THE INFLUENCE OF INNOVATION POTENTIAL ON ECONOMIC PERFORMANCE IN CZECH REGIONS

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Abstract

This contribution looks at the influence which the level of economic performance has on the level of innovation potential in the Czech Republic. One of more ways is described on how to approach the resolved problem, which is either verification or rejection of this assumption: "The weak regional potential for innovation is the cause of the regional economic backwardness". A few methodologies have been developed by some subjects and used for the evaluation of the regional innovation potential level in the Czech Republic, but the availability of their outputs differs, which causes difficulties in further processing. Next, many methodologies are used by different subjects in the Czech Republic for the evaluation of the regional economic performance level. It was verified that Czech regions with strong innovation potential are better performing economically and are wealthier than those with low innovation potential.

Introduction

This article focuses on questions of the relationship between economic performance and innovation potential in the Czech Republic, specifically in Czech regions. The aim is to verify the assumption that weak regional innovation potential causes regional economic backwardness. In other words, it is expected that regions with very strong innovation potential should be better performing economically, more competitive, or wealthier, than regions with low innovation potential.

What does the term "regional innovation potential" mean? Innovation potential can be defined differently depending on analyzed data. It can be discussed in relation to human resources, a number of small and medium-sized enterprises, education and research capacity structure in a region, or in dependence on the innovation infrastructure conditions. "*Regional innovation potential can generally be expressed as the ability of a region, in given conditions, to take advantage of its own internal resources effectively, to react flexibly to external development incentives, to produce and develop activities with higher value-added and thus to take new, hierarchically higher qualities*." [7, pp. 16]

The paper is divided into two main parts. In the first part, regional economic performance and innovation potential in the Czech Republic are analyzed. There are five methodologies described which are applied for the evaluation of regional economic performance in the Czech Republic. Three approaches are listed for the evaluation of regional innovation potential. The second part of this paper focuses on an investigation of the statistical dependency between some selected indicators.

1 Methodology

This part contents a review of methodologies used for the evaluation of regional economic performance and regional innovation potential in the Czech Republic.

1.1 Economic performance evaluation

More methodologies are presently used by some subjects in the Czech Republic for the evaluation of the regional economic performance level. Under the supervision of the Ministry for Regional Development of the Czech Republic, the Regional Development Strategy of the Czech Republic was elaborated and adopted by the Government in July 2000. It was updated in the years 2003 and 2006. In this document, regions with focused state support are identified and classed into three groups: structurally affected regions, economically weak regions, and regions with a well above average unemployment rate [1]. Indicators used for this identification have been analyzed completely in a monograph [2]. Regional methodologies are described in Regional Development Programs. Their analysis was also included in the monograph [2] and the authors revealed that various regional methodologies are incomparable.

The Czech Statistical Office elaborated the publication "Regional differences in the demographic, social and economic development of the Czech Republic in the years 2000–2005". It looks at the differences in the demographic, social and economic rankink of administrative districts of municipalities with extended powers within the Czech Republic and within Czech regions. For each administrative district of a municipality with extended powers, these synthetic indices relevant to four basic spheres were calculated: D – demographic background, S - social environment, E - economic environment, I – infrastructure, location, availability, human living environment. [3]

At the University of West Bohemia, there was developed a methodology enabling the comparison of regional indicators concerning three basic spheres (macroeconomic efficiency, growth potential, quality of life), which can be illustrated as an 18-angle. [4] With the help of this methodology, it is possible to compare the position of regions in relation to each other, with an average level for the entire Czech Republic, and the development of each region over a time period.

A research team from the Technical University in Liberec designed a methodology built around the argument that there does not exist any globally economically weak region. The procedure, results and recommendations were presented in the monograph [5]. For the identification of low-dynamic (respectively sustainable) economic development of municipalities, eight significant factors must be checked individually: unemployment, attractive living, settlement, age structure, civic amenities, economic pattern, sustainable development, and economic activity.

The economic power of a country (region) is measured by the indicator of (regional) real gross domestic product (GDP). As defined by CZSO, "*GDP is the key indicator of economic development and it represents the sum of values added by all branches of activities which are considered productive in the system of national accounts (including market and non-market services*)". [6] The values of GDP (and regional GDP) are listed in the National (pertinently Regional) Accounts of the Czech Republic and published periodically by the Czech Statistical Office.

