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THE ROLE OF BUSINESS ENVIRONMENT IN THE GROWTH AND DEVELOPMENT OF CZECHIA

Vojtěch Tamáš [1], Radka Redlichová [1], Adam Janošec [2], Ludmila Floková [1], Nikola Sedlmajerová [3]

[1] Mendel University in Brno, Faculty of Regional Development and International Studies
Zemědělská 1, 613 00 Brno: Czechia
vojtech.tamas@mendelu.cz ● radka.redlichova@mendelu.cz ● ludmila.flokova@mendelu.cz
[2] Mendel University in Brno, Faculty of Business and Economics
Zemědělská 1, 613 00 Brno: Czechia
adam.janosec@mendelu.cz
[3] PPG Industries
Holandská 873, 639 00 Brno: Czechia

Abstract. The purpose of the article is to identify the impact of different types of companies on regional economic performance. It highlights the significant influence of GDP per capita from newly established companies. The study stresses supporting newly established companies, those investing in R&D, and paying higher average monthly wages to foster economic development. The research provides insights for targeted business environment support, aiding regional growth and decision-making.

Keywords: regional development, business environment, factors of regional development, economic performance of regions.

Introduction

To what extent are the companies located in the region important to its development? For what aspects and to what extent? A lot of authors deal with the impact of small and medium companies or start-ups. Above all Dobrovič (2015) could be mentioned, Blažková and Chmelíková (2016), Erdin and Ozkaya (2020), Stelea and Calefariu (2022) and many others. Smith (2010) believes that companies and entrepreneurialism are important factors in regional development independent of other factors.

Generally, its impact is crucial to generating values (supply) and employment. Therefore, the salaries of the inhabitants lead to the creation of the demand potential. The impact on the environment and the landscape is essential. However, are all companies of the same importance? Do all of them have the same effect on all aspects of development? What kinds of company should we encourage to be located in the region to support economic development? What size, what branch, what age? When developing this research, all of these questions aim to contribute to policy makers' decision making and strategies for promoting local development.

Reaching a balanced development of all regions is a key issue for the well-being of the whole country. The equal quality of life of all citizens ensures stability and potential for the future de-

velopment of the economic, social, and environmental situation. Capello and Nijkamp (2009) state that, as economic development typically exhibits a significant degree of spatial variability, the vital role of regional policy is to aim at balanced development using an efficient set of supporting tools. These tools could in the short run operate with some exogenous aid; however, in the long run it should be replaced by the endogenous solution (see, e.g., Chmelíková and Redlichová, 2020).

According to La Porta et al. (1998) or Demirgüç-Kunt and Maksimovic (1999), choosing and reaching the appropriate structure of companies regarding size, branch, and profitability substantially involve all the issues of regional development. On the other hand, the regional environment determines or at least influences the company's situation in terms of the availability of convenient staff skills, personal costs, supplier relations or demand potential. Differences in the geographical areas within which companies operate, or rather in their institutional environments, can cause variations in the financial structure of companies, since the conditions of access to external finance are different. Research by Chmelíková et al. (2014) on the effect of companies' locations on development found that there is an effect on social and environmental pillars. However, the economic one is not involved because of the tax distribution system.

The development of all Czech regions is a crucial prerequisite for increasing the quality of life of the inhabitants. Scholars have done extensive research on economic growth and development. In addition to being an indicator of economic performance, economic growth is also a measure of the level of welfare of a country. However, Siahaan et al. (2020) argue that a country's economic growth is not always followed by the law and an equal distribution of people's welfare. Todaro and Smith (2011) emphasise that economic development has traditionally meant achieving sustained growth rates of income per capita. The levels and growth rates of the 'real' gross national income per capita (GNI) are then used to measure the overall economic well-being of a population. Indeed, the emphasis is often on increased output, measured GDP. In particular, it is an attempt to answer questions about the level of development of the country as a whole of individual regions and the importance of 'life quality' indicators in the country. From this perspective, answers are sought in economics, statistics, and politics. However, quality-of-life indicators may not always have a clear meaning and, more obviously, concern their role in the region's development.

Stimson et al. (2006) state that regional economic performance is connected to regional policy in which the allocation or reallocation of resources could enhance industries' economic performance. As the key requirement for regional development is its sustainability and evenness throughout the country, governmental expenditure is, according to Siahaan et al. (2020), a significant component of a regional policy. According to the devolution hypothesis (Oates, 1999), a delegation of power and fiscal transfers will translate into accountability, transparency, and output growth at the lower-tier level of government.

Blakely (2017) states that an integral part of the region's economic development is the development of companies that can achieve a growing position and expand in the globalised world. Therefore, the development of companies (or specific sectors) is gradually becoming a driving force for the development of the country's regions. Moreover, the study of Mokiy et al. (2020) shows that the significant impact on the development of the whole region has a construction sector, as a multiplier effect occurs in the case of efficient use of the potential of construction companies in the region.

