Spatial Dynamics of Regional Competitiveness in Central and Eastern Europe

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Abstract: Our study examines the territorial structure of 11 Central and Eastern European (CEE) Member States of the EU in NUTS 2 regional breakdown, considering the regional competitiveness as of the situation over the last couple of years. We focus our research on the question whether the regional competitiveness scores of the CEE regions are spatially auto-correlated. Then, we further analyze the determinants of the existing spatial concentrations. Methodologically, we apply quantitative analyses, including descriptive statistics and data visualization, as well as standard and spatial regression modeling. Our results confirm that the spatial neighborhood effect has a significant explanatory power for the regional competitiveness in CEE. Besides that, developing the high technology and knowledge intensive sectors, together with fostering social integration and inclusion, are crucial for improving the competitiveness of the CEE regions.

Keywords: Central and Eastern Europe, Regional Competitiveness, Spatial Development

JEL Classification: C21, C31, N94, R11, R12

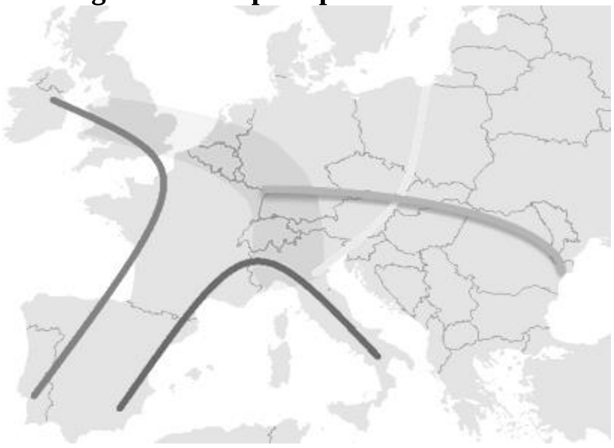
1. Introduction

The objective of this study is to provide an empirical analysis on the spatial structure of Central and Eastern Europe (CEE) in terms of the regional competitiveness in a NUTS2 regional breakdown. Our analysis endeavors to explore spatial concentrations and exceptions based on insights gleaned from the latest EU Regional Competitiveness Index (RCI) report and dataset.

The spatial structure of Europe, revealed through economic regions like the 'Blue Banana,' traditionally linked London to Milan, symbolizing Europe's economic center (Brunet, 1989). However, recent recognition of potential growth areas like the 'Yellow Banana' and 'Sunbelt' suggests evolving economic poles alongside or beyond the Blue Banana (Hospers, 2003; Miljković; 2018; Capoani et al, 2023). In Figure 1, five key European economic regions are depicted: the Blue Banana in blue, the Latin Arch in red, the Atlantic Arch in purple, the Rhine-Danube corridor in orange and the Adriatic-Baltic Corridor in yellow. Besides analyzing the RCI, we also aim to evaluate the current significance and competitive dynamics entrenched within the strategic transport networks of the Rhine-Danube Corridor and the Baltic-Adriatic Corridor. These corridors' establishment has been instrumental in fostering economic interlinkages, enhancing social connectivity, and bolstering infrastructural advancements, cementing their pivotal roles within CEE (Peijis, 2020; Jensen, 2020).

The Baltic-Adriatic Corridor and the Rhine-Danube Corridor are respectively the first and the latest project of the new core Trans-European Transport Network (TEN-T) that were originally announced on the 17th October 2013 to support the development of the core EU infrastructure policy (European Commission, 2013). By connecting at least three Member States through three transportation modes with no less than two cross-border sections, each corridor constitutes the beating heart of a truly internal market that grants free movement of people and goods. As such, both the Baltic-Adriatic Corridor and the Rhine-Danube Corridor are conceptualized and built via robust infrastructural capabilities and intricate transportation networks supporting the expansive industrial presence (European Commission, 2013). Their infrastructural prowess not only underpins their fundamental roles in trade facilitation but also earmarks these corridors as critical hubs for economic development, fostering regional prosperity while promoting connectivity (Czech, 2021).

