ESTIMATION OF REGRESSION EQUATIONS BETWEEN SOME FORMAL EDUCATION INDICATORS AND GDP, IN ROMANIA

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Motto: "*Education is the most powerful weapon which you can use to change the world.*"

Nelson Mandela

Abstract

The present paper is a part of a post-PhD research entitled Assessment on the impact of education on the macroeconomic development in Romania, as compared to other EU member states. The survey starts with a short overview on the history of education and macroeconomic development in Romania, starting from the 19th century. The paper presents contextual data, indicators as well as the outcome of the research, conducted in order to identify and analyze the impact of education on the macroeconomic development in Romania. The study is based on linear regression models and, respectively, on double log regression models. The purpose is to analyze the relationship between a set of educational indicators as predictors and Gross Domestic Product as a dependent variable.

Keywords: *formal education, macroeconomic development, statistical analysis, regression models*

1. Introduction

Formal education occurs in a structured, systematic and controlled environment where students are learning together with a trained, certified (preschool, primary, secondary or tertiary) teacher, professor or lecturer of the subject.

Etymologically, the word "*formal*" is derived from the Latin *formalis* which means "official", "organized", therefore, formal education is official education. Philip H. Coombs[1] defined *formal education* as the hierarchically structured, chronologically graded education system, running from primary school through the university and including, in addition to general academic studies, a variety of specialized programs and institutions for full-time technical and professional training. Formal, official education includes social managing and evaluation, centered on the development of self-assessment capabilities learned within the formal education.

Formal education is extremely important because it provides access to cultural, scientific and artistic values, to literature and scientific knowledge as well as to social and human experience, having a critical role in shaping the students' personality, according to society and individual needs. Investing in human resources, i.e. in education, training and healthcare systems, is aimed at improving the professional and scientific abilities of trainees as well as at increasing their adaptability to cope with structural economic changes and the technological progress as well as efficiency.

Below, I intend to show that formal education plays a key role in improving living standards, leading to prosperity.

2. DEFINING CONTEXTUAL INDICATORS AND MODELS APPLIED

To analyze the impact of education on Romania's economic growth, statistical data provided by EUROSTAT and World Bank are processed in order to understand specific indicators. The three models applied are the following: *simple linear regression and log-log regression*.

Using available data, we obtain the general linear model presented below:

$$y_j = b_0 + bx_j + \varepsilon_i, j = \overline{1,T}$$

where T is time in years.

The model is used (i) to analyze the relationship between two variables, i.e. a dependent variable - Education and, respectively, an independent one – Economy, as well as (ii) to assess the relationship between the two variables during a given period of time (2001-2015).

For the analysis of panel data to be further developed, we get the following general linear model:

$$y_{ij} = b_0 + bx_{ij} + \varepsilon_{ij}, \quad i = \overline{1,N}, \qquad j = \overline{1,T}$$

where N shows the correlation between countries and T is time in years.

To interpret correctly the parameters, namely the impact of education on economic development, we use

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[1] Philip Hall Coombs (1915-2006) was a program director for education at the Ford Foundation; he was appointed by President John F. Kennedy to be the first Assistant Secretary of State for Education and Culture; he worked for UNESCO and served as vice-chair and chair of the International Council of Economic Development.

logs for variables, i.e. semi-log or log-log regression model

$$y_j = b_0 + blnx_j + \varepsilon_j, j = \overline{1,T}$$

and, respectively

$$lny_j = b_0 + blnx_j + \varepsilon_j, j = \overline{1,T}$$

Using natural logs and the real value of the dependent variable, and, respectively, natural logs for both variables x_j and y_j.

If linear regression uses variables we want to predict, i.e. dependent variables, logistic regression enables you to calculate predicted probabilities using a factor variable (i.e., categorical variable), which should be included in the model as a series of indicator variables regression. The logistic regression algorithm is developed to determine what class a new input should fall into. One of the nice properties of logistic regression is that the *sigmoid* function outputs the conditional probabilities of the prediction. A sigmoid function is a mathematical function having an "S" shaped curve, and is bounded differentiable real function that is defined for all real input values and has a positive derivative at each point. The logistic function has this further, important property, that its derivative can be expressed by the function itself. The advantage of this model is that we are not really restricted to dichotomous dependent variables and that it can be developed into one unified model.

