Level of population education and its economic consequences

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Summary

There are several possibilities how to express level of population education, e.g. average length of education (ALE), education potential of a society (EPS) etc. The main aim of this paper is to discuss and deal with mutual relations between the level of population education and its economic consequences expressed by the unemployment rate. Even though an unemployment rate, in general, is considered as a multivariate problem we investigated this relation applying simple regression analysis, in which the unemployment rate (UE) was considered as a dependent variable and the level of population education expressed by ALE as an independent variable. Several types of regression functions were used for the best fitting of this relation, e.g. exponential, reciprocal, multiplicative model, etc. We conclude that more complex approach should be considered for investigating this relation, because some measures used for discriminating between the statistical models cannot give us definitive answer.

1. Introduction

In general it can be stated that education is one of the components of the well-being which can be used as a measure of economic development and quality of life of a population in a country. Since the nineties of the 20th century, empirical researchers have begun to acknowledge the importance of effects caused by education on economic growth. Nowadays these effects are considering in empirical growth models and consequently including into them. In these models one of the problems is how to measure and express the level of population education. For example, both Liu and Armer [8] and Tallman and Wang [12] measured the education variable as the number of people in a population who have completed different levels of schooling. They investigated the effects of education on economic growth considering three or four different independent categories of education achievement as proxies for human capital. Lin [7] introduced four indices of education achievements, as well, while each of them was focused on and strengthened different level of education: primary, junior-high, senior-high (secondary) and college or university (tertiary) education. Postulating that human capital (and education as a part of it) is accumulated in time, he concluded that primary education carried the greatest credits in economic development. The main aim of this paper is to discuss, compare, deal with and propose some indicators for measuring level of education and to search for possible relations between the level of population education and its economic consequences expressed by an unemployment rate.

2. Material and methods

To construct an adequate statistical model describing the corresponding relation between rate of unemployment and education level of a population we used two kinds of data for all 79 districts of Slovakia. The data describing the measure of unemployment were taken from [10], where the data on unemployment rate expressed as a percentage of the labour force for 8 regions, 79 districts and Slovakia as a whole were published. The data were gathered during the census of population, houses and dwellings in 2001. Of course, an unemployment rate can be sensitive in a great deal in time and regions, so the data used in our analysis are out of date from the today´s point of view. They were also subtantially changed because of the global world economic crisis. On the other hand, level of education of population is not changing so rapidly in time, but from 2001 up till now could be found some differences in structure of education distribution, as well. Anyway, those possible changes are not so important for our purpose to costruct a model between the above mentioned indicators. These changes can be reflected just in different values of constants used in model.

As to the education level, several different (sometimes similar) notions, definitions and expressions can be find in literature on this term. One of them is an Education Index (EI), which (along with Gross Domestic Product Index and Life Expectancy Index) is one part of the Human Development Index (HDI). It is published every year by the United Nations in the United Nations Development Programme for UN member states[1]. The Education Index is measured by the adult literacy rate (with 2/3 weighting) and the gross enrollment ratio (GER) (with 1/3 weighting). Gross enrollment ratio (GER) or gross enrollment index (GEI) is defined as a ratio of the number of actual students enrolled and the number of all potential students enrolled. Instead of GER the combined gross enrollment ratio (CGER) is sometimes used, which incorporates all levels of education from kindergarten to postgraduate education regardless of age. The EI is dimensionless index and it ranges from 0 to 1. The EI was 0,928 for Slovakia and 0,938 for Czech Republic for 2006[2].

The education coefficient (EC1) was used by A. Klas in his work [2] as a measure of education level of the population. He calculated it as a quadruply share of university educated population (f_T), double share of secondary educated population (f_S) and single share of other (i.e. with primary or unfinisher of without any education) population (f_P) of productive age according to the following equation:

$$EC1 = 1{,}0.f_P + 2{,}0.f_S + 4{,}0.f_T \,. \tag{1}$$

He uses the value of 1,82 for EC1 for Slovakia and for 1995.

On the contrary, sometimes the same term „education coefficient“ or sometimes similar one (e.g. index of education or simply level of education) is used by many researchers with the same aim to measure the level of population education. For example, the authors of „Projekt Konštantín“ [9] used the following formula for expression of the level of education (LE):

$$LE = 1{,}0.f_P + 2{,}0.f_S + 3{,}4.f_T \,. \tag{2}$$

As we can see, the EC1 and LE indicators differ just in a factor by which the f_T is multiplied. They stated that the LE measured by (2) increased for Slovakia from 1,41 in 1970 to 1,71 in 1991. According to the aims of „Projekt Konštantín“, the LE value should increase up to 1,89 in 2010.