Figure 1: Europe's spatial structure



Source: Authors based on literature

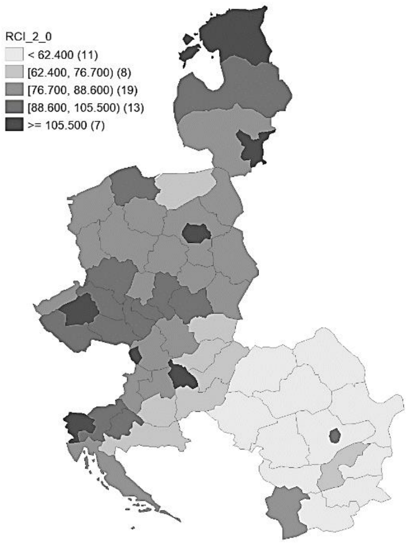
In the next section, we focus our research on the question whether the regional competitiveness scores of the CEE regions are spatially auto-correlated. Then, we further analyze the determinants of the existing spatial concentrations.

2. Standard and regional correlates of the regional competitiveness in CEE in 2022

To provide a comprehensive picture about the landscape of regional competitiveness in CEE, we apply quantitative analysis methods, including descriptive statistics and data visualization, as well as standard and spatial regression modeling. The outcome variable is the revised version of the EU Regional Competitiveness Index (RCI 2.0) for the year 2022. Dijkstra and coauthors (2023) give a detailed description about conceptual framework and calculation of the RCI. Although the latest scores are calculated for 2022, data for many of the pillar variables originate from 2019 in order to avoid the biased effect of the pandemic situation. Appendix 1 shows the RCI 2.0 framework structure.

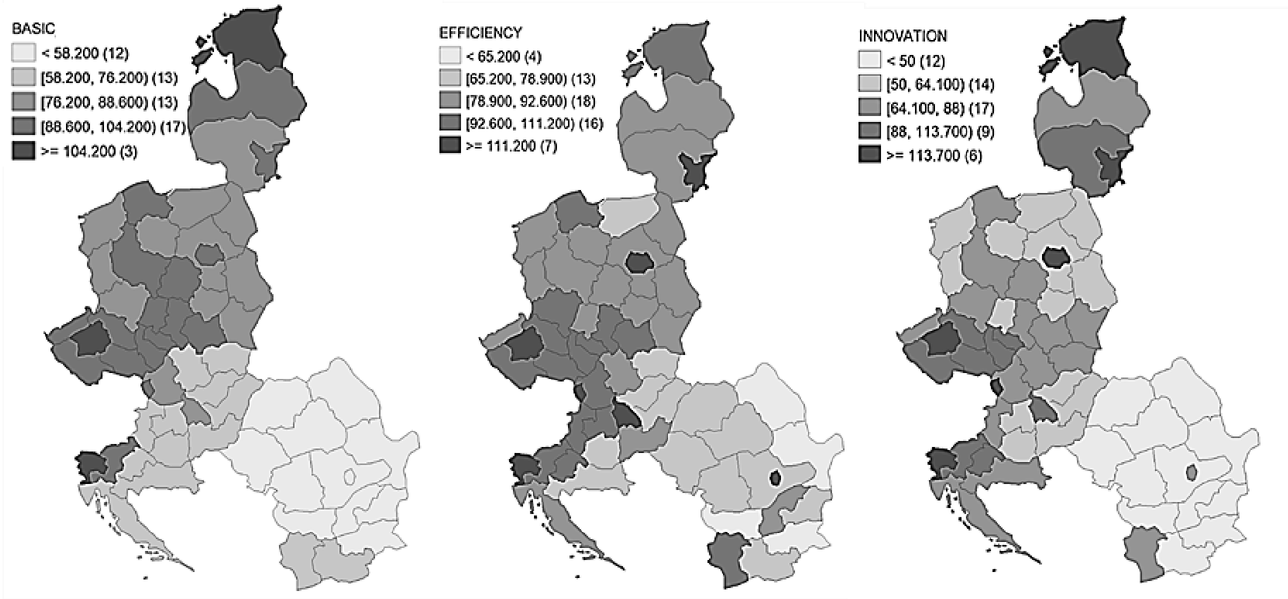
The analyzed territories are the NUTS2 regions of 11 CEE countries, which are Bulgaria, the Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. Looking at the RCI 2.0 map of the CEE regions in 2022 (Figure 2), we see that the Bulgarian and Romanian regions, apart from the capitals, are the lowest scored regions. On the other hand, the Baltic countries, the Czech Republic and Slovenia consist exclusively of relatively high-scored regions. In general, the capital regions have the highest scores in each country. Looking at the three sub-indices of the RCI (Figure 3), we get similar patterns of regional scores overall with some slight differences.

