HOW DO REGIONS USE INDIRECT R&D SUPPORT FOR THEIR INNOVATION ACTIVITIES?

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Abstract: *It is broadly accepted that innovation is an important source of competitiveness in developed regions and that research and development brings new knowledge that can be utilized for the development of new innovations. This paper deals with indirect support for research and development that is used for promotion of innovation activities in the Czech Republic. The aim of the article is to provide new empirical evidence on using of indirect support of research development for financing of innovation activities in Czech regions. The statistical data are analysed through descriptive statistics, cluster analysis and correlation analysis. It was observed that indirect R&D support is strongly concentrated in Prague and the Central Bohemian Region. The situation in the South Moravian Region is different, although this region has many common features with the former regions. The cluster analysis also revealed a group of regions with quite a high level of indirect support. These regions are not the innovation leaders, but they can be characterized by a strong industrial base.*

Keywords: *Indirect support, Tax incentives, Research and development, Innovation, Region*

JEL Classification: *R12, H25.*

Introduction

If developed countries and regions want to be successful in the global market and reach sustainable economic and social development they have to build their competitive advantage on innovations, quality, and uniqueness. Innovations bring economic prosperity, social development, new jobs, better quality of life, and international competitiveness. Although successful companies have to be able to operate in international markets nowadays, innovations are considered of territorial matters. Outstanding innovations arise in regions due to their specific features and unique environments. The main regional competitive advantages include the presence of research organizations, the availability of skilled workforce, the presence of innovative firms, formal and informal relations among innovation actors, mutual learning, networking, and a favourable innovation atmosphere. Research and development (R&D) is one of the most important sources for innovations (Kraftová, Miháliková, 2011; Barge-Gil, A., López, A., 2014). R&D creates new knowledge and enables companies to create radical innovations with high value added.

Research and development can be financed from public or private resources. Public expenditures on research and development are paid by governments and universities and this type of source is particularly important for financing of basic research. On the other hand, private sources are invested by innovative companies and are dedicated especially for conducting of applied research. The most developed countries (innovation leaders) invest more than 3 per cent of gross domestic product (GDP) in R&D and a significant part of it is financed by business. It is generally accepted that

private sector finances a large proportion of R&D expenditures in top-performing countries (Crespi et al., 2016). For example, the most developed countries in the EU invest more than 3% of GDP in R&D, out of which more than 50% is financed by business sector. Just for comparison, the Czech Republic invested 1.95% of GDP in the same period and the share of business sector was less than 50% (Eurostat, 2016).

Research projects in businesses can be supported in a direct or an indirect way (Kraftová, Miháliková, 2011). The direct way is based on providing subsidies to companies in public tenders. The indirect support of research and development usually lies in some type of tax incentives. In general, the following main kinds of indirect support can be used: tax deduction (allowance) and discount (credit), discounts (of benefits) for social insurance, progressive financial depreciation for long-term assets, and customs regulations (e.g. Janeček et al., 2012; OECD, 2016).

1 Support of research and development

1.1 Theoretical background

The scientific literature on innovation emphasizes that market failures discourage companies from investing in R&D. Results of R&D have a character of a public good, because knowledge is regarded as a nonrival and nonexcludable good (Arrow, 1962). New knowledge cannot be fully appropriated and due to knowledge spillovers the firm's rivals may be able to free-ride on its investment (Aerts, Schmidt, 2008; Crespi et al., 2016). This imperfect appropriability causes underinvestment in R&D activities, which means that the level of R&D expenditures is below the socially desirable optimum (Weber, Rohracher, 2012; Brown et al., 2017). In other words, knowledge spillovers cause a tension between social and private returns to innovation. Furthermore, results of research projects are uncertain and come in long-term perspective. It means that profits from innovations are uncertain and long-term too. This market imperfection is perceived as a rationale for policy intervention (McCann, P., Ortega-Argilés, R., 2013). Public funding reduces the R&D costs for companies to a level at which the research projects become profitable for investors (Aerts, Schmidt, 2008).

