Czech regions: Relationship between Research and Development expenditure and economic strength

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Abstract

Purpose of the article The economic strength of a country can be measured through the GDP. R&D expenditure is one of the economic indicators, which influence the economic performance of the country. The difference in the level of GDP and R&D expenditure should be kept in sustainable limits for the welfare of the country as a whole. The analysis of the relationship between GDP and R&D expenditure can serve as the basis for the fiscal policy on a regional level.

Methodology/methods To test the autocorrelation of time series, the Durbin-Watson test used. The correlation analysis found to be suitable for searching for the influence of the selected variables.

Scientific aim The aim of the article is to analyse the interdependence of R & D expenditure and of the GDP of individual regions of the Czech Republic in the period 2005 – 2017.

Findings The Durbin Watson test excluded the autocorrelation of the selected variables. Authors performed statistical testing and correlation analysis. The correlation analysis did not confirm the correlation between R & D expenditure and regional GDP. An only slightly positive correlation was identified in the Central Bohemia region with a GDP + 1 prediction indicator. It is clear from the results that the selected indicators are almost independent of each other.

Conclusions The relationship R & D expenditure and GDP is seen as a source of growth in the standard of living of the population in many professional works. This research did not show the interdependence of R & D expenditures and GDP in the regions of the Czech Republic. Despite the fact that delays of individual indicators were observed by one or two years respectively. The dependence of R & D expenditure growth on GDP was not confirmed.

Keywords: correlation, GDP, R & D expenditure, Czech Republic

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Introduction

The Lisbon Strategy (European Committee, 2000) and the European Union (EU) 2020 strategy (European Commission, 2014) are the EU's agencies for growth and jobs for the current decade. They emphasize smart, sustainable and inclusive growth as a way to overcome structural weaknesses in Europe's economy, improve its competitiveness and productivity and underpin a sustainable social market economy. The strategies targets are valid for all EU members. We are interested in the Czech Republic regions and their economic strength. The Czech Republic is enjoying an economic upswing. Following a shallow recession in 2012 and 2013, real GDP grew by 9.5 % per year on average between 2015 and 2017. Rapidly increasing wages are projected to have supported solid household consumption growth in 2017. The Czech economy is shifting towards more knowledge-intensive activities, with increased business R&D investment, mainly through foreign direct investment FDI. The country saw some of the strongest EU growth in high-tech and medium-high-tech manufacturing and know-ledge-intensive services sectors, in terms of share of value added. Business expenditure on R&D (BERD) has increased from 0.7% of GDP in 2008 to 1.03% of GDP in 2017 (61.1 % of total R&D). There are significant inequalities between regions.

The territorial economic and social inequality is one of the most fundamental factors in the development of the economy. Of course, the analysis of territorial inequalities has high priority in the EU. With the increasing number of EU Members, the economic and social inequalities were also changing. According to the current dates of the Eurostat (European Commission, 2018), there is a 50-fold difference between the richest Inner London - West and the poorest Severozapaden, Bulgaria in terms of GDP per capita. Regions of the Czech Republic are better off. The difference was in 2004 between the richest Inner London and the Czech poorest Severozápad region only 19.68-fold, in 2016 decreased only to 17.28-fold. The Czech richest region is Praque. The difference between the Inner London and Prague region was in 2004 7.56-fold and in 2016 5.97-fold. Why do some regions grow continuously for many years whereas others stagnate? The theoretical breakthrough in answearing this and similar questions started by Schumpeter (1912), Dorfman et al. (1986) and Romer (1986, 1990). Following the endogenous growth and neoclassical growth theories, Research and Development (R&D) and technological advances are believed to the major driver of economic growth. How exactly new knowledge translates into preferable economic performance by regions described the growth theories nor found an unequivocal empirical explanation (Maradana et all., 2017).

In the recent years, many researchers and policymakers have increasingly paid attention to investigating the relationship between regional outcomes, R&D expenditure, Innovation and Entrepreneurship (Ulku, 2004; Wong et al., 2005; Tsvetkova et al, 2014).