Figure 2: NUTS2 regions of the 11 CEE countries according to the RCI



Source: Authors based on data published by the European Commission (2023)

Figure 3: NUTS2 regions of the 11 CEE countries according to the three sub-indices of the RCI



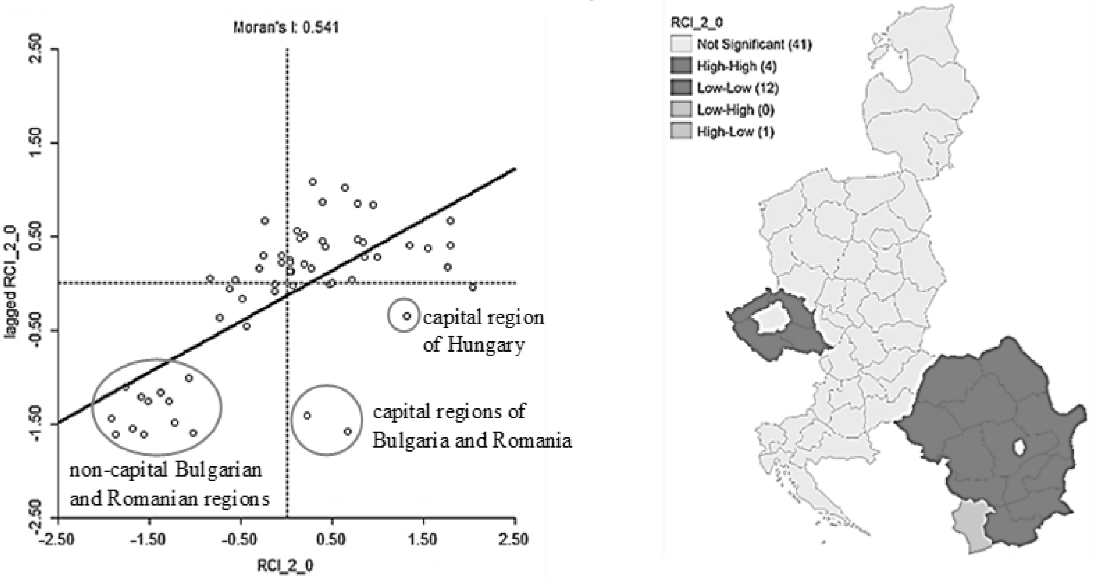
Source: Authors based on data published by the European Commission (2023)

The socioeconomic landscape of CEE according to the RCI and its sub-indices reflects the spatial role of the so-called Baltic-Adriatic Corridor; those regions that are within or nearby this corridor have higher scores while the more distant southeastern regions have the lowest scores. In this context, it is essential to emphasize that the Baltic-Adriatic Corridor, facilitating efficient movement between the Baltic and Adriatic Seas, stands as a crucial transport link for goods and people. This network significantly contributes to the economic development of the involved regions and plays a pivotal role in fostering economic growth and infrastructural integration (Schuschnig, 2015; Jensen, 2020).