The economic level of a country (region) is measured by the indicator of (regional) gross domestic product per capita. GDP per capita is GDP divided by the population and is sometimes used as an indicator of standard of living. For the purposes of this contribution, the

economic performance of all fourteen Czech regions at level NUTS 3 was measured by regional GDP per capita.

1.2 Evaluation of regional innovation potential

Under the aegis of the Technology centre AS CR, a publication entitled "*Innovation Potential of the Czech Regions"* was published in 2008, which included the methodology and results of the innovation potential analysis of fourteen Czech regions at level NUTS 3. Its authors were inspired by the methodology proposed for the European Trend Chart on Innovation and geared it to conditions in the Czech Republic. So, the indicators were sorted into two main groups: inputs and outputs. The factor analysis and calculation of the weighted average led to results in the form of one synthetic index for each region in the Czech Republic. There are fourteen Czech regions classed in a scale with five categories according to the innovation potential level: well below average, below average, average, above average, and well above average. However, no concrete numerical values on innovation potential were presented in the document [7], only the ranking of the regions.

The methodology proposed for the European Trend Chart is applied in the European Innovation Scoreboard and was updated for the last time in 2005, while in 2002 and 2003 two Regional Innovation Scoreboards (RIS) were published. Building upon the methodology used in the 2003 RIS, two indexes are calculated from which a weighted mean is taken for the Revealed Regional Summary Innovation Index (RRSII): the RNSII or Regional National Summary Innovation Index, which takes the average of the re-scaled relative to the country mean indicator values, and the REUSII or the Regional European Summary Innovation Index which takes the average of the re-scaled relative to the EU25 mean indicator values. Both composite indicators are only calculated when data are available for at least 6 indicators. [8, pp. 28-29] The values of RRSII were calculated for regions at level NUTS 2.

In their contribution "Analysis of the Czech Participation in Projects Financed from European Framework Programs", Rydvalová and Pittnerová compared some special indicators related to the innovation performance of the regions. 1,635 project teams from Czech economic subjects were characterized and statistically described in the regional structuring, and they received grants for research and/or innovation projects within the 5th and 6th Framework Programme (FP) supporting research activities of the European Union in the years 1998-2008. The unique database was created through the analysis of development strategies, databases and documents of the Ministry of Finance, the Czech Statistical Office, and the Community Research and Development Information Service. The methodology and results were presented in the above-mentioned contribution [12]. Indicators related to the innovation performance could be, for example, the intensity of regional involvement in the 5^{th} and 6^{th} FP converted to an average FTE (FTE = average number of employees recalculated to full time work devoted to R&D activities).

2 Results

In this part, data processing, statistical tests and an investigation of the statistical dependency of economic performance on innovation potential are described.

2.1 Review of the indicators applied in the analysis

The goal of this contribution is to verify that regional innovation potential significantly influences regional economic performance in the Czech Republic. For the purposes of this

contribution, the economic performance of all fourteen Czech regions at level NUTS 3 was measured by regional GDP per capita in CZK in the years 2006 and 2008.

The data about innovation potential were extracted from the European Innovation Scoreboard 2006 (below as "RRSII 2006", a dimensionless numerical variable) and from the publications of the Technology centre AS CR (below as indicator "IP 2008" – an ordinal variable).

Values of the four indicators mentioned above for each Czech region at level NUTS 3 are listed in *Tab. 1*.

Tab. 1 Regional GDP per capita and regional innovation potential – values

	Economic performance indicators		Innovation potential indicators		
Region (NUTS 3)	**GDP p. c. 2006 (in CZK)**	**GDP p. c. 2008 (in CZK)**	**RRSII 2006**	**IP 2008**	**IP 2008 code**
Hl. město Praha	659756	756883	0.7	extremely strong	5
Středočeský	296556	325996	0.43	average	3
Jihočeský	281664	298052	0.34	average	3
Plzeňský	296510	300594	0.34	average	3
Karlovarský	225263	243860	0.12	weak	1
Ústecký	255100	283933	0.12	below average	2
Liberecký	255133	257638	0.34	below average	2
Královéhradecký	266319	295834	0.34	above average	4
Pardubický	263436	294153	0.34	average	3
Vysočina	264423	277913	0.43	weak	1
Jihomoravský	287472	344098	0.43	above average	4
Olomoucký	232639	266339	0.31	average	3
Zlínský	255695	299589	0.31	below average	2
Moravskoslezský	261316	305458	0.24	average	3

Source: CZSO, [7], [8], authors elaboration.

