EU practices of education staff planning (Application of econometrics models)

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Summary

The aim of the paper is to give an overview of the real situa-tion, experiences and developments in planning the education system staffing with the use of Econometric Models in Kosovo. Based on the research results and theoretical/scientific achieve-ments as well as practices in the field of these models in EU Coun-tries and wider, suggest application of these Econometric models to Kosovo Institutions for the purpose of adequate planning of needs for new cadre in the education system based on certain le-vel of economic development. The paper will in present the ma-thematic-economic dimension of the research of education system in a thorough manner. The paper does not analyze the complica-ted network of interaction between education in one hand, and other components of life quality on the other hand, and does not make a research of the education system quality, but rather the quantitative aspect of education system, as a sub-system of the social system in general. Education is not only limited to produc-tion of knowledge, but has an irreplaceable role in creation of many other cultural values. The paper is dedicated to Econometric Modeling in general, where the three internationally recognized models, the relatively complicated education models, and the relatively simple model but in our view very practical as a forecast models namely the regression model, have been presented in an analytical manner.

The research results indicated that there is great interdepen-dence between the economic growth norm in the country in one hand and the attained educational results on the economy of knowledge on the other hand. The interdependence between the number of workers and their qualification structure and the re-sults attained in the education field in models, was expressed through equations. The Empiriev model as a concrete model for planning the necessary education cadre for certain levels of economic development is based on the basic model of Tinbergen – Bos. The coefficient values of regression ref-lect the form and intensity

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of interdependency between the number of students per million inhabitants and the national income per capita.

***Key words**: Econometric models, educational system, planning staff, nece-ssities staff, economic development,*

Foreword

As the education sector particularly requires the efficient use of limited resources, a reasonable requirement emerged for the establishment of a separate area, namely, Education Economy. This area should also include the issue of assessment of Education Economy. There are several levels in education which may be considered as analogical to the generation system through which people undergo to with the aim of acquiring certain qualifications, or drop-out of the process.

Econometric Models should be used as measures to determine the labor market needs for various qualifications, needs which should be filled by the Education system. Creation of any development policy, in particular education policies, without any basis to the econometric analysis has a higher failure risk than decision-making based on modern economic-statistic-mathematic model.

Economic trend measurements through Econometric Modeling are a today's necessity. The Education Econometric Model is a presentation in form of mathematical relations, which combine two or more variables, and one of them is related to the education sector. The modeling methodic for education is an outcome of a methodic of several applicable economic areas. With the exception of Economy, Modeling is rather underdeveloped, and less testable in practical reviews of social phenomena. However, results achieved in the recent years should not be underestimated. Therefore, it is necessary to explore know-how in building Econometric Models.

The product generated in the education system is called knowledge; hence the 21st Century Economy is rightfully called the Economy of knowledge. Hence, the focus of today's economic analysis is the human and his intellectual skills.

A. The use of basic Econometric objectives in Education development policies

Application of econometric models on education governance first appeared in the sixties.

Econometric models are yet to be used in our country on forecasting and planning education requirements.

Models should be used to explore quantitative relations between the projection of the number of pupils and students of universities, higher and high on one side, and economic growth parameters on the other.

The following are the three main objectives of econometrics [1]

1. Testing economic theories on the analysis of reality, with the aim of better understanding and explaining economic phenomena and activities – Formulation of the Econometric Model
2. Assists economic policies, respectively extracts numerical values of economic relation coefficients which can be used in decision-making (in terms of assessing or improving decisions and measures – namely assessment of econometric model parameters).
3. Development of predictions means the use of numerical evaluation of coefficients in order to predict future values of economic variables (development of predictions for the education system according to the econometric model)

A modern societal community can survive and fully develop if the required knowledge is available [2]

B. Model

The Model represents an *idealized* view of the situation it explores, and includes all components critical for the real circumstances. The Model is defined here as an idealized view as it only focuses in the vital aspects of the occurrence, or a combination of occurrences, excluding less important aspects entirely. Hence, the Model becomes part of the regular scientific instruments which, through scientific research isolates only the essential features of the occurrence in question, in order to explore legal and systematic connections between several components, thus creating possibilities for their future prediction[3]

Bross[4] consequentially distinguishes the <<real world>> of the original from the <<symbolic world<< of the model, also providing an outline of the interaction between the two worlds in the modeling process << .