Regarding the Baltic-Adriatic Corridor, based on the RCI scores, there is potential for its extension northward to the Baltic countries, not limited solely to the Polish coastal area. Similarly, the Rhine-Danube Corridor, stretching eastwards through Hungary, Romania, and Bulgaria to the Black Sea, is another vital transport route. This corridor, too, facilitates the seamless transportation of goods, bolstering economic ties and infrastructural connectivity in the Eastern European regions it traverses. Together, these corridors form crucial links in advancing economic development and promoting greater integration within Europe's transport infrastructure (Sava, 1997; Peijis, 2020). In order to improve the situation in the Balkan area too, widening the Baltic-Adriatic Corridor into a Baltic-Adriatic-Balkan Triangle would be expedient. Based on the spatial effect, we suppose that improving the infrastructural connectivity with the southeastern parts would be beneficial for CEE as whole. International scholars suggest that infrastructural policies are moving towards a much greater connectivity between the EU and the CEE in support of further EU integration (Przygoda, 2017; Meka, 2016; Bruszt et al., 2020). Indeed, the *Western Balkan Summit* (2015) triggered a deeper regional integration in Central Eastern Europe. After two years it occurred the signature of a *Transport Community Treaty* (2017) to improve the efficiency of the logistical network and to deliver transportation modes of greater quality – all while favoring the path of EU political integration of the entire Balkan region.

Moran's I test, run on neighborhood-based spatial weight matrix, demonstrates a significant overall spatial autocorrelation (Figure 4). Besides, the local Moran's I test shows a high-scored territorial concentration among the Czech regions and a low-scored concentration among the (non-capital) Bulgarian and Romanian regions. Looking at the scatter-plot, the non-capital Bulgarian and Romanian regions are remote from the rest of the regions. Furthermore, the capital regions of these two countries are spatial exceptions; while they have higher RCI scores than the standardized mean value, their neighbors have low scores, resulting in a large distance from the regression line on the scatter plot. In this regard, the Hungarian and Polish capital regions are also spatial exceptions, although to a less significant extent. Moreover, the capital region of Poland has the highest RCI score among all of the examined regions.

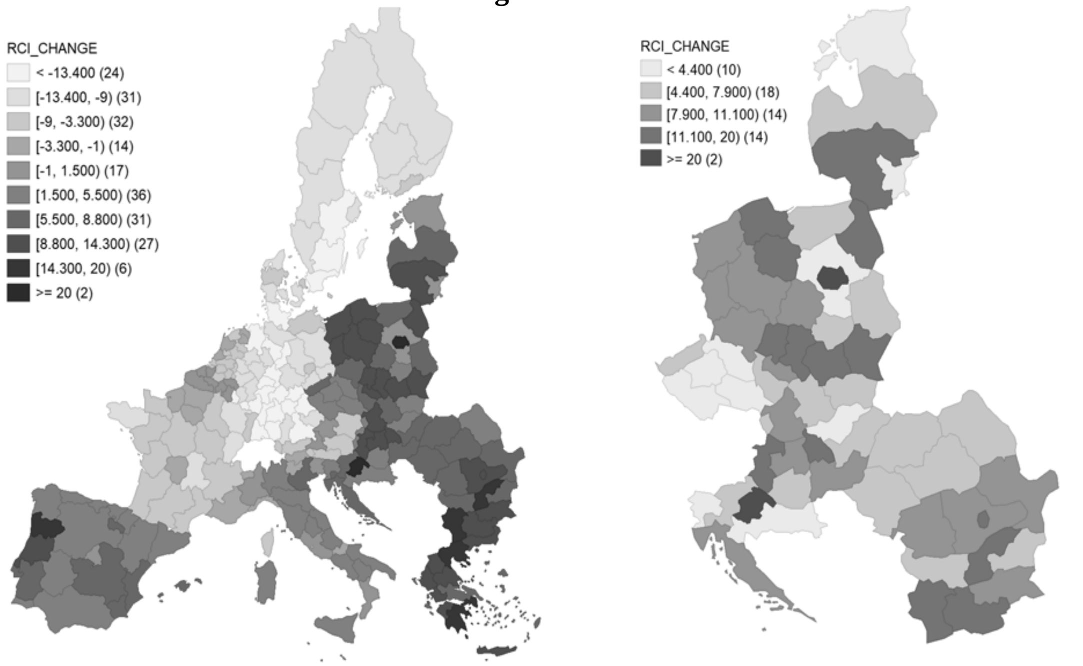
Figure 4: Global (left) and local (right) Moran's I tests on the spatial autocorrelation of the RCI among the CEE regions