Notes to Tab. 1:

The data about GDP p. c. 2006 and 2008 were related to 31. 12.; their validity was verified on 20. 8. 2011.

The value of RRSII 2006 of each Czech region at level NUTS 3 was taken as equal to RRSII of the respective high-level region NUTS 2.

The last column, headed "IP 2008 code", includes numerical expression of the "IP 2008" level, which is important for computing the Spearman Rank Correlation Coefficient, but has no influence on the results of the ANOVA test mentioned below.

2.2 Data processing

All data were entered into the statistical analysis software Statgraphics Centurion XVI (SGP). First of all, the strength of the associations between regional GDP per capita and innovation potential was measured through the Spearman Rank Correlation Coefficient. This correlation coefficient ranges between -1 and +1 and measures the strength of the association between the

variables. The Spearman Coefficient is computed from the ranking of the data values rather than from the values themselves. Consequently, it can be applied when data do not come from a normal frequency distribution and it is less sensitive to outliers. An outlier is an observation that lies outside the overall pattern of a distribution [13]. Outliers can occur among others when comparing associations between two sets of data.

Two variables, GDP p. c. 2006 and RRSII 2006, were compared and the Spearman Rank Correlation Coefficient was computed as equal to 0.8329. This signals a strong positive ranking association.

The comparison of GDP p. c. 2008 with IP 2008 code led to a Spearman Rank Correlation Coefficient equal to 0.7143. This signals a relatively strong positive ranking association.

Also the *P-values* were computed, which verified that both estimated correlations are statistically significant at the 95 % confidence level. (For a better understanding of the *P-value*, look at the statistical hypothesis testing below.)

What can be said about the two results above? Both computed values indicate a relatively strong association between the ranking of regional GDP p. c. and the ranking of regional innovation potential in the Czech Republic. This means the higher the innovation potential is, the higher the economic performance is, too.

The next step in the investigation of the statistical dependency of economic performance on innovation potential is further statistical hypothesis testing, specifically the statistical test Analysis of Variance.

2.3 Statistical hypothesis testing

Generally, hypothesis testing is the use of statistics to determine the probability that a given hypothesis is true or not. The process of hypothesis testing consists of four steps:

- Formulate the null hypothesis H_0 and the alternative hypothesis H_1.
- Identify a test statistic that can be used to assess the truth of the null hypothesis.
- Compute the *P-value*, which is the probability that a test statistic at least as significant as the one observed would be obtained assuming that the null hypothesis were true. The smaller the *P-value*, the stronger the evidence against the null hypothesis.
- Compare the *P-value* to an acceptable significance value α. If $P \leq \alpha$, that the observed effect is statistically significant, the null hypothesis is ruled out, and the alternative hypothesis is valid. [10]

To make the decision about the rejection of the null hypothesis, the statistical test Analysis of Variance was used (ANOVA). To apply the test, these assumptions are specified: numerical dependent variable and numerical/ordinal/nominal independent variable; independence of cases, data from a normal probability distribution, and homogeneity of variances [11].

Resolving the independence of the cases is pointless here, as the 14 Czech regions are a population, not only a selection. With the assumption above, normality was tested for all data. Therefore, two tests were applied to determine whether variables GDP p. c. 2006 and 2008, RRSII 2006 and IP 2008 code can be suitably modeled by a normal distribution: Kolmogorov-Smirnov and Shapiro-Wilkov W. Both tests led to the results that the data about GDP p. c. do not come from a normal distribution, but they did not reject the fact that the data about the IP 2008 code met the criterion of normality at the 95 % confidence level. As to the variable IP 2006, the tests outcomes were different. Referring to the robust approach, the condition of normality is the only one which can be waived [14]. But the homogeneity of variances is considered to be important. Using Variance Check in SGP, namely Bartlett's test, the hypothesis about the equality of variances was verified (not rejected) at the 95.0 %

confidence level for both pairs of variables compared. (This requirement was also tested for other indicators on innovation potential or performance, but it was not met.)

2.4 Statistical dependency of GDP per capita 2006 on RRSII 2006

The analysis of the variance started with the formulation of the null hypothesis H_0: "Regional gross domestic product per capita in the Czech Republic 2006 is not dependent on the Revealed Regional Summary Innovation Index 2006." The alternative hypothesis H_1 was: "H_0 is not true".