Another strand of scientific literature stresses the importance of place for development of innovations. It is obvious that neither innovation nor research activity is equally distributed in regions (Žítek, 2016). The role of place in development of innovation is also broadly discussed in the framework of the regional innovation systems (Autio, 1998; Doloreux, 2002; Hudec, Urbančíková, 2009). This concept investigates individual elements of innovation systems and mutual relations among them. Protagonists of this concept analyse for instance R&D intensity or presence of research organizations and they give recommendations for research and innovation policy (Fritsch, Stephan, 2005; Borrás, Edquist, 2013).

This article focuses on the indirect support for research and the development, which is provided in the form of tax incentives. This type of support is characterized by several specifics and has several advantages and disadvantages for governments as well as companies. Czarnitzki et al. (2011) pointed out the government failure that is usually connected with direct support. In the case of indirect support, this risk is minimized. They also stressed that indirect support is considered to be a neutral form of encouragement to R&D as all companies, irrespective of the industry, size and

innovation activity, can claim it. In other words, this type of support is not selective and is compatible with economic competition. Tax incentives are market-based and thus they are considered more neutral than direct support. On the other hand, it means that government cannot influence structure of research and choice of R&D projects (Elscher et al., 2011). Many researchers discuss the problem of crowding-out effect (e.g. David et al., 2000; Gonzáles, Pazó, 2008; Crespi et al., 2016), i.e., if public subsidies replace private investments or not. Most of these studies state that the crowding-out effect was not confirmed (or is lower than in the case of direct support). Some authors argue that private companies use indirect support to implement projects with high private returns inducing investments with a short-term horizon that would have been implemented in any case, i.e., without public aid, as well (Crespi, et al., 2016). The main disadvantage for companies is the fact that indirect support can be used only after they have been able to generate taxable profit.

1.2 Support of research and development in the Czech Republic

Direct support of research and development has quite a long tradition in the Czech Republic. Basic research is funded by the Czech Science Foundation (GACR), but this type of support is not focused on business. The main recipients are universities and public research institutes. Applied research is sponsored by the Technology Agency of the Czech Republic (TACR). Furthermore, various types of applied research are also sponsored by individual ministries in compliance with their competences. Research activities in business are also supported by operational programmes, in particular OP Enterprise and Innovation (2007–2013) and OP Enterprise and Innovation for Competitiveness (2014–2020). Guidelines for direct public aid are given by the European Union regulations.

Indirect support for research and development has been provided in the Czech Republic since 2005 in the form of expenses as deductible items from the tax base of income tax. It means that the taxpayer can deduct the expenditures on research and development from the tax base and in reality, these expenses are deducted twice. They are first deducted within the tax base calculation (i.e., revenues minus expenses, in a simplified way) and for the second time they are deducted from the calculated tax base. Tax rate for corporate income tax is 19%; therefore, the taxpayer can save up to 19% of the R&D costs. The main tax-deductible expenses are labour costs, depreciation for long-term assets, overhead costs, and contracted research with public research organizations. The basic condition for using this type of support is that the same research project (and the same expenses) cannot be subsidized by any type of direct public aid. The innovative company has to decide whether it prefers direct or indirect form of support.

2 Data and methods

The aim of the paper is to provide new empirical evidence on using indirect research and development support for financing of innovation activities in Czech regions. Previous research studies did not pay attention to spatial distribution of the indirect R&D support. The carried out research can contribute to proper policy targeting.

Statistical data about the indirect support for research and development are published by the Czech Statistical Office (CSO) which uses income tax returns for their collecting. The methodical principles are based on the Frascati manual (OECD, 2015) and therefore the statistics are comparable internationally. The Czech data have been collected since 2005, but detailed regional data are available from 2007. Three basic indicators are monitored, namely number of enterprises with indirect support, volume of deducted expenses on R&D, and amount of indirect support. The research in this paper comes out from this statistical source (CSO, 2017b) and completes it with other statistical resources (CSO, 2016a, 2016b, 2017a). The paper analyses Czech regions at the NUTS3 level (14 regions). The conducted research looks for answers to the three basic research questions:

- How do Czech regions differ in characteristics of indirect support for R&D?
- What public aid do Czech regions use for financing of their research activities?
- Does the exploitation of indirect support depend on some economic indicators?

