Orientation of Public Policy by Highlighting the Relationship between Economic Development, Education and Eco-Innovation in EU Countries

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ABSTRACT

The authors' scientific endeavour takes into account the fact that one of the most important drivers of a nation's economic growth is the population's level of education and skills. Nowadays, when growth is slowed down and highly volatile, many countries are looking for policies that will stimulate growth. The objective of this research is to investigate some of the aspects concerning the relationship between economic development and human capital through the role of education and eco-innovation activities in EU countries. For the empirical results, some multivariate regression models are computed in R software. The outputs include parameter estimates and standard errors, as well the residual standard error and multiple R-squared. The research results obtained emphasised the fact that "the school expectancy", "training" and "eco-innovation" indicators have a significant impact on the GDP per capita.

Keywords: *public policies, economic growth, education, training, eco-innovation*
JEL Classification: *I, I2, I25, I28, O1, O15, M21*

INTRODUCTION

It is well known that one of the most important determinants of a nation's economic progress is the population's level of education and skills. In all countries, designing and implementing public policies to stimulate economic growth is a constant concern.

The main objective of this research endeavour is to investigate some of the aspects concerning the relationship between economic development and human capital through the role of education and eco-innovation activities in EU countries.

Using two multiple linear regression models, we will study the relationship between the GDP per capita and the variables School expectancy, Training and Eco-innovation, for a total of 28 European countries.

To ensure data consistency, we will use the Eurostat database.

The paper is structured in such a way, presenting the literature review, the research methodology, the data and software used and the main empirical results followed by the main conclusions.

LITERATURE REVIEW

Although the general theme of economic and social development was intensively approached and investigated in the literature, there is a relative few studies that examines education and eco-innovation in EU countries in relationship with GDP. It is a well-known that education is a dynamic development tool that requires constant investment and innovation and contributes to increasing the educational potential. Investments in education bring benefits to both individuals and society, but their effects - are materialised over a longer period of time.

In this context, the economic development of society must be based on investment in education, because "only science that is filtered through the minds and hearts of people, creating systems of attitudes, skills and spiritual capabilities becomes an active and beneficial driver of the economic and socio-cultural development", Vaideanu (1998).

Over the years, many authors have tried to assess the contribution of education to economic growth. The most famous studies were those by Schultz and Denison according to Suciu, (2000). The two authors, using two different analysis methods, noticed that, theoretically, they yield relatively similar results.

Other authors Plant and Welch (1989) highlighted the impact of education on labour productivity, considering that "the phenomenon most directly linked to economic growth is increased productivity as a result of investment in education ". The two authors have used the method of opportunity costs related to education.

Through their empirical research, Mc.Mahon (2004) confirms the "positive effect of education on economic growth and highlights the positive relationship between education and productivity."

The authors Mingat and Tau (1996), in the studies they performed, showed that marginal macroeconomic impact of the different levels of education varies widely, depending on each country's development level.

Investment in education and its economic effects are analysed by Becker (1997), in his famous book "*Human Capital*". Starting from the estimated costs and benefits of education, the author shows "correlations between the level of education, wages or getting a job''. The performed analysis indicates that "the wages of educated and trained persons increase more rapidly than those of less educated and trained persons”, which leads to the concept of age-wages or age-wealth curves, and emphasises that their shape is determined by investment in the individual’s education.

In the paper *Landmarks of Tomorrow*, Druker (1999) emphasises the fact that, “in a constantly changing society, where the labour market requirements are more and more refined, it is necessary that individuals continue their lifelong vocational training”.

In their studies, Wilson and Briscoe (2004) show that “education and training are key contributors to the development of skills and knowledge”. And increasing investments in education leads to higher productivity and wages for each individual, as well as for society.

In the literature, authors Lucas (1988), Romer (1990), Aghion and Howitt (1998) emphasise that “education may trigger an increase in the innovative capacity of the economy, the development of new knowledge by means of the new technologies”, thus being an important factor of economic growth.

