

STOCHASTIC MODELING OF ROMANIAN PRE-UNIVERSITY SYSTEM VARIABLES

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ABSTRACT:

*This study is based on analyzes of comparative statistical correlations in education based on secondary data provided by the Romanian Statistical Year book characterizing the Romanian pre-university education system. **The originality** of this work lies in combining research methods and statistical techniques used for time series for characterizing macroeconomic variables of the education system as school population, number of teachers in secondary education, the number of graduates, the degree of inclusion in education, and GDP allocated to education.*

***The objective of this paper** is to present the general frame work of the Romanian pre-university education system in order to identify the general features and areas where steps can be taken to improve the quality and increase efficiency. The Romanian educational system is seen in its correlation with the labor market inducing the need to reorient and reconvert graduates according to the needs of the labour market.*

Keywords: correlation and regression method, pre-university education system, factorial analyses, macro-economic indicators, primary cycle, secondary cycle, vocational school.

1. INTRODUCTION

World wide the educational system is facing the new communication technologies and knowledge, with in globalization and multicultural communication. In order to establish key indicators necessary to analyze the educational standards achievements, the components of under graduate education reform should be considered as the development of new curriculum, the new text books written, permanent training for teachers, modernization of assessment and examination, the introduction of occupational standards and certification and the management of financing for schools.

Strongly linked to the primary cycle, the secondary educational system distinguishes itself from it by a number of distinct features: the schools are larger and are not placed on isolated locations. The gymnasiums dispose of a surplus of school spaces, even if most part of the spaces are used in common with the primary cycle. The average size of a class is also larger than in the primary cycle. In terms of efficiency analysis primary, the first problem that arises is that of the difference between grades in urban or rural areas. Besides the strong influence of the location of the school over school results, there are other factors that

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determine educational effectiveness of primary education, for example, the influence of teaching time and teacher characteristics and credentials.

Education Reform in Romania has gone through several stages and took into account mainly the restructuring of the educational system and educational programs, according to the economic and social needs and demands in Romania especially during the crisis, and in accordance with guidelines and changes in Europe. As a consequence of the crisis, the insertion rate of graduates with different levels of education and professional training on the labour market follows the external efficiency assessment of the educational system and its degree of adaptation to the needs of the labour market (Summaries - Economic status and social-Romanian Statistics, National Institute of Statistics 2009).

Regarding the secondary cycle, this is a system with reduced volume compared to the primary one and it is characterized by a relatively higher autonomy. Characteristic to this type of schooling is the large number of pupils per teacher. The demographical tendencies led to a decrease in the school-aged population. Along with the school-aged population's decline (2006-2012), a decrease with 159 thd. persons of the population comprised in the educational system also occurred (2004-2005), from 4549.8 thousand to 4390.8 thousand (Romania in figures statistical abstract, the National Institute of Statistics, 2005). The negative demographic tendencies affected drastically the number of pupils within the primary cycle, which must comprise the whole population of the appropriate age. At the secondary and professional level of education, due to the increased demand for education in such training units, the number of pupils increase in spite of the demographics decreases. In early 2011 a new law on education putted together all the detailed aspects of academic management, evaluation, bench marks of good practice in scientific research. (Social and Economic Status, Summaries, National Institute of Statistics, 2012).

The results of the national education system are measured by indicators expressing its ability to create potential skilled labor necessary, adapted to the requirements of economic and social development. Such education system should also provide abilities and skills of the school population, a more flexible educational offer, based on a correlation between the number of graduates and the demand for labor, for all fields. (Social and Economic Status, Synthesis, National Institute of Statistics, 2011 and 2013).

The total number of graduates from under graduate education of successive declined during 2001-2012, reaching in 2012 a value of 497 116 graduates. This is due to lower degree of preparation and interest of students enrolled in under graduate education, the impossibility of continuing studies for a large part of them as a result of the economic crisis that has led to lower standards of living for the people of Romania.

According to World Bank reports, one of the main issues characterizing Romanian education is the low quality of the education system. The changes were not significant even after budget allocations have increased (more than doubled from 2005 to 2008). Interim Report *"Detailed work program on the implementation of the objectives of education and training in the European Union"*, approved by the Council of Ministers of Education (Bergen, 2004), signals failures: the reforms

introduced by the Member States are too slow; progress is sufficiently persistent gap between Europe and its competitors.