The null hypothesis was verified at the 95 % confidence level. The population is 14 Czech regions. (Although the region Hl. město Praha appears to be an outlier, it is part and parcel of the small population and may not be removed.) RRSII 2006 here is an independent variable (factor X), and GDP p. c. 2006 is the dependent variable Y. Further, a test statistic was identified that could be used to assess the truth of the null hypothesis. In this case, it was the *F-Ratio*, the test statistic with Fisher's probability distribution and two degrees of freedom - see (1).

$$F = \frac{\frac{Q_M}{k-1}}{\frac{Q_R}{n-k}}; F[(k-1);(n-k)] \tag{1}$$

The numerator and denominator are designated mean squares and are computed in *Tab. 2*.

Entering data into SGP and choosing the function One-way ANOVA, the ANOVA table was generated (*Tab. 2*).

Tab. 2 ANOVA table A

Source	Sum of Squares	Df	Mean Square	*F-Ratio*	*P-Value*
Between Groups	1.48252E11	5	2.96504E10	101.28	**0.0000**
Within Groups	2.34205E9	8	2.92756E8		
Total (Corr.)	1.50594E11	13			

Source: Author's elaboration, SGP.

The ANOVA table A decomposes the variance of the dependent variable Y values into two components: a between-group component and a within-group component. The F-test in the ANOVA table tests whether there are any significant differences amongst the means. The *F-Ratio*, which in this case equals 101.28, is a ratio of the between-group estimate to the within-group estimate. Since the *P-value* of the F-test is less than 0.05, there is a statistically significant difference between the mean Y from one level of X to another at the 95 % confidence level. This leads to the rejection of the hypothesis of equal means. The alternative hypothesis was verified that regional GDP per capita in the Czech Republic is dependent on the Revealed Regional Summary Innovation Index.

To determinate the degree of the dependence of variable Y on factor X, the Pearson Correlation Coefficient is the right instrument to use. In this case, it equals 0.7979 indicating a strong positive linear relationship between the variables. However, the subsequently used Simple Regression Analysis leads to the ascertainment that the linear model is not adequate to describe the observed data even though the computed R-Squared statistic indicates that the linear model explains only 63.7 % of the variability in GDP per capita 2006. In other words,

stronger innovation potential causes higher economic performance of Czech regions, although the increase is not proportional.

2.5 Statistical dependency of GDP per capita 2008 on IP 2008 code

The procedure is identical as in the previous case. The IP 2008 code is factor X, GDP p. c. 2008 is dependent variable Y. Firstly, H_0 and the alternative hypothesis H_1 were formulated:

H_0: Regional GDP per capita 2008 in the Czech Republic is not dependent on IP 2008 code.

H_1: H_0 is not true.

The steps noted above led to ANOVA table B (*Tab. 3*).

Tab. 3 ANOVA table B

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Between Groups	2.05001E11	4	5.12502E10	102.37	**0.0000**
Within Groups	4.50555E9	9	5.00616E8		
Total (Corr.)	2.09506E11	13			

Source: Author's elaboration, SGP.

Since the *P-value* of the F-test is less than 0.05, the alternative hypothesis was verified which means that regional GDP per capita in the year 2008 in the Czech Republic is dependent on the IP 2008 code.

How strong is the dependence of GDP per capita on the IP 2008 code? In this case, the Pearson Correlation Coefficient equals 0.6720 and signals a relatively strong positive linear relationship. However, the application of the Simple Regression Analysis leads to the finding that the linear model is not suitable to describe the observed data and the computed R-Squared statistic indicates that the linear model would explain only 45.2 % of the variability in GDP per capita 2008. As above, it is possible to say that stronger innovation potential causes higher economic performance of Czech regions, but the increase is not proportional.

2.6 IP 2006 vs IP 2008

An additional investigation of the statistical relationship between innovation potential measured by two different methodologies (IP 2008 by Technology centre AS CR and IP 2006 by European Trend Chart) led to the value of Pearson Correlation Coefficient equalling 0.6402. Although this indicates a positive relationship between innovation potential measured by two special subjects, the value is too low considering that both methodologies measured the same thing, i.e. the innovation potential of Czech regions. The question is: which methodology is the most accurate? It is not simple to decide, and so it could be a subject of further research.