Similarly, but using the different weighting coefficients for the ratio of people with secondary f_S and tertiary f_T highest attained education, the following expression was used in [11] for index of education (iED1):

$$iED1 = 1{,}0.f_S + 2{,}0.f_T \,. \tag{3}$$

The next approach to evaluate the level of education is simply to use the ratio of people with tertiary education f_T, i.e.:

$$iED2 = 1{,}0.f_T \,, \tag{4}$$

whereas into the tertiary level of education are included people with bachelor, college, university and post doctoral highest attained education.

The education potential of a society (EPS) was introduced by Kulčár in [3] in the following way:

$$EPS(r) = \frac{1}{r - \sum_{k=0}^{r} f_k.k} \,, \tag{5}$$

where f_k stands for relative frequency of the k-th education level (category) in a educational system in a society and r equals the maximum assigned to the highest education level, i.e. r = max {k}. Some properties, relations and applications of the EPS to economy were found and published in [4] and [5].

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[1] http://hdr.undp.org/

[2] http://hdr.undp.org/en/media/HDI_2008_EN_Tables.pdf

As we can see from (5), the EPS depends on *r*, which can be considered as a parameter. It means, the EPS depends on how many different levels (how deeply) is the education system of a society splitting. This can vary from country to country and from time to time, of course. That is, why this methodology for evaluation of the education level is suitable mostly in that cases, when we want to compare the changes in education level in the same society with the stabile education system.
The values of *k* were assigned according to the educational system in Slovakia in the following way:
k = 0 stands for the lowest category of the education level, i.e. for people without any education,
k = 1 stands for the people with elementary (primary) education level (including unfinished education),
k = 2 stands for people with education level without General Certificate of Education (GCE) exam including apprentice and specialized schools,
k = 3 stands for people with general secondary and comprehensive schools with CGE exam,
k = 4 stands for people with post-secondary non-tertiary (specialized vocational qualificatory) education with CGE exam,
k = 5 stands for people with bachelor (college) education level, i.e. the first step of the tertiary education level,
k = 6 stands for people with university education level, the second step of the tertiary level of education,
k = 7 stands for people with postgraduate (PhD) education level, the third step of the tertiary level of education.

The assignment of the *k* values to the levels of education was done in this way because of the data from the Census of population, houses and dwellings in 2001 [10] were structurated in the same way. The value of f_k represents the ratio of people in population with the *k*-th level of education as the highest institutionally achieved education. It is clear, that the following relation must hold:

$$\sum_{k=0}^{r} f_k = f_P + f_S + f_T = 1 .$$

We can assign the categories of education levels used in Eqs. (1) – (4) to those used in Eq. (5) in the following way: $f_P = f_0 + f_1$; $f_S = f_2 + f_3 + f_4$ and $f_T = f_5 + f_6 + f_7$.

To give our assignment of the *k* values to the accordance with the ISCED categories[3], we can find this corresponding relation given in Table 1.

Table 1 Assignment of the ISCED categories to the *k* values used in Eq. (5)

	ISCED							
	0	1	2	3C	3 – 3A	4, 5B	5 – 5A	6
K	0	1	1	2	3	4	5, 6	7

The author of this paper introduced the following multiplicative factors used for expression of the education coefficient EC2:

$$EC2 = 1.f_0 + 2.f_1 + 4.f_2 + 8.f_3 + 16.f_4 + 32.f_5 + 64.f_6 + 128.f_7 . \quad (6)$$

Equation (6) weights each level of education by the factor powered by 2, by which the synergic influence of the higher education levels is strengthened.

We can see from the relations (1) – (4) that the mutual relations between EC1, LE, iED and iED1 are statistically strongly linear related. A little difference is in using the EPS (Eq. 5) and EC2 (Eq. 6), but also in these cases can be found strong relations (although not linear) between them. The paired correlation coefficients obtained between education levels expressed by Eqs. (1) – (6) for 79 districts of Slovakia range from 0,9351 up to 0,9995.

All indicators defined by Eqs. (1) – (6) express the level of education by non dimensional values and they are based on frequencies of categories of education levels. Different approach for evaluation of education level of population was used by Fischer and Mazouch in [1] and Kulčár in [6]. They used as a measure of education level the average length of education (schooling) of the population in a given region. The data on the highest level of education attained in official institutional educational system are considered for evaluation of the average length of education (ALE). ALE

[3] http://www.unesco.org/education/information/nfsunesco/doc/isced_1997.htm

represents the number of years, on average, a student remains at school and university, including years spent on repetition. It is approximated as the sum of age-specific enrollment ratios for primary, secondary, post-secondary non-tertiary and tertiary (included bachelor, university and post-doctoral) education. So we have for ALE:

$$ALE = \sum_{k=0}^{r} f_k . l_k \ , \tag{7}$$

where k and f_k have the same meaning as in Eq. (5) and l_k (expressed in years) stands for the length of schooling typical for the k-th category of the educational system. The values of l_k for different k values for educational system in Slovakia were estimated as followed (in years): l_0 = 0; l_1 = 8,6; l_2 = 11,6; l_3 = 12,4; l_4 = 14,4; l_5 = 15,4; l_6 = 17,5; l_7 = 21,5 [5].

