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# EXPENDITURE FOR EDUCATION AND GDP: ECONOMETRIC MODEL

In the modern world, the problem of education has ceased to be the prerogative of the state; it is under constant control of international organizations. In May 2015, the World Education Forum was held in Incheon, Republic of Korea, attended by 1,600 delegates from 160 countries. This forum identified the main direction of development in the education sector until 2030. One of the priority goals is to provide inclusive and equitable quality education and to promote lifelong learning opportunities for all [1]. Quality education and lifelong learning opportunities for all are central to ensuring a full and productive life to all individuals and to the realization of sustainable development. The state must ensure that every child is able to complete school and gain the skills that are necessary him to lead a healthy and productive lifestyle, as education is the basis of sustainable development of the country. That education is capable of "healing" the planet and of depriving mankind of poverty. It also helps reduce inequalities between the rich and the poor. For example, from 1985 to 2005, studies in 114 countries showed that one additional year of training corresponds to a reduction in the Gini coefficient that measures inequality by 1.4 percentage points.

The most important condition for raising the level of education of the population of the country is an increase in funding. But the possibilities of each country to fund education are very different. In this paper, the link between the GDP of the country and its educational expenditures, as well as between these indicators per capita, is considered. The research was based on the statistical data obtained during a large-scale monitoring, the results of which are presented in the report of the UNESCO Institute for Statistics.

Let's consider the dependence of education costs on the volume of gross domestic product for different countries. We have constructed an econometric model of pair regression, which considers the dependence of education expenditures on the gross domestic product of different countries. In this model, the external (exogenous) variable is the GDP of the country, and the education expenditures are an internal (endogenous) variable. We have analyzed the data of the observation of 160 countries for which in 2014 the monitoring of the educational level of versatile population and the amount of expenses on education as a percentage of GDP was carried out. We selected 154 countries, because it was precisely for them that the full amount of data was given. The monitoring was initiated by UNESCO [1] and the World Bank [2]. We also chose the GDP of the countries as of 2014 [3]. The calculations were performed using the built-in functions and add-ins MS Excel.

To determine the approximation function, a graph was constructed that reflects the dependence of education expenditure on GDP (Fig. 1).

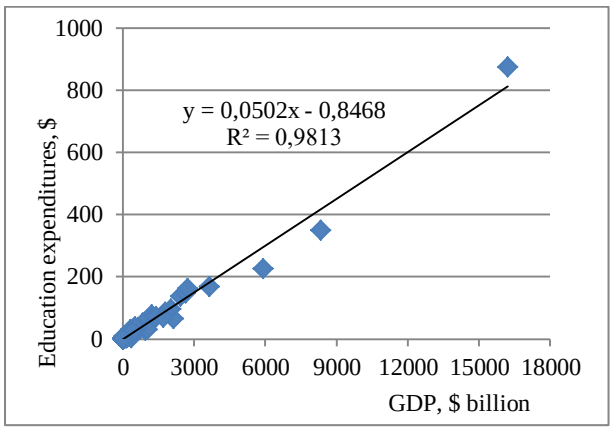


Fig.1. Government expenditure on education as a function of country's GDP (in 2014).

In the approximation of this graph, one can assume that the dependence is linear. Applying the ordinary least squares (OLS) method, we obtain the following regression equation:

$$\hat{Y} = -0.847 + 0.052\,X \qquad (1)$$

Note that $X$ is the explanatory variable (the GDP of the country, $ billion) and $\hat{Y}$ is the estimate of dependent variable (the education expenditures, $ billion)

According to model (1), the determination coefficient is $R^2 = 0.9813$, that is, 98.13% of the variability of the internal factor is due to the influence of the external factor and only 1.87% is due to the influence of factors that are not taken into account in this model (the "unexplained" part of the regression). Testing the significance of the model parameters according to Student's criterion has shown that the regression coefficient is statistically significant. So, it is $t_{b_1} = 89.37$ as long as $t_{0.05}(df = 152) = 1.97$. However, for a free term of the regression equation $t_{b_0} = 0.9$, hence the free term is statistically insignificant.