OECD-PISA reports (national report of the administration of the program: 2005-2006) considers the problems of education in the pre-university education emerge clearly from the results of international tests PISA, TIMSS and PIRLS. The same report stated that globally, Romania ranked 47 out of 57 participating countries, placing it behind countries such as Chile, Uruguay, Jordan and Thailand. The study of motivation in learning and social success (Institute of Education Sciences, 2005) speaks strongly about emigration young teacher demonization and lack of interest in education. The Bologna Process and the Lisbon process draw the lines of the European education and quality assurance in education. Lisbon European Council determined that by 2010, Europe should become "the most competitive and dynamic economy based on knowledge and able to sustain rapid economic growth with more jobs and better". Barcelona European Council adopted the "Program details working on implementing the objectives of education and training in the European Union" become a reference for the development of European policy in education.

Finally, the most pertinent conclusion regarding the evolution and changes in the educational system in Romania are highlighted by the National Education Law, issued by Ministry of Education (National Education Act, 2011), which emphasizes that the educational ideal of the Romanian school is the free, full and harmonious development of human individuality in personality formation autonomous and assuming a value system that are necessary for personal fulfillment and development, entrepreneurship development for active citizen participation in society, social inclusion and employability.

2. RESEARCH METHODOLOGY

The process of statistical analysis considering the organization and completion of several distinct and successive stages which include data selection, summarizing and processing, analysis and results interpretation. Statistical methods applied in education were based on secondary data research, i.e. the data from the Romanian Statistical Yearbook published by the Romanian NIS and other public publications. The main variables used in this case are macro-economic variables that describe the educational system such as the degree of coverage in education of all school-age population, the population with pre-university education, real GDP in education and pupils enrolled in pre-university education system. The analysis and modeling (multiple regression and correlation method, statistical analysis of descriptive indicators, testing the validity of regression models) will be achieved with the help of special econometrical software (Cristache, Vuta, Gruiescu et al, 2011).

The relation between the variables is illustrated both graphically and using an equation. (Mitrut C., Serban D. 2007). Correlation method leads to pertinent conclusions even it is difficult to measure the set of all causal factors and their socio-economic effects.

The choice of these methods was motivated by the following objectives: the accurate quantification of the effects produced by all the factors, selecting the main factors, and measuring the intensity of correlation existing between indicators characterizing pre-university educational system. Statistical analysis aim first to identify correlations, identifying and prioritizing their influence, followed by the analysis of the forms that show causal relations and statistical measurement of the degree of correlation. Multifactorial ANOVA also allows analysis of the indicators characterizing educational system activity due to several factors and default comparison typical values in order to determine whether there are significant differences between them (Andrei, Stancu, Iacob et al, 2008). However, in the multiple correlation, variable shave different influences on the variable factor the result; some exerts a significant effect on the phenomen on and must be taken into calculations of regression and correlation, while others have as hare less important and can be neglected.

Analysis of dependencies between variables that characterize the pre-university educational system in Romanian

Educational quality assessment process is performed based on the main results of the educational activity, based on a set of statistical indicators that reflect students 'graduation, the baccalaureate results, and dropout rate.

Measurement methods and statistical techniques, factor analysis, estimation and testing are represented by anextensive and varied lot of procedures and statistical and mathematical tools. In this case the regression analysis covers the following stages: developing the regression model and estimating the model parameters, checking the accuracy of results.

Model 1. Financial Factors influencing the pupils enrolled in pre-university education system. Analysing the evolution of pupils enrolled in pre-university education system during 2001-2012, according to independent variables as real GDP evolution in education, average monthly real net salary in education and real net investment in education, determined the result obtained for the multiple regression function using the multiple linear regression:

$$\hat{y}_{x_1, x_2, x_3} = 2963,63 - 0,146x_1 + 0,442x_2 - 0,076x_3 \quad (1)$$

Checking the accuracy of the multiple regression models and of the multiple correlation ratios, based on "Fisher" criterion, it leads to the following conclusion that for the significance level of 5% the multiple regression models is valid.

The slope, has the value 0.14, which means that when the real GDP is bigger by one million euro, the number of pupils enrolled in pre-university system is expected to be bigger with 0.14 persons. Since $p\text{-value} = 0.008 < 0.05$ it means that the coefficient of regression is valid at a significance level of 0.05. The second slope b_2 has the value 0.44 which means that when the real net investment from education branch growth with one million euro, the number of pupils enrolled in pre-university system in education will increase by 0.44 persons. Since $p\text{-value} = 0.004 < 0.05$ it means that the second slope coefficient is significantly different from

zero for a significance level of 0.05. The third slope, b3 coefficient, has the value of 0.07, which means that if the real average net monthly salary in education increases at all levels with one unit this will determine the number of pupils enrolled in pre-university system to decrease by 0.07 persons. Since $p\text{-value} = 0.43 > 0.05$ it means that the coefficient is not valid for a significance level of 0.05.