2.1 Characteristics of indirect support in Czech regions

Characteristics of indirect support in Czech regions are investigated on the basis of the above-mentioned statistical resources. To avoid an incorrectness caused by an extreme value of an indicator in certain period, the average value for the period 2013–2015 is used in the analyses. Examining the regional characteristics and specifics, the following indicators have been chosen:

- total amount of indirect R&D support (in mil. CZK) – IND
- amount of indirect R&D support per inhabitant (in CZK) – INC
- share (in %) of deductible expenses on BERD (regional business expenditures on R&D) – EXP
- number of enterprises that used the indirect support (number) – ENT
- share of enterprises with indirect support among all R&D workplaces in business sector (in %) – EWP

All the indicators are assumed to reach high values ("more is better" principle). With regard to the nature of the indicators, which are expressed in different units and gain different values, it seems appropriate to use the point method. However, as its results are to a large extent affected by potential major differences in the values of one or more indicators, it can be further combined with the cluster analysis.

The point method is based on finding the region that, in the analysed indicator, reaches the maximum or minimum value. In this research, all the indicators are assumed to reach high values ("more is better" principle). In other words, the maximum value is relevant if the indicator's increase is considered positive. The point value of the specific indicator in the case of the maximum is set as follows:

$$B_{ij} = \frac{x_{ij}}{x_{i\,max}} \tag{1}$$

where B_{ij} is the point value of the i_{th} indicator for the j_{th} region, x_{ij} is the value of the i_{th} indicator for the j_{th} region, $x_{i\ max}$ represents the maximum value of the i_{th} indicator.

The region with the maximum value of the indicator is assigned with a certain number of points within the point evaluation of each (100 in the calculations carried out here); other regions are rated according to their indicator values (0–100). The main advantage of this method is that it allows expressing the original indicators in different units as dimensionless figures.

The point values of the individual parameters can further be used as data for the cluster analysis. By means of the cluster analysis, regions can be grouped into clusters based on their resemblances (Melecký, Poledníková, 2012). Non-hierarchical clustering is used, specifically, the method of k-means with Euclidean distances is appropriate for this purpose. Using the cluster analysis, the regions were divided into five clusters (k = 5). First the regions are divided into five groups and initial centroids of single clusters are calculated. Subsequently, the Euclidean distance between the value of particular region and the centroid of its own cluster and other clusters is calculated. If the value of the region is relatively near to the centroid of its own cluster, the region remains in the same cluster. If the value is closer to another cluster, the region is moved to this cluster. The procedure is repeated as long as movements come.

2.2 Public aid for financing of research activities in Czech regions

This part of the article evaluates whether enterprises in Czech regions use some type of R&D support and which type. The size of projects with indirect support is examined too. This partial analysis uses methods of descriptive statistics. As mentioned above, companies can use direct or indirect support to finance of their research activities. Nevertheless, they cannot use both forms at the same time (or more precisely, to finance the same costs). It means that they have to choose one of the public aid types. When deciding, they usually contemplate intensity of support, administrative requirements and probability of success in public tenders. The public aid never covers all eligible costs. The intensity of direct support depends on the enterprise size and the type of research. In the case of applied research the intensity usually varies between 25% (big enterprises) and 45% (small enterprises). The intensity of indirect support is 19% (all types of research, all types of enterprises). The following three indicators expressed as the average value for the period 2013–2015 have been chosen as the characteristics of public aid for financing of research activities:

- Share of indirect support in the total public aid (in %).
- Share of indirect and direct support in business expenditures on R&D (in %).
- Deductible expenses per one supported enterprise (in CZK).

