of data at the regional level (Statistical Office of the Slovak Republic), the input database consisted of 12 indicators. The data were converted to the population of the region in the given period. Input indicators: Ratio of pupils to teachers - grammar school, Ratio of pupils to teachers – secondary vocational school, Ratio of pupils to teachers - primary school, Crude birth rate, Crude death rate, Crude rate of natural increase of population, Crude rate of migration, Economically active population – basic and eneducated, Economically active population – upper secondary, Economically active population – tertiary (academic), Criminal offences, Gross domestic expenditures on research and development. Positive performance interval was constructed. Its higher value is better for the company. The input values of the analysed indicators were normalized, considering the positive or negative direction of the indicator. After normalization, it is necessary to assign a weight w_j to the individual indicators j in the process of creating a composite index. In our case, the indicator was assigned the same weight. In table 1 and 2 are lower (LB) and upper (UB) bound for the composite index. In this case LB represents non-compensatory index and UB represents full compensatory composite index. The table still shows the values of Midpoint (compensatory CI) a Geometric mean (non-compensatory CI). Due to the necessity to compare the calculated values with the RCI, the resulting data were transformed into z-scores.

Tab. 1: Composite indicators in 2010

		CI 2010			
		Performance interval		Composite indicator	
Regions NUTS2	Regions NUTS3	LB	UB	Midpoint	Geometric Mean
SK01	Bratislava	**-2,01**	**2,29**	**-0,23**	**2,35**
	Trnava	1,34	0,45	2,04	0,33
	Trenčín	0,40	-0,40	0,10	-0,54
	Nitra	-0,11	-0,92	-1,01	-0,58
SK02		**0,54**	**-0,29**	**0,38**	**-0,26**
	Žilina	0,53	-0,40	0,26	-0,35
	Banská Bystrica	0,08	-0,63	-0,50	-0,80
SK03		**0,31**	**-0,51**	**-0,12**	**-0,57**
	Prešov	-0,80	-0,13	-1,10	0,03
	Košice	0,28	0,14	0,47	-0,03
SK04		**-0,26**	**0,00**	**-0,31**	**0,00**

Source: SOSR, author´s calculations

In 2010, the Bratislava region was the best ranked using CI (Geometric Mean), $\mathrm{CI}_{\mathrm{BA}}^{2010} = 2{,}35$. The regions of Trnava and Prešov were also rated above average. From a NUTS-2 perspective, SK02 and SK03 were below average. Region SK03 (Eastern Slovakia) was rated as average. The width of the Performance interval should also be considered. The length of the interval characterizes the balance of individual assessed indicators. The greatest width is in region SK01 $(|UB - LB| = 4{,}30)$. The smallest region Košice. The region that has the performance interval of the smallest length shows the best balance of indicators. The largest length of the performance interval is displayed for the Bratislava region. This is due to the value of the Separate waste collection indicator. In this area, the Bratislava region is in last place compared to other regions.

Tab. 2: Composite indicator in 2020

		CI 2020			
		Performance interval		Composite indicator	
Regions NUTS2	Regions NUTS3	LB	UB	Midpoint	Geometric Mean
SK01	Bratislava	**-1,99**	**2,29**	**-0,42**	**2,27**
	Trnava	0,87	0,27	1,21	0,12
	Trenčín	0,09	-0,67	-0,43	-0,59
	Nitra	-0,91	-0,91	-1,77	-0,33
SK02		**0,02**	**-0,44**	**-0,33**	**-0,26**
	Žilina	1,16	-0,04	1,29	0,26
	Banská Bystrica	-0,01	-0,63	-0,52	-1,10
SK02		**0,57**	**-0,33**	**0,38**	**-0,42**
	Prešov	0,03	0,16	0,17	0,08
	Košice	0,36	-0,10	0,33	-0,31
SK04		**0,20**	**0,03**	**0,25**	**-0,12**

Source: SOSR, author´s calculations

On the contrary, as far as other indicators are concerned, they always come first. Regional policy interventions should be interested in a certain homogeneity of important indicators. The results further show that a region can perform better that another region from a non-compensatory point of view, but it can perform worse from a full compensatory point of view. This is an example of a pair of regions SK01 – SK04. In this case, the performance interval of the region is contained within a larger performance interval.