According to Kruszelnicki et al. (2020), since SMEs form the most active and prominent group of economic actors in the EU, any improvement in their innovation performance would have significant consequences for the whole European research and innovation (R&I) landscape. Foray (2004)

states that the innovation of a company is determined by its ability to accumulate and use new knowledge through learning or other available knowledge channels.

Small companies and their role also significantly affect the economic growth of Czechia (Blažková & Chmelíková, 2016). Similarly, Lawless (2014) identified small forms as the driving force for job creation.

Therefore, the article aims to identify what types of companies have the most significant impact on GDP per capita of the region and, in this respect, should be encouraged to be in the region to support its economic growth.

In this research aim, we have decomposed two research questions that we have formulated as follows.

1) How is the region's growth affected by the number of newly formed companies and companies that ended their business?
2) What characteristics related to the companies located in the region are crucial to the growth of the region?

At the beginning of the research, we assumed that small and medium companies or newly merged companies had a crucial impact on GDP per capita.

Methods and Data

We have focused on the NUTS 3 regions of Czechia to test the relationship between economic performance measured by GDP per capita and control for the various characteristics of the companies described in Figure 2. In our study, the analysis was conducted during the period 2013–2019. This period was chosen for two facts. Firstly, our intention was to analyse the period that covered the cohesion policy in Czechia in 2014–2020. EU programming periods are time periods during which EU financial programmes and funds, including structural and investment funds, are budgeted and implemented to support the economic development of regions. Second, to meet the objective of this study, statistical calculations and analyses were performed in the year 2023, however, the data for 2020 and later were not publicly available for some of our selected indicators. To ensure data consistency, the period was tracked until 2019 and the year 2013 has been added to maintain the 7-year time series.

The first challenge we have faced has been to identify the appropriate characteristics. To solve this, we pay attention to the variables already used in the most up-to-date research, keeping in mind the availability of data. Based on these assumptions, we have identified 17 variables that could affect GDP per capita.

The next step is to mitigate the mutually correlated variables. This issue has been solved by the correlation matrix presented in the Sample section. Finally, 11 variables have been used to prepare the regression model (see Fig. 2). These variables were available in seven-year time series from 2013 to 2019 for all 14 NUTS 3 regions in Czechia. Hence, the data set entering the model contained 98 complete records, covering both the time and spatial dimensions.

The regression model was constructed using the Random Forest (RF) algorithm. It is a machine learning method based on creating an ensemble (a forest) of decision trees as introduced by Ho (1995). The predicted value is calculated as the mean predicted value of the individual trees. For each tree, a given number of predictor variables are randomly selected following the principle of bagging, i.e., bootstrap aggregation (Breiman, 1996, 2001). Variables not included in the tree construction (unseen data) can be used for model error estimation. This diagnostic is called the OOB

error (out-of-bag error) and enables model error estimation even without splitting the dataset for training and testing subsets.

The model was trained using 100 trees. The Root mean squared error (RMSE) and coefficient of determination (R2) derived from OOB error diagnostics were used for model accuracy evaluation. Both of these metrics are useful for evaluating model performance. RMSE explains the model predictive ability in absolute terms, the lower it is, the better. R2 shows how well the model can explain the variability of a dependent variable in a given data set. The RMSE of the model used in this study was 0.089 and R2 reached 90.07; that means the model can explain more than 90% of the variability of the dependent variable.

Although RF is a robust technique that does not tend to overfit, further tests were performed. Overfitting occurs when a model learns the details in the training data, including noise and outliers, but is unable to generalize the rules to give good results with a new data. Such a model performs very well with the training dataset but very poorly with the testing dataset not involved in the training process. A validation was carried out using independent training and testing datasets leaving 20% of records to be used as testing data sets. The difference between OOB error and validation using separate testing and training datasets is that not only trees constructed with unseen data (see above), but the entire forest could be used. The selection of the testing data set is random, and each run can produce different validation diagnostics; therefore, the validation process was run iteratively 30 times and the mean values were compared (Table 1 and Fig. 1). The performance of the model for training and testing datasets did not differ much. These results also corresponded well to OOB error diagnostics.

Table 1. Model performance using training and testing subsets

	R2	p-value	RMSE
Training	0.98	0.00	0.04
Testing (30 runs mean value)	0.96	0.00	0.06

Source: authors.

