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Article

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Asymmetry effects of government expenditure on education and impacts on economic growth

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Abstract

The aim of this contribution is to evaluate the efficiency of the Czech educational system. If we take into account the fact that investments are made in consideration of future returns, then it holds true that investments in the form of public finances invested in the education system are implemented with an eye to future returns, in particular in terms of future growth in economic performance. Based on the time series of the development of government expenditure on education, and with regard to the differentiation of this sector into primary, secondary, and tertiary education, this article evaluates the relationship of the government expenditures to the development of the gross domestic product for the Czech Republic in the period 1992-2015. A regression analysis method is used, modified by the ARIMA model and the time lags assumed for the relationship of these two variables.

A relationship between growth in government expenditure on secondary education and subsequent growth in GDP has been demonstrated. According to the results, a time lag of 6 years can be expected between these occurrences.

JEL classification: C12, D61, E62, H41, H52

Keywords: Czech Republic, Economic growth, Education, Government expenditures, Human capital

1. Introduction

Education is key to the development of the individual and society as a whole. Thus, investment in education is one of the most important for the development of both human capital and the development of society as a whole. The return on such an investment is not immediate, but often long-term, sometimes more than 10 years. The current state of the issue focuses more on the question of fiscal policy aimed at short-term expansionary goals, but does not specifically address the question of return on investment in education. Although models focusing on the relationship between output (economic growth) and, for example, technological progress have been defined in the past, studies directly addressing the impact of increasing human capital through investment in education on economic growth are lacking. Therefore, the present study aimed to investigate the relationship between investment in education on the changes in

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the value of gross domestic product as an indicator of economic performance. On the basis of the proven relationship between the effectiveness of these investments (i.e. the fact that investments in education lead to GDP growth over time), it is then possible to recommend in particular fiscal measures leading to further investments in education, development, innovation and expansion of the range of study opportunities in the Czech Republic, as the returns on such investments are proven in the long run.

2. Literature review

Over the past decades, human capital has increasingly gained the attention of the professional economic world. The basic principle of capital is the fact that it is a production factor that is itself produced. Human capital is an accumulation of investments in the labour force. Education is the most important type of human capital. Like all forms of capital, even education represents a release of resources at some point in time in order to increase future productivity. However, unlike investments in other types of capital, investments in education are connected with a particular person, and it is this connection that makes human capital what it is (Avilova, 2017; Holden and Biddle, 2017).

On average, labor with higher human capital earn more than those who have less human capital. University graduates in developed market economies receive up to 2/3 more pay than those who only have secondary education, which is presented in his classic work "Human Capital" by Becker (1997) and followed by others (Strawinsky et al., 2019; Marek and Doucek, 2016). This considerable difference has been documented in a number of countries around the world, and it is usually even more pronounced in less developed countries where there are few educated labor (Anyzová, 2017; Yang and Gao, 2018). From the perspective of supply and demand, it is clear why education is associated with higher wages. The companies on the demand side are willing to pay more to highly educated labor, because educated employees create a higher marginal product. On the other hand, labor on the supply side is willing to pay for education costs only if such an investment is efficient for them. The difference between the salary of an employee with higher education and that of a less educated employee is basically a compensatory difference covering the cost of education.

A number of studies show that the gap between the earnings of skilled and less skilled labor has increased over the last two decades. In explaining this trend, economists are inclined towards two hypotheses. Both point to the fact that there has been a relative increase in the demand for skilled labour over time compared to the demand for unskilled labour. This change in demand triggered a corresponding change in wages, reflected in an increase in income inequality (Gross, 2012; Budria and Telhado-Pereira, 2011). According to the first hypothesis, international trade led to a relative change in the demand for skilled and unskilled labour. With increases in international trade, the domestic demand for skilled labour grows and the domestic demand for unskilled labour falls. According to the second hypothesis, the relative change in the demand for skilled labour compared to unskilled labour occurred due to technological changes. A quantitative validation of these hypotheses is difficult. It is, of course, possible that both are correct: increasing international trade and technological changes can work in conjunction to increase the inequality observed in recent decades.