What affects the economy in multiple channels, such as global competitiveness, economic strength and growth, quality of life, infrastructure development, employment, trade openness, and hence, spawns high economic growth? Many studies mostly focus on the impact of innovation on economic growth, indicating the supply-driven approach of innovation-growth nexus. But in reality, it is the economic growth that can also increase the level of innovation in the development process. Pradhan et al. 2016) discussed feasibility of bidirectional causality between innovation and economic growth. Hence, the main objective of this paper is to examine the relation-ship between innovation and economic strength. In sum, we would like to assess the importance of innovation-economic strength linkage, by investigating whether the level of innovation has contributed to economic strength, or whether the extension of the innovation is simply a consequence of economic strength. The main contribution of the study is twofold. First, we specifically assess the importance of R&D expenditure on economic growth, by investigating whether the innovation activities have contributed to economic growth and economic strength, or whether the expansion of innovation activities is simply a consequence of rapid economic growth. Second, our data set is comprehensive (i.e. 2005–2017) and compile the entrance EU period, the world crisis years and period of high economic growth in Czech regions.

The rest of the paper is sketched as follows. The second part presents the theoretical basis and literature review. The „Data structure and methods“ section describes the variables, data and used methods. The „Result“ section presents the results of statistical calculations. The „Discussion“ section describes our discussion. Finally, we summarize and conclude in the „conclusion“ section.

1 Theoretical basis and literature review

The first issue of the relationship between wealth, investment and economic strength was presented by Giffen (1892). On the occasion of 100 anniversary of the invention of Edison's electric lamp was presented the strength

of the U.S. economy. In 1978 fewer patents were issued to U.S. residents than at any other time since 1964. The share of patents which the United States granted to nationals rose in 1978 to 37%, from 20% in 1964. The Japanese share alone rose from 1 to 10%. Science and technology is key to economic strength. It has estimated that technological innovation was responsible for 45% of the nation's economic growth from 1929 to 1969 (Banner, 1979). Accumulated wealth is only one element of economic strength. Creativity and innovation are real keys to America's economic strength. Innovation has generated the productivity that has accounted for half of the GDP growth over the past 50 years, argues Engler (2006). R & D is not a single major factor influencing the economic strength of the region. This is especially the impact of fiscal access. Malin (1989) argued that local governments in many of the region's metropolitan centres forecast their most serious fiscal imbalances in at least a dacade, raising the prospects of higher taxes, cutbacks in public services and reduced competitiveness against lower cost areas of the country. Many local government officials fear what economist have long acknowledged; a shrunken manufacturing base, dependence on the volatile financial and business sectors, and losses of industrial diversity. This susceptibility to economic unpleasantness.

Factors economic forces were examined in other regions. For example, Kazachstan's researchers identified the key competitive advantages of the Pavlodar region, which is a large industrial center of the Republic of Kazakhstan and has substantial economic strength. Competitive advantages of the region, including a rich natural resources potential, availability of a developed industrial and social infrastructure, high scientific and technical capacity, and the connecting role between Central Asia and Siberia, have been reviewed. Solid competitive ad-vantages for investing in the development of the region have been revealed. The authors have stated general positive factors that contribute to the expansion of the economic strength of the Pavlodar region and positively influence the sustainability of the development of the regional economy (Bayandin et al,2017).

The initial point of many growth theories is connected with a model of Solow (1956). This is known as the Solow-Swan model which considers long-run economic growth. The neoclassical production function - Cobb-Douglas form is a base of this model. This model i sone of the first that considered the impact of technological change on economic growth. The Solow-Swan model recognizes the significance of the positive impact of technology changes on economic growth, but it is considered exogenous. Modern developed economy gains more and more features innovative economy. This is related to the research, development, and implementation and uses innovation for growth in living standards. Innovation has become a decisive factor in the stable development of the country. Innovation was also emphasized by J.A. Schumpeter (1912). He argued that only entrepreneurs and their entrepreneurial ideas can bring innovations leading to technological progress. He adds that innovation is concentrated in larger cities where conditions for innovation activities are. Some researchers analysed the interaction between technological change, focusing on the role of technological innovations in the decline of mortality and fertility, across societies (Boserup, 1981; Rostow, 2001). The R&D was identified as the major component of economic growth and Romer (1986) based endogenous growth theory on investment in R&D activities. Romer (1990) and Grosman and Heplman (1991) confirmed the results of the model for most of the developer countries and argued that R&D expenditure are vital for economic growth. Innovation is an important source and inherent power which maintains sustainable economic development of a country or region, and an index which measures the economic strength of a country, and it is also a crucial embodiment of the core competitiveness of enterprise a company (Turečková, 2018).