It should be noted that the value of the factors varies in a wide range. At one end of the ranking range such countries as Tonga (GDP = $ 0.4 billion, and education expenditure are $ 0.02 billion, this is 4.9% of GDP) and Comoros (GDP = $ 0.6 billion, education expenditure are 0.05 billion, that is 7.6% of GDP) are located. At the other end of the ranking range countries

such as the United States (GDP = $ 16,208.9 billion, while the education expenditure are $ 875.3 billion, i.e. 5.4% of GDP) and China (GDP = $ 8,333.3 billion, education expenditure are $ 350.0 billion, i.e. 4.7%) are located. By comparison, in 2014 Ukraine's GDP was $ 132.3 billion, while education expenditures amounted to $ 7.1 billion, or 5.3% of GDP. Consequently, we observe a significant difference in the amount of expenditures on education in absolute terms. However, as a share of GDP, education expenditure ranges from 1% (United Arab Emirates) to 12.9% (Cuba).

It is interesting to compare these results with the results of observations that were carried out in 1994 [4]. The sample consisted of 34 countries. For the state of the countries at that time, the following regression equation was obtained:

$$\hat{Y} = -2.309 + 0.067\,X \qquad (2)$$

According to model (2), the determination coefficient is $R^2 = 0.9797$ . Testing the significance of the model parameters according to Student's criterion has shown that the regression coefficient and free part of the equation are statistically significant. So, $t_{b_1} = 39.25$ and $t_{b_0} = 2.54$ under $t_{0.05}(df = 32) = 2.04$ .

The models (1) and (2) have close values of the regression coefficient. Let's check it out whether the coefficients in two linear regressions on data sets of different years are equal. To do this, the Chow test was applied. In order for the study to be correct, we will build an econometric model based on the data sets of the study of the same 34 countries, as in the work [4], but as of 2015. Compare the sum of squared residuals from each of the models separately and sum of squared residuals from the model, which is constructed for the combined data. For the empirical value of Fisher's criterion we have $F$ = 4.87. For a significance level of 0.05, we have $F(2; 62)$ = 3.15. Consequently, the difference between regression coefficients by models (1) and (2) is statistically significant. We conclude that over the past 20 years, the impact of GDP on education expenditures has slightly decreased. So, in 1994, on average, an increase in GDP per 1 dollar has leaded to an additional 6.7 cents were spent on an increase in education expenditures. In 2014, an increase in GDP by $ 1 will add 5.2 cents to education expenditures.

Let's pay attention to one more circumstance. Due to the fact that GDP changes occur in wide boundaries, there is a threat of heteroskedasticity of the model's residuals. Consequently, one of the conditions for using of OLS method may be violated, namely the assumption of homoskedasticity of variance may not be executed. Indeed, studies have shown that the variance of random errors of the model increase with an increase in the explanatory variable. Therefore, the least squares estimators cease to be best linear unbiased estimators (BLUE). Thus, it is advisable to apply the model (1) to analyze the process. However, with large values of the explanatory variable, the accuracy of the forecast for this model decreases, as the width of the confidence interval for the predicted value increases.

In order to get rid of the heteroskedasticity of the remnants of the model, we switched from the absolute values of the investigated factors to their specific values (in relation to the population of the countries under consideration). These data were calculated by the author based on population data for 2014 [5]. Applying the method of least squares, we obtain the following linear regression model in specific values:

$$\hat{y} = 222.610 + 0.033\,x, \qquad (3)$$

where $x$ is the explanatory variable (the specific GDP, $ per capita) and $y$ is the dependent variable (the specific education expenditures, $ per capita).

According to model (3), the determination coefficient is $R^2 = 0.6378$ , that is, 63.78% of the variability of the internal factor is due to the influence of the external factor but 36.22% is due to factors that are not taken into account in this model. This means that in calculating GDP per capita we have much greater variation in the education expenditures. According to Student's criterion, both parameters of the model are statistically significant. In accordance with model (3), an increase in GDP per capita per one dollar leads to average increase 3.3 cents for education expenditures per capita.

It should be noted that the ranking of countries in terms of GDP per capita significantly changed if you compare it to the rating in terms of GDP. According to this indicator, the poorest countries are Burundi (specific GDP is $ 101.9 per person, and education expenditures are $ 9.4 per person) and Niger (specific GDP is $ 174.2 per person, and education expenditures $ 6.6 per person). The richest countries are Liechtenstein (specific GDP is $ 177,024.1 per person, and education expenditures is $ 3,717.5 per person) and Monaco (specific GDP is $ 186,451.7 per person, and education expenditures is $ 2,237.5 per person). For comparison, in Ukraine, these indicators are, respectively, $ 3,198.46 per person and $ 169.5 per person.

The obstacle to the implementation of the "Quality Education for All" program for countries with low GDP but large populations are the low level of governmental expenditure on education and the lack of funding from outside sponsors. So it's necessary to search out innovative approaches and to use additional resources.

## References


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