Chinese Business Review, Nov. 2018, Vol. 17, No. 11, 546-569
doi: 10.17265/1537-1506/2018.11.004

Socio-Economic Inequality and Economic Growth: Measurements for Central and Eastern Europe

Ana Michaela Andrei, Irina Georgescu
Bucharest University of Economic Studies, Bucharest, Romania

The objective of this work is the study of social and economic inequality in the space of Central and Eastern Europe and its impact on economic growth. Our study includes a three-stage methodology: (1) application of a clustering method based on neural network (Self Organising Maps), to the series of panel data in order to divide countries into clusters, corresponding to the degree of economic and social inequality; (2) computing a composed index of economic and social inequality, using Principal Component Analysis and an extension of the method provided by OECD for computing composite indicators; (3) constructing an econometric model to establish the impact of social and economic inequality on economic growth and a VAR model to determine the causality between main determinants to growth and inequality as well as the response to shocks to the dynamics of the variables. The 24 Eastern and Central European countries have been grouped in five clusters, according to 11 attributes. In the results obtained, the third cluster comprises countries with the most equitable income distribution: Czech Republic, Croatia, Hungary, Slovak Republic, Slovenia. To the opposite side is the fifth cluster with the deepest inequality, including only one country, namely Georgia. The second and third steps of our methodology, were applied only for the extreme clusters namely, the clusters with the highest (C5) and lowest (C3) inequality respectively.

Keywords: economic growth, economic inequality, Gini coefficient, income distribution, Self Organising Maps—SOM, Principal Component Analysis, VAR models

Introduction

In the economic theory, the economic inequality is defined as the discrepancy between poor and rich in terms of: income distribution, distribution of wealth, access to education, employment rate, life satisfaction and happiness, and so on. The inequality could manifest within a country, between countries and between geographical areas.

Decades following the Second World War were marked by a significant overall growth, with low social inequality in the industrialized countries and in some developing countries.

In the last decades, marked by slowing global growth and by appearance of global crisis in 2008, the social

---

Ana Michaela Andrei, Ph.D., professor, Department of Economic Informatics and Cybernetics, Bucharest University of Economic Studies, Bucharest, Romania.
Irina Georgescu, Ph.D., lecturer, Department of Economic Informatics and Cybernetics, Bucharest University of Economic Studies, Bucharest, Romania.
Correspondence concerning this article should be addressed to Irina Georgescu, Calea Dorobantilor nr. 15-17, sector 1, Bucharest 010552, Romania.

inequality has increased dramatically, reaching levels encountered in the 1920s, with high imbalances within and between countries.

The subject of social and economic inequality has been treated abundantly in the economic literature from the remarkable work of Kuznets (1955).

The principal channels of transmisson of economic inequality on growth, considered in the literature, are political economic policies of income distribution (both cause and instrument of reducing inequality), credit market imperfections, and social disturbancies generated by poverty and social discontent and claims. Research has moved from the analysis of the various aspects of economic inequality to the study of the relationship between inequality and economic growth.

The literature divides the empirical studies into three categories:

(1) The studies that use cross-country data to study the long-term relationship between inequality and growth (Persson & Tabellini, 1994; Alesina & Rodrik, 1994; Perotti, 2007);

(2) The studies that use panel or longitudinal data to determine a medium-term analysis of inequality and growth (Li & Zou, 1998; Atkinson, Piketty, & Saez, 2011);

(3) The studies that use time series to determine the correlation between social inequality and economic growth for a country (Ortega Diaz, 2007; Kolawole, Omobitan, & Yaqub, 2015; Barro, 2000; Gregorio & Lee, 2002).

Regarding the sense of the impact of inequality on economic growth, the studies could be divided in four categories: Some studies found a negative relationship, others found a positive relationship, some other studies found a nonlinear relationship with changing sign, and finally, some found no relationship between inequality and growth as well.

Alesina and Perotti (1993), Perotti (1996), De la Croix and Doepke (2002), Persson and Tabellini (1994), Castelló and Domenech (2002), and Kanbur (2016) emphasize the income inequality effect on access to education and human capital formation that farther negatively influence the economic productivity and long term growth.

Alesina and Rodrik (1994) and Persson and Tabellini (1994) are also the supporters of negative relationship between inequality and growth, proving that the tax policy and unequal levels of income determine a negative influence on the rate of economic growth.

De la Croix and Doepke (2002) conclude that fertility differentials affect productivity and economic growth through the reduction of the human capital stock, that farther negatively influence the growth.

Positive relationship between inequality and growth is found (Li & Zou, 1998; Nahum, 2005). Li and Zou (1998) consider that in an economy with high median income, the government expenditures are to a great extent allocated to consumption so, low inequality, low growth rate.

Barro (2000), as the main supporter, found a weak and non linear positive relationship between inequality and growth, conditional to the average income. Pagano (2004) reached a nonlinear relationship between inequality and growth but with contrary effects (a positive relation for rich countries and a negative one for poor countries).

Voitchovsky (2005) obtained a nonlinear relationship income-growth with different signs for groups with high income and low income. Castelló-Climent and Cabrillana-Hidalgo (2010) study the effect of human capital inequality on economic growth, finding both negative (for the poor countries) and positive (for developed countries) relationship of inequality on growth.

The world economy globalization, supranational economic and monetary bodies induced transformations in all areas, with strong consequences on inequality.

In Romania considerable research has been done on this topic. Molnar (2010) analysed the income inequality in Romania, using a set of indicators among Kuznets index, Gini coefficient, Éltetö-Frigyes indices, Theil index, Atkinson index. She concluded that income gaps between different categories of households have increased between 1995 and 2008, stated also that the income distribution in Romania is marked by the general low income level and a relatively high and increasing inequality. Another conclusion she stated, is that the economic crisis has a strong negative impact on household incomes, while protection exists at a low level, having in any case an important contribution to the income distribution.

Using NIS and EUROSTAT data relative and absolute measures of poverty, Precupeţu (2013) analyzes three levels of inequality: income, labour market, and education inequality. The conclusion is that in Romania there has been a growing process of inequality and risk of poverty between individuals and households, between regions and between ethnical groups as well.

Using 2011 Romanian Household Budget Survey data, Domnişoru (2014) shows that a 4.5 point drop in the Gini coefficient during the years affected by the severe economic crisis in Romania is caused by the austerity policies that cut the incomes.

Andrei, Galupa, and Georgescu (2017) introduce a methodology for the study of the relationship between inequality and growth and partially apply it on a sample of 24 countries from Central and Eastern Europe.

Summarizing the economic thinking on social inequality some traits can be extracted as follows: Global inequality remains high; middle class in emerging economies rose and the top class in the developed economies reduced; inequality between countries, geographic areas increased; poverty decreased in many countries but increased in developed countries; the concentration of global wealth rose; inequality in wealth sharpened more than inequality in income; inequality in access to health services increased and in education access in developing countries decreased.

Our contribution to the theoretical field is the methodology of study of the inequality by geographical areas, computing method of the composite index of social and economc inequality, adapting the inequality-growth relationship models found in the literature to correspond to our issue and, the empirical work.

Self-organizing Maps

SOMs (Self-Organizing Maps) are a type of unsupervised artificial neural network frequently used for data visualization and clustering. It was initiated by Kohonen (2001) to create a two-dimensional representation of the input data. SOM network consists of an input layer and an output layer. The input data are mapped on a rectangular or hexagonal grid which is the output layer. The network is divided into nodes or neurons; the number of neurons can vary. The neurons are grouped in clusters based on the distance between nodes. The most common distance measure between the neurons is the Euclidian distance. SOM is based on BATCH algorithm (Vesanto, Himberg, Alhoniemi, & Parhankangas, 2000), that we briefly present.

The training of the map processes all data simultaneously (Sarlin, Yao, & Eklund, 2011). A reference vector m_j of the same dimension as the input data are associated with each node j. The algorithm has two steps: In the first step, each input data vector x_j is associated with m_j :

$$\left\| x_i - m_i \right\| = \min_j \left\| x_i - m_j \right\| \quad (1)$$

The new reference vector m_i is adjusted as:

$$m_i(t+1) = \frac{\sum_{j=1}^{n} h_{ic}(t) x_j}{\sum_{j=1}^{n} h_{ic}(t)} \quad (2)$$

where n is the number of input vectors, $c = \arg\min_k \{\|x_j - m_k\|\}$ is the index of the best matching neuron of data sample x_j, $h_{ic}(t)$ is the neighborhood function value at its best matching neuron.

Growth-Inequality Modelling and Empirical Study

The Three Stages Methodology

Our methodology is structured in three stages as follows:

(1) The first stage consists of the application of an unsupervised neural network algorithm to divide the European countries in some clusters according to various economic and social inequality levels.

The data base used consists of a panel data of attributes by country and period, indicating the economic and social inequality.

(2) The second stage consists of computing the composite index of social and economic inequality. The computation of the composed index is imposed by the fact that the international statistics present a great number of indicators reflecting inequality, the use of all of them in the model being difficult. We computed these mixed inequality indicators for the limit clusters, high inequality, and low inequality clusters, respectively.

The algorithm of computing the mixed indicator of economic and social inequality (ESI_t—Economic and Social Inequality) is based on Principal Component Analysis and includes two stages:

(a) In this stage we used the scree plot in order to select the principal components that explain together most of the variability. The composite principal component is computed as a weighted sum of the principal components selected according to the scree plot criterion. The weights equal the corresponding proportion of the variance explained by each component in their total variance (*OECD Handbook on Constructing Composite Indicators*, 2008; Davidescu, Vass Paul, Gogonea, & Zaharia, 2015):

$$PC = \sum_{i=1,n} \frac{\text{Proportion of variance of } PC_i}{\text{Cumulative proportion}} PC_i \quad (3)$$

$$PC_i = \begin{pmatrix} pc_{1i} \\ . \\ . \\ . \\ pc_{mi} \end{pmatrix} \quad (4)$$

where *n* represents the number of principal components PC_i selected according to the scree plot and *m* represents the number of attributes. Composed PC vector has elements obtained as a weighted sum of the corresponding coefficients in the principal components selected.