The Europe 2020 strategy has also set a target for R & D. This is measured using the GERD indicator defined by Frascati Manual. The indicator provided is GERD (Gross domestic expenditure on R&D) as a percentage of GDP. "Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications". A country's gross domestic expenditure on R&D (GERD) is broken down into four sectors of performance, which are expenditure by the business enterprise sector (BERD), the government sector (GOVERD), the higher education sector (HERD) and the private non-profit sector (Chung, 2015). GERD (Nevima, Kiszová, 2012) is an important driver of regions' economic strength. We will use the annual change in R & D expenditure for monitoring trends in the regions.

The other indicator, GDP per capita, is calculated as the ratio of real GDP to the average population of a specific year. GDP measures the value of the total final output of goods and services produced by an economy within a certain period of time. It includes goods and services that have markets (or which could have markets) and products which are produced by general government and non-profit institutions. It is a measure of economic activity and is also used as a proxy for the development in a country's material living standards. However, it is a limited measure

of economic welfare. For example, neither does GDP include most unpaid household work nor does GDP take account of negative effects of economic activity, like environmental degradation (European Commission, 2019a).

2 Data and Methodology

For the empirical analysis, we selected two variables: R&D expenditure, GDP per capita for the regions of the Czech Republic, for description of variables and regions see Tab. 1., Tab. 2. There are significant inequality, Expenditures for research and development cover basic research, applied research as well as experimental development, therefore fuelling one of the most powerful engines of Innovation. R&D Expenditure cover basic research, applied research as well as experimental development, therefore fuelling one of the powerful engines of Innovation. R&D Expenditure as a percentage of the GDP is the most commonly used measure of innovation, indicating the intensity of Research and Development of a region. R&D expenditure is an important enabling factor for human capital because it supports knowledge generation and skills development. On the other hand, highly skilled human resources are for the total EU's research and innovation capacity and competitiveness. The dynamism of creativity and adaptability of human resources to successfully deal with the most diverse tasks. GDP per capita reveals the accumulated productivity of the economy. As a measure of material prosperity, well-being, level of development, and so on, GDP per capita is a usually linked to competitiveness, therefore it was a natural decision to include it in the analysis as part of the economic pillar.

Table 1 Definition of variables

Indicators	Acronyms and period	Description
Gross Domestic Expenditure on R&D (GERD) as a percentage of GDP	GERD_2002-2017	Gross domestic expenditure on research and development (GERD) is the total intramural expenditure on research and development performed on the national level during a given period
Regional GDP	GDP_2002-2017	Regional gross domestic product (GDP) is a geographic breakdown of national GDP presented in nominal terms. Regional GDP provides an indication of the size and structure of regional economies and provides a benchmark for measuring changes to regional economies over time.

Source: CZSO, 2019a

The source of the data is the Eurostat database and CZSO database for the dependent and independent variables. The analyzed period was 2002-2017. The regions were created by the legislature in the year 2000. The name of the region is replaced by an abbreviation and the description is complemented by population development in the years 2002 – 2017, see Tab. 2. The decline in population in the period considered is obvious in the regions that have the lowest GDP R & D expenditure and low. An exception consists of the Olomouc Region and Zlin Region where R & D expenditure in the year 2017 increased significantly.