It is clear from the nature of education that its effects interfere with all areas of the development of social life, i.e. also with the economic sphere. In the economic sphere, it is mainly manifested as one of the main factors in economic growth (Šrédl, 2006). The theories of growth have not been able adequately to explain and describe the causes of and reasons for economic growth, and it was thus necessary to include and endogenise the human capital factor in standard models, as defined by, for example, Ramsey (1928) or Solow (1956), who no longer posit the elementary theory of economic growth based on the invisible hand of the market. One of the important theories is in an article written by the prominent economist Becker (1962). In it, he deals with the development of theories of investment in human capital based on empirical findings and the theoretical knowledge of the time. He generally quantifies the returns to education as follows:

$$Y = X + r * C \tag{1}$$

where C is the value of the total investment costs, letter r represents the average rate of return, and letter X represents the earnings if no capital investment is made. Human capital thus has a certain natural level of value.

People, their work, productivity, and human capital are the most important drivers of the economy. It is precisely human capital that is lately becoming the greatest wealth of every individual. Investments in human capital are thus becoming the most needed investments for the future. *„Human capital is identified as one of the main determinants of economic growth and plays an important role in the technological progress of countries"* (Queirós, 2014).

This paper will focus on human capital and investments in human capital. Human capital can be defined as "the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being" (OECD, 2007). Through education, each individual thus increases their position, competencies and productivity, which ensures a greater reward for their work. For society, the benefit of a well-educated and productive workforce is greater economic growth than would be the case without this advantage. It is, therefore, a positive externality that effects both the individual and the entire economy.

Education is one of the areas that fall under non-market services and is therefore not determined by standard supply and demand interactions. Market-based forms of education include those that are shaped by the market, and they comprise other types of education, such as driving schools or language schools. However, this paper will deal with dominant, non-market education. This is also a public good, with the characteristics of such. As Musil (2015) states, in such a case, it is necessary to distinguish the different stages of the whole process of genesis and development. These stages are Inputs, Activity, Output and Outcome. This paper is primarily focused on the area of Inputs and Outcome. The activity variable is assumed to be constant, because no major education reform has taken place in the Czech Republic during the monitored period, and we also consider output to be constant.

Moreover, as Barro (2000) demonstrates in his article, based on a thorough correlation made in a sample of OECD countries, there is no direct and conclusive relationship between the skills, or knowledge, of students tested in science, mathematics, and reading and educational attainment, which is quantified as the average number of school years completed. On the other hand, as the author himself states, "the effect of school quality is quantitatively much more important" (Barro, 2001). The negative impact of rising public spending on economic growth is generally confirmed by many studies, such as those by Chen (2005) and Afonso (2010). Based on modified regression, which works with panel data from OECD countries, Zimčík (2016) states that there is a negative relationship between growth in government sector spending and overall economic growth. Nevertheless, he notes that the general reason why increasing government sector spending has such an impact is that the private sector is pushed out. However, this is a minority sector in the case of education and this assumption does not apply here.

A similar model, again based on OECD countries, is used by Queirós (2014). A more highly educated society supports the growth of the economy. Queirós also logically concludes that growth is supported even more if the economy is focused on areas that require educated human capital. Similar research was conducted by, for example, Shukla (2017). It is also necessary to take into account the specification of the given area related to time lags, as is stated by Kazmi (2017). Based on the Johansen cointegration technique, he distinguishes the impacts of human capital on GDP over short and long periods in which investments in human capital have a significantly positive effect. In this context, the question of measuring their efficiency arises as well. An investment, no matter of what type, is made with the goal of future returns. If we invest in a new production hall, or in securities, we know methods for evaluating these investments. It is relatively easy to estimate the future financial flows of such investments and to assess the level of risk. An evaluation of the efficiency of government expenditure on education, i.e. the school system, is the subject of this article. Among other things, such investments indicate the priority given to education by the government.

There are a considerable number of contributions to this issue. However, this paper deals with the last decades and issues, which is based on the example of a country transforming from a developing country to a developed one after a change in the political as well as the economic regime. This is a very unique example, and human capital theory can be considered one of the causes of economic growth, such as Loxley (2014) in his paper on the example of Ireland, where the initial low economic level was caused by the end of World War II.

A current paper on the relationship between education expenditure and economic growth is, for example, from Benos (2014), based on an examination of the empirical literature and meta-regression analysis. Based on this, he confirms the existence of considerable heterogeneity of results in the case of papers that address this, for example, Hanushek denies that extended tertiary education should lead to growth and argues for cognitive skills. As one of the reasons, Benos (2014) states that education differs in countries. Therefore, this paper aims to contribute its analysis of one country to a comprehensive analysis of individual countries, instead of one aggregate analysis of disparate countries.

Other works are mainly focused on the concept of the rate of return on investment in education (Card 2001; Oreopoulos 2006). However, it is an assessment of the costs and benefits of only one component of gross domestic product and is not examined as a whole. However, this can be problematic for a more comprehensive evaluation and partial conclusions need to be compared with general outputs. It tries to offer this paper.

