ANALYSIS OF THE RELATIONSHIP BETWEEN DEMOCRACY AND EDUCATION USING SELECTED STATISTICAL METHODS

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Abstract

Across the world, higher education leads to more democratic politics. The correlation between education and democracy is extremely. This idea has received a good deal of empirical support. Index of education in the newly associated states is due to compulsory schooling in the past higher than in the EU15.

To analyse the relationship between the Index of Democracy and the Index of Education we used the Pearson Correlation Coefficient. The Pearson Correlation Coefficient was calculated not only between the Education Index and the Democracy Index but also between the Education Index and particular sub-indices of the Democracy Index: Electoral Process and Pluralism, Civil Liberties, Functioning of Government, Political Participation and Political Culture. Moreover we calculated the Pearson Coefficient of Correlation for newly associated EU countries and for all EU countries. Later we analysed the relationship between Democracy Index and Education Index via new methods: The Moran Scatters Plots and Moran's Coefficient of Spatial Autocorrelations were calculated. The geographic location and history are significant. Finally, the temporal spatial econometric model is constructed.

Key words: *democracy index, education index, correlation coefficient, Moran Scatter Plot,* Moran's coefficient, *spatial error model.*

Introduction

The hypothesis that higher education leads to more democratic politics (Lipset, 1959, 1960) has received a good deal of empirical support (Barro, 1999, Glaeser et al., 2004, Pa-

paioannou and Siourounis, 2005, Zelenický, 2009). However, the theoretical reasons for this relationship remain unexplored. In this paper, we investigate theoretically and explore empirically why list of stable democracies usually corresponds with countries with high levels of education and introduce Glaeser, Giacomo Ponzetto and Andrei Shleifer´s (2005) connection between education and political participation. This connection has been emphasized by Almond and Verba (1989, 1st ed. 1963) who see education as a crucial determinant of "civic culture" and participation in democratic politics. "The uneducated man or the man with limited education is a different political actor than the man who has achieved a higher level of education." (Verba, 1989).

The standard of living and the quality of life reach the highest levels in the most free and most democratic countries (Gola, 2009). The Economist regularly evaluates democratic conditions in 167 states on the basis of Democracy Index (Kekic, 2007).

Democracy Index is constructed as a combination of partial evaluations of following criteria:

1. Electoral process and pluralism
2. Civil liberties
3. Functioning of government
4. Political participation
5. Political culture.

Resultant Index can have values from 0 to 1. Countries with the highest level of democracy reach values more than 0.9 of the Democracy Index range. According to reached values of the Democracy Index the countries are divided into following categories:

- Full democracies   (scores of 8-10)

- Flawed democracies   (scores of 6 to 7.9)

- Hybrid regimes   (scores of 4 to 5.9)

- Authoritarian regimes (scores below 4)

The Human Development Index (HDI) is an index used to rank countries (nearly 200) by level of "human development" which usually also implies whether a country is developed, developing or underdeveloped. The United Nations publishes a Human Development Index every year which consists of the

- Education Index
- GDP Index
- Life Expectancy Index.

These three components measure the educational attainment, GDP per capita and life expectancy respectively. The Education Index is measured by the adult literacy rate (with two-thirds weighting) and the combined primary, secondary, and tertiary gross enrolment ratio (with one-third weighting). Resulting Education Index can reach values between 0 and 1. 1 is the highest possible theoretical score, indicating perfect education attainment. All countries considered to be developed countries possess a minimum score of 0.8 or above, although the great majority has a score of 0.9 or above. World map indicating Education Index (2007) can be found at Wikipedia[2].

Table 1 lists countries with the highest and the lowest value of Education Index in 2007 (Human Development Report 2009[3]), including Slovakia.

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[2] http://en.wikipedia.org/wiki/Education_Index
[3] http://hdr.undp.org/en/media/HDI_trends_components_2009_rev.xls

Table 1. **Values of Education Index of selected countries in 2007.**

Rank 2007	Country	Education Index 2007	Education Index 1990
1-5	Australia	0.993	0.919
1-5	Cuba	0.993	0.883
1-5	Denmark	0.993	0.931
1-5	Finland	0.993	0.958
1-5	New Zealand	0.993	0.929
… 20-21	USA	0.968	0.960
20-21 …	Lithuania	0.968	0.905
Rank 2007	**Country**	**Education Index 2007**	**Education Index 1990**
… 46	Slovakia	0.928	0.906
… 183	Mali	0.331	0.115
184	Burkina Faso	0.301	0.144
185	Niger	0.282	…

Source: http://hdr.undp.org/en/media/HDI_trends_components_2009_rev.xls.