Table 2 Description of regions

Region NUTS 3	Acronyms	Population 2002	Population 2017
Prague	CZ010	1 170 571	1 286 554
Central Bohemian Region	CZ020	1 144 071	1 345 764
South Bohemian Region	CZ031	625 712	639 180
Pilsen Region	CZ032	549 618	579 228
Karlovy Vary Region	CZ041	304 588	**296 106**
Usti Region	CZ042	822 133	**820 937**
Liberec Region	CZ051	427 563	440 934
Hradec Králové Region	CZ052	547 296	550 848
Pardubice Region	CZ053	505 285	517 243
Region Vysočina	CZ063	517 153	**508 664**
South Moravian Region	CZ064	1 123 201	1 180 477
Olomouc Region	CZ071	635 126	**633 133**
Zlín Region	CZ072	590 706	**583 039**
Moravian-Silesian Region	CZ080	1 257 554	**1 207 419**

Source: Own compilation, CZSO 2019b

The main method used in this research is the correlation analysis method. It determines whether regional GDP, GDP per capita, and R & D expenditure depend on each region. The correlation analysis for GDP indicators, GDP per capita and R & D expenditure is used in many types of research (see Klímová and Žídek, 2015; Maradana et al., 2017, Dima et al., 2018). It is well known that for linear autoregressive models with autocorrelated residuals, the least squares estimator is asymptotically biased, and therefore the estimated model is not the correct one. Consequently, to ensure a good interpretation of the results, it is necessary to have a powerful tool allowing to detect the possible autocorrelation of the residuals. The well-known statistical test of Durbin-Watson was introduced to deal with this question, and more specifically, for detecting the presence of a first-order auto-correlated noise in linear regression models, firstly and for linear autoregressive models secondly. To the best of our knowledge, no such serial correlation statistical test is available for controlled autoregressive processes (Bercu, 2014). It will be used the serial correlation test, based on the Durbin-Watson statistic. It validates the hypothesis that residues of e_i are mutually uncorrelated. We will test the hypothesis H_0: $p = 0$ against H_1: $p \neq 0$ engine at significance level α and we count the test criterion.

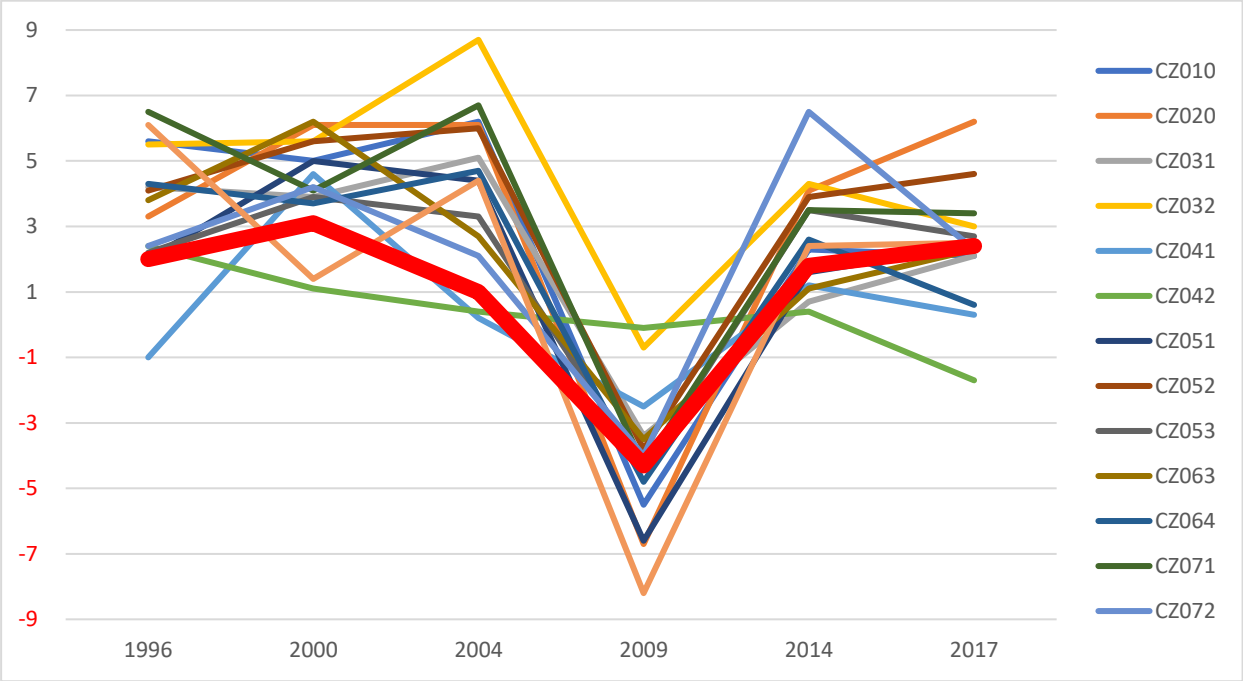
$$D = \frac{\sum_{i=2}^{n} (e_i - e_{i-1})^2}{\sum_{i=1}^{n} e_i^2}$$