(b) The composite index ESI_t is computed in the second stage and is expressed as a product of the PC index elements multiplied by vectors of observed attributes:

$$ESI_t = \sum_{k=1,m} pc_k x Attribute_{kt} \tag{5}$$

where $pc_k, k = 1,...,m$ are the elements of the composite PC vector, and the $Attribute_{kt}$ is the elements of the $k = 1,...,m$ observed vectors of attributes for each period *t*.

(3) The third step consists of the growth—inequality relationship modelling. In order to approximate the influence of the economic and socio-political inequality on the economic growth, we got inspired from some notable models in the economic literature on this topic namely, Alessina and Perotti (1993), Ortega Diaz (2007), Barro (2000), Gregorio and Lee (2002), Kolawole et al. (2015).

We constructed two econometric models. The first of them has the dependent variable, the growth rate of income per capita GRR_t and independent variables investments rate, INV_t, economic and social inequality composite index ESI_t, human development index HDI_t, government expenditures rate GE_t, and total population rate PT_t, ε_t error term.

$$GRR_t = a_1 INV_t + a_2 ESI_t + a_3 HDI_t + a_4 GE_t + a_5 PT_t + \varepsilon_t \tag{6}$$

In order to estimate the parameters of the multiple regression function, we used the statistical data by country and periods for the independent variables listed above.

The second model used is a VAR model for the endogenous variables GRR_t, INV_t, ESI_t, HDI_t, GE_t, used to study the Granger causality and to compute impulse response functions for determine the evolution of the variables after a shocks. The VAR model used is:

$$y_{it} = A_i + A_i(l) y_{i,t-1} + u_{it}, i = 1,..., N; t = 1,...T$$

where Index i is the country in the cluster, N is the number of countries in the cluster, t is the time period, and $T = 48$ monthly dates for the years 2011-2015, u_{it} is the vector of random disturbances, $A(l)$ is a polynomial matrix in the lag operator, and A_i is deterministic components of data for any country. We applied the VAR model for the cluster C3 comprising the countries with the lowest inequality and C5, the cluster comprising countries with highest inequality.

Empirical Evidence and Results

For the empirical study, we considered in the first stage, 24 countries situated in the Central and Eastern Europe space, namely: Czech Republic, Croatia, Georgia, Latvia, Lithuania, Moldova, Montenegro, Poland, Romania, Russian Federation, Turkey, Ukraine, Albania, Armenia, Belarus, Bosnia and Herzegovina, Bulgaria, Estonia, Greece, Hungary, Macedonia, Serbia, Slovak Republic, and Slovenia.

We started our empirical study by grouping the 24 countries from Central and Eastern Europe during 2011-2015 in clusters, using SOM clustering software. The attributes considered are: Human Development Index (HDI), Poverty Headcount Ratio at $1.25 a day (PPP) (% of population), GINI index, income share held by highest 20%, income share held by lowest 20%, rates of: number of poor at $1.25 a day (PPP) (millions), minimum yearly wage (nominal US$), average monthly wage (US$), midclass (third and fourth quintiles of income classes), primary school enrolment (million persons), GDP per capita (PPP—current international dollars). Most data were extracted mainly from the World Bank Statistics, and the missing data are completed from different national documents and statistics. We changed the frequency of the data using the facilities of Eviews program.

The HDI was computed according to UN Development Program 2014 methodology based on the following indicators: life expectancy at birth, minimum years of schooling, and expected years of schooling, Gross National Income per capita. The indicator “Poverty headcount ratio at $1.25 a day” is the percentage of population living less than $1.25 a day at 2005 international prices.

We have chosen the number of clusters so that each country is included in a single cluster for all the periods. The structure of the clusters is the following:

The first cluster (C1) includes seven countries: Latvia, Lithuania, Poland, Turkey, Bulgaria, Estonia, Greece; the second cluster (C2), the largest, includes nine countries: Belarus, Bosnia and Herzegovina, Ukraine, Albania, Moldova, Romania, Armenia, Serbia, Montenegro; the third cluster (C3) includes five countries: Czech Republic, Croatia, Hungary, Slovak Republic, Slovenia; the fourth cluster (C4) includes two countries: Macedonia and Russian Federation; and finally, the fifth cluster (C5) includes only one country, namely, Georgia.

The third cluster comprises indicators that reflect the most equitable income distribution (see Table 1), having the lowest GINI coefficient (27.1), the lowest income share held by the richest 20% of population (36.04%) and one of the highest share of income held by the poorest 20% of population (8.92%). The number of poor with the daily income of $1.25 has the lowest value 0.0078 million persons. The highest value of HDI in this cluster is 0.8379, and the highest minimum monthly average wage of 1,739 USD (see Table 1).

Table 1

Summary Statistics

Cluster	Description	Abs. Profil...	Frequency	GINI index [SI.POV.GINI]	Income share held by highest 20% [SI.DST.05TH.20]
C 1		0,561	29,17%	34,99	42,12
C 2		0,646	37,50%	28,56	37,37
C 3		0,886	20,83%	27,10	36,04
C 4		1,410	8,33%	43,52	40,72
C 5		1,929	4,17%	41,64	47,19

Cluster	Income share held by lowest 20% [SI.DST.FRST.20]	Number of poor at $1.25 a day (PPP) (millions) [SI.POV.NOP1]
C 1	6,70	0,0684
C 2	9,00	0,0394
C 3	8,92	0,0078
C 4	8,08	0,0009
C 5	5,18	0,7362

Cluster	Poverty headcount ratio at $1.25 a day (PPP) (% of population) [SI.POV.DDAY]	GDP per capita, PPP (current international dolars)	Human develoment Index
C 1	0,96	21345	0,8122
C 2	0,52	11019	0,7390
C 3	0,21	25013	0,8379
C 4	0,22	17372	0,7529
C 5	15,55	6546	0,7385

Cluster	Minimum yearly wage (Nominal US$)	Ave wage (US$)	Primary school enrolement	Midclass
C 1	6479	1326	96,5	39,34
C 2	2504	900	93,0	39,84
C 3	7227	1739	94,5	40,42
C 4	2543	1170	91,4	34,78
C 5	601	1557	97,3	37,44

This cluster has also the highest ratio of primary school enrolment, of 94.5% and the highest ratio of midclass (40.42%, composed by third and fourth quartile).

To the opposite side is cluster number 5 that is considered having the deepest inequality.

The indicators of this cluster are: the greatest values of Gini (41.64), income share held by highest 20% (47.19% of GDP), the most reduced share held by lowest 20% (5.18% of GDP), the highest number of poor with a daily income of 1.25 USD (0.7362 million), the lowest GDP per capita PPP (international dollars), the lowest HDI (0.7385), a minimum annual wage of 601.0 USD, and a monthly wage of 1,557 USD (whose high value is due to the high share held by the rich class). With respect to Midclass and the Primary School Enrolment, these indicators held reasonable shares of 37.44% and 97.3% respectively, but the other attributes have led us to frame C5 in the last position in the hierarchy of clusters, with the greatest inequality.

Between the two limits there are clusters C2, C1, C4, in this order, starting with the lowest inequality. Romania is situated in the cluster C2, the next after the lowest inequality cluster, C3.

The map of the five clusters can be seen in Figure 1.

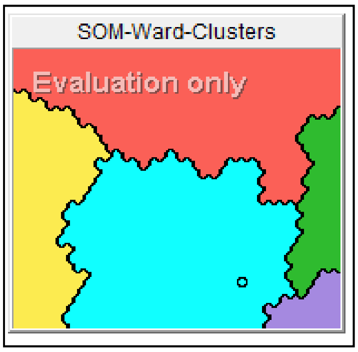

Figure 1. The SOM grid: the clusters in the increasing order of inequality (yellow for C3, red for C2, blue for C1, green for C4, magenta for C5).

The largest area is occupied by C2 and C1, marking the fact that most of the countries in the space considered have a level of inequality between the highest and the lowest. The second observation is that the highest inequality (magenta colour) corresponds to a lower surface than the lowest inequality (yellow colour).

We continued our study with the approximation of the composite indicator for the limit clusters.

We used the Principal Component Analysis, first for cluster 3, in order to do that. Table 2 shows the results for cluster 3.

The scree plot (Figure 2) is used as a criterion for determining the number of chosen principal components. It shows the eigenvalues on the y-axis and the number of principal components on the x-axis. It always displays a downward curve. The point where the curve levels off indicates the number of principal components retained.

According to the scree plot below, we retain only the first three principal components which explain 95.95% of the variance in the dataset.

The first principal component accounts for the most variability (0.4435), while the succeeding one accounts for the remaining variability.

As it can be seen from Table 2, PC1 decreases with Human Development Index (-0.418420) and with income share held by highest 20% (-0.395156). PC1 increases with the other attributes. PC2, that accounts for 0.3502 of the variability decreases with: GINI index (-0.243413), income share held by lowest 20% (-0.189220), midclass (-0.074722), poverty headcount ratio at $1.25 (-0.226314), and increases with the other attributes. PC3 accounting for 0.1658 of the variability decreases with: midclass (-0.532242), primary school enrolment (-0.603511), and increases with the other attributes.