Modeling

Modeling is a procedure in which a system called the original is presented (modeled) through another system, namely a model[5]

Econometric models

From the inception of the development of econometrics, according to O. Lange, three types of models have been created:

Conjuncture Econometric models

Market Econometric models

Operational research Econometric models [6]

B1 Econometric models used in education today

Econometric Models used in education can be divided as follows.

1. Global education models
2. Schooling models
3. Student communion parametric models
4. Teachers' offer and demand models
5. Resource models
6. Education relation with other branches of the society models
7. Institutional models
8. Programming models

B2 Mathematical models of the education system according to OECD

A OECD study on education system mathematical models as a subsystem of the societal system[7] produced an extensive and rather interesting list of econometric modeling objectives;

Policy-making facilitation models

1. Models as a means for decision-making
2. Models as a means for specific problem-solving
3. Models as a means for planning and leadership
4. Models as a means for conflict resolution
5. Models for discussion on alternative solutions
6. Models as a facilitation for analysis performance
7. Models for control
8. Models for information
9. Models for the presentation of the estimated reality
10. Model as an idealized system
11. Models as an expression of the "blueprint" of reality
12. Models as a presentation of new predictions
13. Models which serve for other objectives
14. Models as an ideological weapon
15. Models as pedagogical means
16. Models as confusion and deception.

I Timbergen - Bos model[8]

In the seventies, this model enjoyed a large interest not only for the scientific and public parts of the globe, but also for Governments of developed and underdeveloped countries and various international organizations.

This model was used in Greece, Italy, Yugoslavia, Spain and Turkey as part of interdisciplinary studies, the so-called "Mediterranean Project".

Timbergen and Bos studies represent a summary of several articles which comprise the methodological basis for six separate studies which analyze the situation in the aforementioned Southern European countries. Its title is: "A planning model for the educational requirements of Economic Development". This model is divided into the nine following chapters:

1. Introduction
2. Some applications of the basic model, Generalizations to be considered
3. Generalization of demand functions
4. Sectorial desegregation of production and its manpower requirements
5. Drop out
6. Alternative treatment of retirement
7. Increase of the number of education processes
8. Using smaller time units
9. The elimination of surpluses of the labor force

The Model is described as follows:

$$(1)$$

$$N_t^2 = (1 - \lambda^2) \; N_{t-1}^2 + m_t^2 \qquad (2)$$

$$m_t^2 = n_{t-1}^2 - n_t^3 \qquad (3)$$

$$m_t^3 = n_{t-1}^3 \qquad (4)$$

$$N_t^3 = (1 - \lambda^3) \; . \; N_{T-1}^3 + m_t^3 \qquad (5)$$

$$N_t^3 = \nu^3 \; u_t + \pi^2 \; . n_t^2 + \pi^3 \; n_t^3 \qquad (6)$$

Where:

ν = total volume of production (income) of the country

N^2 = the labor force with a secondary education

N^3 = the labor force with a third-level education

m^2 = those who have entered the labor force N^2 within the previous 6 years

m^3 = those who have entered the labor force N^3 within the previous 6 years

n^2 = the number of students in secondary education

n^3 = the number of students in third-level education.

The Authors comment the model equations as follows:

Equation 1: The labor force with a secondary education is used for production only and must develop proportionally with the volume of national production (where ν – is the coefficient of proportionality and t – is a certain period of time).

Equations (2) and (5): The labor force consists of those already in it, one time unit earlier and those who have joined it during the previous 6 years. It is

assumed that a proportion λ^2 and λ^3 respectively of those already in the labor force one time unit earlier has dropped out due to death or retirement.

Equitation 3: The number of newcomers to the labor force with a secondary education is equal to the number of students from precious years, minus the number of students now on third-level education.

Equation 4: The number of newcomers to the labor force with a third-level education is equal to the number of third-level students one time period earlier.