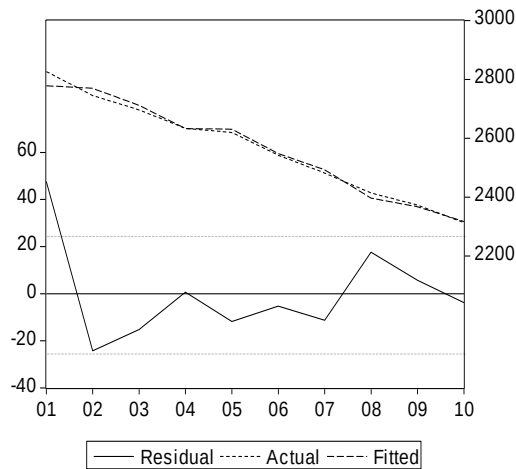


Fig. 1. Actual, Fitted, Residual Graph

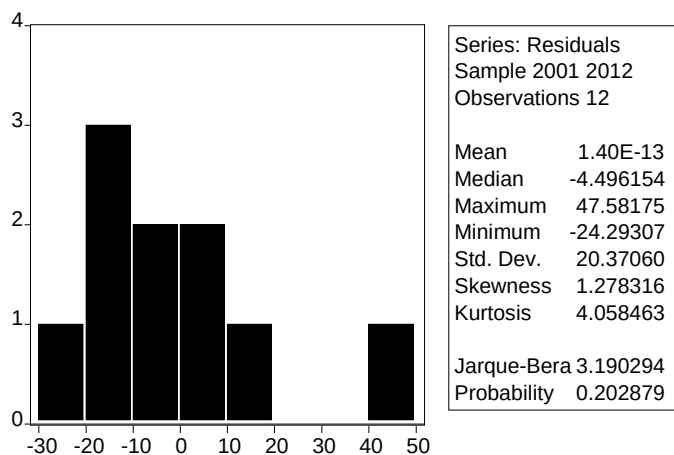


Fig.2. Histogram-Normally Test

The chart trend (see Figure 1) of macro-economic indicator used in Model 1, to characterize the activity of teaching considers as dependent variable the number of school students in the period 2001-2012 which had a decreasing trend while the factorial variables included in model 1, real GDP allocated to education, educational investment and actual net average earning of education, had an ascending evolution. One possible main cause is the pupils abandoning school phenomenon on that had repercussions of increasing illiteracy

rate in our country. Together with the economic crisis the result was the impoverishment of the population. The Durbin-Watson test, used in the errors autocorrelation analysis, in Model 1 case, has registered a computed value $DW=1.82$, value which was compared with the critical statistic values for $\alpha=0.05$, $p=4$ and $n=12$; $d_1=0.82$ and $d_2=1.75$ indicates the errors are positively auto correlated. Verifying the normality of errors using Jarque-Bera test one observes that the computed value $JB=3.19 < \chi^2_{table}=9.49$ which means that the errors are not normally distributed (see Figure 2). The model is affected by multicollinearity also representing correlation between regressors, so a further development would be to eliminate regressors and develop simple regression models analysis (see Table 1).

Table 1. Correlation Matrix for model 1

	Average monthly real net salary	Real net- investment in education	Pupils enrolled in pre-university	Real GDP in education
Average monthly real net salary	1.000000	0.810114	-0.963891	0.981111
Real net-investment in education	0.810114	1.000000	-0.696173	0.848675
Pupils enrolled in pre-university	-0.963891	-0.696173	1.000000	-0.964468
Real GDP in education	0.981111	0.848675	-0.964468	1.000000

In further analysis to allow the analysis of correlation between the dependent variable number of students in pre-university and factorial variables included in Model 1: Real GDP allocated to education, net real investment in education and net average earning education is characterized by relatively stable homoscedasticity using White test errors. White test is a statistical test which takes as its starting point the explanation of the observed errors in relation to one or more exogenous variables. (Voineagu V. et al, 2007). Interpreting E Views results it shows that $F_c = 220.8 > F_{0.05;3;8} = 4.07$ and $LM = 9.97 > \chi^2_{0.05;3} = 7.81$, and estimators for model parameters are insignificant for the level of significance $\alpha = 0.05$ ($t_{0.05/2;8} = 2.306$). So homoscedasticity hypothesis is verified. One of the main reasons for this development indicators characterizing work force of pre-university education system is to increase the unemployment rate of young people aged 15-24 years, the most significant share of them in young people with primary or no education. This is due to unfavorable failure to adapt the educational system to labor market requirements.