3. Results and discussion

The aim of this paper was to find statistical model, by which we could describe relation between the measure of unemployment and the level of education. We accept the fact that the relation between unemployment and education level should be considered as a multivariate problem. For our model we considered this relation just as a univariate problem, in which the measure of unemployment stands for dependent variable and the level of education is considered as an independent variable. To find this relation we used as a measure of the education level the average length of education ALE (in years) expressed by Eq. (7) and as the measure of unemployment we considered the rate of unemployment (UE) expressed in percentage of the labour force.

For modelling this relation as the first step we solved this as a problem of regression analysis, in which we used some statistical functions that were offered us by Statgraphics Package Programme. After visual inspection of the graphical representation of the relation between ALE and UE we omitted at first some of the offering functions which could not be suitable at the first glance. The regression functions, which we then used as a possible functions, were the following ones:

- Linear model: $UE = 124{,}076 - 8{,}46298.ALE$
- Reciprocal model: $UE = \dfrac{1}{0{,}0325.ALE - 0{,}3421}$
- Double reciprocal model: $UE = \dfrac{1}{0{,}473398 - \dfrac{5{,}09356}{ALE}}$
- Exponential model: $UE = \exp(8{,}93994 - 0{,}48892.ALE)$
- Multiplicative model: $UE = 1{,}01329.10^8.ALE^{-6{,}1827}$

Mainly standard error of estimate (S_e) and index of determination (I^2) were used as the measures which we used for finding the best fitted model and quality of it. In addition, the M.S.E. and M.A.P.E. measures usually used in the theory of time series were used, as well. Those ones measures mentioned above are collected for the regression functions in Table 2.

Table 2 The measures of quality for fitted models

Model / Measures of quality	Linear	Reciprocal	Double reciprocal	Exponential	Multiplicative
S_e	4,78467	0,01427	0,01453	0,23560	0,23460
I^2	0,50030	0,77559	0,89613	0,48961	0,51408
M.S.E.	22,31347	21,93970	23,94340	20,74741	20,55292
M.A.P.E.	0,21172	0,19326	0,19908	0,19461	0,19329

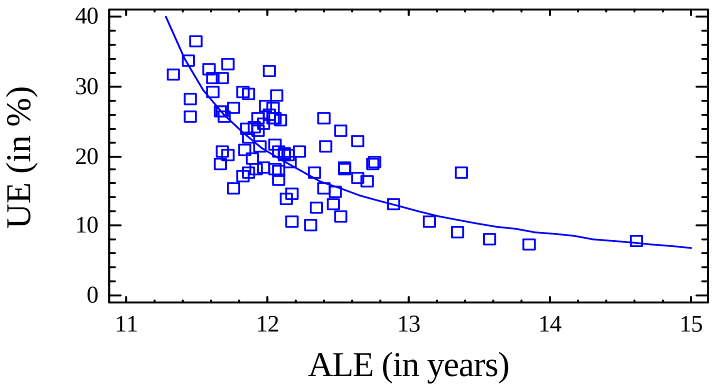
It can be clearly seen from Table 2 that reciprocal or double reciprocal regression functions are those ones which can be conidered as possible suitable models, while linear model should be rejected definitively. Taking into account also economic aspects of the relations between unemployment and level of education, we finally choose as a best fitted model the reciprocal model.

Reciprocal regression model can be transformed into the following form of the regression function:

$$UE = \frac{1}{0{,}0325.ALE - 0{,}3421} \approx \frac{30{,}73}{ALE - 10{,}51}. \qquad (8)$$

The constant of 10,51 has its logical meaning. It is a minimum value of the ALE, i.e. the minimum number of years of schooling. The value of 10,51 is in a good accordance with reality in Slovakia for two reasons:firstly, minimum years of compulsory school attendance is 10 years, and secondly, no one district of 79 districts of Slovakia had its minimum ALE value lower than 11,44 years. We can consider this value of 10,51 years as a theoretical minimum and write as ALE(min) = 10,51. The fitted reciprocal model can be graphically seen on Graph 1. The squares represent real observations for 79 districts of Slovakia and the full line represents the fitted model expressed by Equation (8).