Otherwise, “the introduction of innovative teaching methods and the use of interactive software and online materials require the existence of modern ITC equipment in schools, as prerequisite. Yet, integrating ITC in school education is a complex process and it is affected by several different factors”, Balanskat, Blamire and Kefala (2006).

At the same time, the rapid development of information technology and communications in recent years has had “a major impact on the global society and economy, with fundamental changes in production and distribution models, employment and daily life”, Dumitrescu, (2006). On the other hand, the new software as well as R are able to perform graphical visualization, “prompt and effective response, given the rapid changes in data sources”, Alexandru and Caragea (2016).

RESEARCH METHODOLOGY

In order to analyze the relationship between economic development, education and eco-innovation in EU countries, certain regression models were used. The output variable is mainly Gross Domestic Product computed for all 28 countries across the EU. The explanatory variables are the potential factors that could have contribution to GDP growth of countries, as well as the education and eco-innovation. Two indicators were used in order to capture the impact of education on the GDP: training and School expectancy.

The indicators were described by reference to the Eurostat database, http://ec.europa.eu/eurostat/data/metadata.

Description of the variables

Dependent variable (Y) - as the variable of interest in this study - is the **Gross domestic product** (GDP per capita Euro).

Independent variables (Xi) are considered the followings:

X1 – School expectancy - stands for “the expected years of education in a lifetime and has been calculated by adding the single-year enrolment rates for all ages.

This type of estimate will only be accurate if current enrolment patterns continue in the future. Headcount data is the basis for such estimates. To illustrate what school expectancy means, we will take the following example: school expectancy would be one year for the age of 8 if all 8-year-old students (in the year the data was collected) were enrolled. But, if, let's say, only 50% of 8-year-olds were enrolled, then school expectancy would be half a year for the age of 8", *http://ec.europa.eu/eurostat/data/metadata*.

X2 – **Training** - is the rate of Participation in education and training. This variable is provided by the **Adult Education Survey (AES)** which encompasses the participation of adults in education and training (whether formal, non-formal or informal learning); it is one of the main sources of data for statistics regarding EU lifelong learning. The AES concentrates on people aged 25-64 who live in private households. The reference period for their participation in education and training is the interval of twelve months preceding the interview.

Learning activities: these are any activities an individual performs with the aim to improve one's knowledge, abilities, and competences. The definition of intentional learning (unlike random learning) is that of deliberate quest for knowledge, abilities or competences. Organized learning is to be understood as learning mapped out in a pattern or sequence with explicit or implicit goals. The various types of learning activities are synchronised with a classification of learning activities (CLA), namely:

- **Formal education and training** means "education as it is provided within the system of schools, colleges, universities as well as other formal education institutions that usually represents a continuous "ladder" of full-time education for children and young people, which generally begins at the age of 5 to 7 and continues to up to the age of 20 or 25", http://ec.europa.eu/eurostat/data/metadata;
- **Non-formal education and training** means "any learning activities which are organized and sustained and which do not correspond entirely to the definition of formal education mentioned above. Thus, non-formal education may take place both inside and outside education institutions and addresses people of all ages", http://ec.europa.eu/eurostat/data/metadata.

According to national contexts, it may include educational programs which disseminate literacy, life-skills, work-related skills, and general culture among adult. There are four types of activities associated with non-formal learning that can be emphasised (details of those categories are not available in the online tables):

o Courses;

o Workshops or seminars;

o Instructor-led on-the-job training (scheduled periods of time allocated to education, instruction and/or training directly at the workplace, which the employer organizes with the support of an instructor);

o Lessons.

Informal learning (*only referenced in 2007 data in the domain **trng_aes_007h**)* means "learning which is intentional but less organized and less structured compared to the previous types. It may include a variety of learning activities (or events) for an every person, for example, some that occur in the family, some at work, and in their daily life , on a self-directed, family-directed or socially-directed basis", *http://ec.europa.eu/eurostat/data/metadata*.

The **education and training participation rate** refers to participation in both formal and non-formal education and training. Lifelong learning becomes possible through participation in education and training.