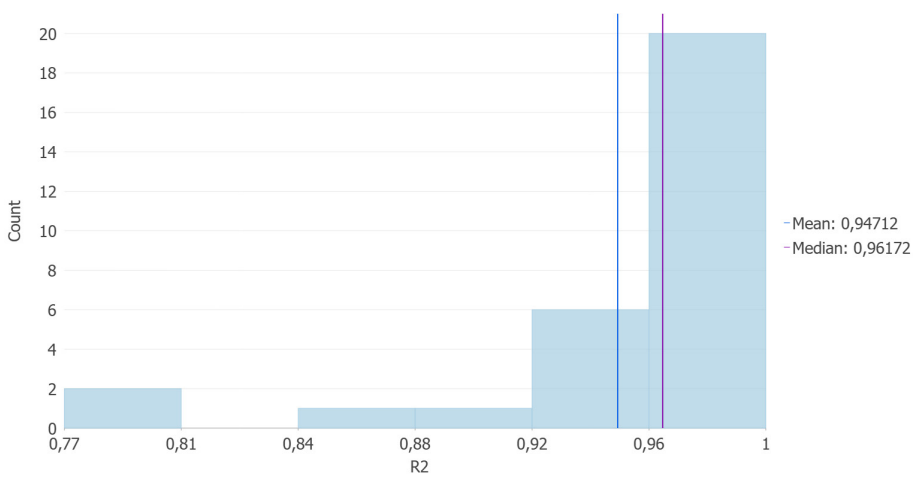

Figure 1. Distribution of R-squared (R2) during 30 runs of the model with the validation data set
Source: authors.

Based on the validation results, the model was considered reliable. Modelling was processed in ArcGIS Pro 3.0.2 environment to capture both time and spatial dimension.

The model accuracy was examined using a residual analysis. For this purpose, standardized residuals expressing the strength of the difference between reference and predicted values were calculated according to equation 1.

$$\text{standardized residual} = \text{reference value} - \text{predicted} \frac{\text{value}}{\sqrt{\text{predicted value}}}$$

The distribution of standardized residuals is shown in Appendix 1. It shows normal distribution with mean value 0 and median value -0.03. Five values outside the range of <-2; 2> are considered outliers. More details about time and space distribution of standardized residuals are explained in the Results.

The construction of the model assumes that not all businesses in a region have the same impact on its economic performance. Businesses with certain characteristics are more likely to influence GDP growth, such as the industry of the company, the size of the enterprise, the number of employees, the structure of expenditure, or the average wage paid to its employees. 17 indicators were selected through this lens. However, some of them were later found to be highly correlated, and therefore the final number was finally 11, which is shown in Figure 2.

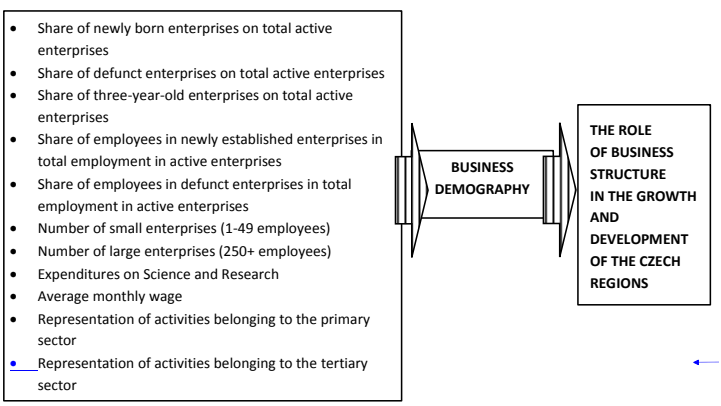

Figure 2. Variables analysed to determine the role of the company structure in regional development
Source: authors.

The dependent variable is GDP per capita. At the regional level, the differences in GDP values show the development of the region.

As we keep in mind the development process, we have proposed the set of explanatory variables changes, which could correspond to the GDP per capita change. The first variable is the share of newly established companies (share_N). A newly built company is considered to have started its activity in the year *t* but was not active in the year 't-1' (Yarkova et al., 2017). Blažková and Chmelíková (2016) noted that the establishment of new companies in Czechia is crucial not only for value creation, but also in terms of creating new jobs, which confirms the previous result of Fritsch and Mueller (2004). Another explanatory variable is the share of defunct companies (share_D). Yarkova et al. (2017) defined defunct enterprises as being active in the year *t* and no longer in the year *t + 1*. The unit's demise may appear in the following year: an increase in unemployed persons, a lack of job positions, or a failure of a product or service that another company further processes.

The explanatory variable is also the share of three-year-old companies in the total number of companies in Czechia (share_3). These variables monitor enterprises that have overcome the initial phase, the so-called start-up, and have survived for at least three years. Lawless (2014) distinguishes between companies that have survived up to five years and companies that have survived for more than twenty years. Blažková and Chmelíková (2016) found that only 30% of the companies in 2007 remained on the market for six years since their establishment. The company, which has been operating for three years and more, has built a larger so-called supplier-customer network within which it operates. López-Garcia and Puente (2006) noted that about 90% of enterprises entering the market survive more than 2 years. Up to 70% can last on the market for up to eight years. In Czechia, in 2017, 82% of companies survived one year, almost 65% of companies survived three years, and 45% of units survived five years (Eurostat, 2020).