Table 2

Principal Component Analysis for Cluster 3

Principal Components Analysis
Date: 05/27/16 Time: 14:06
Sample: 1 208
Included observations: 208
Computed using: Ordinary correlations
Extracting 11 of 11 possible components

Eigenvalues: (Sum = 11, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	4.878428	1.026378	0.4435	4.878428	0.4435
2	3.852050	2.028205	0.3502	8.730479	0.7937
3	1.823846	1.382492	0.1658	10.55432	0.9595
4	0.441354	0.437469	0.0401	10.99568	0.9996
5	0.003885	0.003451	0.0004	10.99956	1.0000
6	0.000434	0.000430	0.0000	11.00000	1.0000
7	3.56E-06	3.56E-06	0.0000	11.00000	1.0000
8	1.22E-15	3.86E-16	0.0000	11.00000	1.0000
9	8.32E-16	4.78E-16	0.0000	11.00000	1.0000
10	3.54E-16	6.90E-16	0.0000	11.00000	1.0000
11	-3.36E-16	---	-0.0000	11.00000	1.0000

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9	PC 10	PC 11
GDP_PER_CAPIT...	0.212949	0.443404	0.101094	-0.076932	0.126616	0.525490	0.670624	1.66E-09	-2.00E-09	2.71E-09	3.63E-09
GINI_INDEX__SI_...	0.325544	-0.243413	0.372704	-0.056448	-0.021796	-0.006303	0.003962	-0.210666	-0.479642	0.485663	0.426428
HUMAN_DEVELO...	-0.418420	0.178681	0.099168	-0.106193	-0.044998	0.001691	-0.005236	0.651018	-0.100383	0.567269	-0.118893
INCOME_SHARE_...	0.339535	-0.189220	0.329029	0.481240	0.059851	0.005129	0.007581	0.034077	0.084561	0.180423	-0.681565
INCOME_SHARE_...	-0.395156	0.180429	0.211883	0.264854	0.000362	0.008787	-0.002331	-0.499785	0.527020	0.368875	0.180468
MIDCLASS	0.274039	-0.074722	-0.532242	-0.465105	-0.009219	-0.010300	-0.000924	-0.241849	0.208185	0.485222	-0.286795
PRIMARY_SCHOO...	0.133669	0.119560	-0.603511	0.661951	0.151501	0.015350	0.004785	0.118919	-0.144903	0.195288	0.262577
RATE_AVE_WAGE...	0.251266	0.421917	0.016038	0.083794	-0.832127	-0.243151	-0.003918	5.85E-11	-7.16E-11	9.66E-11	1.29E-10
RATE_MINIMUM_Y...	0.222446	0.437137	0.105105	-0.070416	0.166623	0.412731	-0.738453	-2.74E-09	3.32E-09	-4.49E-09	-6.02E-09
RATE_NUMBER_...	0.192304	0.451284	0.127444	-0.099212	0.484374	-0.702760	0.069183	9.69E-10	-1.18E-09	1.59E-09	2.14E-09
RATE_POVERTY_...	0.399505	-0.226314	0.113270	-0.039427	0.005694	-0.005540	0.004444	0.456307	0.640803	0.011720	0.394623

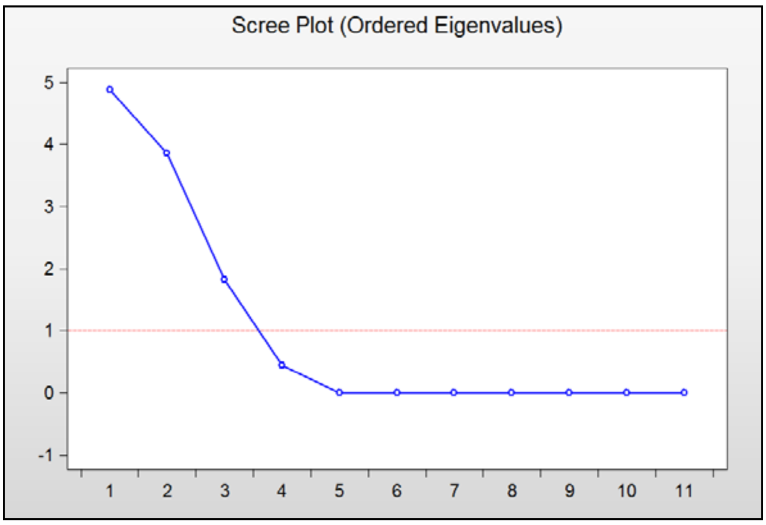

Figure 2. Scree plot for C3.

Using the three PC selected, we computed a mixed PC index whose coefficients are the weights equal to the corresponding proportion of the variance explained by each component in their total variance. The compound PC for C3 obtained is (see Table 2):

$$PC = \frac{0.4435}{0.9595} PC1 + \frac{0.3502}{0.9595} PC2 + \frac{0.1658}{0.9595} PC3 = 0.4622199 PC1 + 0.36498 PC2 + \\ +0.17298 PC3 \quad (7)$$

where PC is a vector, whose elements are the values of the attributes computed as the weighted sum of the first three principal components, with the weights: 0.4622199, 0.36498, 0.17298, respectively.

For example, the coefficient of PC representing average wage rate is:

$$0.4622199 \cdot 0.251266 + 0.36498 \cdot 0.421917 + 0.17298 \cdot 0.016038 = 0.272903 \quad (8)$$

In PCA, the loadings not close to zero show the (positive and negative) magnitude on that principal component. Based on this idea, we built the composite indicator ESI_t as a linear combination of the observed attributes (Word Bank Statistics) whose coefficients are the elements of the PC vector.

For C3, the composite indicator ESI_t—Economic and Social Inequality in the period *t*, is:

$$\begin{aligned} ESI_t &= 0.267273 Average\ wage\ rate_t - 0.11175 HDI_t + \\ &+0.144734 Income\ share\ of\ highest\ 20\%_t - 0.08021 Income\ share\ of\ lowest\ 20\%_t + \\ &+0.007424 Midclass_t + 0.243946 Minimum\ yearly\ wage\ rate_t + 0.275321 Number\ of\ poor\ rate_t + \\ &-0.121487 Poverty\ headcount\ ratio\ at\ 1.25\$ / day - 0.00089 \Pr imary\ school\ enrollment_t + \\ &+0.12615 GINI_t + 0.277627 GDP\ per\ capita\ rate_t \end{aligned} \quad (9)$$

The graph of the composite index ESI_t for C3 could be seen in Figure 3.

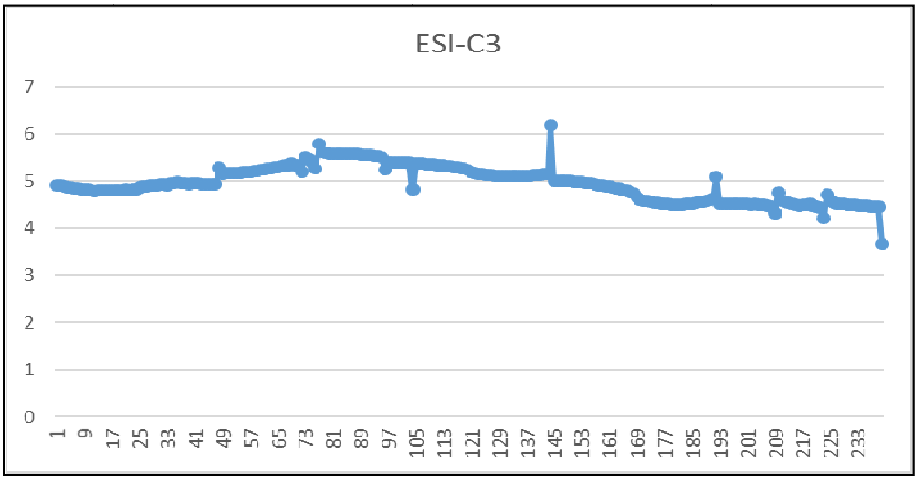

Figure 3. The composite index ESI_t for the cluster C3.

With some exceptions (Hungary 2013Q4 with the value higher than six, Latvia 2010Q3 with a value less than four), the values for the countries with the lowest inequality are concentrated between four and six, proving the homogenity between countries and periods form the view point of economic and social inequality.

The ESI_t indicator is then used, together with the statistical series of INV_t (total investments rate), HDI_t (Human Development Index), GE_t (Government Expenditures Rate), PT_t (Total Population Rate), to measure their influence on the growth rate in the regression Equation 6:

The regression statistics could be seen in Table 3.

From the regression statistics in the table above, we conclude that the model fits well the data and the parameters could be considered good estimators for the model.

So, $Multiple\ R = 0.890611$ assures us that the dependent variable (growth rate) is correlated with the independent variables (INV_t, HDI_t, GE_t, PT_t, ESI_t).

Table 3

Regression Statistics for GRR_t *for C3*

SUMMARY OUTPUT									
Regression Statistics									
Multiple F	0,890611								
R Square	0,793189								
Adjusted I	0,78877								
Standard E	0,54621								
Observati	240								
ANOVA									
	df	*SS*	*MS*	*F*	*gnificance F*				
Regressio	5	267,7546	53,55092	179,4933	5,73E-78				
Residual	234	69,81271	0,298345						
Total	239	337,5673							
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95,0%*	*pper 95,0%*	
Intercept	16,24948	2,424095	6,703317	1,51E-10	11,47364	21,02532	11,47364	21,02532	
X Variable	1,134859	1,897117	0,598202	0,050284	-2,60275	4,872471	-2,60275	4,872471	inv
X Variable	-0,78341	0,149515	-5,23965	3,59E-07	-1,07797	-0,48884	-1,07797	-0,48884	esi
X Variable	4,291676	231,6852	-2,36654	0,018771	-1004,75	-91,8363	-1004,75	-91,8363	hdi
X Variable	1,343872	1,06665	1,259899	0,008961	-0,75759	3,445336	-0,75759	3,445336	ge
X Variable	1,522196	0,051456	7,582367	5,06E-81	1,42082	1,623573	1,42082	1,623573	pt

The coefficient of multiple determination, $R^2 = 0.793189$, shows that the regression model is a good fit of the data, meaning that it explains much of the variability of the data.

The adjusted R shows that 78.877% of variation is explained by the significant independent variables. The significance F is very small, $5.73x10^{-78}$, hence the results are reliable.

All *p*-values are less than 0.05, so we can reject the null hypothesis.

The estimated model obtained is:

$$GRR_t = 16.24948 + 1.134859 INV_t - 0.78341 ESI_t + 4.291676 HDI_t + 1.343872 GE_t + \\ + 1.522196 PT_t + \varepsilon_t \quad (10)$$

First we notice a negative relationship between inequality and growth, meaning that as ESI_t increases one unit; GRR_t decreases 0.78341.