Equation 6: The labor force with a third-level education consists of those employed in production, and is assumed to be proportional in numbers to the volume of production, and those teaching at both levels of education and assumed to be proportional to the respective student numbers (where π^2 and π^3 are coefficients of proportionality – our remark)

The following coefficient values have been found in numerical calculations

v^2, v^3, λ^2 , λ^3 , π^2, π^3

The interpretation of the last two coefficients π^2, π^3 indicates the number of students per one teacher (e.g. 25 students per one teacher, namely 12 students)

II Emmpirijev model[9]

This model represents a concrete application of the Tinbergen-Bos basic model for the planning of required education staff for certain economic development levels.

By means of a simple mathematics -

The Empirijev model includes the interdependence between the basic model and economic growth in Spain

Title of the original is: L. J. Emmerij: "Planning Models for the Calculation of Educational Requirements for Economics Development – Spain" and consists of the following chapters:

1. The Spanish Educational System
2. Application of the original model
3. Breakdown of the economy into sectors
4. Introduction of Drop-out and Effective period of study
5. Changing Coefficients
6. Types of labor force and education
7. A marginal approach

Application of the original model

The original Tinbergen-Bos model with six equations is described above.

According to the Emmerijev data, the following coefficients should be calculated

The value of coefficients v^2, v^3, is calculated according the values expressed for the Gross National Production in billion Spanish pesetas (according to the prices of 1960) and the number of employed persons in 1960 with a secondary and higher education, expressed in thousands. The Author states that there were difficulties in calculating coefficients λ^2 and λ^3, measuring deaths and retirements of the second- and third-level manpower stock respectively. These values are affected by the age of employees. In the case of a country where this growth has been relatively low in the past and where the number of middle and high level personnel has to increase rapidly in the future, the values λ^2 and λ^3 will fall rapidly over time. The last two coefficients π^2, π^3 indicate the number of students per teacher (e.g. 25 students, namely 12 students per one teacher)

The level of deaths and retirement of employees according to age groups was developed by **Amatya Sen) 10** , OECD expert, and member of the study group on education economy.

Sen indicates the dynamics of the level or retirement and deaths of employees. With the labor force generation getting older, this level also increases. The number of secondary education employees in the period,, t ,, N_t^2 can be expressed as a sum of the number of newcomers in the labor market throughout the years (m_t, m_{t-1}) amended according to the level of reduction of employees due to death and retirement $(1-\lambda_t^2, 1-\lambda_{t-1}^2)$. Hence, equation (2) can be expressed as follows: $N_t^2 = m_t^2(1-\lambda_t^2) + m_{t-1}^2(1-\lambda_t^2)(1-\lambda_{t-1}^2) + m_{t-2}^2(1-\lambda_t^2)(1-\lambda_{t-2}^2).....,$ respectively $\lambda_{t-r}^2 = 1$ where r is the number of required periods to reach the right to retirement. Determination of such values, as the author notices, is not an easy task, as we have to possess reliable data on the labor force employed every six years, and which go back 50 years.

These values have been calculated by assuming an average active life of secondary education employees N^2 is 48 years of age (17- 65), and the third-level education employees N^3 42 years (23 - 65). By applying the real death rates, the following coefficients are reached for all age groups λ^2, and λ^3 as below.

The model explains further that economic growth in Spain is 6% annually, namely 42% for 6 years. The increase of all variables will be thus expressed through the exponential equation; $Z_1 = Z_0(1.42)^t$

Real values of life four variables in the 1960s are:

Hence, the model suggests that Spain in 1960 to achieve an economic development of 6% per annum has had a sufficient number of labor force with secondary and tertiary education, and a sufficient number of students in secondary and tertiary schools, with, however, an insufficient number of students in post-graduate studies.

III Grozdast model[11]

Here, we will briefly present another model which indirectly forecasts the educational needs in the sense of the examination of the correlation between the employment rate on one side and the social productivity rate on the other.

This model analyzes the efficiency of labor force, which is in close functional relation with their real productivity.

The links to our problems is twofold. We will provide an overview of the so-called Grozdast Model, presented by Galenson and Piata[26]

The Grozdast model of economic development includes the review of economic relations between the production factors, labor and capital, which are viewed, for the purposes of this analysis, from a complementing perspective.