The share of employees in newly established companies (share_EN) participate in the operation of enterprises that have been newly established in each territorial unit and thus begin to participate in GDP creation. Blažková and Chmelíková (2016) point to the fact that newly created companies are the biggest creators of new job positions. The faster the dynamics of new companies' creation, the more progressive growth of GDP could be assumed. Another variable is the share of employment in defunct companies (share_ED). In more than 90% of enterprises, which disappear, according to Schrör (2009), work a maximum of four employees. In Czechia, enterprises with four or no employees at their death make up 88.6%. Although smaller companies are considered to be more innovative and flexible, lack of economy of scale could be a disadvantage to competitiveness, especially at the beginning of running a business.

Small companies are a driving force for development, which is why the variable number of small companies in Czechia (small) is included. Lawless (2014) points to the fact that smaller companies do make a significant contribution to job creation and the company's age. By listing this indicator, we would like to recon the influence of small companies whose contribution to the employee may not be so high. However, their number (share of the total number of companies) continues to be influential. According to the Czech Statistical Office (2013), small and medium companies are important employers and more than half of them participate in production or power consumption in the corporate sector. Therefore, they are moving towards a positive trend towards activities with higher added value as an indicator of economic maturity. In 2003 and 2010, small and medium companies in the Czech economy generated up to a third of the nominal GDP, about 36.5% of the total gross value added. Redlichová et al. (2019) regard small companies to be the economic stabilisers and performance drivers, as regions with higher share of small companies are less sensitive to unemployment rate changes and have higher GDP growth rate.

López-Garcia and Puente (2006) stress the importance of enterprise size in connection with newly established enterprises and the survival of enterprises into the future. Large, newly established companies will survive for more years than small companies. Geroski et al. (2007) also add that the current size should be considered, indicating the company's performance and ability to stay in the market. For these reasons, the variable number of large companies in Czechia (NLC) is included in the model.

If an enterprise invests in research that would help improve existing technology, it can achieve a better market position, better profitability (profit), and a higher contribution to the GDP of a country. Scholars have observed the positive impact of technology investment on the factors productivity of companies (Novotná et al., 2011), and we have considered variable expenditures on science, research, and development (RD).

It can be assumed that the higher the average monthly wage (wage), the more employees will be willing and motivated to work, so the contribution to the value creation and GDP could be higher. For this variable, it is possible that the influence of the wage change on GDP could be delayed, so we use the previous year variable ($t - 1$).

The primary sector currently contributes little to the total economic value of Czechia. However, it is a prerequisite for the follow-up sectors. Loizou et al. (2019) emphasized the potential of the primary sector, specifically agriculture, in the development of the regional economy, in connection with estimated regional multipliers (employment and output), as well as the output and employment elasticities for the local economy. According to Pečarić et al. (2021), a significant factor that influences both the primary and secondary sectors is the impact of foreign direct investment (FDI). In the short term, FDI inflows do not contribute to technological advancement or increase productivity and competitiveness in the typically labour-intensive primary and secondary sectors. De Vita et al. (2021) emphasize that FDI inflows negatively affect the primary and secondary sectors, whereas they positively influence the tertiary and quaternary sectors, thereby promoting regional GDP growth. Therefore, the representation of activities belonging to the primary sector (prime) is included in the model.

Boldureanu (2015) points to the secondary sector (specifically, the commercial and manufacturing industries) as the fastest growing area in Romania until 2011. In Czechia, industry and construction account for 38% of newly established companies (Eurostat, 2020). Therefore, the representation of activities belonging to the secondary sector (second) could be an essential factor in the creation of GDP.

The list summarising the 11 independent variables and their relationship to the dependent variable can be seen in Table 2.

Table 2. Summary of the Sustained Impact of Variables on GDP

Variable	Impact on GDP
Share of newly born enterprises in total active enterprises	+
Share of defunct enterprises in total active enterprises	-
Share of three-year-old enterprises in total active enterprises	+
Share of employees in newly established enterprises in total employment in active enterprises	+
Share of employees in defunct enterprises in total employment in active enterprises	-
Number of small enterprises (1-49 employees)	+
Number of large enterprises (250+ employees)	+
Expenditures on Research and Development	+
Average monthly wage	+
Representation of activities belonging to the primary sector	-
Representation of activities belonging to the secondary sector	+

Source: authors.