Graph 1 Plot of fitted model: UE = 1/(0,0325.ALE – 0,3421)



If we put for ALE in Eq. (8) the maximum value of ALE, which is in our case 14,62 years for Bratislava I district, we obtain the value of about 7,48 % for the unemployment rate UE, which is in a good accordance with real situation for this district. Theoretically, if the population has reached the highest possible education, i.e. the ALE value was about 21,5 years, the rate of unemployment would be about 2,8 %.

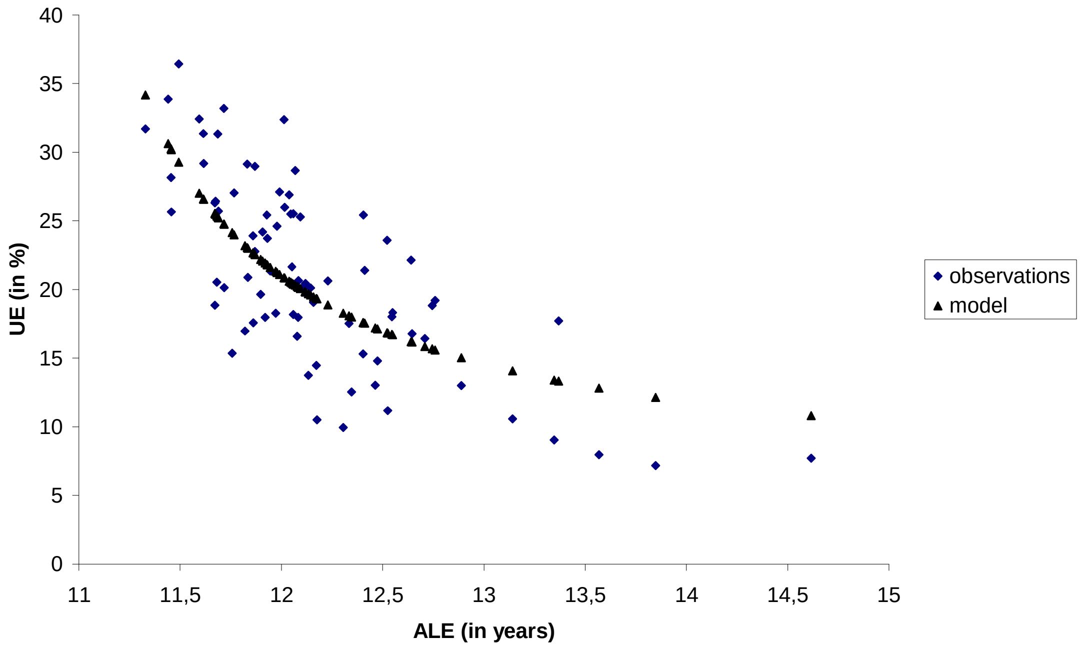
The regression model related unemployment rate with the average length of schooling was introduced in [5] for real trade stable economy in the following form:

$$UE = UE(\min) + \frac{C}{ALE - ALE(\min)}, \qquad (9)$$

where UE(min) represents the minimum value of the unemployment rate. The values of UE(min) and ALE(min) can be considered as some marginal restrictions based on real situation. The value of ALE(min) is usually mostly stable on a long time interval (years or tens of years). On the other hand, the value of UE(min) and consequently the constant C are much more sensitive in time and depend on various economic indicators and even on political situation in a country. If we put 5 % for the value of UE(min), which can be considered as its estimate based on a real economic situation in many stable economics, we obtain the value of 23,85 for the constant C. The value C = 23,85 was find as a compromise between minimum values of M.S.E. and M.A.P.E. for this case. So, then we can write the relation (9) in this form:

$$UE = 5 + \frac{23,85}{ALE - 10,51}. \qquad (10)$$

The graphical presentation of the relation (10) together with the real observed data represented by squares are presented on Graph 2.



From Graph 2 clear discrepancies can be seen between measured data and theoretical expected data mainly for extreme values of ALE. It seems that from the point of statistics the model presented by Eq. (8) is more suitable than that one descibed by Eq. (10), but, on the other hand, for realistic model should be taken into account economics restrictions, as well.This can be considered as a topic for future discussions.

4. Conclusions

Several models describing relation between unemployment rate and education level of population were proposed. It was found that it is not reasonable and probable cause to chose the right fitting model based on statistical measures only. Some reasonable economic restrictions, which can be incorporated as some constants into statistical models, should be taken into account, as well. The values of these constants are variable in time, in regions and they may be dependent also on some other hidden factors, which can be scope for future discussions. The next field of research and a topic of discussions should be concentrated on a problem of multivariate relation between unemployment rate and education level of population, or on human capital, in general.

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