Conclusion

The aim of this article was to investigate the relationships between the economic performance and innovation potential of Czech regions. Specifically, two statistical dependencies were examined: the dependence of regional GDP per capita on innovation potential in accordance with methodology proposed for the European Trend Chart (ETC), and the dependence of regional GDP per capita on innovation potential in accordance with methodology proposed for the Technology centre AS CR. The dependencies measured by the correlation coefficient

were relatively strong and positive in both cases. Pursuant to the first result, it can be said that, according to the ETC methodology, the higher the innovation potential 2006 is, the higher the GDP per capita is. The second result would be interpreted so that the higher innovation potential in 2008 (according to methodology proposed for the Technology centre AS CR) led to the higher GDP per capita. These results were expected by the author. The regions with strong innovation potential are better performing economically, wealthier and more economically powerful than the regions with low innovation potential. The target was met and the assumption that weak innovation potential causes economic backwardness of a region was verified.

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VLIV INOVAČNÍHO POTENCIÁLU NA HOSPODÁŘSKOU VÝKONNOST REGIONŮ V ČESKÉ REPUBLICE

Příspěvek věnuje pozornost tomu, jak úroveň inovačního potenciálu regionu ovlivňuje jeho hospodářskou výkonnost, přičemž se zaměřuje na kraje v České republice. Je zde popsán jeden ze způsobů, jak lze přistupovat k řešenému problému, jímž je potvrzení či vyvrácení předpokladu: Slabý inovační potenciál regionu je příčinou jeho hospodářské zaostalosti“. Různými subjekty bylo vyvinuto jen málo metodik sloužících k ohodnocení úrovně inovačního potenciálu regionů v České republice, avšak dostupnost jejich výsledků se liší, což komplikuje další zpracování. Dále, více metodik je používáno českými subjekty pro ohodnocení hospodářské výkonnosti krajů. Bylo ověřeno, že kraje se silným inovačním potenciálem jsou hospodářsky výkonnější a bohatší než kraje s nízkou úrovní inovačního potenciálu.

DER EINFLUSS DES INNOVATIONSPOTENZIALS AUF DIE WIRTSCHAFTLICHE LEISTUNGSFÄHIGKEIT DER REGIONEN IN DER TSCHECHISCHEN REPUBLIK

Der Beitrag widmet sich dem Thema, welchen Einfluss das Niveau des Innovationspotenzials einer Region auf ihre wirtschaftliche Leistungsfähigkeit hat, wobei er sich auf die Regionen in der Tschechischen Republik konzentriert. Hier wird eine der Möglichkeiten des Herangehens an das zu lösende Problem beschrieben, das in der Bestätigung oder Widerlegung folgender Prämisse besteht: „Ein schwaches Innovationspotenzial der Region ist die Ursache ihrer wirtschaftlichen Rückständigkeit“. Seitens verschiedener Subjekte wurden nur wenige Methodiken entwickelt, die der Bewertung des Niveaus des Innovationspotenzials der tschechischen Regionen dienen, wobei sich die Verfügbarkeit ihrer Ergebnisse unterscheidet. Darüber hinaus werden durch tschechische Subjekte mehr Methodiken für die Bewertung der wirtschaftlichen Leistungsfähigkeit der Regionen im Sinne der Selbstverwaltungseinheiten angewendet. Es wurde festgestellt, dass Regionen mit einem stärkeren Innovationspotenzial wirtschaftlich leistungsfähiger und reicher sind als Regionen mit einem geringen Niveau des Innovationspotenzials.

WPŁYW POTENCJAŁU INNOWACYJNEGO NA KONDYCJĘ GOSPODARCZĄ REGIONÓW W REPUBLICE CZESKIEJ

Artykuł poświęcony jest wpływowi potencjału innowacyjnego regionu na jego wyniki gospodarcze. Uwaga skoncentrowana jest na regionach (krajach) w Republice Czeskiej. Opisano jeden ze sposobów podejścia do tego tematu, jakim jest potwierdzenie lub obalenie założenia: "Słaby potencjał innowacyjny regionu jest przyczyną jego zacofania gospodarczego“. Różne podmioty opracowały kilka metodyk służących do analizy poziomu potencjału innowacyjnego regionów w Republice Czeskiej, ale dostępność ich wyników jest zróżnicowana, co utrudnia ich dalsze wykorzystanie. Ponadto, większa liczba metodyk jest stosowana przez czeskie podmioty do celów analizy kondycji gospodarczej regionów. Stwierdzono, że regiony (kraje) o silnym potencjale innowacyjnym są silniejsze gospodarczo i bogatsze od regionów (krajów) o niskim poziomie potencjału innowacyjnego.