2.3 Relation between indirect support and selected economic indicators

Employment of the indirect support for financing of business research activities is related to economic environment in regions. We can expect that exploitation of this type of support is dependent on some economic features of regions. Therefore, we can expect a close relation between indirect support and regions' economic and research characteristics. The Pearson correlation coefficient is used for its validation:

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}} . \quad (2)$$

The coefficient can take a range of values from +1 to -1, positive correlation being anticipated. The values of the correlation coefficient can be interpreted as follows: 0.10–0.39 weak correlation; 0.40–0.69 medium correlation; 0.70–0.89 strong correlation; 0.90–1.00 very strong correlation (Bajgar et al., 2012). The correlation analysis works with the average values of all indicators for the period 2013–2015 and these indicators are explained in section 3.3.

3 Results and discussion

This section shows results of indirect support analysis in Czech regions. The attention is paid to characteristics of regions, utilization of public aid for research activities, development of indirect support for R&D, and relations between indirect support and selected economic indicators.

3.1 Characteristics of indirect support in Czech regions

Table 1 shows characteristics of Czech regions with respect to indirect support for R&D. For a better informative value the analysis works with three-year average values of all indicators. The highest amount of indirect support (IND) is allocated to Prague and the Central Bohemian Region. The remaining regions follow at a huge distance. When we convert the total amount of support to relative value (per capita), the position of Prague and the Central Bohemian Region stays dominant (INC). Comparing the deductible expenses on R&D to the total amount of business expenditures on R&D (EXP) in regions, the highest share can be observed in the Karlovy Vary Region. Nevertheless, this result is influenced by the very low value of indirect support and BERD at the same time. In Prague, the share of deductible expenses in BERD is 34 % and 69% of business R&D workplaces (EWP) use indirect support for financing of their research and innovation activities. On the other hand, it is necessary to say that the extraordinary results of Prague can be caused by the fact that Prague has limited access to the direct public aid, because it is not eligible for drawing subsidies from some operational programmes.

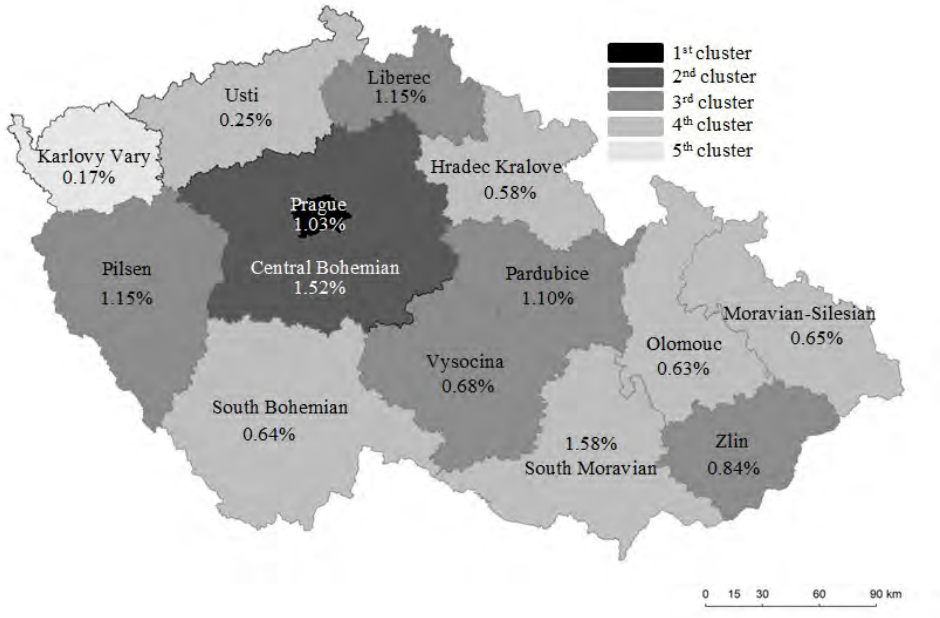
As mentioned above, in section 2.1, the indicators were recalculated to dimensionless figures by the point method and similarities among regions were assessed through the cluster analysis. Fig. 1 shows distributing the regions into five groups. The clusters are arranged in top-down order. The regions in the first cluster use the indirect support more intensively and vice versa, regions in the fifth cluster use the indirect support with the lowest intensity. For the sake of completeness, information about share of BERD in regional gross domestic product has been added to the map. The comparison of the South Moravian and Central Bohemian Regions is quite interesting. These regions have the highest shares of BERD in their gross domestic product, but they differ significantly in exploitation of the indirect R&D support.