If we distinguish between developed and developing countries, the papers show, for example, Asiedu (2014) in a sample of 38 countries, that in the case of developing countries, the development of primary education has a positive effect on growth, while other levels are not conclusive. The Czech Republic, as a representative of a developed country, should then confirm these studies and thus the impact on product growth should be identified in secondary and tertiary education mainly.Časové zpoždění investice a dopady

This article is further divided into a chapter describing the data used and its source databases. The indicators and abbreviations used will be explained as well. Furthermore, the methodology used in the research part in analysing the time series will be described. In the next chapter, the results are presented step-by-step according to the procedures of the authors. The conclusions are then discussed in the subsequent chapter, followed by a brief summary.

3. Materials and Methods

This paper primarily deals with time series that focus on government expenditure on education. They are further selected according to the individual levels of education - primary, secondary, and tertiary. Furthermore, time series on the development of the annual nominal gross domestic product (GDP) are selected, all in the time horizon from

1992 to 2015 (taking into account the availability of data at the time of the research). These data files are generated from the World Bank database. GDP is also adjusted for the effects of the price level, and real GDP reflecting changes in volume is thus used in the research itself. The year 1992 was chosen as the base year.

To fulfil the objective, hypotheses are proposed that will be the subjects of subsequent testing. The evaluations of the hypotheses will enable the evaluation of the efficiency of government expenditure on the Czech Republic's schooling system.

The hypotheses tested are:

- H01: The real gross domestic product depends on the amount of government expenditure on education
- H02: There is a time lag between growth in government expenditure on education and GDP growth
- H03: With more advanced forms of education, the contribution to GDP growth increases

The H01 hypothesis tests whether government expenditures invested in the school system are reflected in the gross domestic product, i.e. whether there is a correlation between the development of real GDP and government expenditure invested in the school system in the Czech Republic. Government expenditure is expressed for primary, secondary, and tertiary education as the absolute value and as a percentage of real GDP.

The H02 hypothesis tests whether there is a time lag between government expenditure on education and growth in real GDP. A confirmation of this hypothesis would demonstrate that investments in the education system lead to subsequent growth in real GDP within a certain time frame. Government expenditure is expressed for primary, secondary, and tertiary education as the absolute value and as a percentage of real GDP, i.e. without taking inflation into account.

The H03 deals with the assumption that the higher the level of education, the higher the subsequent increase in real GDP should be, or that tertiary education should bring the highest increase. If human capital is equipped with more knowledge, then it is able to utilize even more demanding physical capital with higher productivity and thus also add to product growth.

Table 1 shows the indicators used, including their abbreviations. These indicators are explained below the table.

Table 1

Variable	**Real gross domestic product**	**Government expenditure on primary education**	**Government expenditure on secondary education**	**Government expenditure on tertiary education**
Abbreviation	GDP	GE^P	GE^S	GE^T

The gross domestic product is used at nominal value, i.e. at the current prices of the individual periods, and real, i.e. at constant prices to eliminate the effect of inflation. The calculation of the real gross domestic product is based on the relationship:

$$Deflator = \frac{Nominal\ GDP}{Real\ GDP} \tag{2}$$

$$Real\ GDP = \frac{Nominal\ GDP}{Deflator} \tag{3}$$

The regression and correlation analysis method is used to test the individual hypotheses. The correlation between two variables is determined using regression analysis. The regression analysis seeks to find the so-called regression function, whose aim is to express the nature of the correlation between the two variables examined and to show the course of changes in the conditional averages of dependent variables. Hebak (2007, p. 20) states that its main benefit is the estimation of values (or mean values) of variables that are conditional upon the values of one or more independent variables.

Correlation analyses complement and develop the regression analysis as the second stage of analysis. The correlation analysis expresses the degree of dependence of two or more variables and de facto determines the extent to which the model is real and corresponds to reality. The simple Pearson correlation coefficient, which is also used to test the hypotheses in this article, is used most commonly.

The correlation analysis then develops the analysis and expresses the strength of dependence of two or more numerical variables. It thus determines to what extent the model is real and corresponds to reality. The degree of dependence of two variables is expressed by the Pearson correlation coefficient. As Hendl (2012, p. 253) states, despite some shortcomings, the Pearson correlation coefficient is the most important measure of the strength of the relationship between two random variables. The Pearson correlation coefficient is determined using so-called covariance and standard deviations.