Using the same data, we could obtain the following linear multiple regression model:

$$y = b_0 + b_1x_1 + b_2x_2 \ldots + b_px_p + \varepsilon$$

where *p* represents the number of predictors used to explain or predict the other variable *y*.

Description of the Contextual and Specific Indicators Used

The specific, educational indicators we analyzed are the predictors, i.e.[2]:

1. *School life expectancy* is the total number of years of schooling (primary to tertiary) that a child can expect to receive, assuming that the probability of his or her being enrolled in school at any particular future age is equal to the current enrollment ratio at that age. School life expectancy shows the overall level of development of an educational system taking into account the years of schooling.
2. *Total public expenditure on education* refers to combined public, private and international expenditure on education, i.e. funding by the government or education expenditure by educational institutions, as well as private expenditure.
3. *At least upper secondary educational attainment, age group 20-24 years - %* (ISCED 3) the indicator is defined as the percentage of people aged 20-24 who have successfully completed at least upper secondary education. This educational attainment refers to ISCED 3. The indicator aims to measure the share of the population that is likely to have the minimum necessary qualifications to actively participate in social and economic life. It should be noted that completion of upper secondary education can be achieved in European countries after varying lengths of study, according to different national educational systems. It reveals the efficiency of national strategies and policies in the field.
4. *Tertiary educational attainment, age group 30-34 years*, % - the indicator is defined as the percentage of the population aged 30-34 who have successfully completed tertiary studies (e.g. university, higher technical institution, etc.). This educational attainment refers to ISCED 5-6 and reveals the distribution of the respective share of population. The indicator helps us draw conclusions on the quality of human resources, being a part of the Education and Training 2020 (ET 2020) framework for cooperation. It shows the share of 30-34 year olds with tertiary educational attainment, with a view to achieving the strategic objectives under the ET 2020.
5. *Employment rates of recent graduates* - % presents the employment rates of persons aged 20 to 34 fulfilling the following conditions: first, being employed according to the ILO definition, second, having attained at least upper secondary education (ISCED 3) as the highest level of education, third, not having received any education or training in the four weeks preceding the survey and four, having successfully completed their highest educational attainment 1, 2 or 3 years before the survey. The indicator is calculated based on data from the EU Labor Force Survey.
6. *Employment by educational attainment level, annual data, age class-15-64 years, tertiary education* per thousands shows the percentage of a population aged between 15-64 that has reached a higher level of education and holds a qualification at that level, being employed. It reveals the efficiency of labor policies and is used at international level.
7. *Population by educational attainment level, sex and age* -% highlights the share of the population having completed at least upper secondary education, age class 15-64 years.
8. *Enrolment rate %* is expressed as net enrolment, which is calculated by dividing the number of students of a particular age group enrolled in all levels of education by the size of the population of that age group[3]. It is widely used to show the

[2] Source: EUROSTAT.
[3] Source: INS, TEMPO Online.

general level of participation in and capacity of education.

9. The broadest indicator of *economic output and growth* is the Gross Domestic Product or GDP[4], expressed in million of Euros, which represents the dependent variable.

To illustrate the impact of education on the medium and long term, the relationship between variables was considered as *asynchronous* (for example, there is a 12 year gap between GDP and the Enrolment rate).

3.1. ANALYSIS OF CORRELATIONS BETWEEN EDUCATIONAL AND MACROECONOMIC INDICATORS

The analysis of the sample correlation presented below clearly illustrates the moderate relationship ($r_{GDP;Public\_exp} = 0.62$), and, respectively, the strong relationship between GDP and the rest of indicators, except for the *Employment rates of recent graduates,* which is the best example for an inverse correlation ($r_{GDP;Employment\_level} = -0.42$).