Model 2. Human Resources Factors influencing the Pupils enrolled in pre-university education-system

Analysing the evolution of the pupils enrolled in pre-university education system during 2001-2012, accordingly to the causal variables as pay of the pre-university graduates, number of Baccalaureate graduates of the pre-university level, tertiary

population with pre-university education give the linear function using the multifactorial linear regression model 2 (see Table 2):

$$\hat{y}_{x_1, x_2, x_3, x_4} = 2017257 + 1.97x_1 + 0.76x_2 - 31857.68x_3 \quad (2)$$

The correlation intensity between this model's variables measured using the multiple correlation ratios (0.92) suggests that this correlation between variables is strong and direct.

Table 2 Multiple correlations between pupils enrolled in pre-university system in education as redundant variable and pay of the pre-university graduates, number of Baccalaureate graduates of the pre-university level, tertiary population with pre-university education as factorial variables-Model 2

Dependent Variable: Pupils enrolled in pre-university				
Method: Least Squares				
Sample: 2001-2012				
Pupils enrolled=C(1)+C(2)*Number of Baccalaureate graduates +C(3)*Pay of graduates +C(4)*tertiary population				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	2017257.	1197036.	1.685210	0.1358
C(2)	1.979357	1.713451	1.155188	0.2859
C(3)	0.764346	3.718019	0.205579	0.8430
C(4)	-31857.68	22122.74	-1.440042	0.1930
R-squared	0.839294	Mean dependent var		2530955.
Adjusted R-squared	0.770420	S.D. dependent var		194063.4
Log likelihood	-138.9645	F-statistic		12.18595
Durbin-Watson stat	0.943224	Prob(F-statistic)		0.003623

The coefficient of determination shows that 83.9% of the variation in pupils enrolled in pre-university system in education is explained by the influence of variables such as: pay of the pre-university graduates, number of Baccalaureate graduates of the pre-university level, tertiary population with pre-university education, holding other variables constant. Checking the accuracy of the multiple regression models and of the multiple correlation ratios, based on "Fisher" criterion, leads to the following conclusion: because the probability Sig. F is less than 0.05 the multiple regression models is valid, for a significance level of 0.05. The slope, b1 coefficient, has the value 1.97, which means that number of Baccalaureate graduates of the pre-university branch growth of one person, some with a measure of pupils enrolled in pre-university system in education will increase by 1.97 persons. Since p-value = 0.28 > 0.05 it means that the coefficient of regression is not valid for a significance level of 0.05. The second slope b2 has the value 0.76 which means that the pay of graduates of the pre-university level branch growth of one thousand lei pupils enrolled in pre-university system in education will increase by 0.76 persons. Since p-value = 0.84 > 0.05 it means that the coefficient is not valid for a significance level of 0.05. The

third slope, b3 coefficient, has the value of 31858, which means that tertiary population in pre-university education increases at all levels with one persons, the pupils enrolled in pre-university system in education will decrease by 31858 persons. Since p-value = 0.19>0.05 it means that the coefficient is not valid for a significance level of 0.05 (see Table 2).

Verifying the normality of errors using Jarque-Bera test one observes that $JB_{calc}=0.69 < \chi^2_{table}=9.49$ which means that the errors are not normally distributed (see Figure 4).

The Durbin-Watson test, used in the errors autocorrelation analysis, in Model 2 case, has registered a computed value $DW=0.94$, value which was compared with the critical statistic values for $\alpha=0.05$, $p=4$ and $n=12$; $d1=0.82$ and $d2=1.75$ indicates the errors are positively auto correlated.