When D = 2, the correlation is zero. When is the strong positive correlation, D is approaching 0, when is the strong negative correlation is D close 4. All the statistical analyses in this research will perform using the statistical software Statistica 12.0 and R software.

3 Results

The Czech Republic as a one of Central and Eastern Europe (CEE) country is in a long process of transforming into knowledge-based economies. After political changes, the Czech Republic began its transformation from the previous level, currently in the level of economic development, government priority as well as living standard. The economic growth was driven by domestic consumption before 2008, claimed Kravtsova and Radosevic (2012). The current government and regional government policy is closely focused on R&D-based growth and do

not address the key drivers of technology accumulation and economic growth. I this recent re-search we have analyzed the relationship between regional GDP, GDP per capita and R&D expenditure among the regions in the Czech Republic. The first step of our analysis was to count the increment for each time series.



Source: Own compilation, Eurostat, 2018 and CZSO 2019a

Figure 1 GDP growth rate in the Czech regions and EU

GDP created in the region is not a suitable unit for interregional comparisons. It is necessary to eliminate different population numbers in individual regions, inflation, etc. GDP growth compared to the EU average used only for illustrative graphical comparisons, see. Fig. 1. It is seen that in the long term, the Central Bohemian Region is the most stable and the average growth rate is 3.95%, Prague is second. The Karlovy Vary region, with an average growth rate of 0.17%, is in the last place. All Czech regions affected by the world crisis in the years 2008 – 2009. Six regions have a higher GDP growth rate than the EU average, as seen in Fig. 1. The least affected by the economic crisis was the Usti region in 2009. However, its trend has a downward trend. The smallest growth rate is recorded in the Karlovy Vary Region; the sharpest growth is evident in the Prague region. In order to compare the interdependence of the development of the R&D expenditure and GDP variables, it is necessary to have a data line for many years. The pace of growth of individual variables was used to eliminate the national currency. This relationship, of course, does not imply the conclusion that one variable was causing the second and the second as a result. It cannot be concluded from these results that higher GDP of the region, higher per capita GDP in the region. Or conversely that a higher R & D expenditure means that the region is capable of creating a higher GDP, or that increases the standard of living of the population. This relationship examines using the correlation of selected variables. It is a time series and it is, therefore, appropriate to make the Durbin-Watson test. R&D expenditure and GDP year on year changes present Table 3. If the period of the year's decline indicates it in red colour.

Table 3 shows that GDP development in the region does not reflect the development of R & D expenditure. Higher variability we see in R & D spending compared to GDP growth. Annual GDP change ranges from -4.41% (Central Bohemian Region in 2009) to 14.49% (Moravian-Silesian Region in 2004). Year-on-year change in R & D expenditures has a significantly higher amplitude. R & D expenditure is not so dependent on the economic situation. Czech Republic's accession to the EU in 2004 marked the accession to the Lisbon objectives and changing priorities in connection with the commitment to increase R & D spending. One-off actions in the form of various grant opportunities and an inflow of foreign direct investment, which often meant the transfer of innovation centers to the Czech Republic, are also significant. R & D expenditure decreased in the Zlin region

since 2002, so the increase in one-off increase in R & D expenditure meant growth of 99.77% in 2005. Significant is the fact that the South Moravian Region, as the only one, shows steady growth in R & D expenditure, indicating its outstanding position in research, development and innovation. It is a region of many innovation centers and incubators. Significant is the support of the region's government in the form of innovative vouchers.