As regards the issue of the influence of time series on mutual development, it is necessary to eliminate this shortcoming. An AutoRegressive Integrated Moving Average (ARIMA) is used to improve the analysis and the interpretation of the subsequent results. This model consists of three parts:

- AR: Auto-regressive model;
- MA: Moving Average model;
- ARIMA: Auto-regressive Integrated Moving Average model.

Wang (2016), for example, also uses it to test economic growth and confirms its suitability for use. Thus, a non-parametric regression model is not used but a structural econometric ARIMA model following Box-Jenkins technique.

Box and Jenkins (1976) united the two autoregressive and moving average terms in order to shape an ARMA model.

An autoregressive model:

$$Y_t = a_1 Y_{t-1} + a_2 Y_{t-2} + \cdots + a_p Y_{t-p} + e_t \tag{4}$$

A moving average model:

$$y_t = et + b_1 e_{t-1} + b_2 e_{t-2} + \cdots + b_q e_{t-q} \tag{5}$$

Then ARMA (p,q) model is specified as:

$$Y_t = a_1 Y_{t-1} + a_2 Y_{t-2} + \cdots + a_p Y_{t-p} + e_t + et + b_1 e_{t-1} + b_2 e_{t-2} + \cdots + b_q e_{t-q} \tag{6}$$

As mainly the economic time series are non-stationary in nature afterward, the order of “integration” at which the series develop into stationary is built-in, in the model. If y_t is not stationary moreover it is stationary at "d" difference, the ARIMA (p,d,q) model (Zakai, 2014):

$$y_t = a_1 Y_{t-1} + a_2 Y_{t-2} + \cdots + a_p Y_{t-p} + e_t + et + b_1 e_{t-1} + b_2 e_{t-2} + \cdots + b_q e_{t-q} \quad (7)$$

We assume the interdependence of consecutive time intervals. So that the independent variable of the current time series is not the preceding variable, an AR1 process is carried out. It captures the relationship between the two periods and eliminates the dependence between them. The dependence in adjacent periods, or the year-on-year correlation, is eliminated.

The difference between the individual consecutive years can be written as follows:

$$\Delta Y_t = Y_t - Y_{t-1} \quad (8)$$

The current product, Y_t, is thus deprived of the effect of the previous year, Y_{t-1}, which is again adjusted for the effect of the year before that. The paper, therefore, works with the autoregression model of order 1, or AR (1), and the present value in the time series is not so dependent on the preceding values in this series. The model can be defined using a simple basic equation:

$$Y_t = \phi_1 * Y_{t-1} + \varepsilon_t \quad (9)$$

where ϕ_1 is the real number, $Y_t$is the current year, $Y_{t-1}$is the previous year, and ε_t represents an error component. This equation is then modified to reflect the dependence between GDP and government expenditure. There is still expected to be a lag effect. The equation then looks like this:

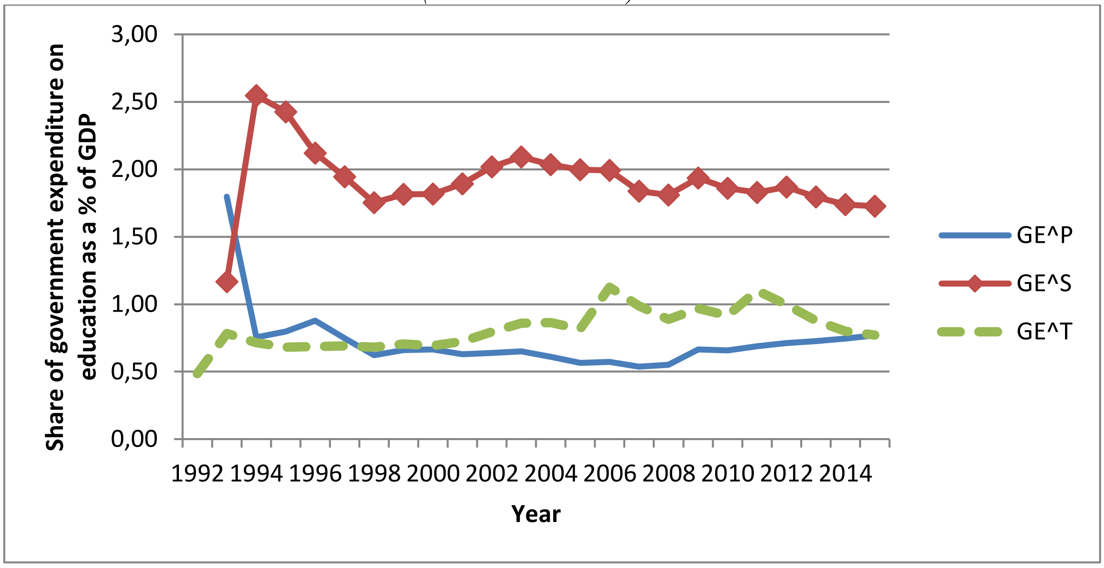
$$Y_t = \phi_1 * Y_{t-1} + \phi_2 * GE_{t-n} + \varepsilon_t \quad (10)$$