Methodology of Research

To calculate the dependency rate between Democracy Index and Education Index in the EU member countries, we used the *Pearson – Bravais Coefficient of Correlation* which is defined as follows (Anděl, 2003):

$$ r = \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2}\ \sqrt{\sum_{i=1}^{n} (y_i - \bar{y})^2}} \ , $$

where $x_1, x_2, ..., x_n$ are values of X and $y_1, y_2, ..., y_n$ are values of Y.

Correlation Coefficient can reach values in the interval $\langle -1, 1 \rangle$. The Pearson Correlation is +1 in the case of a perfect positive (increasing) linear relationship, −1 in the case of a perfect decreasing (negative) linear relationship, and any value between −1 and 1 in all other cases indicating the degree of linear dependence between the variables.

Spatial autocorrelation means the degree to which a set of features tends to be clustered together (positive spatial autocorrelation) or be evenly dispersed (negative spatial autocorrelation) over the earth's surface. Moran's coefficient is a measure of the degree of spatial autocorrelation presented by the data.

Its formula is: $I = \dfrac{n}{S_0} \dfrac{\sum\limits_{i=1}^{n}\sum\limits_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum\limits_{i=1}^{n}(x_i - \bar{x})^2}$,

where w_{ij} is the weight between observation i and j, and S_0 is the sum of all w_{ij} 's. Quite not so intuitively, the expected value of I under the null hypothesis of no autocorrelation is

not equal to zero but given by $I_0 = \dfrac{-1}{n-1}$. The expected variance of I_0 is also known, so we can make a test of the null hypothesis. If the observed value of I (denoted $\hat{I}$) is significantly greater than I_0, then values of x are positively autocorrelated, whereas if $\hat{I} < I_0$, this will indicate negative autocorrelation. This allows us to design one- or two-tailed.

The significance of the Moran coefficient is tested using Monte Carlo Method (the number of permutations is 9999).

The Moran scatter plot provides a tool for visual exploration of spatial autocorrelation. Anselin (2002) describes Moran scatter plot as "the spatial lag of the variable on the vertical axis and the original variable on the horizontal axis" - the spatial lag refers to the values of a neighbours´ location. Spatial weights matrices are necessary elements in most regression models where a representation of spatial structure is needed. A traditional way to represent neighbour relationships is as a spatial weights matrix. It is an $n \times n$ matrix, with n being the number of states. There is a row and column for each country. The value in each cell represents whether the location in the column header is a neighbour of the row location, termed "ego". Cells with nonzero weights are considered the neighbours of that ego.

When data are spatially autocorrelated, the assumption that they are independently random is invalid; so many statistical techniques are also invalidated. Therefore, we used spatial error model (Ward, Gleditsch, 2008).

In the calculations we used the program Geoda[4].

Results of Research

Following table (Table 2.) shows values of Education Index (1990) and Democracy Index (2007) and its individual sub-indices. Last available data of Democracy Index is from the year 2007. For our purposes we chose the Education Index measured in 1990, so as the level of education had enough time to "manifest"in the real life.