Calculation of increases in the regions was subjected to statistical analysis. For the results of the Durbin-Watson statistical test, see table 4. Autocorrelation for time series of 16 interval values (1.36092; 2) means that we assume the H0 hypothesis when the time series is not correlated. As the results did not show positive auto-correlation in the regions, the correlation between GDP and R & D expenditures in the period 2002 - 2017 was made in all regions of the Czech Republic.

Table 4 Statistical tests

	DW	t	p
CZ010	1,38	2,57	0,022
CZ020	1,66	3,68	0,0024
CZ031	1,37	3,03	0,009
CZ032	1,71	4,52	0,0005
CZ041	1,38	3,32	0,005
CZ042	1,97	3,48	0,0037
CZ051	1,47	2,54	0,0237
CZ052	1,41	3,32	0,0051
CZ053	1,39	2,88	0,012
CZ063	1,42	5,08	0,0002
CZ064	1,39	3,74	0,002
CZ071	1,69	4,77	0,0003
CZ072	1,38	3,83	0,0018
CZ080	1,43	3,31	0,0051

Source: Own compilation

After the Durbin Watson test, we performed a correlation analysis in STATTIATICA 12 software. We tested the dependence of GDP against R & D Expenditure by correlation analysis. We have also calculated variants for leading indicators. So when one pointer overtakes the second for one year and also two years. For the results see Table 5.

Table 5 Negative correlation coefficient values

	GDP/R&D	GDP+1/R&D	GDP+2/R&D	GDP/R&D+1	GDP/R&D+2
CZ010	0.51	0.44	0.27	**0.12**	0.06
CZ020	0.00	0.58	0.16	0.06	**0.12**
CZ031	0.46	0.48	0.30	0.50	**0.04**
CZ032	**0.20**	**0.26**	0.03	0.09	**0.20**
CZ041	**0.07**	**0.50**	0.08	**0.37**	**0.10**
CZ042	0.08	0.06	0.29	**0.22**	**0.16**
CZ051	0.26	**0.15**	0.00	0.20	**0.28**
CZ052	0.37	0.05	0.34	**0.18**	**0.00**
CZ053	0.12	0.21	0.02	**0.08**	**0.26**
CZ063	**0.32**	**0.25**	0.38	0.10	**0.10**
CZ064	0.17	0.14	0.02	**0.06**	**0.38**
CZ071	**0.13**	**0.38**	0.12	0.10	**0.24**
CZ072	0.22	0.19	0.13	**0.14**	**0.17**
CZ080	**0.04**	0.34	**0.25**	**0.15**	**0.35**

Source: Own compilation

It is clear from the results that the selected indicators: GDP of the region and R&D expenditures of the region do not depend on the long term. Most of the correlation coefficients are closer to Zero. Only for the Prague region and the Central Bohemia has a coefficient of value> 0.50. Here we can think of moderate dependencies. The data published in Table 3 suggest this. Firstly, there has been a drop in R & D expenditure and consequently a decline in GDP growth. From an overall impression of this dependency cannot be regarded as relevant. Inter-dependence has not been confirmed in either of the leading indicators. When selecting a lead R & D expenditure + 2 years, the correlation coefficient is negative.

4 Discussion

R & D support is included among strictly monitored economic indicators in developed countries. The Czech Republic ranks GERD among the first half of the EU member states. In 2017, the GERD was 1.79%. Its economic strength is increasing, but it varies greatly between regions. A correlation analysis was used to determine the relationship between R & D expenditure of the region and GDP of the region that measured economic strength. The monitored time series was the longest possible. The emergence of contemporary regions is dated to 2001. This research used data in the time series 2002-2017. The Durbin-Watson test was used to exclude autocorrelation. Autocorrelation isn't positive.