The countries included in C3 are, as we showed before: Czech Republic, Croatia, Hungary, Slovak Republic, and Slovenia. All the five countries are from the Central Europe, ex-communist countries with an average development degree. So, for these five countries, the growth-inequality relationship during the period studied, is negative.

Another observation refers to the influence of the real investments and the government expenditures: As expected, the two have positive and important influence, the highest influence belonging to the government expenditures. Human Development Index has by far the most important influence on the growth rate, revealing, besides the total population positive influence, the importance of the human factor in the economic growth.

We made a linear forecast for the independent variables during the quarters of 2016, computing then the corresponding values for GRR_t.

From Figure 4, we can observe that the model is well specified and fits good the data, though under estimating the data for Czech Republic during 2010, 2011 the fourth month, 2013 the second month, Croatia

2012 the first month, Hungary during 2010 the fourth month—2013 the third month, Slovak Republic during the first and the fourth month of 2010.

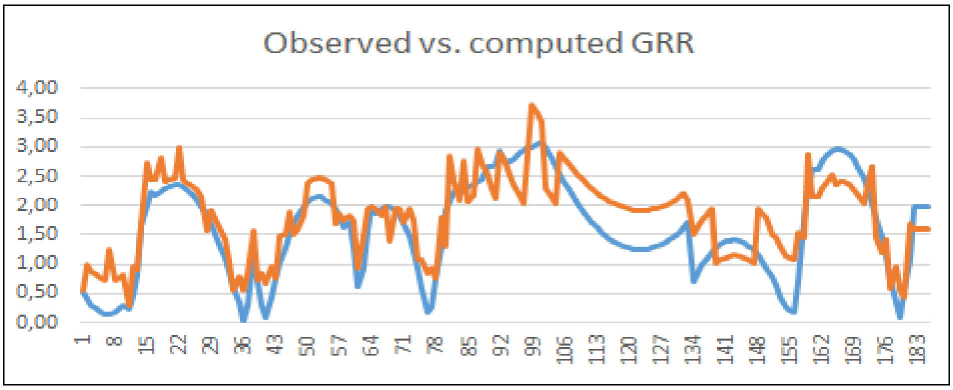

Figure 4. Observed (red line) and computed (blue line) GRR for C3.

The growth rates are between 0.0% and 3.5%; the highest values are for Hungary, the second month of 2010, for Czech Republic during the second and the 10th month of 2011, for Slovak Republic, the 12th month of 2010.

The lowest growth rate registered Czech Republic during the 11th month of 2012 and the sixth month of 2013.

We applied the same methodology for the fifth cluster comprising a single country, Georgia.

First we apply the PC analysis.

According to the scree plot from Figure 5, we retain only the first two principal components which explain 68.54% of the variance in the dataset.

Figure 5. Scree plot for C5.

As can be seen from Table 4, PC1 that accounts for 0.4378 of the dataset variability, decreases with Human Development Index (-0.418041), income share held by lowest 20% (-0.387397), primary school enrolment (-0.375438). PC1 increases with the remaining attributes. PC2 that accounts for 0.2477 of the dataset variability, decreases with GINI index (-0.185238), HDI (-0.014810), income share held by highest 20% (-0.184633), income share held by lowest 20% (-0.111732), number of poor rate (-0.095191). PC2 increases with the remaining attributes.

Table 4

Principal Component Analysis for C5

Principal Components Analysis
Date: 05/26/16 Time: 17:14
Sample: 1 20
Included observations: 20
Computed using: Ordinary correlations
Extracting 11 of 11 possible components

Eigenvalues: (Sum = 11, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	4.815469	2.091250	0.4378	4.815469	0.4378
2	2.724219	1.697494	0.2477	7.539688	0.6854
3	1.026725	0.227768	0.0933	8.566413	0.7788
4	0.798958	0.229685	0.0726	9.365371	0.8514
5	0.569273	0.078276	0.0518	9.934644	0.9031
6	0.490997	0.200585	0.0446	10.42564	0.9478
7	0.290412	0.037683	0.0264	10.71605	0.9742
8	0.252729	0.234066	0.0230	10.96878	0.9972
9	0.018663	0.006108	0.0017	10.98745	0.9989
10	0.012555	0.012555	0.0011	11.00000	1.0000
11	-8.15E-17	---	-0.0000	11.00000	1.0000

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9	PC 10	PC 11
GINIINDEX	0.399619	-0.185238	-0.047144	-0.022500	0.124461	0.229371	0.149081	0.590239	-0.424960	0.428909	-3.18E-16
HDI	-0.418041	-0.014810	-0.065731	0.391882	0.156872	0.124758	0.027281	-0.004957	0.403123	0.680941	3.22E-16
INCOMESHAREHE...	0.355102	-0.184633	-0.309097	0.063336	-0.086245	0.618898	0.015236	0.024120	0.530339	-0.260222	4.91E-16
INCOMESHAREHE...	-0.387397	-0.111732	0.020650	0.307918	0.363613	-0.056689	0.007518	0.586533	0.043573	-0.510682	1.96E-16
MIDCLASS	-0.223226	0.370068	0.235767	-0.341960	-0.515244	0.086002	0.346643	0.424572	0.257874	0.030046	2.30E-16
POVERTYHEADC...	0.206484	0.053761	0.776713	-0.091445	0.478582	0.196763	0.144591	-0.134784	0.189488	-0.009720	1.20E-16
PRIMARYSCHOOL...	-0.375438	0.156544	-0.002967	0.133663	-0.036104	0.635701	0.241538	-0.274182	-0.513068	-0.120376	-4.86E-16
RATE__MINYEARL...	0.138219	0.557090	-0.045102	0.129694	0.083421	0.087142	-0.355631	0.101206	-0.018582	0.008780	-0.707107
RATE_AVERAGE_...	0.138219	0.557090	-0.045102	0.129694	0.083421	0.087142	-0.355631	0.101206	-0.018582	0.008780	0.707107
RATE_GDP_PERC...	0.250996	0.353253	-0.302134	0.232593	0.224116	-0.269191	0.723929	-0.113519	0.053950	-0.065328	-2.76E-17
RATE_NUMBER_...	0.233981	-0.095191	0.378495	0.718465	-0.510178	-0.087730	0.017711	0.003831	-0.067066	-0.062739	-2.46E-17

The methodology for computing the compound PC is explained above.

The PC vector for C5 computed as a linear combination of the first two PCs, is:

$$PC = \frac{0.4378}{0.6854}PC1 + \frac{0.2477}{0.6854}PC2 \tag{11}$$

The weights used are taken from Table 4. The mixed PC for C5 is computed, similar to mixed PC for C3.

The composite index of social and economic inequality for C5, computed as a weighted sum of the PC elements and observed attributes vectors is:

$$\begin{aligned} ESI_t &= 0.289614 Average\ wage\ rate_t - 0.27238 HDI_t + \\ &+0.160096 Income\ share\ of\ highest\ 20\%_t - 0.28782 Income\ share\ of\ lowest\ 20\%_t \\ &-0.00885 Midclass_t + 0.289614 Minimum\ yearly\ wage\ rate_t + 0.115054 Number\ of\ poor\ rate_t \\ &+0.150678 Poverty\ headcount\ ratio\ at\ 1.25\$/day - 0.18324 \Pr imary\ school\ enrollment_t \\ &+0.188313 GINI_t + 0.287986 GDPpercapitarate_t \end{aligned} \tag{12}$$

The economic and social inequality mixed index ESI_t has an expected variation according to the following indicators: HDI_t (ESI_t decreases with 0.27238 as HDI_t increases one unit); income share of highest 20% (ESI_t increases 0.160096 with each percentage point increases of the indicator); ESI_t decreases with 0.28782 for each percentage point increase of income share of lowest 20%; ESI_t decreases with 0.00885 as midclass increases one unit; ESI_t increases 0.115054 as number of poor rate increases one unit; ESI_t increases 0.150678 as poverty headcount ratio at $1.25 increases; ESI_t decreases 0.18324 as primary school enrolment increases one unit; ESI_t decreases 0.18831 as Gini increases one point.

For Georgia, the composite indicator ESI_t has the values between 5 and 10, so, greater than the same indicator for C3. After an increase between the periods 57-113, the inequality has a slightly decreasing tendency.

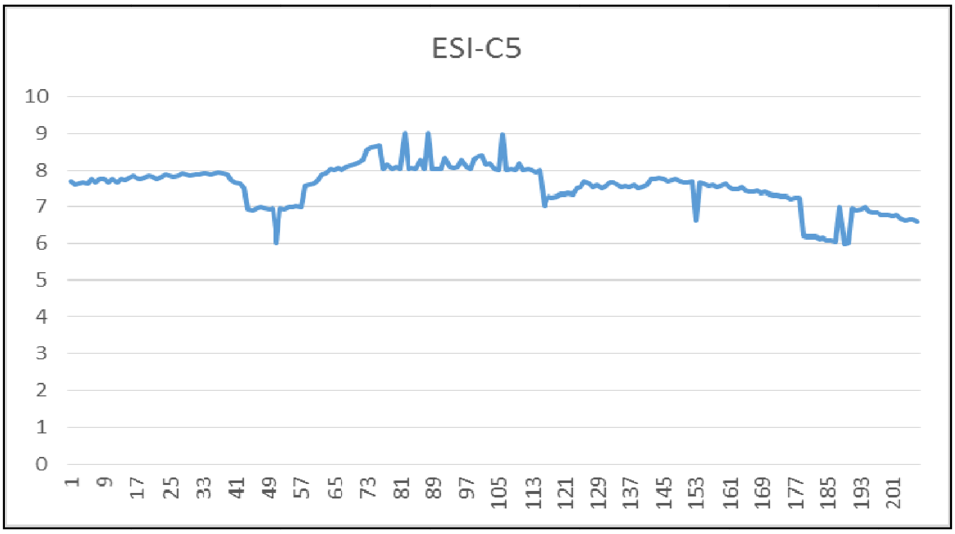

Figure 6. The ESI_t indicator for C5.