X3 - Eco-Innovation Index (%) - This index is based on 16 indicators from eight contributors in five areas: eco-innovation contributions, eco-innovation activities, eco-innovation products, environmental outcomes and socio-economic outcomes. The unweighted mean of the 16 sub-indicators is used in calculating an EU Member State's overall score. It shows the performance level achieved by individual Member States in eco-innovation as compared to the EU average, which is equated with 100. For 2010-2012, the average used for indexing to 100 is the average of EU-27. From 2013 onwards, the average used is calculated from the data for 28 EU Member States. The relevant target in the Roadmap is for an increase in the funding for research that contributes to the environmental knowledge base. Such increases will improve a Member State's positioning according to the index. Although the index is published annually, its sub-indicators are often not, so the index is a collation of the most recent data available each year. As its units are relative it cannot indicate progress in absolute terms.

Description of regression models

Regression analysis is used for explaining or modelling the relationship between a single variable Y, called the response or dependent variable, and one or more predictor, independent or explanatory variables (Xi). "We generally are interested in finding a weighted combination of some set of variables that reproduces or predicts as well as possible the values that we have observed on the response or outcome variable", Babyak (2004). "If this aim is achieved, the model we develop will predict well not only in the sample data set at hand but also in new data sets", Babyak (2004).

In this research study Multiple Linear Regression model Baltagi (2008), Freedman (2005) were applied to observe the influence of certain socio-economic factors on the economic development level. Our goal is to find and explain the relationship between the interest variable (GDP per capita in EURO) and particular independent variables. We chose several explanatory variables for testing.

In theory, the model takes the following form, given n observations:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + ... + \beta_p x_{ip} + \varepsilon_i , i = 1,2,...,n$$

with the equation having the following form:

$$\hat{y} = b_0 + b_1 x_{i1} + b_2 x_{i2} + ... + b_p x_{ip} , i = 1,2,...,n$$

b0, called intercept parameter, shows the value of the response variable considering the predictor variables as null. It is more useful in calculation since it does not have a definite significance.

The rest of bi parameters show how the response variable (y) modifies when a predictor variable (xi) changes with one unit, and all other variables remain constant.

“The sign of the parameters shows the type of relationship between the dependent and independent variables; when the parameter is below 0 they are related in a negative linear sense, when the sign is positive there is a positive linear sense”, Popa (2016).

The OLS - ordinary least squares method for estimating the unknown parameters in a linear regression model - is the most commonly used method, finding regression parameters that gives the best fit of dependent variable. Least squares method minimizes the residual sum of squares where the residuals (ε_i) are given by the differences between observed and expected values of response. In other words, we must find the theoretic values of the response as “close” as possible to the observed values. Residuals:

$$e_i = y_i - \hat{y}_i$$

Residual sum of squares (Sum of Squares for Errors):

$$SSE = \sum_i e_i^2 = \sum_i (y_i - \hat{y}_i)^2 = \sum (y_i - \beta_0 - \beta_1 \times x_i)^2$$

The confidence interval gives an estimated range of values for the estimated parameters, with a selected probability.

Data source and software used

In order to measure the dimensions of economic development, we established a set of indicators that have been selected on the basis of literature review and the available data in the from Eurostat database, http://ec.europa.eu/eurostat/data/database.

The comparability of data between countries is assured by the application of common definitions. The data refers to 28 countries (EU countries) in the reference years 2011 respectively 2014. The reason for choosing these reference years was data availability and to test the time evolution of the impact of independent variables (Eco-Innovation Index, School_Expectancy and Training) on the independent variable (GDP). To assure the comparability between countries for GDP we used GDP per capita. The data used in models are presented in Table 1.

To compute the multiple linear regression model the lm function in R was used Dusa et al, (2015). The goodness of fit of the model was established using the ANOVA function in R, and the confidence interval for the estimators was established using the confint function in R. In R, the lm function computes the coefficients. The output includes a table with parameter estimates and standard errors, residual standard error and multiple R-squared.