Tab. 1: Indirect R&D support in Czech regions (average values for 2013–2015)

Region		IND (mil. CZK)	INC (CZK)	EXP (%)	ENT (number)	EWP (%)
CZ010	Prague	713	567	34.20	321	68.96
CZ020	Central Bohemian	554	422	39.27	106	44.62
CZ031	South Bohemian	29	45	10.59	42	49.27
CZ032	Pilsen	174	303	36.19	45	50.20
CZ041	Karlovy Vary	18	59	69.79	11	54.54
CZ042	Usti	28	34	22.66	35	38.74
CZ051	Liberec	122	277	39.96	39	40.91
CZ052	Hradec Kralove	56	101	25.71	58	46.60
CZ053	Pardubice	103	199	28.69	69	54.09
CZ063	Vysocina	93	182	42.16	46	48.19
CZ064	South Moravian	188	160	13.28	177	45.03
CZ071	Olomouc	44	70	18.65	60	46.74
CZ072	Zlin	120	205	35.57	109	64.15
CZ080	Moravian-Silesian	122	100	23.81	113	48.89
Czech Republic		2,362	224	29.54	1,230	52.27

Source: author's own processing based on (CSO, 2016b, 2017a, 2017b)

Fig. 1: Results of cluster analysis and share of BERD in GDP



Note: The percentage values express the share of BERD in GDP (this indicator is not included in the cluster analysis).

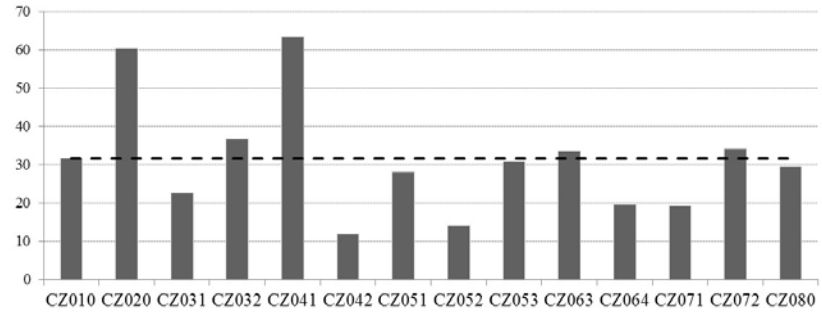
Source: author's own processing and (CSO, 2016b)

3.2 Public aid for financing of research activities in Czech regions

In this section, usage of direct and indirect support for business research activities is analysed. Average values for period 2013–2015 have been used in all cases. Figure 2 shows the share of indirect support in total amount of support. We can see that indirect support is preferred in the Central Bohemian (CZ020) and Karlovy Vary (CZ041) Regions (more than 50%). Because the research features of both regions are

very different, we can suppose that reasons for these results are different too. Whereas enterprises in the Central Bohemian Region use indirect support to a large extent, usage of indirect support in the Karlovy Vary Region is poor. Furthermore, companies in the Karlovy Vary Region may be less successful in public tenders for direct support.

Fig. 2: Share of indirect support in the total public aid (in %)