Table 1. Correlations. The highlighted correlations are strong for p < .05000 N=8

	GDP	School exp	Public exp	At least upper secondary (%)	Tertiary (%)	Employ-ment rate	Employ-ment level	Population (%)	Enrolment rate (%)
GDP	1.00	0.81	0.62	0.78	0.86	-0.42	0.87	0.83	0.88
School exp	0.81	1.00	0.91	0.95	0.97	-0.82	0.90	0.96	0.96
Public exp	0.62	0.91	1.00	0.96	0.85	-0.82	0.76	0.87	0.80
At least upper secondary (%)	0.78	0.95	0.96	1.00	0.93	-0.75	0.88	0.93	0.88
Tertiary (%)	0.86	0.97	0.85	0.93	1.00	-0.80	0.97	0.99	0.99
Employment rate	-0.42	-0.82	-0.82	-0.75	-0.80	1.00	-0.71	-0.82	-0.78
Employment level	0.87	0.90	0.76	0.88	0.97	-0.71	1.00	0.98	0.96
Population (%)	0.83	0.96	0.87	0.93	0.99	-0.82	0.98	1.00	0.98
Enrolment rate (%)	0.88	0.96	0.80	0.88	0.99	-0.78	0.96	0.98	1.00

3.2. ESTIMATION OF REGRESSION EQUATION

Based on statistical data for 2001-2015, linear regression equations, and, respectively, log-log equations showing the relationship between GDP and each predictor were developed, illustrating strong correlations, along with the analysis and the regression model .

3.2.1. The impact of School life expectancy on GDP

According to Europe 2020 guidelines included in the most important strategic document drafted and promoted by the European Commission for the next 10 years, which defines education as one the top priorities and the factors that could lead to economic growth within the EU, Romania should reduce school drop-out rate (PTS), age class 18-24 years, down to 11.3% until 2020, and, respectively, increase tertiary education attainment rate, age class 30-34 years, up to 26.7%. The goal is difficult to achieve due to high school drop-out rates, age class 18-24, i.e. one child in 5 leaves primary school (17%) and 50% of students leave secondary school and fail to pass the final exam. Although reforms were implemented to improve access to education and ensure quality education, further measures should be applied and major investments should be made in this sector, to cope with the challenges faced by these vulnerable categories.

Based on the regression model, the following linear regression equation illustrating the relationship between the dependent variable *GDP* and the independent variable *School life expectancy* was developed:

$$GDP = 102259 * School\_exp - 1427211$$
$$(83816) \quad (1368881)$$
$$R^2 = 0{,}14$$

after normalization (standardized independent variable value – 0 and dispersion value – 1) we obtain:

$$GDP = 0{,}376719 * School\_exp$$

The coefficient of determination denoted $R^2(\%) = 14\%$, indicates that *School life expectancy* influence on *GDP* values is of 14%.

[4] Source: EUROSTAT - for variables 1)-7) and GDP.

At the same time, we obtain the following log-log equation:

$$lnGDP = 4{,}71454 * lnSchool\_exp - 1{,}18165$$

(2.512)(7.00)

$$R^2 = 0{,}28$$

In comparison with other EU member states, Romania's *School life expectancy* was 16.9% in 2012, according to EUROSTAT, above the UK – 16.6%, but below Sweden – 19.9%, Denmark – 19.3%, and Germany – 18.2%.

The log-log regression equation (9) shows that a 1% increase in *School life expectancy leads to a 4.71% GDP growth during the analyzed period. In the future, we can predict a 17% increase in School life expectancy*, above Denmark (19.3%) and almost equal to Sweden (19.9%), *leading at the same time to a 109.63% increase in GDP*.

3.2.2. The impact of Total public expenditure on education on GDP

According to EUROSTAT, Romania's GDP was 27% of the average EU GDP per capita (EU-28) in 2015, being the second poorest EU member state, above Bulgaria (22.8%). Romania's *Total public expenditure on education* accounts for 4.1% of the country's GDP, as compared to an average of 4.7% in Eastern Europe and, respectively, 5.4% in EU.

Since 2005, secondary and tertiary education has received more money than preschool or primary education. The education sector is strongly interconnected with public expenditure, since private funding accounted for 0.12% of the country's GDP in 2010, as compared to 0.82% in EU.

According to the UNICEF survey[1], currently, approximately two thirds of public spending on education targets two fifths of rich people (65.8%), and only 9.9% - poor people. At the same time, 61.2% of public expenditure on education targets urban educational facilities, despite efforts to reduce the gap between urban and rural areas. The two examples presented above show that there are major equality issues and that significant investments should be made to eliminate this gap between rich and poor people (for e.g., inclusive education policies).