Comparing year-on-year R & D expenditures and GDP growth, no positive correlation was observed. Also, the positive correlation was eliminated with the use of leading indicators, the delay of one or the d_t variable. Only the negative correlation, excluded by Prague, was observed for the delay of R & D expenditures by two years. For results, see Table 5. It is not possible to clearly identify the relationship between R & D expenditure and the economic strength of the region. More accurate results and possible demonstration of mutual relationship is the topic of further research. In order to clarify mutual influence, it is possible to use R & D expenditures in the business sector only, the economic level measured GDP per capita, recording the knowledge capital of the measured level of tertiary education. This is one of the Europe 2020 Strategy targets.

Conclusion

The level R&D expenditure and structure of innovation should not be ignored because it plays an imperative role in stimulating economic growth (Pradhan et al. 2016) and economic strength (Kiszová and Nevima, 2012). This paper explored the correlation analysis between R&D expenditure and regional GDP for the 14 Czech regions using time series data from 2002 to 2017. The economic strength of the country is based on the economic strength of its regions. The pivotal message from our study for the policymakers and academicians alike is these implications drawn from research on economic strength growth that disregards the dynamic interrelation of the two variables will be imperfect. It is the conjoined back-and-forth relationship between innovation and economic strength growth that builds our study and guides future research on this topic.

The aim of the article was to assess the interdependence of R & D expenditure and of the GDP of individual regions of the Czech Republic in the period 2005 – 2017. Correlation analysis of applied research with precocious indicators. Our calculated evidence is based on annual data from 14 regions of the Czech Republic. The economic strength of regions and R & D expenditure increased during the reference time period. But interdependence between them has not been observed. Neither prediction of individual indicators has been confirmed.

The influence may be the fact that R & D spending relative to GDP is relatively low. Most active is in the Central Bohemia region in the year 2015 (2.85%). The low percentage of R&D Intensity each special-purpose increase R & D expenditure reflected more intensely. When we use the ignition advance indicators is also interdependence. From the calculations, it is impossible to infer that the R & D support has a positive effect on the economic strength growth of the region. The inclusion of different factors may affect our main findings and this could be the subject of future research.

Additional, the other limitations do exist in this study. First, no indirect or complementary effects on the nexus between R & D Expenditure on economic strength growth; second, the findings are regulated to Czech regions only; third, exclusion of sector-wise impact of innovation activities an economic strength growth; and fourth small time-dimension of data, i.e. 2005 - 2017. Consequently, further study in these mutable areas can produce more inspiring and spontaneous findings to the nexus between R&D Expenditure and economic strength growth.

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Appendix

Table 3 Development of GDP and R & D expenditure in regions of the Czech Republic