Source: Authors based on data published by the European Commission (2023)

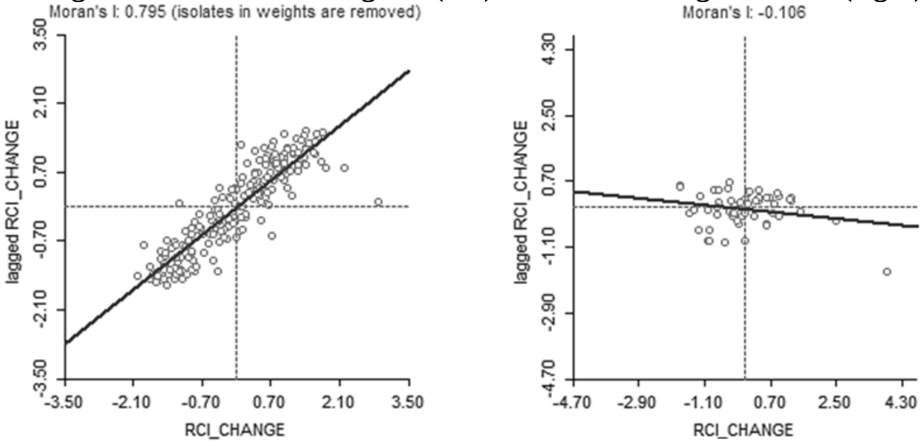
When we consider the RCI change between 2016 and 2022, we get a particular picture in the CEE context, compared to the EU as a whole. The regions of the Mediterranean and CEE area could improve their scores more than the most developed Western European and Scandinavian regions over the period (Dijksta et al., 2023), which is visible on the map of Figure 5. However, considering only CEE, the change in scores is spatially fragmented, despite that all of these regions improved their RCI. The global spatial autocorrelation tests confirm this finding (Figure 6); there is a strong and significant spatial autocorrelation in terms of the RCI change between 2016–2022 within the whole continental area of the EU, while the same variable is spatially un-auto correlated when we consider CEE alone. It is worth comparing this result with the findings of Egri and Tánczos (2018); analyzing the convergence in the CEE regions in terms of GDP per capita and Human Development Index (HDI) between 2004–2014, the authors find convergence between the less and the more developed regions, as well as a significant spatial neighborhood effect. Nevertheless, the authors also involve the Austrian and German NUTS2 region into their analysis while they do not consider the three Baltic countries and Croatia.

Figure 5: NUTS 2 regions of the EU (without Ireland) (left) and CEE (right) according to the RCI change during 2016–2022



Source: Authors based on data published by the European Commission (2023)

Figure 6: Global Moran's I test on the spatial autocorrelation of the RCI change between 2016–2022 among the continental EU regions (left) and the CEE regions alone (right)



Source: Authors based on data published by the European Commission (2023)

Next, we examine the determinants of the RCI scores of the CEE regions in 2022 with standard and spatial regressions. Table 1 summarizes the explanatory variables for the modeling.

Table 1: Independent variables included in the regression model

Variable	Year	Information	Source
Population	latest available	capita	Eurostat
GDP per capita	2020	in PPS, expressed as index (EU27=100)	Eurostat
Unemployment rate	2019	percentage	Eurostat
Employment in high tech. and knowledge-intensive sectors	2019	percentage of total employment in the NUTS 2 European regions	Eurostat
Female Achievement Index	2019-2020 (latest available)	expressed on a 100-point scale	Norlén et al. (2021)
NEET rate	2019–2021 (average)	share of young people (aged 15–29) not in education, employment or training; percentage	Eurostat and DG Regional and Urban Policy
Capital region	-	dummy variable	own

Source: Own editing.