where GE means government expenditure, selected for primary, secondary, and tertiary education as needed, and *n* is a positive real number determining the expected time lag.

4. Results

The time series obtained are shown in Figure 1. They are government expenditures on education relative to GDP[1], differentiated into primary, secondary, and tertiary parts. The shares are then shown in the graph, and the data is further analysed in detail using statistical methods.

Figure 1: Share of government expenditure on education as a percentage of GDP in the period 1992-2015 (source: own calculation)



Based on a Figure 1, it can be concluded that the trend is constant and unchanged for all three, except in the initial period. In recent years, the share of secondary and tertiary education, which add the most value to human capital, has been decreasing.

The proposed hypothesis states that the gross domestic product is a variable dependent on the amount of government expenditures invested in education. As regards the differentiation of the educational process in the Czech Republic, the expenditures are further divided into primary, secondary, and tertiary education. A classical regression analysis checking the interdependence and significance is carried out. The results are presented in Table 2.

[1] Gross Domestic Product

Table 2: Regression analysis of the GDP of the Czech Republic and government expenditures on primary, secondary, and tertiary education for the period 1992-2015 (source: own calculation)

					Estimate	**SE**	**t**	**Sig.**
GDP-Model_1	GDP	No Transformation	Constant		-242825.261	155870.286	-1.558	0.136
	Expenditure on primary education	No Transformation	Numerator	Lag 0	38.588	8.360	4.616	0.000
	Expenditure on secondary education	No Transformation	Numerator	Lag 0	37.832	5.858	6.458	0.000
	Expenditure on tertiary education	No Transformation	Numerator	Lag 0	11.533	9.875	1.168	0.257

The significance is low in the case of tertiary education, and we thus cannot reject the hypothesis that there is no relationship between expenditure on tertiary education and GDP development. However, the coefficient of determination, i.e. R-squared, is significant at 0.979, and there is a high percentage of common variability among the studied variables. However, the examined analysis needs to be adjusted for the time factor. Furthermore, the higher the investment in human capital that is efficient educated, the more positive the effect is. It can, therefore, be assumed that secondary and tertiary education have the greatest influence on subsequent GDP growth, and we will therefore neglect primary education henceforth. The time lags present in education are another factor. In the case of secondary education, an optimum time lag of 5 years is initially assumed, and in the case of tertiary education, a time lag of 6 years is assumed in consideration of the standard length of studies in the Czech Republic, extended by one year.

The issue of lagging time series is often addressed by other authors as well. For example, the time lag between growth in government expenditure and the subsequent change in economic growth, as stated by Bleaney (2001), is approximately 8 years. Conversely, Devarajan (1996) states that such a long period of time is meaningless, as the effects are already manifested after 5 years, and only insignificant changes occur in subsequent years. Changes in government expenditure usually arise due to a change in the economic cycle, to which it reacts retroactively, and the shorter period of five years should thus be sufficient to reflect this. The results are presented in Table 3.

Table 3: Regression analysis of the GDP of the Czech Republic and the government expenditures on secondary education (time lag of 5 years) and tertiary education (time lag of 6 years) for the period 1992-2015 (source: own calculation)

					Estimate	SE	t	Sig.
GDP-Model_1	GDP	No Transformation	Constant		838159.984	380359.518	2.204	0.045
	Expenditure on secondary education	No Transformation	Delay		5			
			Numerator	Lag 0	53.268	14.290	3.728	0.002
	Expenditure on tertiary education	No Transformation	Delay		6			
			Numerator	Lag 0	-10.939	20.464	-0.535	0.601

After the elimination of primary education and the extension of the model to include the time lag, the model parameters deteriorated. The significance is now higher than in the previous case for both of the examined variables, and the common information R-squared at 0.891 also has a lower value.