Data for these variables were obtained from publicly available databases of Eurostat (Business Demography Statistics) and the Czech Statistical Office. All NUTS 3 regions of Czechia were included, i.e., 14 regions. The time series covered 7 years (2013–2019). In total, there were 98 surveys for each variable. The specific values of the variables were subjected to a correlation test. For each pair of values, a correlation value of less than 0.8 (or greater than -0.8) was required.

Table 3. Descriptive statistics

Variable	Unit	N	Mean	StDev	Min	Max	Kurtosis	Skewness	Confidence level
GDP	EUR	98	15 916.08	7 411.47	11 311.92	50 093.21	9.09	3.07	1 485.90
share new	%	98	0.01	0.01	0.01	0.03	0.81	1.01	0.00
share dead	%	98	0.01	0.01	0.01	0.05	8.88	2.35	0.00
share three	%	98	0.01	0.00	0.00	0.02	1.68	1.38	0.00
share_ emp_new	%	98	1.36	0.34	0.85	2.45	1.00	1.03	0.07
share_ emp_dead	%	98	1.26	0.57	0.85	4.33	7.25	2.36	0.11
RD	mil. of CZK	98	122.85	347.61	4.67	1 630.68	4.72	2.27	69.69
small	number	98	13 484.50	33 301.49	5 996.00	138 003.20	4.89	2.44	6 676.53
large	number	98	113.00	157.23	35.00	734.00	6.71	2.68	31.52
wage	CZK	98	27 306.00	4 063.56	22 333.00	43 062.00	1.83	1.25	814.69
primar	number	98	10.74	5.17	0.61	20.20	-0.93	-0.11	1.04
second	number	98	125.83	46.11	54.02	233.4	-0.11	0.67	9.2

Note: The average exchange rate of CZK/EUR for the year 2023 was 24 CZK/EUR (Czech National Bank, 2024).
Source: authors.

Table 4. Correlation matrix of variables entering the model

	share_N	share_D	share_ three	share_ EM	share_ ED	small	large	RD	wage	prim	second
share_N	**1**										
share_D	0.6521	**1**									
share_three	0.5364	0.4790	**1**								
share_EM	0.5990	0.4196	0.0592	**1**							
share_ED	0.2187	0.7941	0.1007	0.4196	1						
small	0.4720	0.3244	0.6558	0.1878	0.0355	1					
large	0.2812	0.1891	0.3702	0.2951	0.1030	0.7214	1				
RD	0.4790	0.3539	0.6083	0.2344	0.0789	0.7256	0.5700	1			
wage (t-1)	0.3076	0.0839	0.4857	-0.0144	-0.2525	0.7456	0.3813	0.7289	1		
prim	0.0533	0.0179	-0.0097	-0.1243	-0.1012	-0.1443	0.1471	-0.2681	-0.2072	1	
second	0.4247	0.2734	0.4345	0.1398	-0.0557	0.3532	0.5661	0.2607	0.1668	0.5867	1

Source: authors based on data Czech Statistical Office (2020) and Eurostat (2020).

Results and Discussion

The analysis of residuals conducted over time series (Fig. 3) and over spatial units (Fig. 4) showed that variability occurs to a greater extent in the spatial aspect. The level of variability in the time series 2013–2019 does not show significant.

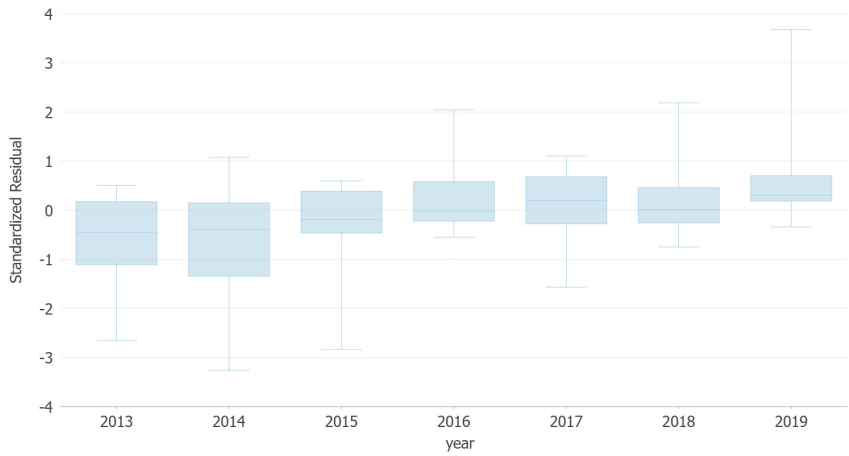

Figure 3. Residual analysis – time series
Source: authors based on data Czech Statistical Office (2020) and Eurostat (2020).