DATA USED IN MODELS

Table 1

Country	GDP_per capita_2011_ Euro	School_ Expectancy_2011 (years)	Training_2011 (%)	Eco_Innov_ 2011 (%) EU average=100	GDP_per capita_2014_ Euro
Belgium	34500	19.6	37.7	115	35900
Bulgaria	5600	16.4	26.0	67	5900
Czech Republic	15600	18.1	37.1	91	14700
Denmark	44200	19.6	58.5	138	46200
Germany	33700	18.1	50.2	123	37100
Estonia	12500	18.2	49.9	74	15200
Ireland	38000	17.3	24.4	118	41000
Greece	18600	18.1	11.7	59	16200
Spain	22900	17.7	37.7	128	22400
France	31500	16.5	50.5	99	32200
Croatia	10400	16.2	21.2	47	10200
Italy	27300	17.3	35.6	90	26500
Cyprus	23000	14.9	42.3	71	20400
Latvia	9800	18.1	32.3	77	11800
Lithuania	10300	19.1	28.5	52	12400
Luxembourg	81300	15.0	70.1	130	87600
Hungary	10100	17.7	41.1	83	10600
Malta	16500	15.0	35.9	82	19000
Netherlands	38500	19.0	59.3	109	40000
Austria	36800	17.1	48.2	125	38500
Poland	9900	18.1	24.2	50	10700
Portugal	16700	18.4	44.4	81	16700
Romania	6600	17.5	8.0	67	7500
Slovenia	18000	18.4	36.2	109	18100
Slovakia	13000	16.5	41.6	52	13900
Finland	36500	20.6	55.7	149	37600
Sweden	42900	19.8	71.8	142	44400
United Kingdom	29600	16.6	35.8	105	34900

Sursa: Eurostat, http://ec.europa.eu/eurostat/data/metadata

RESEARCH RESULTS

Model 1

The research authors aimed at identifying the relationship between the GDP per capita and the two indicators, namely School_Expectancy, respectively Education and Training, and a composite indicator in the field of eco-innovation. When selecting these indicators, we considered the following arguments:

- In time, numerous studies have emphasised the contribution of education to economic growth - Schultz and Denison in Suciu (2000), Beker (1997).

The originality of our research is the fact that we identify and emphasise those indicators in the domain of education and training which have a significant impact on economic growth. The purpose of the study is to bring scientific arguments to substantiate the future public policies with long-term significant impact on GDP growth;

- The School_Expectancy indicator captures also school drop-out. In our opinion, medium and long-term school drop-out may have a substantial effect on the potential for economic growth. Moreover, the results obtained by means of the econometric models employed confirmed this assumption;
- The indicator Participation rate in education and training captures lifelong learning. In the modern economy, where changes occur at very high pace, it is necessary to update the knowledge and skills specific to the human capital permanently, so that the latter contributes to economic growth Vaideanu (1998), Druker (1999);
- Eco_Innovation Index is a composite indicator which captures the research field.

The model tested in R software is:

GDP_per_capita_2011_Euro=β0+β1xSchool_Expectancy_2011+β2xTraining_2011+ β3xEco_Innov_2011

By running the multiple linear regression model in R software, the following equation is obtained, according with the results presented in Table 2:

GDP_per_capita_2011_Euro=34034.17-3109.69xSchool_Expectancy_2011+ 329.62xTraining_2011+ 346.57xEco_Innov_2011

THE RESULTS ON TESTING THE MODEL 1 WITH R SOFTWARE

Table 2

	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	34034.17	22074.28	1.542	0.136205
School_Expectancy_2011	-3109.69	1315.99	-2.363	0.026571
Training_2011	329.62	158.40	2.081	0.048286
Eco_Innov_2011	346.57	84.25	84.25	0.000395
Residual standard error: 9241 on 24 degrees of freedom Multiple R-squared: 0.7141 Adjusted R-squared: 0.6783 F-statistic: 19.98 on 3 and 24 DF p-value: 1.031e-06				

Parameters:

β1=-3109.69 - estimated difference in the GDP per capita with one point increase of School Expectancy. We can see that School Expectancy has the greatest impact on GDP per capita among the independent variables analyzed in model. As we expected it is a negative relationship between this variable and GDP because the school dropout decrease the capacity of human capital to generate economic increase.