The significance result for tertiary education is still 0.6, and the null hypothesis thus cannot be rejected. The cause is probably in the interconnection of time series, whereby one affects the other. To eliminate the influence of time series, the errors are correlated for one period. Thus, the effect of the GDP in a given year on GDP growth in the following year can be eliminated. However, the time series are mutually affected. The errors are thus correlated for one period with a new model and the impact of the GDP in one year no longer affects the GDP in the next year, using AR1, i.e. an ARIMA process; and we still expect the delay to be the same, i.e. 5 years in the case of secondary education and 6 years in the case of tertiary education. The results are presented in Table 4.

Table 4: AR1 analysis of the GDP of the Czech Republic and government expenditures on secondary education (time lag of 5 years) and tertiary education (time lag of 6 years) for the period 1992- 2015 (source: own calculation)

					Estimate	SE	t	Sig.
GDP-Model_1	GDP	No Transformation	Constant		1052865.684	583332.261	1.805	0.094
			AR	Lag 1	0.827	0.172	4.807	0.000
	Expenditure on secondary education	No Transformation	Delay		5			
			Numerator	Lag 0	40.512	11.647	3.478	0.004
	Expenditure on tertiary education	No Transformation	Delay		6			
			Numerator	Lag 0	9.447	11.726	0.806	0.435

In the case of the expenditure on secondary education, 0.004 means a significance that can be interpreted such that every Czech crown invested in secondary education will generate CZK 40 in the GDP in 5 years. This model also includes expenditures on the tertiary sector, where the significance is still high, and again, we do not reject the hypothesis that there is no relationship between GDP and expenditure on tertiary education, i.e. that spending on universities does not affect GDP. This is probably due to the shortness of the time series, given that the dependence must be considered with a time lag of about 10 years. However, there has been an increase in common variability, and R-squared is now 0.954.

The method is thus modified. Again, the ARIMA process is used to eliminate the dependences of the year-on-year development; in the case of secondary education, we expect an optimal lag of 5 years, and 10 years for tertiary education in this case. The results are presented in Table 5.

Table 5: AR1 analysis of the GDP of the Czech Republic and government expenditures on secondary education (time lag of 5 years) and tertiary education (time lag of 10 years) for the period 1992- 2015 (source: own calculation)

					Estimate	**SE**	**t**	**Sig.**
GDP-Model_1	GDP	No Transformation	Constant		1681836.095	318046.117	5.288	0.000
	Expenditure on secondary education	No Transformation	Delay		5			
			Numerator	Lag 0	35.939	11.353	3.166	0.010
	Expenditure on tertiary education	No Transformation	Delay		10			
			Numerator	Lag 0	-0.697	25.123	-0.028	0.978

Increasing the time lag is evidently not the solution. The significance is again at a higher level than in the previous case, and also, the common information R-squared is lower at 0.891. The influence of other factors can be assumed in this case, and the influence of secondary and tertiary education is probably entering the model as well. Thus, only the influence of secondary education on GDP with a lag of 5 years is monitored, based on the classical regression equation, as presented in Table 6.

Table 6: Regression analysis of the GDP of the Czech Republic and government expenditure on secondary education (time lag of 5 years) for the period 1992-2015 (source: own calculation)

					Estimate	SE	t	Sig.
GDP-Model_1	GDP	No Transformation	Constant		1216818.546	202847.701	5.999	0.000
	Expenditure on secondary education	No Transformation	Delay		5			
			Numerator	Lag 0	42.266	3.703	11.415	0.000

The relationship is proven, and we can reject the hypothesis that no correlation exists. The common information R-squared is 0.891. It can thus be assumed that there is a strong link between these indicators, and the analysis can be further refined. Therefore, the model is again adjusted for the influence of individual years by using the ARIMA model. It is still for secondary education and with a lag of 5 years. The results are presented in Table 7.

Table 7: AR1 analysis of the GDP of the Czech Republic and government expenditure on secondary education (time lag of 5 years) for the period 1992-2015 (source: own calculation)

					Estimate	SE	t	Sig.
HDP-Model_1	HDP	No Transformation	Constant		2689729.268	1287860.341	2.089	0.054
			AR	Lag 1	0.972	0.084	11.546	0.000
	Expenditure on secondary education	No Transformation	Delay		5			
			Numerator	Lag 0	15.226	7.101	2.144	0.049

The value of the common information for both examined variables, i.e. R-squared at 0.903, is significant. However, the significance is almost borderline. Therefore, new testing is carried out, again for secondary education using the ARIMA model, but with a lag of 6 years. The results are presented in Table 8.