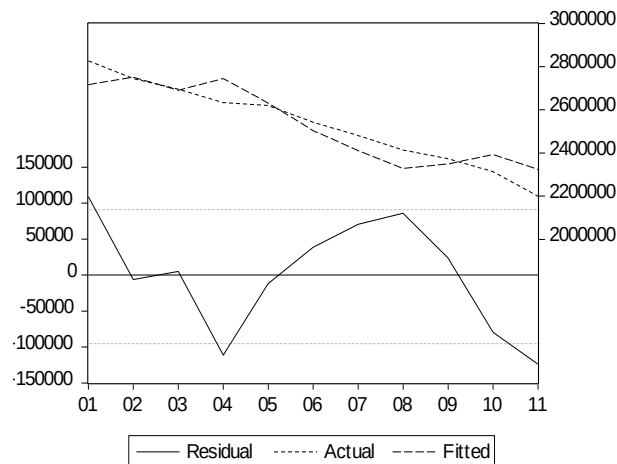


Fig.3. Actual fitted, Residual Graph

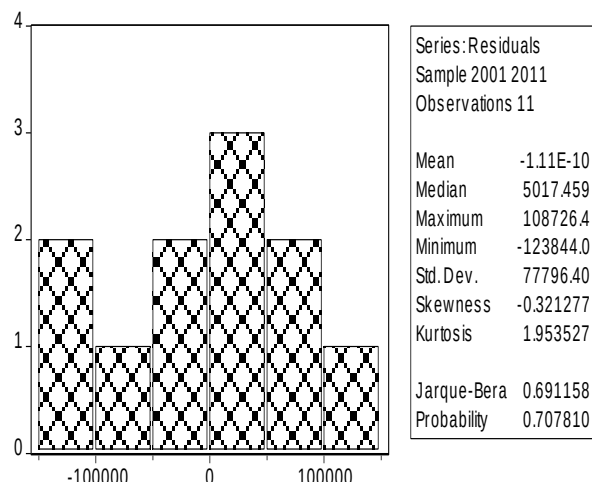


Fig. 4. Histogram Normally Test

Corresponding reduction in the number of primary and secondary schools will continue in the coming years, according to demographic projections, would generate implications for human resources in terms of quantity, and even in terms of network design school, especially in rural areas.

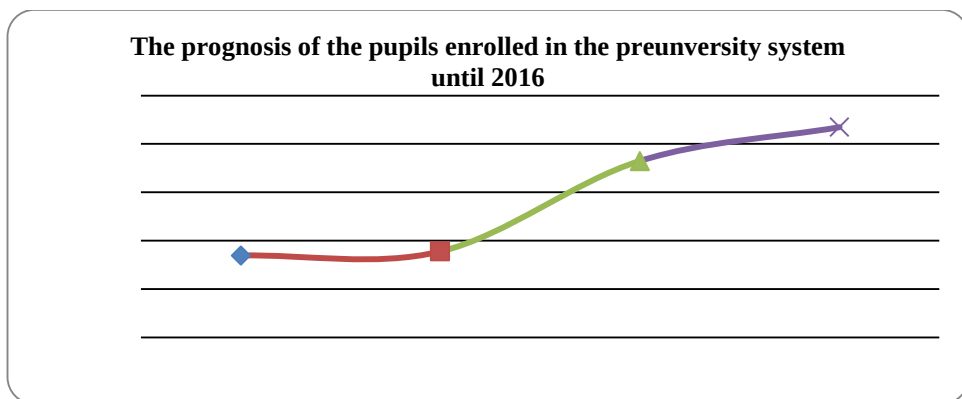


Fig. 5 The forecast of number of pupils pupils enrolled in the preuniversity system until 2016

In conclusion demographic forecasts negative affect drastically the number of pupils in primary and secondary education which, at least theoretically, should include the entire population of the corresponding age. In the hypothesis that the other factors will be registered the same trend with that between 2001 and 2012, we made short time prognosis until 2016. In our country, the ministers of the Education system are replaced in every two years and it is very hard to make prognosis on long term. In figure 5, we can conclude that the number of the pupils enrolled in the pre-university educational system will slow increase.

3. CONCLUSIONS

The result of the national education system is measured by indicators expressing its ability to create potential skilled labor necessary, adapted to the requirements of economic and social development.

The increase in the rate of participation at all levels of education is primarily the consequence of increasing the participation in higher education. Also, in recent years it is found according to the National Institute for Statistics that the school dropout affects more the school population especially in rural areas. The distances between the villages and their respective gymnasiums as well as the lack of proper transportation determine this rate of dropout (Romanian Statistical Year Book-National Institute of Statistics, 2012). In conclusions the negative demographic tendencies are drastically affecting the number of pupils within gymnasium and primary cycle, which, at least theoretically, must comprise the whole population within the school age.

In the context of a European platform for economic recovery after the economic crisis and transformation, the development of education is a major objective in the Europe 2020 strategy.

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