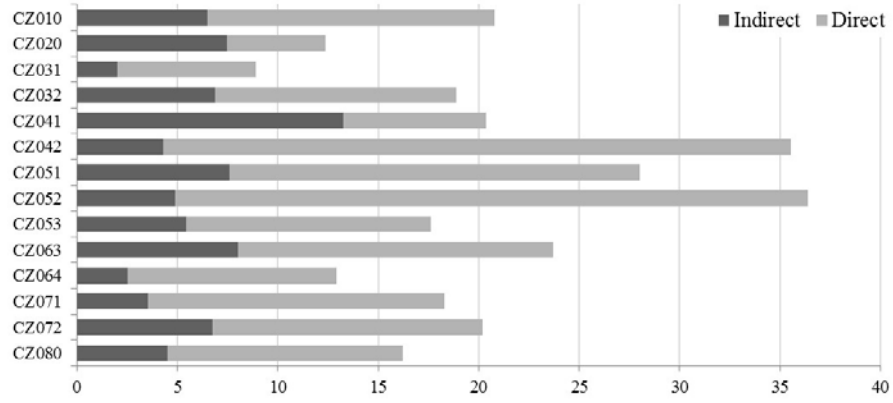


Note: The dashed line shows the average for the entire Czech Republic.

Source: author's own processing based on (CSO, 2017b)

Fig. 3 shows what aid intensity has been granted to actors in individual regions. It represents the share of direct and indirect support in BERD. It can be supposed that a significant part of business research activities is subsidized by some type of public aid in some regions and that these regions are strongly dependent on the public aid. From this point of view the most dependent regions are the Hradec Kralove (CZ052), Usti (CZ042) and Liberec (CZ051) Regions. On the other hand, the less dependent regions are the South Bohemian (CZ031), Central Bohemian (CZ020), and South Moravian (CZ064) Regions. The comparison of the Central Bohemian and South Moravian Regions brings some interesting results, the latter is more dependent on the direct type of support.

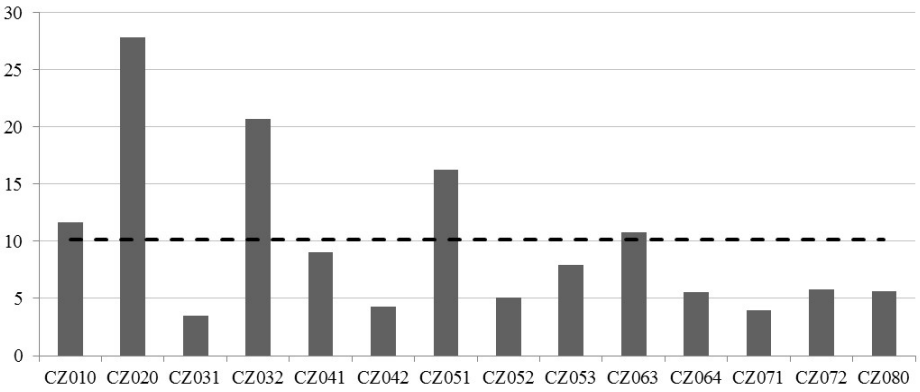
Fig. 3: Share of direct and indirect support in BERD (in %)



Source: author's own processing based on (CSO, 2016b, 2017b)

Fig. 4 shows average deductible expenses on R&D per supported company. In a figurative sense, it can mean an average size of research projects in individual regions. We can see that the highest indirect support per company has been allocated to the Central Bohemian (CZ020) and Pilsen (CZ032) Regions. In some regions, enterprises use the indirect support for quite small research projects.

Fig. 4: Indirect support - deductible expenses on R&D per a supported enterprise (in mil. CZK)



Note: The dashed line shows the average for the entire Czech Republic.

Source: author's own processing based on (CSO, 2017b)

3.3 Relation between indirect support and selected economic indicators

It is possible to expect that usage of indirect R&D support for financing of innovation activities relies on economic and research characteristics of regions. We can observe quite big differences in research and innovation activities among the regions. Innovations are considered to be a territorial matter and they are strongly concentrated in some regions. Therefore, this article deals with the relation between indirect support and selected indicators. In all cases, average values for the period 2013–2015 have been taken into consideration. As was mentioned above, the Pearson correlation coefficient is used for the validation of the relations.

Firstly, the total amount of indirect support for R&D was analysed with respect to these indicators: total gross domestic product (GDP), business expenditures on R&D (BERD), direct support of R&D, number of researches (expressed as full-time equivalent units, FTE), share of companies with technical innovations (reference period 2012–2014).