β2= 329.62 - estimated the increase in the GDP per capita with one percentage point increase of Participation rate in education and training (Training) variable.

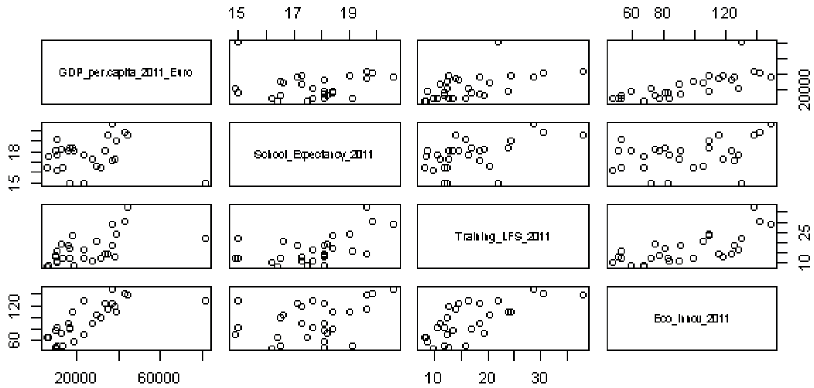
β3= 346.57 - estimated the increase in the GDP per capita with one percentage point increase of Eco-Innovation Index.

The estimated parameters have statistical significance at 95% level. The independent variables explain 71.41% of response variation (GDP per capita).

In Figure 1 we can see that there are correlations between the dependent variable and each independent variable.

THE CORRELATION BETWEEN GDP PER CAPITA IN 2011 AND INDEPENDENT VARIABLES

Figure 1



Model 2

The next model we kept the same variable independent but there is changed the dependent variable. We replaced the corresponding data of the indicator GDP per capita of 2011 corresponding to those in 2014. The goal is to see if the independent variables over time increasing their impact on the dependent variable.

The model tested in R software is:

GDP_per_capita_2014_Euro=β0+β1xSchool_Expectancy_2011+β2xTraining_2011+ β3xEco_Innov_2011

By running the multiple linear regression model in R software, the following equation is obtained, according with the results presented in Table 3 and Figure 2:

GDP_per_capita_2014_Euro=37452.64-3402.32xSchool_Expectancy_2011+ 356.86xTraining_2011+ 366.32xEco_Innov_2011

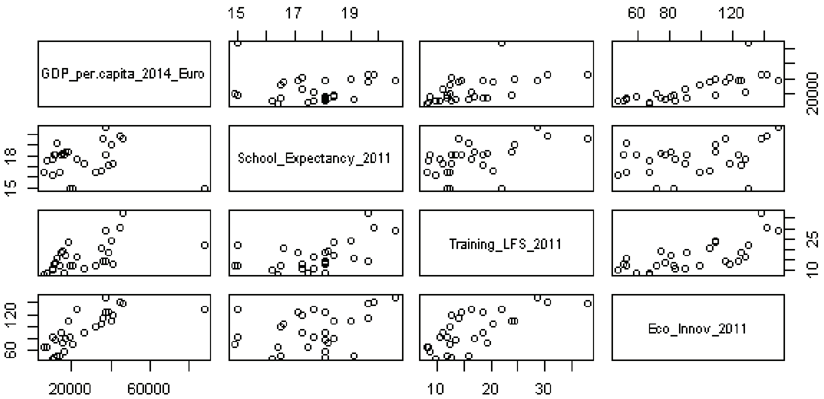
The results on testing the model 2 with R software

Table 3

	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	37452.64	23741.14	1.578	0.127762
School_Expectancy_2011	-3402.32	1415.37	-2.404	0.024305
Training_2011	356.86	170.36	2.095	0.046928
Eco_Innov_2011	366.32	90.61	4.043	0.000473
Residual standard error: 9939 on 24 degrees of freedom Multiple R-squared: 0.71 Adjusted R-squared: 0.6737 F-statistic: 19.59 on 3 and 24 DF p-value: 1.22e-06				