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[4] GeoDa is the collection of software tools designed to implement techniques for exploratory spatial data analysis (ESDA) on lattice data. It is intended to provide a user friendly and graphical interface to methods of descriptive spatial data analysis, such as autocorrelation statistics and indicators of spatial outliers. http://geodacenter.asu.edu/
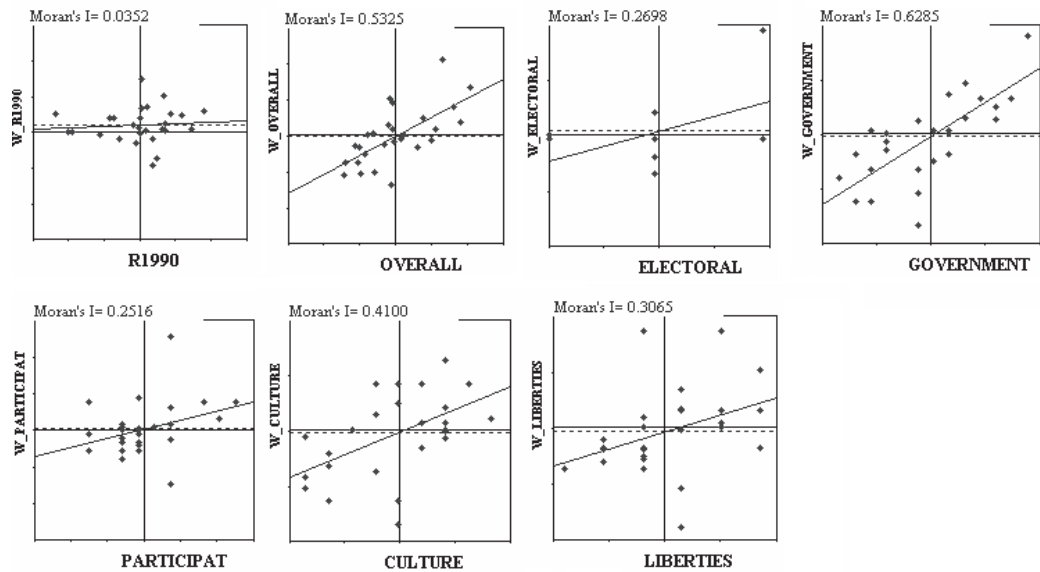
Table 2.   Education Index (year 1990) and Democracy Index and its components (year 2007).

Country	Education Index 1990	Overall Score Democracy Index 2007	Electoral Process and Pluralism	Functioning of Government	Political Participation	Political Culture	Civil Liberties
Bulgaria	0.9181	7.10	9.58	5.71	6.67	5.00	8.53
Cyprus	0.8370	7.60	9.17	6.79	6.67	6.25	9.12
Czech Republic	0.8988	8.17	9.58	6.79	7.22	8.13	9.12
Estonia	0.9317	7.74	9.58	7.50	5.00	7.50	9.12
Hungary	0.8847	7.53	9.58	6.79	5.00	6.88	9.41
Latvia	0.9056	7.37	9.58	6.43	6.11	5.63	9.12
Lithuania	0.9050	7.43	9.58	6.43	6.67	5.63	8.82
Poland	0.9112	7.30	9.58	6.07	6.11	5.63	9.12
Romania	0.8661	7.06	9.58	6.07	6.11	5.00	8.53
Slovakia	0.9058	7.40	9.58	7.50	6.11	5.00	8.82
Malta	0.8334	8.39	9.17	8.21	6.11	8.75	9.71
Slovenia	0.9024	7.96	9.58	7.86	6.67	6.88	8.82
Austria	0.9185	8.69	9.58	8.21	7.78	8.75	9.12
Belgium	0.9301	8.15	9.58	8.21	6.67	6.88	9.41
Denmark	0.9315	9.52	10.00	9.64	8.89	9.38	9.71
Finland	0.9578	9.25	10.00	10.00	7.78	8.75	9.71
France	0.9362	8.07	9.58	7.50	6.67	7.50	9.12
Germany	0.9127	8.82	9.58	8.57	7.78	8.75	9.41
Greece	0.8755	8.13	9.58	7.50	6.67	7.50	9.41
Italy	0.8790	7.73	9.17	6.43	6.11	8.13	8.82
Luxembourg	0.9703	9.10	10.00	9.29	7.78	8.75	9.71
Netherlands	0.9477	9.66	9.58	9.29	9.44	10.00	10.00
Portugal	0.8203	8.16	9.58	8.21	6.11	7.50	9.41
Spain	0.9231	8.34	9.58	7.86	6.11	8.75	9.41
United Kingdom	0.9080	8.08	9.58	8.57	5.00	8.13	9.12
Ireland	0.9280	9.01	9.58	8.93	7.78	8.75	10.00
Sweden	0.9071	9.88	10.00	10.00	10.00	9.38	10.00

Source: www.socrata.com/views/czuq-28j2/rows.xls?accessType=DOWNLOAD

Most of the Eastern Europe illustrates the difference between formal and substantive democracy. The new EU members from the region have relatively equal level of political freedom and civil liberties as the old developed EU but lag significantly in political participation and political culture and reflection of widespread anomaly and weaknesses of democratic development. Only two countries from the region - the Czech Republic and Slovenia - are in the full democracy category. Hybrid and authoritarian regimes dominate heavily in the countries of the former Soviet Union, as the momentum towards «colour revolutions» has petered out, as it is noted in The Economist Intelligence Unit's Index of Democracy 2007.