Compared to 2010, there have been several changes in the assessment of changes in human capital in the regions of Slovakia. The best ranked region is again Bratislava (SK01), while the values of the assessed indices have not changed significantly ($\mathrm{CI}_{\mathrm{BA}}^{2020} = 2{,}25, |\mathrm{UB} - \mathrm{LB}| = 4{,}27$). Significant improvement is rated in the Žilina region, which in 10 years has moved from a below-average region to an above-average one, the second best rated. However, the SK03 region did not improve significantly on average, as the Banská Bystrica region experienced a negative shift. The SK04 region became below average.

The *RCI* has been published four times. Its scores are shown in Table 3.

Tab. 3: Official published RCI values

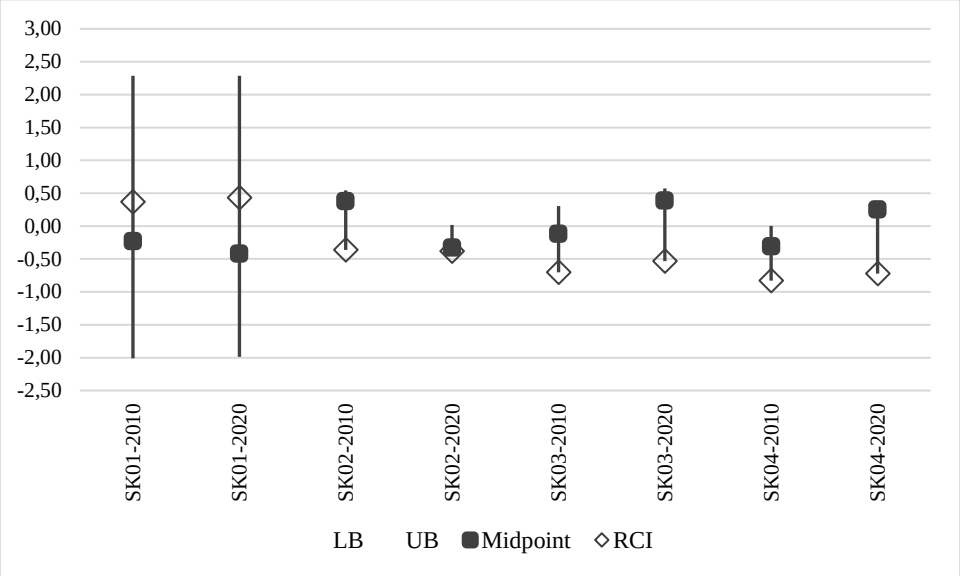
RCI	**2010**	**2013**	**2016**	**2019**
SK	-0,5	-0,59	-0,59	-0,42
SK01	0,37	0,38	0,28	0,43
SK02	-0,36	-0,56	-0,58	-0,38
SK03	-0,7	-0,75	-0,69	-0,53
SK04	-0,83	-0,87	-0,85	-0,72

Source: author´s own using OECD data (2022)

Comparing regions, the higher the positive value, the better the region is ranked. The table also shows the RCI value for Slovakia as a whole, the value is compared with other EU countries. Its negative values mean a below-average rating. There has been very little change for the better in ten years. In 2019, the RCI value was 60,30, compared to 44,01 in Slovakia. Below-average was assessed in all three sub-indices. Again, only the Bratislava region, SK01, is rated above average. The other regions are rated below average in all indicators.

The overall assessment of the analysis of the comparison of the quality of human capital (in terms of the indicators considered) and regional competitiveness (in terms of the RCI) is shown in the following graph. The graph illustrates the width of the performance interval, its lower limit LB, upper limit UB, Midpoint as a representative of CI and RCI index. The graph illustrates the width of the performance interval, its lower limit LB, upper limit UB, Midpoint as a representative of CI and RCI index.