The estimated GRR econometric model is:

$$GRR_t = 572.0521 + 0.200241 INV_t + 0.00000249 ESI_t + 0.105839 HDI_t + 0.314257 GE_t + 0.090108 PT_t + \varepsilon_t \quad (13)$$

From the regression statistics we conclude that the model fits well the data and the parameters could be considered good estimators for the model.

So, $Multiple \quad R = 0.943072$ has a high value, assuring a rather strong correlation between the dependent variable (growth rate) with the independent ones (real investments rate—INV, economic and social inequality mixed index—ESI, human development index—HDI, government expenditures rate—GE, total population rate—PT).

The regression model is a good fit of the data because the coefficient of multiple determinations has a high value $R^2 = 0.889385$ so the model explains much of the data variability. The adjusted R has also a high value showing that 86.3557% of variation is explained by the significant independent variables. The significance F has a very small value $5.36x10^{-21}$, showing that the results are reliable. All *p*-values are less than 0.05, so we can reject the null hypothesis.

The influences of INV, HDI, GE, and PT on the GRR are expected in the sense that the increase in their values implies the increase of the GRR. The highest influence is obtained by GE (0.314257), followed by INV (0.200241), HDI (0.105839), and PT (0.090108). ESI_t has also a positive but weak influence (0.00000249). We can conclude that the relationship ESI_t-GRR_t is positive for C5, but very week.

It could be seen in Figure 7, that the observed and computed values of GRR_t are close, which reveals that the model is well specified. From the period 113, the GRR_t (observed and computed) begins to decrease, showing the fact that Georgia registered a decrease of growth rate simultaneously with the weakly decrease of the inequality.

For the year 2016 we made the forecast and we see in Figure 7, that the results preserve the decreasing tendency of GRR_t.

Also in the third stage, we applied the VAR model for C3, obtaining results for each of the countries in this cluster: Czech Republic, Croatia, Hungary, Slovak Republic, Slovenia.

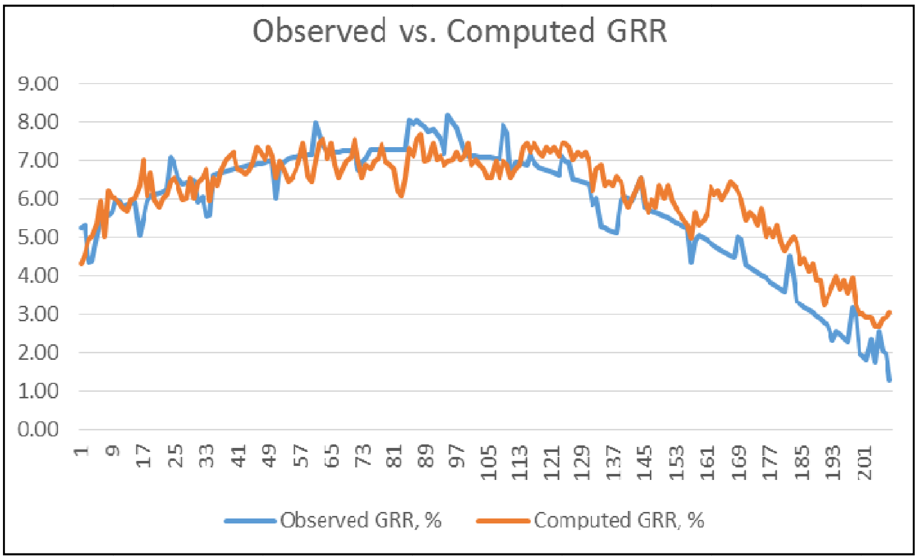

Figure 7. Observed and computed GRR_t for C5.

We first applied for Czech Republic data, the Akaike and Schwartz information criterion, obtaining an optimal lag equal with five units of time (Table 5).

Table 5

Akaike and Schwartz Information Criterion (Czech Republic)

VAR Lag Order Selection Criteria
Endogenous variables: ESI_SA GE_GDP_SA GRR____SA HDI_SA TOTAL_INV_SA
Exogenous variables: C
Date: 07/03/17 Time: 14:13
Sample: 2010M01 2013M12
Included observations: 43

Lag	LogL	LR	FPE	AIC	SC	HQ
0	946.8556	NA	6.49e-26	-43.80724	-43.60245	-43.73172
1	1566.112	1065.698	6.49e-38	-71.44709	-70.21835	-70.99397
2	1625.105	87.80272	1.40e-38	-73.02814	-70.77544*	-72.19741
3	1662.582	47.06380	8.94e-39	-73.60845	-70.33180	-72.40012
4	1715.019	53.65718*	3.26e-39	-74.88462	-70.58402	-73.29869
5	1759.726	35.34907	2.16e-39*	-75.80119*	-70.47663	-73.83766*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

After the application of the Augmented Dicky-Fuller test, we saw that the time series INV, ESI, GE, HDI are stationary, so we applied the VAR(5) estimated model for Czech Republic.

We next applied Granger causality test (Table 6), in order to find the causal relationships between variables. For the cases with *p*-value lower than 0.05, we have Granger causal relationships between the variables. So, there are causal relationships between: ESI, and GE, GRR; GE, and ESI, GRR, HDI, INV; GRR and ESI, GE, HDI, INV; HDI and GE, GRR, INV, ESI; INV and ESI, GE, GRR. That means that economic and social inequality influences and is influenced by growth rate GRR and the other indicators.

Table 6

Granger Causality Test for Czech Republic

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 07/03/17 Time: 14:14
Sample: 2010M01 2013M12
Included observations: 43

Dependent variable: ESI_SA

Excluded	Chi-sq	df	Prob.
GE_GDP_SA	16.74052	5	0.0050
GRR____SA	31.56361	5	0.0000
HDI_SA	3.871380	5	0.5681
TOTAL_INV_...	10.47087	5	0.0629
All	73.22104	20	0.0000

Dependent variable: GE_GDP_SA

Excluded	Chi-sq	df	Prob.
ESI_SA	25.53068	5	0.0001
GRR____SA	27.27697	5	0.0001
HDI_SA	14.19223	5	0.0144
TOTAL_INV_...	59.69312	5	0.0000
All	131.0225	20	0.0000

Dependent variable: GRR____SA

Excluded	Chi-sq	df	Prob.
ESI_SA	23.66133	5	0.0003
GE_GDP_SA	34.11563	5	0.0000
HDI_SA	10.73780	5	0.0568
TOTAL_INV_...	40.56330	5	0.0000
All	119.5596	20	0.0000

Dependent variable: HDI_SA

Excluded	Chi-sq	df	Prob.
ESI_SA	36.13332	5	0.0000
GE_GDP_SA	66.57006	5	0.0000
GRR____SA	32.76164	5	0.0000
TOTAL_INV_...	79.04773	5	0.0000
All	186.6830	20	0.0000

Dependent variable: TOTAL_INV_SA

Excluded	Chi-sq	df	Prob.
ESI_SA	22.11492	5	0.0005
GE_GDP_SA	47.86837	5	0.0000
GRR____SA	22.97680	5	0.0003
HDI_SA	10.10686	5	0.0723
All	129.3205	20	0.0000

Next we computed the impulse response functions to the shocks to the other variables. From the graphs of Figure 8 and Table 7, we see that the shock on GRR has positive impact over ESI for nine periods, except the first period for which it has a negative impact, and conversely. We conclude that for Czech Republic, the relationship inequality-growth is preponderantly positive. The INV impact on GRR is preponderantly positive for all periods, which proves Keynesian effects of investments on income.

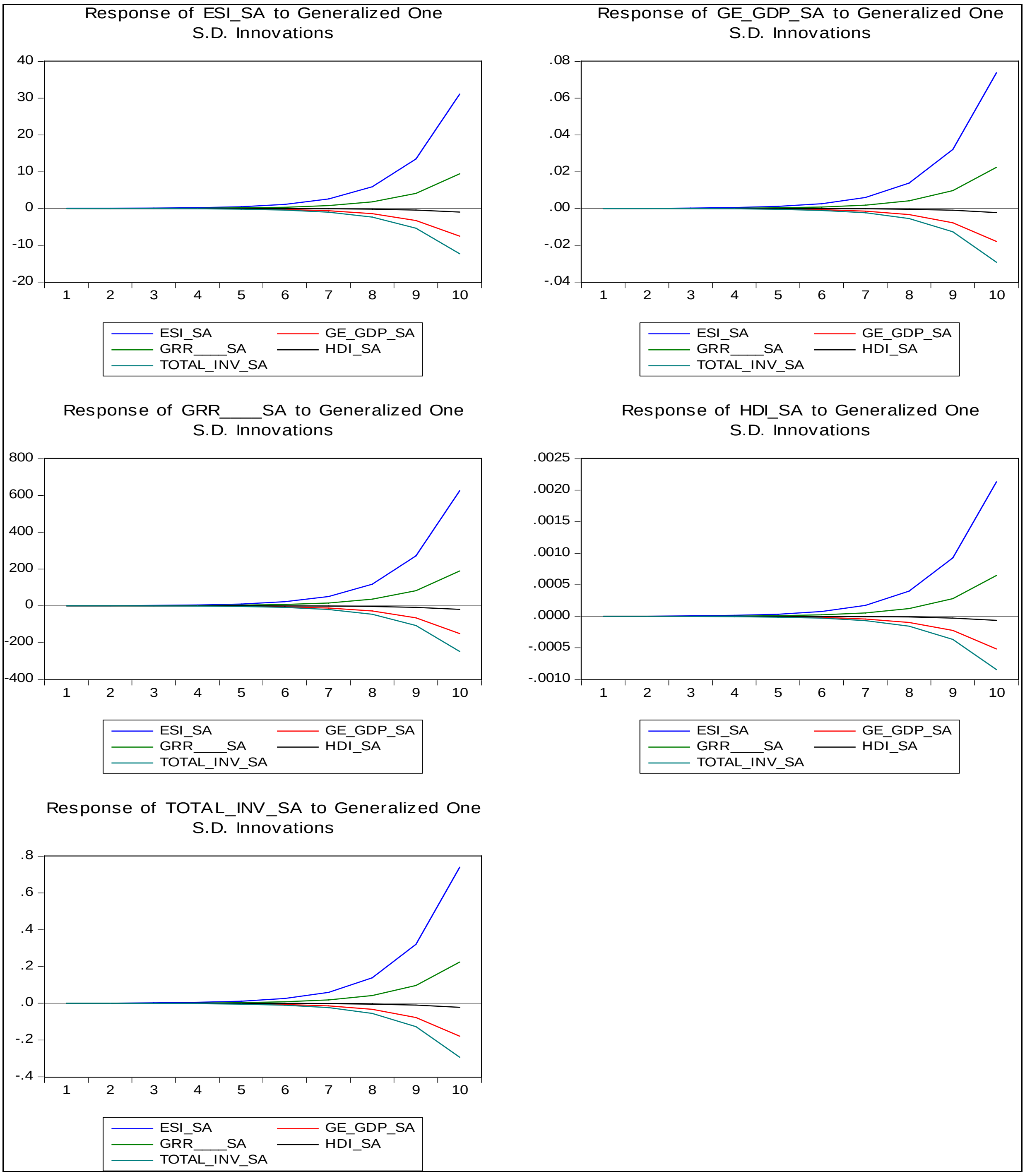

Figure 8. The impulse response functions (Czech Republic).