In other words, if Romania were to progressively increase its investment in education between 2015 and 2025, i.e. from 4.1% to 6% of the GDP, economic growth would increase from 2% to 2.7% - 2.95%. On the other hand, boosting our average PISA scores would also lead to economic growth (the impact of quality education on economic development).

$$GDP = 7{,}86 * Public\_exp + 75075{,}27$$

(2.93) (20884.59)

$$R^2 = 0{,}5$$

and, respectively,

$$lnGDP = 0{,}484558 * lnPublic\_exp + 7{,}493406$$

(0.156) (1.375)

$$R^2 = 0{,}51$$

Thus, the equation (10) shows that *Total public expenditure on education* influence on *GDP* values is of 59%. A 1% increase in *Total public expenditure on education* would lead to a 0.48% increase in economic growth, while a 20% increase in *Total public expenditure on education* would trigger a 9.23% increase in GDP.

3.3.3. The impact of At least upper secondary educational attainment on GDP

This indicator aims to measure the share of the population that is likely to have the minimum necessary qualifications to actively participate in social and economic life. In 2015, it reached 82% at EU level, i.e. Croatia – the highest rate - 95.7%, followed by Ciprus – 94.3%, and Ireland – 92.7%. In Romania, it is 79.7%, which is close to the EU average.

$$GDP = 91901 * At\_least\_secondary - 6987316$$

(84242) (6623873)

$$R^2 = 0{,}11678823$$

and, respectively,

$$lnGDP = 21{,}5066 * lnAt\_least\_secondary - 81{,}9073$$

(12.30)(53.66)

$$R^2 = 0{,}25$$

Regression analysis indicates that *At least upper secondary educational attainment* influence on *GDP* values is of 11%. A 2.3% increase in the number of students graduating from secondary schools to reach EU average would lead to an 84.3% increase in GDP.

3.2.4. The impact of Tertiary educational attainment on GDP

This indicator aims to measure the share of the population aged 30-34 who have successfully completed tertiary studies. It hit 38% in 2015, at EU level, as compared to Lithuania, which held the leading position, i.e. 57.6%, followed by Cyprus - 54%, and Luxemburg - 52%. In Romania, this area experiences an upward trend, i.e. 25.6%.

$$GDP = 19449 * Tertiary - 123466$$

(23733.8) (454719.5)

$$R^2 = 0{,}069$$

and, respectively,

[1] Cost of Non-Investment in Education in Romania, UNICEF and MEN study.

$$lnGDP = 1{,}187959 * lnTertiary + 8{,}526990$$

(0.79) ***(2.29)***

$$R^2 = 0{,}20$$

According to the regression equations developed based on EUROSTAT data for 2004-2015, Tertiary educational attainment influence on GDP values is of 6.9%. A potential 12% increase in Tertiary educational attainment to reach EU average would probably lead to a 60% increase in GDP.

3.2.5. The impact of *Employment rates of recent graduates* (economically active population) on *GDP*

According to EUROSTAT, in 2015, the percentage of economically active population[2], age class 20-64 years, in Romania, was lower (66%) than EU average (70%). The government target is to reach 70% until 2020[3]. As for the economically active population, age class 30-34 years, the percentage (78%) is higher than EU average, i.e. 77.7%, for the age class 25-29 years – above EU average (72.1% as compared to 72%), while for the age class 15-19 and 20-24, the percentage is below EU average.

$$PIB = 532 * Grd\_ocupare - 519003$$

(906) *(1321651)*

$$R^2 = 0{,}41$$

and, respectively,

$$lnPIB = 2{,}44745 * lnGrd\_ocupare - 5{,}78455$$

(2.49) (18.12)

$$R^2 = 0{,}10$$

The equations show that Employment rates of recent graduates influence on GDP values is of 41%**.** *A 1% increase in the economically active population would lead to a 2.44% increase in GDP, while a 10% increase would probably trigger a 26.27% increase in GDP.*

3.2.6. The impact of Population by educational attainment level on GDP

According to the OECD survey[4], the public returns to tertiary education are substantially large, i.e. thousands of dollars (on average across OECD countries, the net public return on an investment in tertiary education was, in 2011, 91,036 dollars for a man), not to mention the new jobs created, and the economic development fueled by innovation. Moreover, European Commission's Europe 2020 strategy[5] shows that almost 16 million new jobs will be created until 2020 for young graduates, while unqualified jobs will decrease by almost 12 millions. As a result, the need to invest in higher education is obvious, since the modern society relies on education as a source of economic growth. In addition, life satisfaction level is strongly influenced by education, the survey showing that the gap between graduates and non graduates is 18%.