Table 8: AR1 analysis of the GDP of the Czech Republic and government expenditure on secondary education (time lag of 6 years) for the period 1992-2015 (source: own calculation)

					Estimate	SE	t	Sig.
GDP-Model_1	GDP	No Transformation	Constant		2628099.230	955026.288	2.752	0.016
			AR	Lag 1	0.960	0.098	9.808	0.000
	Expenditure on secondary education	No Transformation	Delay		6			
			Numerator	Lag 0	17.465	7.219	2.419	0.030

The significance is 0.03 and is therefore below 5 %, and so we cannot reject the hypothesis that the coefficient of relationship 17.5 is equal to 0, which means that 17.5 is far enough away from zero and we have proven empirical dependence between GDP and expenditure on secondary education. The regression equation can then be written as follows:

$$GDP_t = 2628099.23 + 0.96 * GDP_{t-1} + 17.465 * GE_{t-6}^{S} + \epsilon \tag{11}$$

where the GDP at a certain time *t* is influenced by the previous year's GDP value and by the government expenditure on secondary education with a time lag of six years. Parameter ϵ is an error component. The common variability is higher than in the previous case and still very significant, and R-squared is 0.908. The correlation is demonstrably proven.

However, it is problematic to prove the relationship in the case of tertiary education, as the significance does not allow the relationship between the GDP and government expenditure on tertiary education to be demonstrably confirmed. The model will now be further modified so that the expenditures on secondary and tertiary education are totalled, and the ARIMA model and 5-year lag will be used again as well. The results are presented in Table 9.

Table 9: AR1 analysis of the GDP of the Czech Republic and total government expenditure on secondary and tertiary education (time lag of 5 years) for the period 1992-2015 (source: own calculation)

					Estimate	SE	t	Sig.
GDP-Model_1	GDP	No Transformation	Constant		2503602.390	1086569.506	2.304	0.036
			AR	Lag 1	0.964	0.099	9.736	0.000
	Education expenditure - Total Sec.	No Transformation	Delay		5			
			Numerator	Lag 0	12.811	5.368	2.386	0.031

The relationship between GDP and expenditure on secondary and tertiary education has now been demonstrated; R-squared also shows significant values, and the common information is 0.919. Next, the same conditions are tested for a 6-year lag. The results are presented in Table 10.

Table 10: AR1 analysis of the GDP of the Czech Republic and total government expenditure on secondary and tertiary education (time lag of 6 years) for the period 1992-2015 (source: own calculation)

					Estimate	SE	t	Sig.
GDP-Model_1	GDP	No Transformation	Constant		2465759.098	803502.096	3.069	0.008
			AR	Lag 1	0.940	0.121	7.795	0.000
	Education expenditure - Total Sec.	No Transformation	Delay		6			
			Numerator	Lag 0	14.030	5.770	2.431	0.029

This confirms an even stronger relationship between GDP growth and government expenditure on the secondary and tertiary sectors. The result can be interpreted such that every Czech crown invested in education, both secondary and tertiary, will generate CZK 14 in the GDP in 6 years. The common variability is then R-squared at 0.919. The regression equation can be written as follows:

$$GDP_t = 2465759.098 + 0.94 * GDP_{t-1} + 14.03 * GE_{t-6}^{S+P} + \epsilon \tag{12}$$

It represents the dependence of the GDP over time t on the GDP of the previous year and the total government expenditure on secondary and tertiary education. The value of the constant takes on a high value, as it did in previous examinations, because the value of GDP itself is high. This constant indicates how high the value of the dependent variable will be when the value of the independent variable is zero. Theoretically, if GDPt-1 were zero, then GDPt would still be higher than in the previous year.

In order to extend the analysis, the difference will be tested next, i.e. whether the growth rate of government expenditure on secondary education, or its annual changes, influence the rate of GDP growth (again, its year-on-year changes). Table 11 presents the relationship of the difference in the GDP and the difference in the government expenditure for the secondary level with a lag of 5 years, examined using regression analysis.

Table 11: Regression analysis of the difference in the GDP of the Czech Republic and the difference in government expenditure on secondary education (time lag of 5 years) for the period 1992-2015 (source: own calculation)

					Estimate	SE	t	Sig.
GDP-Model_1	GDP	No Transformation	Constant		150203.525	33564.933	4.475	0.000
			Difference		1			
	Expenditure on secondary education	No Transformation	Delay		5			
			Numerator	Lag 0	-1.745	5.596	-0.312	0.759
			Difference		1			

In this case, it is evident that the relationship is not proven, or that we cannot reject the hypothesis that there is no relationship between the variables. Also, the common variability of R-squared at 0.006 indicates that the relationship is not proven.