Table 7

The Impulse Response Functions (Czech Republic)

Response of ESI_SA:					
Perio...	ESI_SA	GE_GDP_S...	GRR____S...	HDI_SA	TOTAL_INV...
1	0.034110	-0.005136	-0.002662	-0.001681	-0.008550
2	0.067922	-0.021995	0.011575	-0.006898	-0.031146
3	0.101754	-0.031986	0.045127	-0.008311	-0.049153
4	0.193444	-0.050036	0.078546	-0.011519	-0.081538
5	0.464309	-0.110985	0.146242	-0.016971	-0.182940
6	1.114899	-0.265047	0.328137	-0.031896	-0.435475
7	2.579560	-0.618655	0.776152	-0.071570	-1.014877
8	5.883304	-1.430574	1.795588	-0.178248	-2.337286
9	13.48666	-3.282776	4.121464	-0.418379	-5.361672
10	31.09477	-7.560455	9.451828	-0.966623	-12.34768
Response of GE_GDP_SA:					
Perio...	ESI_SA	GE_GDP_S...	GRR____S...	HDI_SA	TOTAL_INV...
1	-1.27E-06	8.41E-06	5.66E-06	7.55E-06	8.26E-06
2	4.16E-05	7.79E-06	9.18E-06	1.41E-05	1.87E-06
3	0.000181	-2.43E-05	2.78E-05	1.17E-05	-4.88E-05
4	0.000482	-0.000110	0.000112	-3.76E-06	-0.000181
5	0.001118	-0.000278	0.000318	-3.50E-05	-0.000447
6	0.002564	-0.000635	0.000775	-8.89E-05	-0.001029
7	0.005957	-0.001457	0.001794	-0.000200	-0.002370
8	0.013856	-0.003364	0.004165	-0.000439	-0.005490
9	0.032048	-0.007782	0.009668	-0.000999	-0.012704
10	0.073873	-0.017949	0.022382	-0.002294	-0.029309
Response of GRR____SA:					
Perio...	ESI_SA	GE_GDP_S...	GRR____S...	HDI_SA	TOTAL_INV...
1	-0.007418	0.063982	0.095042	0.071981	0.055301
2	0.475656	0.005503	0.104620	0.090069	-0.064415
3	1.803481	-0.384885	0.276033	-0.005747	-0.631139
4	4.286698	-1.120097	1.149345	-0.144684	-1.767585
5	9.520838	-2.431700	2.939888	-0.375206	-3.899037
6	21.82796	-5.405052	6.699177	-0.799743	-8.765383
7	50.81001	-12.40338	15.30245	-1.701557	-20.19964
8	117.9074	-28.60055	35.51030	-3.697458	-46.69969
9	271.8957	-66.04124	82.26187	-8.451641	-107.8360
10	625.8440	-152.1258	189.9888	-19.44464	-248.4187
Response of HDI_SA:					
Perio...	ESI_SA	GE_GDP_S...	GRR____S...	HDI_SA	TOTAL_INV...
1	-1.06E-08	1.94E-07	1.64E-07	2.16E-07	1.78E-07
2	1.23E-06	2.02E-07	2.73E-07	4.19E-07	1.95E-08
3	5.25E-06	-7.23E-07	7.93E-07	3.30E-07	-1.43E-06
4	1.39E-05	-3.20E-06	3.24E-06	-1.19E-07	-5.24E-06
5	3.23E-05	-8.00E-06	9.17E-06	-1.01E-06	-1.29E-05
6	7.41E-05	-1.83E-05	2.24E-05	-2.56E-06	-2.97E-05
7	0.000172	-4.21E-05	5.18E-05	-5.77E-06	-6.85E-05
8	0.000400	-9.72E-05	0.000120	-1.27E-05	-0.000159
9	0.000926	-0.000225	0.000279	-2.88E-05	-0.000367
10	0.002134	-0.000518	0.000646	-6.63E-05	-0.000847
Response of TOTAL_INV_SA:					
Perio...	ESI_SA	GE_GDP_S...	GRR____S...	HDI_SA	TOTAL_INV...
1	-2.34E-05	9.16E-05	5.43E-05	7.69E-05	9.33E-05
2	0.000402	8.71E-05	9.21E-05	0.000145	3.02E-05
3	0.001794	-0.000232	0.000271	0.000120	-0.000472
4	0.004812	-0.001093	0.001121	-3.35E-05	-0.001798
5	0.011183	-0.002773	0.003169	-0.000351	-0.004463
6	0.025684	-0.006354	0.007750	-0.000888	-0.010293
7	0.059676	-0.014587	0.017949	-0.002002	-0.023734
8	0.138811	-0.033693	0.041719	-0.004395	-0.054984
9	0.321063	-0.077950	0.096842	-0.010011	-0.127259
10	0.740098	-0.179811	0.224221	-0.022986	-0.293616
Generalized Impulse					

For Slovenia, there are three significant variables for VAR model namely: GRR, ESI, and GE. Akaike and Schwartz information criterion indicates a lag of four units of time. After application of the Augmented Dicky-Fuller test we found first order difference for ESI and second order difference for GRR and GE, needed for stationarity. We applied the estimated model VAR(4) for Slovenia.

Except the fail of causality between D(GRR_2) and D(ESI) all the variables are reciprocally causal related.

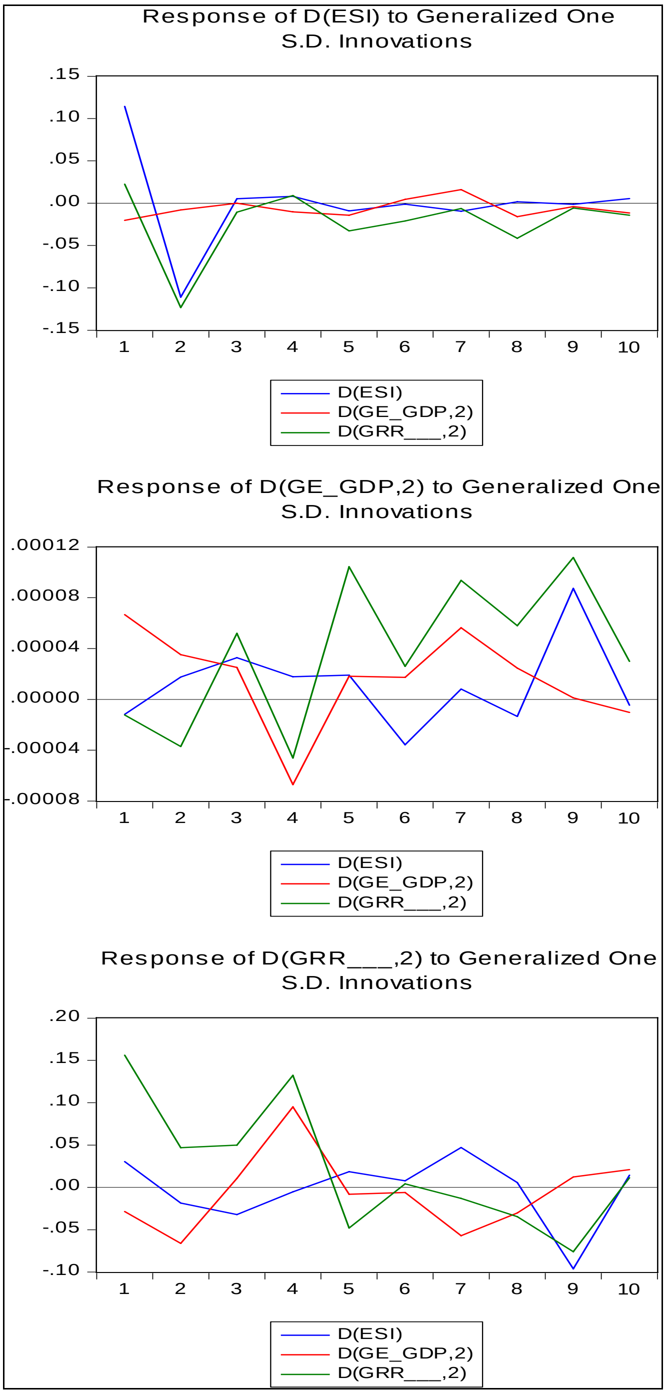

Figure 9. The impulse response functions (Slovenia).

From Figure 9, we see that the D(ESI) has a negative impact on D(GRR_2) excepting the first period, proving that an increase in inequality will negatively affect the growth rate.

For Hungary, applying Akaike and Schwartz information criterion, resulted the lag order equal to two.

After application of the Augmented Dicky-Fuller test, we see that the time series INV, ESI, GE, HDI are not stationary, so we applied the first order difference, obtaining the VAR(2) estimated model for Hungary.