Following pictures (Figure 1.) illustrate the Moran scatter plots.

Source: Own drawings

Figure 1. **The Moran scatters plots for Education index (1990), Overall Score In dex of Democracy (2007), Electoral Process and Pluralism, Functioning of Government, Political Participation, Political Culture and Civil Liber ties (2007).**

Following table (Table 3.) lists values of Moran Coefficient and particular p values (9999 simulations).

Table 3. **Results of testing of spatial autocorrelations.**

	Educa-tion Index 1990	Overall Score Democracy Index 2007	Electoral Process and Plural-ism	Functioning of Govern-ment	Political Participation	Political Culture	Civil Liberties
Moran Coef-ficient _I_	0.0352	0.5325	0.2698	0.6285	0.2516	0.4100	0.3065
_p_ value	0.344	0.001	0.045	0.001	0.065	0.012	0.029

Source: Own calculations

In following tables we show calculated correlation coefficients between Education Index and Democracy Index, between Education Index and components of Democracy Index and also between Democracy Index and components of Democracy Index in newly associ-ated EU members (Table 4) a in all EU countries (Table 5).

Table 4.   **Calculated values of Pearson Coefficient of Correlation for newly associated EU countries.**

	Education Index 1990	Overall Score Democracy Index 2007	Electoral Process and Plu-ralism	Functioning of Govern-ment	Political Par-ticipation	Political Culture	Civil Liber-ties
Education Index 1990	1.000						
Overall Score Democracy Index 2007	-0.327	1.000					
Electoral Process and Pluralism	**0.853**	-0.464	1.000				
Functioning of Govern-ment	-0.255	**0.790**	-0.395	1.000			
Political Participation	-0.137	0.132	-0.131	-0.187	1.000		
Political Culture	-0.295	**0.939**	-0.419	**0.673**	-0.088	1.000	
Civil Liber-ties	-0.418	**0.680**	-0.541	**0.531**	-0.352	**0.761**	1.000

Note. Critical value of Pearson Coefficient of Correlation (with 10 degree freedom) for newly associated countries is 0.576 and for the whole EU (25 degree of freedom) it is 0.381.

Source: Own calculations

Table 5.   **Calculated values of Pearson Coefficient of Correlation for all EU countries.**

	Education Index 1990	Overall Score Democracy Index 2007	Electoral Process and Plural-ism	Functioning of Govern-ment	Political Par-ticipation	Political Culture	Civil Liberties
Education Index 1990	1.000						
Overall Score Democracy Index 2007	**0.418**	1.000					
Electoral Process and Pluralism	**0.643**	**0.546**	1.000				

Functioning of Government	**0.403**	**0.929**	**0.585**	1.000		
Political Participation	**0.389**	**0.817**	**0.524**	**0.642**	1.000	
Political Culture	0.296	**0.902**	0.284	**0.806**	**0.576**	1.000
Civil Liberties	0.255	**0.859**	0.393	**0.815**	**0.592**	**0.790**	1.000

Note. Critical value of Pearson Coefficient of Correlation (with 10 degree freedom) for newly associated countries is 0.576 and for the whole EU (25 degree of freedom) it is 0.381.

Source: Own calculations

The assumption that the variables in regression model are independently random is invalid. For that reason we chose the spatial error model (Figure 2). EU 15 affiliation was chosen as a dummy variable because of the fact that in newly associated states there was a compulsory school attendance. Democracy Index (y) depends on the affiliation to EU 15 (x_1) and on the Education Index in1990 (x_2) as follows:

$$y = 0,8532729x_1 + 9,157863x_2 + u \, .$$
$$(0.3050239) \quad (0.3474758)$$
$$u = 0,7748838Wu + \varepsilon.$$
$$(0.08100591)$$

By using the spatial error model we can see that all coefficients are statistically significant (column Probability – Figure 2.). Coefficient of Determination is 53.76 percent. Value of Akaike Criterion equals to 46.5115. Parameter of spatial error l is 0.77488 and is statistically significant ($P = 0.0016995$). Model does not show any heteroskedasticity ($P = 0.5387119$).