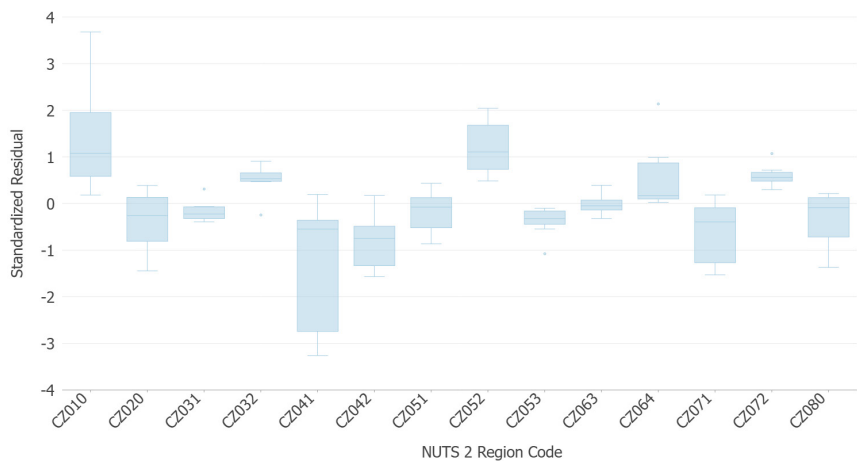

Figure 4. Residual analysis – spatial units
Note: CZ010: Prague, CZ020: Central Bohemia, CZ031: South Bohemia, CZ032: Plzeň Region, CZ041: Karlovy Vary Region, CZ042: Ústí nad Labem Region, CZ051: Liberec Region, CZ052: Hradec Králové Region, CZ053: Pardubice Region, CZ063: Vysočina Region, CZ064: South Moravia, CZ071: Olomouc Region, CZ072: Zlín Region, CZ080: Moravia-Silesia.
Source: authors (2024) based on data Czech Statistical Office (2020) and Eurostat (2020).

In contrast, in the case of regions, a greater variance can be seen for Prague (CZ010) and the Karlovy Vary region (CZ041). Prague, as a region consisting of one (capital and largest) city, has by its very nature specific development relations and links. It is the most developed region with a high concentration of population and firms, high GDP, wages, and significant agglomeration effects, both positive and negative. Therefore, the findings confirm this situation.

The second region that showed a higher level of residual dispersion is the Karlovy Vary region. It is the third smallest region in Czechia (after the Prague and Liberec Region). The region has a high age index (more than 144) and the lowest average wage and GDP per capita of all regions in

Czechia. Therefore, it is a region at the other end of the development spectrum of Prague, the least developed region. It is classified as one of the three structurally damaged regions in the 21+ Regional Development Strategy of Czechia. A Fair Transformation Fund has been established for these regions, which will focus on restructuring these three regions through a separate operational programme.

Both the inclusion and the exclusion of the above-mentioned regions with high residual variances yielded very similar levels of explanatory power of the dependent variable (GDP) by the independent variables.

One of the outputs provided by the RF based regression model is evaluation of variable importance (VI). VI metrics are calculated for each variable during each run of the model based on the reduction in sum of squared errors (out-of-bag, OOB errors) whenever a variable is chosen to split the tree. The variables and their importance are shown in Table 5. Four variables were identified to have the most significant impact on the modelling process (highlighted in bold in Table 5). However, RF works as a black box and the correlation between individual variables and dependent variable (GDP) is unknown. Here, further expertise is required to give a deeper insight and a correct interpretation of the model output.

Table 5. Importance of variables and variables (VI) for the model

Variable	VI
Number of large enterprises (250+ employees)	25%
Expenditures on Science and Research	19%
Average monthly wage	19%
Representation of activities belonging to the primary sector	18%
Number of small enterprises (1-49 employees)	7%
Share of employees in defunct enterprises in total employment in active enterprises	3%
Share of newly born enterprises in total active enterprises	3%
Representation of activities belonging to the tertiary sector	3%
Share of three-year-old enterprises in total active enterprises	3%
Share of employees in newly established enterprises in total employment in active enterprises	1%
Share of defunct enterprises in total active enterprises	1%

Source: authors.

Based on these results, answers to the research questions can be formulated.

1) How is the region's growth affected by the number of newly formed companies and companies that ended their business?

The share of new enterprises, defunct enterprises, as well as the number of their employees is not shown to be a significant factor having a decisive relationship with the level of GDP. On their basis, GDP can be estimated at a maximum of 1-3%.

2) What characteristics related to the companies located in the region are crucial to the growth of the region?

The most important factor on the basis of which the proposed model is able to estimate the GDP from 25% is the level of wages of the previous year. The higher the wages, the higher the GDP will be achieved. The same direction of influence is also exerted by the number of large enterprises and research and development expenditure, which can be used to estimate GDP from 19%. On the contrary, for the primary sector, the higher its share, the higher the GVA. The explanatory level of this variable is 18%.