For Hungary, we applied then the causality test Granger to verify causal relationship between the variables of the model. So, there are causal relationships between ESI, HDI, and GRR; GRR, ESI, and INV; GRR and ESI. That means that economic and social inequality influences and is influenced by growth rate. The response functions to the impulses of one variable to the others are reflected in the following figures (Figure 10):

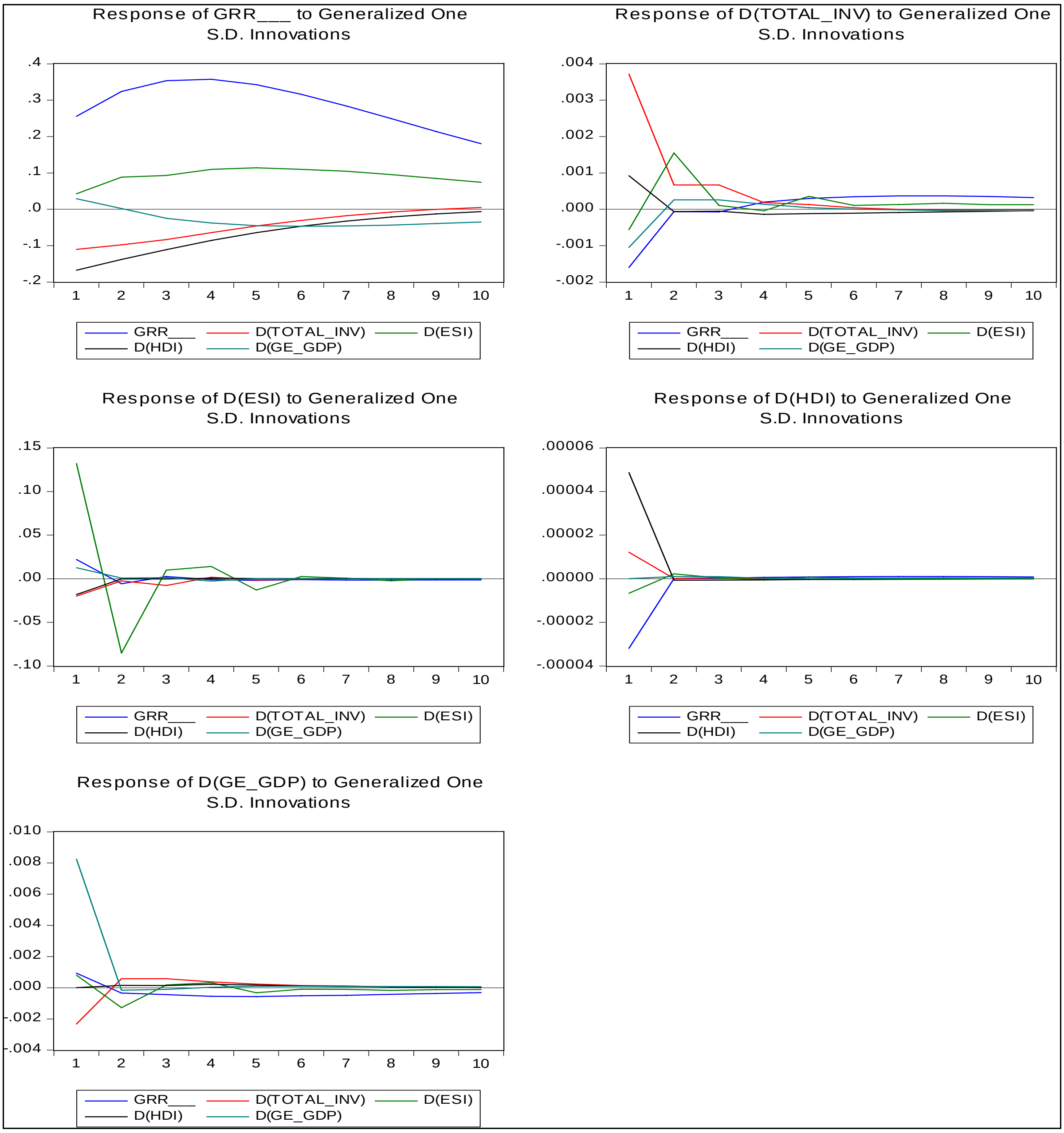

Figure 10. The response function (Hungary).

From the graphs, we see that the shocks on INV have a positive impact on GRR for nine periods, while a shock on ESI determines a weak negative response of GRR variable.

We find that the shock on GE has positive impact on GRR for nine period and negative impact for one period.

For Slovak Republic, Akaike and Schwartz information criterion reveals an optimal lag of two periods. After application of the Augmented Dicky-Fuller test, we show that the time series INV, ESI, GRR are not stationary. To avoid this problem, one needs two order differences, so the VAR(2) estimated model for Slovak Republic is applied.

Granger Causality Wald Test reveals the following causal relationships: GE_GDP and D(INV,2) have impact on D(ESI,2); D(ESI,2) has impact on D(GRR,2); GE_GDP and D(GRR_,2) have impact on D(TOTAL_INV,2).

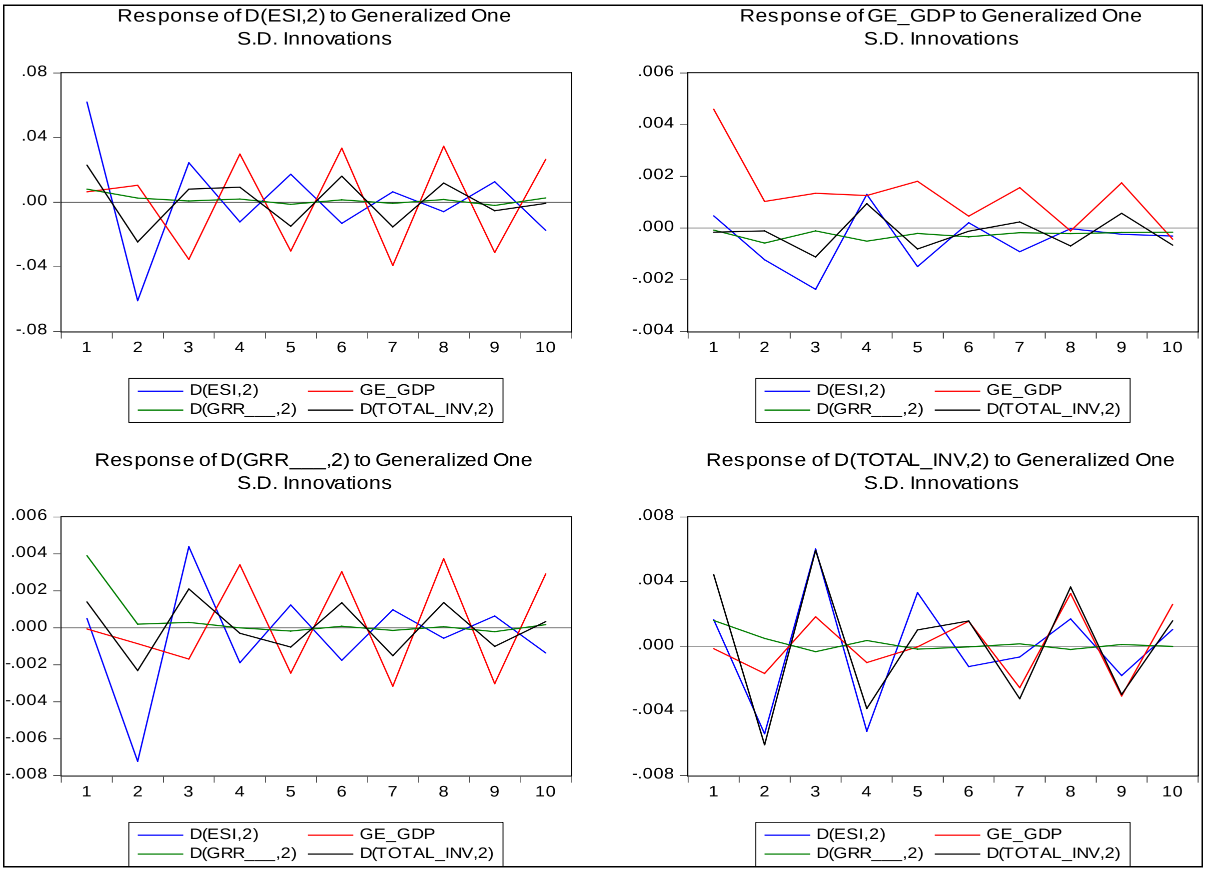

Figure 11. Response functions Slovak Republic.

D(GRR_,2) shock has negative influences on D(ESI,2) for six periods from 10, and D(ESI,2) shock has both negative and positive influence on D(GRR_,2). It is obvious that for Slovakia, the influence of inequality on growth is preponderantly negative.

For Republic of Croatia, Akaike and Schwartz information criterion reveals a five period optimal lag for VAR model.

Augmented Dicky-Fuller test for the Croatia data leads to one order of difference for ESI and two orders of differences for GRR, so the VAR(5) estimated model was applied.

Granger Causality Wald Test shows that causal relationships exist between: D(GRR_2,) and D(ESI); D(ESI) and GE_GDP; D(ESI) and D(GRR_,2).