Tab. 2: Pearson correlation coefficient - absolute values of examined indicators

	GDP (CZK)	**BERD (CZK)**	**Direct support (CZK)**	**FTE (number)**	**Technical innovations (%)**
Indirect support (CZK)	0.88	0.91	0.80	0.84	0.11

Source: author's own processing based on (CSO, 2016a, 2016b, 2017a, 2017b)

The results of the correlation analysis are presented in Tab. 2. We can see a very strong correlation between indirect support and BERD (which cannot be surprising) and a strong correlation between indirect support and GDP and number of researches. The strong correlation with direct support was not expected, because using indirect support excludes using direct support. It is apparent that regions with a high amount of the indirect support use the direct support to a large extent too. The relation between indirect support and share of firms with technical innovations is very disputable. This weak correlation may be partially explained by a different way of statistical data collecting (sample survey) and quite low differences among regions.

Secondly, the amount of indirect support for R&D per capita was analysed with respect to these indicators: gross domestic product per capita (GDP), business expenditures on R&D per capita (BERD), direct support of R&D per capita, number of researches (expressed as full-time equivalent units, FTE) per capita, share of companies with technical innovations (reference period 2012–2014).

The results of the correlation analysis are presented in Tab. 3. We can see strong correlation between indirect support and BERD, GDP, FTE and direct support, but the correlations are not as strong as in the first case. The relation between indirect support and share of firms with technical innovations is the same as in the first correlation analysis.

Tab. 3: Pearson correlation coefficient - converted values of examined indicators

	GDP (p.c., CZK)	**BERD (p.c., CZK)**	**Direct support (p.c., CZK)**	**FTE (p.c., number)**	**Technical innovations (%)**
Indirect support (p.c., CZK)	0.75	0.86	0.71	0.74	0.11

Source: author's own processing based on (CSO, 2016a, 2016b, 2017a, 2017b)

Conclusion

The main advantage of the indirect support for R&D is that this type of support is not selective and each company that meets the legal requirements can use it for financing of its research and innovation activities. Therefore, this support is compatible with economic competition.

Indirect support for R&D is strongly concentrated in Prague and the Central Bohemian Region. Both regions have a high share of business expenditures on R&D in gross domestic product and many companies are settled there, therefore resemblances in their indirect support for R&D have been expected. Nevertheless, we can also observe some differences between them. In spite of the fact that Prague has limited access to some types of direct support, its enterprises are more dependent on it (Fig. 3). In the Central Bohemian Region, a higher share of indirect support in BERD has been observed. On the other hand, a higher share of enterprises in Prague (69%) use the indirect support for financing of innovation activities compared to the Central Bohemian Region (45%). The analysis proved that enterprises in the Central Bohemian Region use the indirect support for larger research projects (Fig. 4).

The situation in the South Moravian Region is different, although this region has many common characteristics with Prague and the Central Bohemian Region. This region also has a high share of BERD in GDP and is well-known for its research and innovation performance. However, companies settled in this region do not use the indirect support so much. Its dependence on public aid is comparable to the Central Bohemian Region (Fig. 3), but the direct support is of greater importance. The indirect support is used for financing of smaller projects. Usage of indirect support in the South Moravian Region is similar to the situation in regions with significantly lower research and innovation performance (e.g. the South Bohemian, Usti, Olomouc, or Liberec Regions, see Fig. 1).

The cluster analysis identified a group of regions with quite a high level of indirect support usage. These regions have been classified into the 3rd cluster and they are represented by the Pilsen, Liberec, Vysocina, Pardubice, and Zlin Regions. It seems that these regions are not the innovation leaders but they have a strong industrial base. These regions have good preconditions for future exploitation of indirect support.

The presented research proved that some regions have quite a low level of research and innovation activity and they do not use the offered public aid for research projects at the same time (particularly the South Bohemian Region). The results of the study can be applied in adjustment and better targeting of innovation policy. Further research should focus on explaining why some regions do not use the indirect support sufficiently. It is possible to expect that importance of indirect support for R&D will grow as the direct support financed from the European Structural and Investment Funds will decline.

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