Based on our results, the **average monthly wage** has a relationship with regional GDP. However, in this context, Sabia (2015) argues that wages must be established efficiently and that wage increases can lead to negative effects on regional performance, as they reduce the employment of less skilled people in some sectors in times of macroeconomic recession, which does not contribute to regional GDP. Liu et al. (2023) also point to the fact that higher wages reduce the number of firms in the region, especially for (low-skilled) labour-intensive industries.

Lawless (2014) argues that the link between age and business size is crucial and that small businesses create the largest share of jobs in the region. Matoušková's research (2000) reveals that the presence of companies in the region is perceived as a great advantage for the region, but the least advantageous are the branches of large companies, which are characterised by low demands on skilled labour. Lehene and Nistor (2023) demonstrated the link between the degree of cooperation between large and medium companies and the performance of a region through research carried out in the Romanian environment. In the model presented by us, **large companies** emerge as a factor that positively influences the economic level of the region. Ciani et al. (2020) state that large companies usually have greater financial resources to invest in research and development of new technologies; they also create new job positions contributing to a reduction in the region's unemployment rate, an increase in the disposable income of the population, and an increase in GDP.

Our research found a relationship between **R&D expenditure** and GDP. Özmen et al. (2016) examined this relationship in 28 countries and found that increased R&D expenditure of enterprises led to higher GDP growth rates in these countries. At the same time, the authors add, the consequence of this process is also the technological progress of the countries, which makes them more competitive in a global space. Sokolov et al. (2016) believe that an increase in R&D expenditure as a percentage of GDP by 1% would cause an increase in the real GDP growth rate by 2.2%. An extensive analysis of the relationship between R&D expenditures and economic growth was carried out by Shahid et al. (2024). On the basis of this analysis, they confirmed the strong impact of these expenditures on economic levels. Derbentsev et al. (2021) emphasise the interplay between R&D expenditure and GDP, where higher values of GDP can influence R&D expenditure and vice versa.

Based on our results, **the representation of activities in the primary sector** plays one of the crucial roles in the regional development of the GDP. In the investigation of Chilean regions, Mardones and Silva (2021) assert that the agricultural-forestry, mining, and manufacturing sectors exhibit the highest average output multipliers between regions. However, these output multipliers show significant heterogeneity between individual regions. This implies that the indirect efficacy of public and private investments will vary depending on the multiplier effect specific to each region. However, economic theory explains that the high significance of the primary and secondary sectors lies particularly in their productivity, which influences the efficiency of subsequent sectors in the tertiary and quaternary sectors. As a subsequent result, the increase in the number of businesses in the tertiary and quaternary sectors significantly contributes to the growth of regional GDP. Understanding these relationships is fundamental for optimal economic planning and regional policy formulation.

Trusina and Jermolajeva (2024) affirm that in accordance with the principles articulated by Kaldor (2007) and Baumol (1967), the diminishing economic vigour of developed nations is ascribed to the alterations in the sectoral makeup of contemporary capitalism, largely stemming from the absence of a sturdy industrial foundation. Kaldor (2007) posits that manufacturing not only possesses intrinsic qualities that propel economic advancement, but also functions as a pivotal 'growth catalyst,' disseminating productivity enhancements to the broader economy, thereby elevating aggregate productivity and GDP expansion. Manufacturing exhibits the capacity to

yield significant spillover effects to other economic domains, catalysing growth in diverse sectors and fostering technological ingenuity. Kaldor (2007) highlighted a strong link in his research between quality of life and the allocation of resources towards production undertakings. Kaldor's Laws of Growth (Thirlwall, 2003) delineate a trio of laws elucidating the determinants of economic progress: 1. GDP growth is positively correlated with the expansion of the manufacturing sector. 2. Productivity levels in the manufacturing sector are directly proportional to the growth in the scale of the manufacturing sector. 3. The productivity of non-manufacturing sectors is positively influenced by the growth of the manufacturing sector. Hence, structural transformations exert a tangible influence on real GDP (Baumol, 1967).

The trained model was used to estimate changes in GDP according to the development of the region. A 20% increase in values compared to 2019 for the number of large enterprises, expenditures on research and development, and average monthly wage resulted in a 1% increase in GDP on average (see Appendix 2)

Conclusions

To estimate the impact of selected variables on GDP (i.e. regional growth), a regression model with machine learning elements 'Random Forest' was used. The model was applied in multiple runs and with different variations of the involvement of each region. The results were very similar. Four explanatory main factors were always identified, namely: last year's wage, R&D expenditure, number of large enterprises, and representation of primary activities.

The contribution of the research is expanding the range of factors affecting the region's GDP; an example is the indicator "expenditure on research and science". It is possible to answer the research questions based on the results achieved:

1) How is the region's growth affected by the number of newly formed companies and companies that ended their business?