Population is included in the model as a control variable. Regional GDP per capita and unemployment rate, as explanatory variables, are conventionally used indicators of formal socioeconomic performance. However, the employment rate in high technology and knowledge-intensive sectors (as the percentage of total employment) may provide a more sophisticated picture about competitiveness, therefore we use it as another independent variable. Further explanatory variables are the Female Achievement Index (FAI), showing the social integration of women as a composite index, and the ratio of non-integrated young population (aged 15–29) who are neither in employment nor in education and training (NEET). These two sociodemographic indicators are included for the suggestion of Dijkstra and coauthors (2023). Finally, as a dummy (i.e. binary categorical) independent variable, we use capital region too.

According to the results of the standard regression model (Table 2), GDP per capita, unemployment rate, NEET rate and the social integration of women influence significantly the regional competitiveness scores. Based on the diagnostics of spatial dependence (Table 3), spatial autocorrelation is significant in form of spatial lag, which suggest that the spatial model can provide a better explanation than the standard model. Therefore, we repeat our regression accordingly as a spatial lag model (Table 4). GDP per capita, NEET rate and FAI remained significant while the unemployment rate has no significant impact in the spatial model. On the other hand, the employment rate in high technology and knowledge-intensive sectors has a significant impact, as well as the category of capital regions. (Appendix 2 and 3 show the detailed software output of the regression models.)

Table 2: Standard regression model on the RCI 2022

Population	1.3279e-06 (1.15148e-06)
GDP per capita	0.1631* (0.0625925)
Unemployment	1.44607* (0.57351)
Employment in high-tech sectors	0.845736 (0.697317)
NEET	-1.47286*** (0.28342)
FAI	0.990315*** (0.149409)
Capital region	3.31624 (3.75367)
Constant	27.0675*** (9.78195)

*p ≤ 0,05; **p < 0,01; ***p < 0,001
Source: Authors' computation

Table 3: Diagnostics for spatial dependence

	Value	Probability
Lagrange Multiplier (lag)	18.6188	0.00002
Robust LM (lag)	12.6735	0.00037
Lagrange Multiplier (error)	6.1553	0.01310
Robust LM (error)	0.2099	0.64681

Source: Authors' computation

Table 4: ML spatial lag model on the RCI 2022

Population	1.58537e-06 (8.65227e-07)
GDP per capita	0.155619*** (0.0469)
Unemployment	0.709735 (0.434791)
Employment in high-tech sectors	1.17795* (0.522435)
NEET	-0.856745*** (0.225877)
FAI	0.625367*** (0.13015)
Capital region	5.62392* (2.85913)
Spatial lag	0.379087*** (0.0646737)
Constant	9.04837 (7.81119)

*p ≤ 0,05; **p < 0,01; ***p < 0,001
Source: Authors' computation

Overall, the spatial regression analyses confirms that the neighborhood effect has a significant explanatory power for the regional competitiveness. Traditional economic indicators, such as regional GDP per capita, still matter in the CEE context. However, when taking into account the spatial effect, the employment rate in high technology and knowledge intensive sectors becomes significant instead of the indicator of mere (un)employment. Capital regions become also significant in the regional model. These results altogether imply that, in order to improve the competitiveness of each CEE region, regional development policies should put the focus on developing the higher technology and more knowledge intensive sectors instead of relying on traditional industrial sectors, not only in the capital regions but in the lagged behind territories as well. Furthermore, fostering social integration and inclusion is also important.

3. Conclusion

Our study provided a comprehensive analysis of regional competitiveness among the NUTS2 regions of 11 Central and Eastern European countries. In terms of the Regional Competitiveness Index in 2022, the territorial structure of CEE is spatially auto-correlated. In general, the capital regions have the highest RCI scores, while the Baltic-Adriatic Corridor also has a significant spatial impact.

Given the evolving economic dynamics, our study underscores the pressing need for strategic interventions aimed at enhancing the competitiveness of CEE regions collectively. One of the most relevant findings of the study is the significant effect of spatial neighborhood on the regional competitiveness. In accordance with this finding, the main conclusion of our analysis is that, in order to counterweight Western European economic predominance, the CEE regions must improve their competitiveness as a whole, which implies the need for more effective regional development policies in the most deprived regions. These interventions should emphasize fostering innovation, boosting infrastructure, and implementing targeted policies to uplift the economic potential of the regions. Effectively addressing these disparities is pivotal for achieving a more balanced and competitive economic landscape across Central and Eastern Europe, as well as within the whole European Union.