Fig. 1: Intercomparison of CI and RCI



Source: SOSR, author´s calculations

The periods 2010 and 2020 are always compared to each other, with the 2019 RCI counted in 2020. For regions SK03 and SK04, there is a clear improvement in both the quality of human potential and competitiveness. As these two regions are the most backward in the long term, in a way this can be seen as the right setting for regional policy in Slovakia. From the width of the intervals considered, for example, it is possible to define opportunities for improvement and to target individual measures more precisely. Regional competitiveness was examined in relation to productivity and also in relation to regional disparities. However, most of these studies do not aggregate the indicators under consideration, so the studies do not provide a comprehensive assessment.

Conclusion

Investments in human capital, innovation and the dissemination of knowledge play an important role in the economic growth of a country and its regions. Quantifying the level of human capital in a region is extremely important. Tracking the impact of changes in the level on the region's competitiveness is essential. Since 2010, the RCI has provided a unique and comparable measure of competitiveness of all NUTS-2 regions in the EU. Through its 11 pillars, it assesses not only aggregate competitiveness but also the strengths and weaknesses of the regions in all its different components. The aim of the paper was to examine the relationship between human capital and regional competitiveness in the Slovak Republic. To achieve the stated objective, a simple model of aggregate index was constructed. The findings in this paper regarding the positive relationship between human capital concentration and economic growth at the local

level are thus in line with the claims arising from the models of foreign researchers. It is necessary to emphasize that the paper used a simple model that does not include several alternative indicators that are commonly used by foreign authors. However, these limitations represent an opportunity for the authors to continue and deepen their research work on the impact of the level of human capital on regional competitiveness.

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References

Annoni, P., Dijkstra, L. (2019). *The EU Regional Competitiveness Index 2019*. Luxembourg: Publications Office of the European Union. https:// doi:10.2776/046835

Arnaut, M., N., Nedoluzhko, O. V. (2022). Scientific analysis of human capital development as the factor of territory competitiveness increase. *Nexo Revista Cientifica*, 35(1), 281-289. https://doi.org/10.5377/nexo.v35i01.13946

Botev, J., et al. (2019). *A New Macroeconomic Measure of Human Capital with Strong Empirical Links To productivity*. Paris: OECD Publishing.

Jones, C. I. (2016). The Facts of Economic Growth. *Handbook of Macroeconomics, 2A*(1), 3-69. https://doi.org/10.1016/bs.hesmac.2016.03.002

Liu, G., Fraumeni, B., M. (2020*). A Brief Introduction to Human Capital Measures.* Bonn: Institute of Labor Economics. https:// https://docs.iza.org/dp13494.pdf

Mazziotta, M., Pareto, A. (2020). Composite Indices Construction: The Performance Interval Approach. *Social Indicators Research.* Springer Nature B.V. https://doi. 10.1007/s11205-020-02336-5

Nardo, M., et al. (2005). *Handbook on Constructing Composite Indicators: Methodology and User Guide.*, OECD Statistics Working Papers, 2005/03, OECD Publishing, Paris, https://doi.org/10.1787/533411815016.

OECD (2001). *The Well-being of Nations: The Role of Human and Social capital*. Paris: OECD Publishing. https://doi.org/10.1787/9789264189515-en

OECD (2008). *Handbook on Constructing Composite Indicators. Methodology and user guide*. Paris: OECD Publications.

Spender, J. C., Marr, B. (2006). How a knowledge-based approach might illuminate the notion of human capital and its measurement. *Expert Systems with Applicaions*, 30, 265-271. https://doi.org/10.1016/j.eswa.2005.07.001

UNECE (2016). *Guide on Measuring Human Capital*. United Nations: New York, Geneva.

Viturka, M. (2007). Konkurenceschopnost regionu a možnosti jeho hodnocení. *Politická ekonomie*. 55(5), 637-658. doi: 10.18267/j.polek.617

World Bank (2011). *The Changing Wealth of Nations: Measuring Sustainable Development in the New Millenium.* Washington D.C.: The World Bank. https:// DOI: 10.1596/978-0-8213-8488-6

Tijanic, L., Obadic, A. (2015). Can We Boost the Competitiveness of the European Union through Reducing Regional Inequalities in Human Capital? *Engineering economics.* Kaunas Iniversity. 26(3) DOI: http://dx.doi.org/10.5755/j01.ee.26.3.8029

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