   Newly arising companies have not been confirmed to have a significant impact on GDP.

2) What characteristics related to the locations of the companies are crucial to the growth of the region?

   The number of large companies, the expenditures on research and development, the level of wage of the previous year, and the representation of the activities of the primary sector have a significant impact on creating GDP per capita.

The size of companies matters in the case of large companies that are positively connected to the economic level of the region.

R&D spending is a key factor in the region's growth. These expenses are also an advantage for companies, while better technology improves quality, retains potential customers, and thus improves market position.

The average monthly wage of the previous year has been shown to be a necessary characteristic that can be connected to the regional growth. It is possible to assume that the higher the average monthly wage, the more employees will be willing and motivated to work, and thus the contribution to the value creation and GDP could be higher. On the side of demand, the higher wage creates higher ability of consumption.

However, the presence of the primary sector has been confirmed as an important factor, in the negative way.

Based on the results, it is advantageous for the economy to support newly established companies, companies willing to invest in R&D and willing to set higher average monthly wage. This conclusion corresponds, in principle, to the theory of growth poles.

The results show what support of the business environment is appropriate to focus on in terms of growth and development. The results can also be used by newly established companies, which can focus on quality and research.

Future research could produce more detailed information related to the business environment. Finding out about predicting future developments or extending the timeline could be beneficial, as well as the specification of variant variables. Research can also focus on other regions, and the methodology can be applied to regional development decision making.

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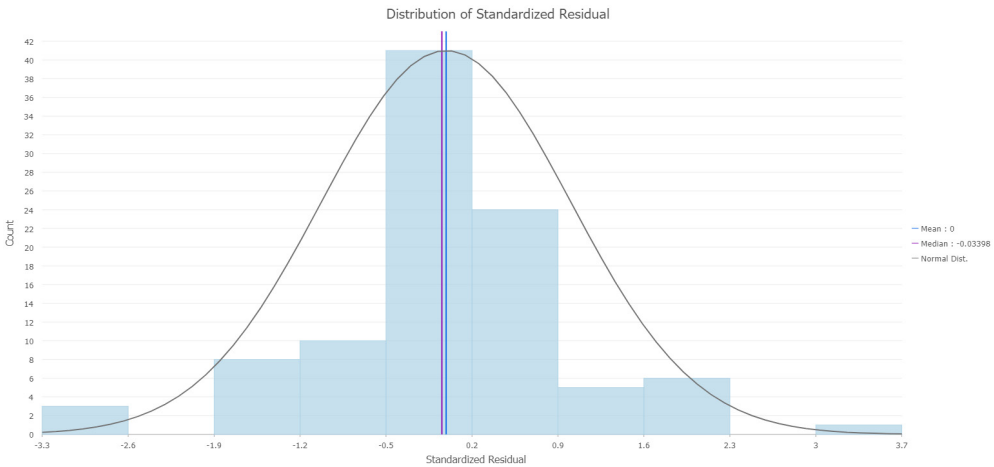
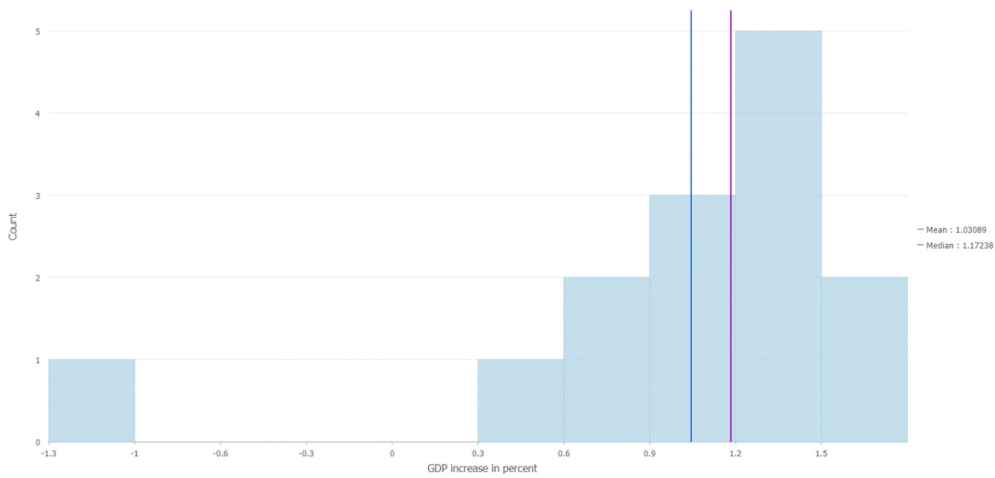
Appendix 1. Distribution of standardized residuals



Source: authors.

Appendix 2. Model-based expected GDP increase



Source: authors.