Acknowledgement

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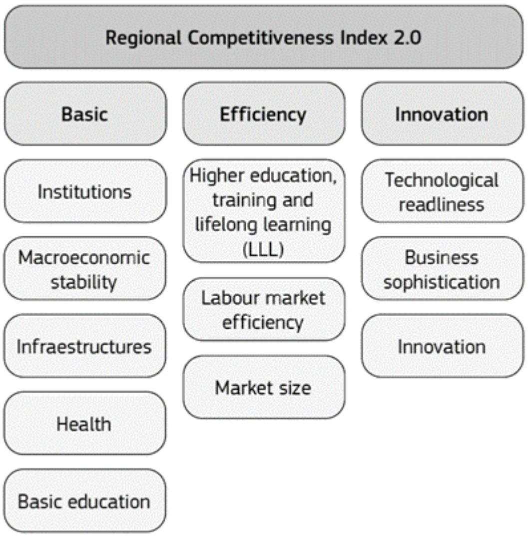
Appendix 1: RCI 2.0 framework structure by Dijksta and coauthors (2023)



Appendix 2: Standard linear regression model on the RCI 2022 (GeoDa software output)

Variable	*Coefficient*	*Std. error*	*t-Statistics*	*Probability*
Population	1.3279e-06	1.15148e-06	1.15321	0.25431
GDP/cap	0.1631	0.0625925	2.60575	0.01205
Unemployment	1.44607	0.57351	2.52144	0.01492
Employment in high-tech sectors	0.845736	0.697317	1.21284	0.23089
NEET	-1.47286	0.28342	-5.19674	0.00000
FAI	0.990315	0.149409	6.62821	0.00000
Capital region	3.31624	3.75367	0.883466	0.38121
Constant	27.0675	9.78195	2.76709	0.00791

Diagnostics for spatial dependence	*Value*	*Probability*
Lagrange Multiplier (lag)	18.6188	0.00002
Robust LM (lag)	12.6735	0.00037
Lagrange Multiplier (error)	6.1553	0.01310
Robust LM (error)	0.2099	0.64681

```
Mean dependent var  :     81.2879
S.D. dependent var  :      18.216

R-squared           :    0.903566
Adjusted R-squared  :    0.890066
Sum squared residual:     1855.94
Sigma-square        :     37.1187
S.E. of regression  :     6.09252
Sigma-square ML     :     31.9989
S.E of regression ML:     5.65676

Number of Observations:   58
Number of Variables   :    8
Degrees of Freedom    :   50

F-statistic           :     66.9273
Prob(F-statistic)     : 3.51946e-23
Log likelihood        :    -182.804
Akaike info criterion :     381.608
Schwarz criterion     :     398.091
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Appendix 3: ML spatial lag model on the RCI 2022 (GeoDa software output)

Variable	*Coefficient*	*Std. error*	*z-value*	*Probability*
Population	1.58537e-06	8.65227e-07	1.83232	0.06690
GDP/cap	0.155619	0.0469	3.3181	0.00091
Unemployment	0.709735	0.434791	1.63236	0.10260
Employment in high-tech sectors	1.17795	0.522435	2.25474	0.02415
NEET	-0.856745	0.225877	-3.79298	0.00015
FAI	0.625367	0.130153	4.80488	0.00000
Capital region	5.62392	2.85913	1.967	0.04918
Spatial lag	0.379087	0.0646737	5.86154	0.00000
Constant	9.04837	7.81119	1.15839	0.24671

```
Mean dependent var  :     81.2879
S.D. dependent var  :      18.216
Lag coeff.   (Rho)  :    0.379087

R-squared           :    0.937312
Sq. Correlation     : -
Sigma-square        :     20.8014
S.E of regression   :     4.56086

Number of Observations:   58
Number of Variables   :    9
Degrees of Freedom    :   49

Log likelihood        :   -171.403
Akaike info criterion :    360.806
Schwarz criterion     :     379.35
```