		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CZ010	GDP	5,68	7,50	9,27	8,63	8,09	11,87	6,37	**2,54**	1,48	**1,41**	0,07	0,69	3,24	10,90	3,68	6,90
	R&D	0,54	15,97	11,73	17,95	16,07	20,55	**3,70**	**2,24**	**0,45**	9,86	7,62	5,98	12,53	12,08	**16,27**	15,93
CZ020	GDP	5,46	1,88	9,67	3,02	11,46	10,22	5,87	**4,41**	**0,08**	4,89	1,92	0,63	9,06	5,19	7,49	7,54
	R&D	5,08	**9,16**	3,24	38,22	15,70	15,85	**10,11**	1,20	5,61	5,53	5,16	45,54	1,65	1,13	11,86	28,47
CZ031	GDP	4,40	2,66	8,12	7,87	6,31	4,79	1,34	0,06	**0,67**	0,51	2,29	1,71	3,50	4,25	3,71	4,26
	R&D	4,97	21,02	11,58	40,08	7,39	3,99	10,17	4,80	2,58	3,75	15,69	**0,11**	**1,80**	7,08	6,81	2,86
CZ032	GDP	3,82	5,81	12,03	3,37	10,00	4,84	**0,57**	2,22	2,56	2,00	**2,04**	4,87	7,12	4,61	4,47	4,75
	R&D	27,17	**14,20**	17,44	34,67	18,08	3,42	28,12	**9,50**	43,49	36,89	20,30	9,36	14,61	**2,75**	**25,18**	4,86
CZ041	GDP	5,97	3,76	4,37	3,81	3,18	8,67	1,19	0,33	**2,01**	0,11	**0,84**	**0,48**	3,15	3,12	1,02	6,08
	R&D	13,67	18,77	5,01	**20,87**	**6,23**	8,34	**28,88**	57,83	23,70	17,30	64,16	**43,65**	31,84	34,01	**14,87**	22,08
CZ042	GDP	5,14	7,10	7,55	6,23	6,78	6,83	4,72	0,33	**2,66**	0,12	0,12	**0,41**	2,33	7,58	**1,28**	4,40
	R&D	**8,54**	31,88	**15,74**	15,38	**0,34**	15,98	19,28	**15,45**	6,45	15,37	33,34	**3,58**	12,13	**9,82**	**21,36**	4,57
CZ051	GDP	2,74	**3,43**	6,95	11,21	5,86	3,82	1,98	**3,51**	2,49	2,00	1,98	0,68	5,25	6,16	3,86	4,60
	R&D	5,21	6,52	6,27	27,44	26,13	**4,30**	13,21	**5,37**	1,14	28,21	53,69	**17,27**	10,47	**3,59**	5,30	9,08
CZ052	GDP	1,80	3,27	8,71	4,73	4,87	9,89	3,99	**0,69**	1,25	0,87	0,53	0,34	7,05	5,17	6,08	10,14
	R&D	**3,26**	18,68	50,19	**0,88**	13,13	22,42	**0,18**	19,28	**1,36**	13,53	0,04	12,50	8,72	**3,29**	**9,02**	19,03
CZ053	GDP	4,37	5,15	6,88	4,32	9,84	9,96	2,01	**3,32**	1,94	3,62	**4,52**	2,26	6,25	6,43	3,81	5,65
	R&D	2,68	24,47	7,96	18,13	15,35	3,44	**2,14**	**2,65**	14,55	15,69	12,58	**3,42**	1,48	**2,83**	**4,45**	9,60
CZ063	GDP	3,38	3,92	6,06	6,63	7,48	9,77	**0,26**	**0,75**	**0,73**	4,50	2,28	0,88	4,09	4,25	4,07	5,60
	R&D	33,31	0,92	23,73	33,36	**27,63**	**1,29**	39,54	0,22	6,75	4,99	18,16	25,86	29,41	2,31	**8,34**	**1,74**
CZ064	GDP	4,05	5,58	7,76	5,67	7,62	10,60	7,62	2,21	1,04	3,32	3,01	4,28	4,55	6,04	2,05	3,69
	R&D	2,94	10,41	14,06	17,39	16,57	18,92	9,12	13,83	5,82	31,38	30,85	10,52	5,11	4,04	**15,43**	3,46
CZ071	GDP	3,31	5,50	9,46	2,26	5,28	8,87	4,93	**2,23**	2,25	3,27	1,12	**0,06**	5,71	4,89	4,72	6,29
	R&D	18,55	3,76	16,15	30,22	**2,40**	15,04	5,43	13,24	**0,37**	32,26	66,77	**13,98**	10,34	**11,67**	**5,02**	18,84
CZ072	GDP	3,27	4,36	5,16	8,39	9,31	7,94	7,77	**2,22**	**1,04**	3,24	**0,21**	1,62	10,29	2,41	3,40	4,96
	R&D	80,63	**26,60**	**12,88**	99,77	9,64	**0,95**	**5,93**	**5,04**	14,76	18,53	9,40	**2,72**	21,95	**7,84**	3,49	27,99
CZ080	GDP	3,59	4,21	14,49	10,08	4,73	9,38	5,18	**5,90**	2,36	4,43	0,68	**2,81**	5,72	4,75	3,17	4,51
	R&D	**19,74**	71,70	**8,23**	**1,19**	6,80	18,53	**3,41**	14,58	1,79	58,87	**6,90**	**1,84**	14,55	0,77	**0,87**	**4,31**

Source: Own compilation, CZSO 2019