The correlation between GDP per capita in 2014 and independent variables

Figure 2

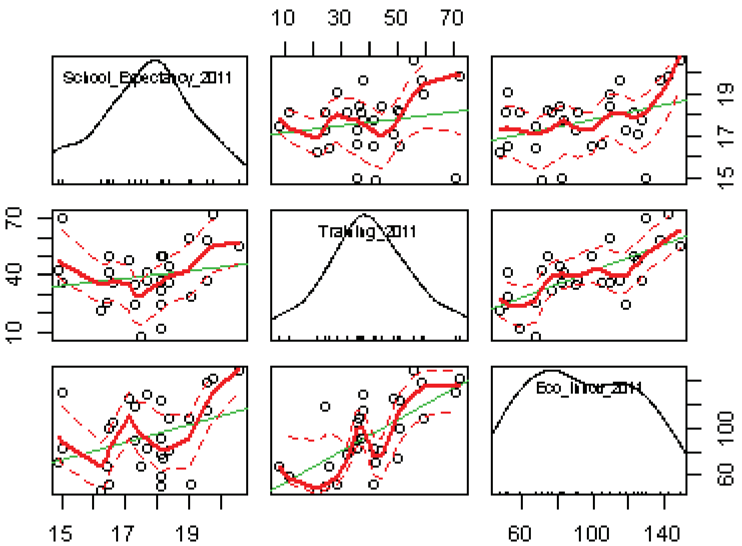


The estimated parameters have statistical significance at 95% level. The explanatory variables explain 71.0% of response variation (GDP per capita). In this situation, it was estimated that the increase of GDP per capita in 2014 across the EU countries are influenced by education patterns (measured by school expectancy and formal and non-formal training of population) and eco-innovation level registered in 2011 (three years lag).

Testing the multicolinearity of the models, it appears a medium intensity level of correlation between explanatory variables *Training* and *Eco-Innovation* (figure 3). For example, the correlation between the result and an explanatory variable might be changed when another predictor is introduced into the model.

Symptoms of collinearity in multivariable regression

Figure 3



Taking into account the definitions and the methodologies to produce data for the indicators under observation, isn't a correlation based on calculation methodology but it obviously that the correlation could be explained: more developed EU member states are characterized by higher levels of eco-innovation outcomes (environmental protection activities have a higher impact on economic and social development). In the same time, all these countries have lifelong learning more developed then less developed EU countries. In this case, multivariable analysis is a useful instrument, yet only if its users have thorough/ full understanding of the premises and drawbacks of these methods.

CONCLUSIONS

During our research, we tested the same model for GDP per capita for 2011 and 2014. In the analysis of the independent variables coefficient considered, we notice an increase over time of their impact on the dependent variable. For example, the impact of the training factor for the year 2011 on the GDP increases from 329.62, if we start from the first model with GDP per capita in 2011, from 356.86, and compared to the second model with GDP per capita in 2014. Consequently, the public policies aimed at stimulating lifelong learning and decreasing school drop-out, respectively at developing eco-innovation, may have a significant impact on the evolution of the GDP. Simultaneously, the public policies in the field of education have a multiplying effect over time. In terms of the investment in education, this is an obvious aspect, as a better trained individual is much more active on the labour market and triggers a positive effect on economic growth.

At the same time, the results of the eco-innovation process may have a certain delay in capturing the impact on the GDP. These empirical assumptions were emphasized by means of econometric tools, in the two multiple linear regression models. In their future research, the authors aim at testing the models again (based on the new statistical data available) because the models may exhibit certain errors caused by the change in the manner of calculating the Eco-innovation Index (%) indicator in 2013 as compared to 2011. Yet, in the analysis of the two models, we notice that emphasizing such an error, this cannot be significant and it may affect only the importance of the cumulated impact of this indicator on the GDP per capita over time.

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