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REGRESSION
SUMMARY OF OUTPUT: SPATIAL ERROR MODEL - MAXIMUM LIKELIHOOD ESTIMATION
Data set            : demokracia
Spatial Weight      : demokracia.GAL
Dependent Variable  :     OVERALL  Number of Observations:   27
Mean dependent var  :    8.208889  Number of Variables   :    2
S.D. dependent var  :    0.782320  Degree of Freedom     :   25
Lag coeff. (Lambda) :    0.774884

R-squared           :    0.537602  R-squared (BUSE)      : -
Sq. Correlation     : -           Log likelihood        :  -21.255736
Sigma-square        :    0.282999  Akaike info criterion :    46.5115
S.E of regression   :    0.531977  Schwarz criterion     :    49.103146

--------------------------------------------------------------------
    Variable    Coefficient     Std.Error     z-value     Probability
--------------------------------------------------------------------
        EU15      0.8532729     0.3050239    2.797397     0.0051517
        R1990     9.157863      0.3474758   26.3554       0.0000000
        LAMBDA    0.7748838     0.08100591   9.565769     0.0000000
--------------------------------------------------------------------

REGRESSION DIAGNOSTICS
DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                                   DF      VALUE         PROB
Breusch-Pagan test                      1      0.3708633     0.5425341
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Figure 2.   Results of spatial error model in software GeoDa.

Discussion

On the basis of p values of Moran Coefficient we can say that for the Education Index 1990 there is no spatial autocorrelation. On the confidence level of 0, 1 there exists spatial autocorrelations for the Democracy Index and all its sub-indices. On the confidence level of 0, 05 there exists a spatial autocorrelation for Democracy Index and all its sub-indices except Political Participation

From results of Pearson Coefficient of Correlation we can conclude that in newly associated countries the Education Index is statistic-evidently dependent on the Electoral Process and Pluralism. No other correlation coefficients with the Education Index are statistically significant. Democracy Index is statistic-evidently linear dependent on Functioning of Government, Political Culture and Civil Liberties. Democracy Index and Electoral Process and Pluralism do not show any statistical dependency.

In all EU countries as a whole all correlations coefficients are statistically significant except correlation coefficient between Education Index a Political Culture, eventually Civil Liberties and correlation coefficient between Political Culture and Electoral Process and Pluralism. That is the result of unstable political environment in newly associated states and compulsory school attendance of former socialist states. Moreover, the spatial autocorrelation between Democracy Index and its sub-indices exists. That means that for evaluation of dependency between Education Index and Index of Democracy it would be wise to choose more sophisticated statistical methods.

Conclusions

A common view clearly articulated by the modernization theory claims that high levels of schooling are both a prerequisite for democracy and a major cause of democratization. The evidence in favour of this view is largely based on cross-sectional or pooled cross-sectional regressions. This paper documents that this evidence is not robust to include fixed effects and exploit the within-country variation. This strongly suggests that the cross-sectional relationship between education and democracy is driven by omitted factors influencing both: education and democracy rather than a causal relationship. This evidence asks some important questions about relationship between education and democracy.

We presented some old and some new facts about education and democracy. We showed that more educated democracies are more stable than the less educated ones; that higher education levels predict transition from dictatorship to democracy but not the other way around; and that the relationship between education and democracy holds within as well as across countries. The available evidence suggests that, consistent with Lipset (1959), education causes democracy.

Education leads to higher participation in a whole range of social activities, including politics. According to Edward L. Glaeser, Giacomo Ponzetto and Andrei Shleifer (2005) higher levels of education make democracy more stable because educated people face higher benefits of political participation and are consequently more likely to support democracy even when it offers few personal rewards. Conversely, in countries with low levels of education, dictatorship is more stable than democracy because only dictatorships offer the strong incentives needed to induce people to defend them.

Countries with higher levels of education are more likely both to experience a transition from dictatorship to democracy, and to withstand antidemocratic challenges. Moreover, the size of the most successful challenger regime to an existing dictatorship rises with the level of education.

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