This model starts with a presentation of the most common production factors and concludes with a complicated mathematical presentation of a wide range of factors.

This model includes a considerable number of factors and parameters, which impact on the dynamic of the economic reality.

The model initially addresses production factors: labor and capital. Investments require the selection of one of the alternative technologies, whereas the selected technology determines the need for labor force and capital. In capitalistic production circumstances, technology is used only in the extent that is profitable. If they fail to bring profit, technologic appliances and capital are not utilized, whereas the labor force seeks employment in another facility.

The increased volume of production in a given year (ΔY), represents the difference between the production volume of the new ward (X), and the production volume observed in the period (X^s), respectively

$$\Delta Y = X - X^s \qquad (1)$$

The difference in labor force employment is also determined in a similar fashion, with the number of employees that lose their employment status after the closing of the ward (N^s) subtracted from the general number of employees in new capacities (N).

$$\Delta L = N - N^s \qquad (2)$$

By multiplying the equation with the production cost (p) and the profit per working unit (w), and subtracting the equations, one comes to the equation:

$$p \cdot \Delta Y - w \cdot \Delta L = (pX - wN) - (p \cdot X^s - w \cdot N^s) \quad (3)$$

The equation on the left represents the difference in profits. On the right side we have the expressions between brackets. These two expressions represent the difference in income and profit, with the first expression representing the relation of the new installed capacities and the second representing the closed ward. As the old (decommissioned) ward was not profitable, the expression in the second bracket is annulled and the equation can be reduced as follows:

$$p \cdot \Delta Y - w\Delta L = pX - wN \quad (4)$$

This model no also includes a variable – investments (I), which represent the expenditure for goods that occurred during the previous year. By finding the ratio between profit (p X – w N) and investments (I), one finds the rate of increased investments, or the profit rate (r), i.e.:

$$r = \frac{pX - wN}{I} \text{ respectively} \quad (5)$$

$$p\Delta Y - w\Delta L = r \cdot I \quad (6)$$

Whereas the expression $\frac{I}{pX - wN}$ represents the period for return of investments [27]

The sum of the equation (6) completed by $\frac{1}{py}$ brings about the following expression, which is the fundament of the research:

$$\frac{p\Delta Y}{pY} - \frac{w\Delta L}{pY} = \frac{r \cdot I}{pY} \quad (7)$$

Which, after the regulation, derives as

$$\frac{\Delta Y}{Y} = (\frac{w \cdot \Delta L}{pY}) \cdot \frac{\Delta L}{L} + \frac{rI}{pY} \quad (8)$$

As Y represents the output-input outcome, then ΔY / Y represents the social productivity and the expression wΔL/pY represents the proportion of payment of salaries in relation to the result of works, whereas the contribution of capital is measured towards the productivity of the profit scale and investment participation in social productivity:

The following model can be expanded to include new variables, namely:

λ = average rate of return on investments

$\lambda*$ = maximum value of λ

ω = w/p (profits/prices) = rate of increase of real profits (constant growth)

r* = maximum profit rate when λ* has maximum values

ϵ = percentage of investment expenditure growth, in order to compensate for the diminished labor force, for the percentage that was transferred to the other factory

The inclusion of these factors results in the expression:

$$r^* = \lambda^* + \epsilon\ \omega \qquad (9)$$

IV Regression model[12]

The model is founded on the regression between the number of students per one million inhabitants and the national income per capita.

The model sheds light on the consistent scale of connections and relations at the economic development level on one side and the intensity of studies in high and superior educational facilities on the other.

The calculation of parameters through regression can, to a satisfactory level of reliability, serve as an indication for further developments.

Here, one should consider the fact that there is no causal functional dependency, whereby the number of students with superior education per one million inhabitants would represent a "consequence" of the certain level of national income and certain level of income per capita, or vice versa. Similar to any other analysis, the regression will serve to the exploration of the stochastic character of the connectivity among the two phenomena, thus providing us with the possibility to significantly increase the explicative and prognostic capacities in this field.