In addition to these benefits, higher education helps students learn to think more critically, being focused on developing students as individual thinkers in search for the best solution, establishing thus the basis for more social and economic growth. Inclusive education is very important because it supports coherent and sustainable development at social and economic levels, solving the issues faced by all social categories with the help of qualified people.

$$GDP = 53674 * Population - 405081$$

(68743) *(852371.8)*

$$R^2 = 0{,}07$$

and, respectively,

$$lnGDP = 1{,}804858 * lnPopulation + 7{,}518492$$

(1.55) *(3.88)*

$$R^2 = 0{,}14$$

The regression equation (17) shows that *Population by educational attainment level* influence on GDP values is of 7%.

The log-log regression equation (19) illustrates that *a 1% increase in the number of graduates would lead to a 1.8% increase in GDP, during the analyzed period. A potential 20% increase in the number of graduates would probably lead to a 39% increase in GDP.*

3.2.7. The impact of *Enrolment rate* on *GDP*

As for the benefits of investing in education, the same survey[6] shows that one additional year of schooling increases earnings by 8-9%, reduces the probability of being unemployed by 8% and the probability of bad or very bad health or suffering from a chronic long-standing disease by 8.2%. Secondary school graduates earn more than primary or college graduates, i.e. by 25%-31%. Tertiary level graduates earn more than secondary school graduates, i.e. by 67%. The increase in the number of tertiary level graduates from 13.6% to 19%, in 2025 would lead to an approximately 3.6% increase in GDP. Even a slight increase in the number of secondary school graduates,

[2] The percentage of economically active population.

[3] According to European Commission's *Recommendation for a COUNCIL RECOMMENDATION on Romania's 2013 national reform programme and delivering a Council opinion on Romania's convergence programme for 2012-2016* {SWD(2013) 373}, p. 4, available on http://ec.europa.eu/europe2020/pdf/nd/csr2013_romania_en.pdf.

[4] OECD, Education at a Glance 2011: OECD Indicators, OECD Publishing, Indicator A9, p. 166, 2011.

[5] European Commission, *Europe 2020 Strategy*, 2010.

[6] Cost of Non-Investment in Education in Romania, UNICEF and MEN survey.

i.e. from 58% to 59.7%, in 2025 would generate a 0.52% increase in GDP.

According to the same survey, at macroeconomic level, one additional year of schooling leads to an average 12.1% increase in GDP.

$$GDP = 18480 * Enrolment\_rate - 996358$$

(27487) (1839069)

$$R^2 = 0{,}47$$

and, respectively, the log-log equation:

$$lnGDP = 4{,}54648 * lnEnrolment\_rate - 7{,}13556$$

(3.50) *(14.7)*

$$R^2 = 0{,}15$$

The 0.47% coefficient of determination shows that *Enrolment rate* influence on GDP values is of 47%.

The log-log equation (21) can be interpreted as follows: *a 1% increase in the enrolment rate would lead to a 4.54% increase in GDP, during the analyzed period. An alleged 10% increase in the enrolment rate would lead to a 54% increase in GDP*.

4. Conclusions

To analyze the impact of education on Romania's GDP, research using statistical methods to determine specific economic and education indicators was conducted, i.e. based on EUROSTAT data. The analysis presented in this paper clearly illustrates the important role of skilled workforce on economic growth, i.e. the influence of specific educational indicators on GDP values. Thus, increasing levels of educations reduce the probability of being unemployed and increase earnings, which could lead to economic growth.

In conclusion, I believe that, in a constantly changing world, the achievement of the key goals concerning education, included in Europe 2020 strategy as well as in national policies, such as encouraging learning, reducing school drop-out rates, and improving skills, could make our dream that Romania would achieve smart, sustainable and inclusive growth come true.

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