A similar result is presented in Table 12, describing the relationship between the difference in the GDP and the difference in the government expenditure for the secondary and tertiary levels with a lag of 5 years.

Table 12: Regression analysis of the difference in the GDP of the Czech Republic and the difference in total government expenditure on secondary and tertiary education (time lag of 5 years) for the period 1992-2015 (source: own calculation)

					Estimate	SE	t	Sig.
GDP-Model_1	GDP	No Transformation	Constant		165270.030	39526.522	4.181	0.001
			Difference		1			
	Education expenditure - Total Sec.	No Transformation	Delay		6			
			Numerator	Lag 0	-3.208	4.831	-0.664	0.517
			Difference		1			

Again, the differences do not work, and it is therefore not proven that the year-over-year changes in government expenditures affect year-over-year changes in GDP.

5. Discussion

Government expenditure is seen as an investment that should appreciate over time. In this case, the financing of education should lead to growth of the economy as a whole, to GDP growth and an increase in living standards. Therefore, if these investments have the expected effect, the correlation between the development of the gross domestic product and government expenditure on education in particular should be demonstrated.

The fact is that the amounts invested in education are not small. Hypothesis H01 was clearly confirmed in the case where the nominal GDP and the government expenditure on secondary education were examined. The level of common information reached the value of 0.98. Therefore, it can be concluded that by increasing government expenditures invested in secondary education, the nominal GDP can be boosted by CZK 17.50 in 6 years from an increased investment of CZK 1.

Hypothesis H02 can also be confirmed, but only in part, as a sufficient correlation between government expenditure on the education system and tertiary education has not been demonstrated. This fact departs from the conclusions formulated by Vltavská (2017). This may be due to a failure to include time lags and smooth out data files. In the case of secondary education, a lag of 6 years is proven. This is consistent with the conclusions described by Folster (2001), as the economic cycle and its changes are temporally captured.

Hypothesis H03 can be rejected, because there is no proven relationship in the case of tertiary education. Despite this, the results of all models indicate that the contribution of tertiary education to GDP is lower than that of secondary education. It is therefore not possible to verify the assumption of the higher significance of higher education.

Even in the case of confirmed results for secondary education, it is necessary to consider the fact that the dependence can be illusory and caused by the growth of both time series, i.e. both government expenditure on secondary education and GDP. There was an attempt to deal with this shortcoming by using an analysis of the differences, but the results for the influence of the year-over-year change in government expenditure and year-over-year GDP changes are insubstantial and no conclusions can be drawn from them.

The fact that the correlation of expenditure in relation to real GDP has not been proven can be explained by the fact that inflation, by which GDP is adjusted, is a monetary phenomenon, and therefore no dependence can be expected between inflation and government expenditure, or their influence on GDP.

6. Conclusion

The main objective of this article was to demonstrate the relationship between changes in government expenditure on education and changes in the GDP of the Czech Republic with a time lag for the period 1992-2015. As regards the structure of education, it was divided into primary, secondary, and tertiary education, and primary education was neglected after the initial analysis due to its low expected contribution to GDP. A regression equation was formed and used to examine the relationship between the individual components, also with regard to the elimination of the correlation of the year-on-year data development and taking into account the time lag reflected in the GDP.

The results show that in the case of secondary education there is a demonstrable relationship between growth in government expenditure on this sector and GDP growth after the time lag. Based on the statistical methods used, this time lag is established as six years. In the case of tertiary education, the relationship between the growth of government expenditure on this sector and subsequent GDP growth could not be proven, not even with the elimination of the influence of year-on-year changes and with different time lags.

Further research can focus on a more detailed analysis of secondary education and confirmation of the relationship of government expenditure on education. At the same time, the government expenditure indicator can be extended to include other things that relate to the sub-components of state proceedings, i.e. more objects of public spending. In the Czech Republic, the question of increasing public spending on education is an important issue of political debate. Research confirms, among other things, the importance and, above all, the returns on these investments in the long term in the form of increasing performance of the Czech economy. It is thus a question and a possible subject of further research whether any appropriate systemic changes in the education system would allow for a higher return on investment in education. In this respect, there is, for example, room for the development of private education in the Czech Republic, which, in combination with public spending in the form of subsidies, would help to improve and modernise Czech education, as well as increase its availability and supply.

It is also necessary to analyse tertiary education again and try to describe the problems that led to the failure to prove the relationship - whether they are structural problems or a problem with the model used in this article.

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