The purpose of the regression research

As mentioned in the introductory section, the main purpose of this research is to provide a clear overview and understanding of the interdependency between the two phenomena: the scale of economic development and the scale and intensity of utilization of the two most advanced levels of education, respectively provide us with some reliability in the forecasting of future developments. In the event that the correlation coefficient is high, the dependency between the two parameters will be large (with the consequence being the cause further resulting in new consequences).

To accomplish this substantial objective, we have to initially provide:

- the critical data mass
- the calculation of the linear, parabolic and exponential regression, exploring the quality and suitability of basic data.

Second, using classic mathematical and statistical methods, we have to calculate:

- Standard errors
- Determination coefficient

- Correlation coefficient
- Average variable values
- Variant
- Standard deviation
- Relative variant
- Variation coefficient percentage
- Asymmetry coefficient
- External coefficient, etc.

The following methods of regression functions were used:

a) Linear regression; $Y_c = ax + b)$

b) Parabola; $Y_c = ax^2 + bx + c$

c) Exponential function; $Y_c = ab^x$

The parameters for these functions were accomplished, by resolving the following equation systems:

a) For the linear regression;

$a \sum x^2 + b \sum x + = \sum xy$

$a \sum x + bN = \sum$

b) For the parabola:

$a \sum x^4 + b \sum x^3 + c \sum x^2 = \sum x^2 y$

$a \sum x^3 + b \sum x^2 + c \sum x = \sum xy$

$a \sum x^2 + b \sum x + c N = \sum y$

c) For the exponential function:

$(\log b) . \sum x^2 + (\log a) \sum x = \sum x \log y$

$(\log b) . \sum x + (\log a) .N = \sum \log y ,$

And subsequent use of the anti-logarithm.

Clarification:

Reciprocal value $\frac{I}{r-k}$ *, denotes the number of years required for the factory to function in order to cover the assumed expenditure. This is the period required for the return of preliminary investment.*

The higher the profit scale is the shorter the period for debt return will be.

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Conclusion

The study aims to present comprehensively the mathematic-economic dimension of the research on education system. In the study there is not analyzed the complicated network of the interaction between education in one hand and other components of life quality on the other hand. Also, there is not researched the quantity side of the education system, as a subsystem of social system in general. Education is not limited to knowledge making only, but it has irreplaceable place on bringing back other multiple cultural values.

The study in general is dedicated to econometric model, where analytically are presented three internationally well-known models, relatively complicated education models, and one model relatively simple, but according to our view quite practical as a prognostic model constructed by our experts of former Yugoslavia, under which the name comes "A model of ours".

TI

Mbergen model – Bos

The authors determine the link between the economic growth in one hand, and the educating effect on the other hand, and then the Relation between the number of employees and production volume is indicated through the equations (1) to (6) in the basic model. This relation may be expressed through the production function in the following two methods:

a) production factors (work is on of these factors) may be expressed as functions of production volume
b) production volume ma by expressed as function of production factors.

In this model can be used the first method of expressing this interrelation, respectively, the employment be expressed as a function of production volume, relation is linear.

Emmpirijev model

The model presents a realistic application of the main Model of Timbergen – Bos, for the purposes of planning necessary staff on education for a certain rate of economic growth.

The Emmpirijev Model includes the interrelation between the main model and the economic growth in Spain.

On further elaboration of the model Emmirej involves the following magnitudes: employment rate for students and qualified experts, graduated rate by generations, enrolling rate to institutions, the rate of abandoning studies due to employment with secondary education.

Grozdast model

The model foresees the education demands through researches of the correlation between the rate of the growth on employment in one hand, and the rate of social production growth on the other hand. The model analyzes the efficiency of the labour force, which is in close functional relation with their realistic production.

Regression model

The model is based on the regression between the number of students on millions people and national income per capita. If the coefficient of correlation is big then the link between these two magnitudes will be bigger (the result will be the cause, which afterwards will cause other results). The Model calculates the linear, parabolic and exponential regression, having researched the quality of the consistency of basic data.

Researches through Econometric Models should serve us as baseline on formulation of education policies in the society.

1. I am conscious that such researches are not applied in our country, but my opinion is we should start applying these econometric methods on solving some current education problems, even though such application requires intensive work for several years.