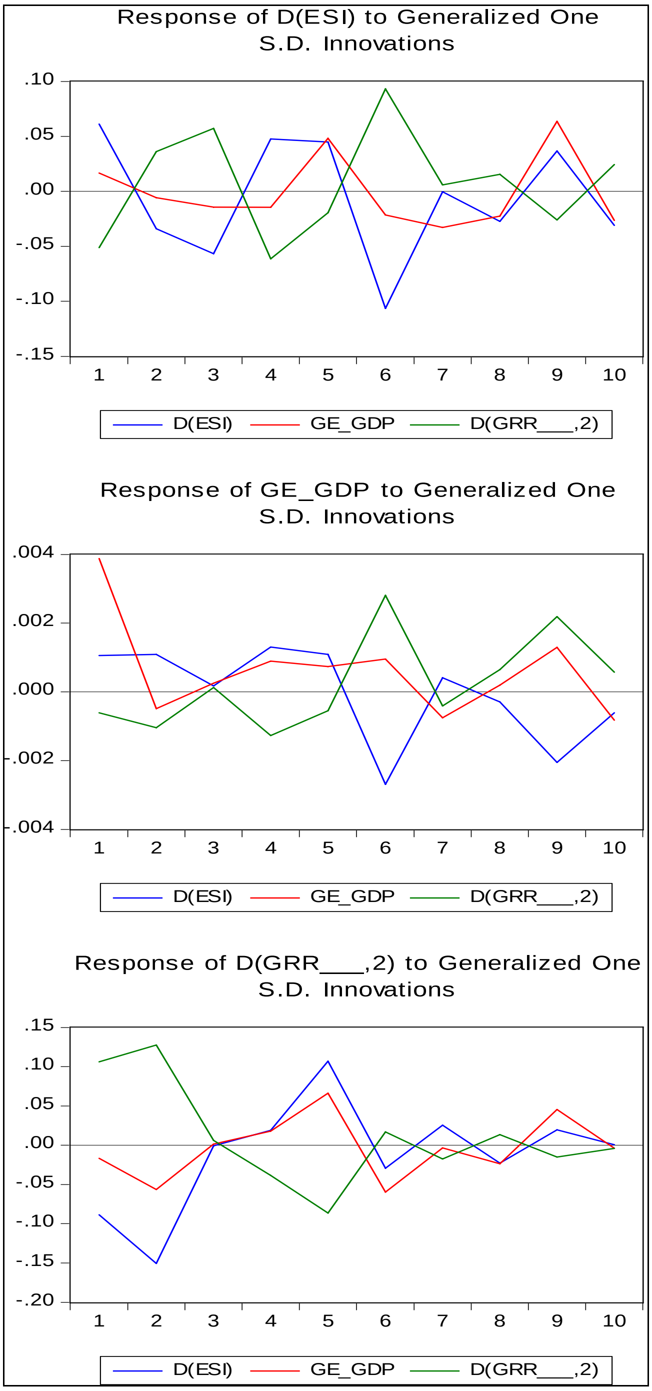

Figure 12. Response functions for Republic of Croatia.

We can see that D(ESI) negatively influences D(GRR_,2) for five periods of 10 periods, and D(GRR_,2), negatively influences D(ESI), for six periods, concluding that the relationship inequality-growth changes the sign, being alternatively negative and positive.

The fifth cluster, corresponding to the highest inequality comprises solely one country: Georgia. The VAR model for the cluster C5 comprises the variables: GRR, INV, ESI, and GE. Akaike and Schwartz information criterion proves the fact that the delay order is 7, so we have a VAR(7) model for Georgia.

After the application of the Augmented Dicky-Fuller for each data, we see that they become stationary after the second order differences.

Table 8

The Granger Causality (C5, Georgia)

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 07/03/17 Time: 11:50
Sample: 1 208
Included observations: 199

Dependent variable: D(ESI,2)

Excluded	Chi-sq	df	Prob.
D(GE____G...	9.448785	7	0.2220
D(GRR___,2)	4.154703	7	0.7618
D(TOTAL_IN...	8.433606	7	0.2959
All	21.97685	21	0.4008

Dependent variable: D(GE____GDP,2)

Excluded	Chi-sq	df	Prob.
D(ESI,2)	3.579514	7	0.8267
D(GRR___,2)	1.100516	7	0.9930
D(TOTAL_IN...	1.641150	7	0.9770
All	8.209074	21	0.9942

Dependent variable: D(GRR___,2)

Excluded	Chi-sq	df	Prob.
D(ESI,2)	3.577730	7	0.8269
D(GE____G...	0.469782	7	0.9995
D(TOTAL_IN...	0.483613	7	0.9995
All	15.62550	21	0.7903

Dependent variable: D(TOTAL_INV,2)

Excluded	Chi-sq	df	Prob.
D(ESI,2)	5.079904	7	0.6502
D(GE____G...	1.304722	7	0.9883
D(GRR___,2)	1.130359	7	0.9924
All	10.60703	21	0.9699

Due to the fact that the probabilities are greater than 0.05, we concluded that there are not causal relationships between the variables, so that the VAR(7) model will not be used for forecast.

As a conclusion resulted by application of VAR model, the relationship inequality-growth is preponderantly negative, exceptions making Check Republic, with positive weak relationship. And Republic of Croatia, with changing signs correlation.

Conclusions and Further Research

Using the research studies on the topic of long-term relationship between inequality and growth (Alesina & Perotti, 1993), we developed a three-stage method. The first stage is the grouping of the countries in inequality classes. The second stage is the principal component analysis for determining the composite inequality indicators for limit clusters. The third stage is the estimation of the influence of some indicators, including the composite inequality index, on the growth rate for limit clusters resulted as well as construction of VAR models in order to identify the causal relationships between variables and the impact of shocks over them.

From the 24 countries, 12 countries are members of the EU space: Czech Republic, Poland, Romania, Bulgaria, Estonia, Greece, Hungary, Slovak Republic, Slovenia, Latvia, Lithuania, Croatia.

From these EU countries, Czech Republic, Croatia, Hungary, Slovak Republic, and Slovenia, are comprised in the more equitable cluster, C3.

The next equitable cluster C2 includes as the EU countries only Romania. The third cluster in the order of decreasing equity/increasing inequality is the cluster C1, with the following EU countries: Latvia, Lithuania, Poland, Bulgaria, Estonia, and Greece. The cluster C4 is the penultimate from the viewpoint of fairness and does not include some EU countries, the same for the cluster C5 with the highest inequality.

Regarding the impact of inequality on growth, for C3 we obtained negative relationship that means that an increase of the inequality one unit will decrease the growth rate 0.78341 units, and for C5 the relation is positive, but very weak, so one unit increase in inequality will increase 0.00000249 unit, the growth rate. Also for C3, using VAR model, we found, the following relationship between social and economic inequality and growth: Three countries of five have negative correlation, one country has positive relationship, and one country has changing sign relationship.

References

Alesina, A., & Rodrik, D. (1994). Distributive politics and economic growth. *Oxford Journal of Economics, 109*(2), 465-490.

Alesina, A., & Perotti, R. (1993). Income distribution, political instability and investment. NBER Working Papers 4486, National Bureau of Economic Research, Inc. Retrieved from http://www.nber.org/papers/w4486.pdf

Andrei, A., Galupa, A., & Georgescu, I. (2017). Measuring the influence of economic and social inequality on growth, empirical evidences for Central and Eastern Europe. In proceedings of the *16th International Conference in Economy* (pp. 463-469). IE 2017, Bucharest, Romania, 4-7 May.

Atkinson, A. B., Piketty, T., & Saez, E. (2011). Top incomes in the long run of history. *Journal of Economic Literature, 49*(1), 3-71.

Barro, R. J. (2000). Inequality and growth in a panel of countries. *Journal of Economic Growth, 5*, 5-32.

Castello-Climent, A., & Domeneck, R. (2002). Inequality and economic growth: Some new evidences. *The Economic Journal, 112*(478), C187-C200.

Castello-Climent, A., & Cabrillana Hidalgo, A. (2010). Quality and quantity of education in process of development. Economics Working Papers 1020, Universidad Carlos III, Departamento de Economia.

Davidescu, A. A., Vass Paul, A. M., Gogonea, R. M., & Zaharia, M. (2015). Evaluating Romanian eco-innovation performances in European context. *Sustainability, 7*, 12723-12757.

De la Croix, D., & Doepke, M. (2002). Public versus private education when differential fertility matters. UCLA Economic Working Papers 816, UCLA Department of Economics.

Domnişoru, C. (2014). The largest drop in income inequality in the European Union during the Great Recession: Romania's puzzling case. International Labor Office, Geneva, Conditions of Work and Employment, No. 51. Retrieved from http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---travail/documents/publication/wcms_313840.pdf

Gregorio, J., & Lee, J.-W. (2002). Income inequality is not harmful for growth: Theory and evidence. *Review of Income and Wealth, 48*(3), 395-416.

Handbook on constructing composite indicators. (2008). Methodology and user guide. OECD 2008. Retrieved from http://www.oecd.org/std/leading-indicators/42495745.pdf

Kohonen, T. (2001). *Self-organizing maps*. Berlin: Springer-Verlag.

Kolawole, B. O., Omobitan, O. A., & Yaqub, J. O. (2015). Poverty, inequality and rising growth in Nigeria: Further empirical evidence. *International Journal of Economics and Finance, 7*(2), 51-62.

Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review, 45*, 1-28.

Li, H., & Zou, H. (1998). Income inequality is not harmful for growth: Theory and evidence. Retrieved from http://down.aefweb.net/WorkingPapers/w74.pdf

Molnar, M. (2010). Romanian's households' income inequality. Romanian Statistical Review No. 7/2010. Retrieved from http://www.revistadestatistica.ro/Articole/2010/A3en_7_2010.pdf

Nahum, R. A. (2005). Income inequality and growth: A panel study of Swedish countries 1960-2000. Working Papers Series 2005: 8. Uppsala University, Department of Economics. Retrieved from http://www.diva-portal.org/smash/get/diva2:107265/FULLTEXT01.pdf

Ortega Diaz, A. (2007). Channels to which income inequality influences growth: Fiscal and sociopolitical instability approaches. Retrieved from http://sitios.itesm.mx/egap/que_es_egap/inv_pub/EGAP_EC_09_07.pdf

Pagano, M. (2004). The European bond markets under EMU. *Oxford Review of Economic Policy, Oxford University Press, 20*(4), 531-554.

Person, T., & Tabellini, G. (1994). Is inequality harmful for growth? *American Economic Review, 84*(3), 600-621.

Perotti, R. (2007). In search of the transmission mechanism of fiscal policy. *NBER Macroeconomics Annual 2007, 54*(3), 169-226.

Perotti, R. (1996). Redistribution and non-consumption smoothing in an open economy. *Review of Economic Studies, Wiley Blackwell, 63*(3), 411-433.

Precupețu, I. (2013). Inequality trends in Romania. *Calitatea Vieții, XXIV*(3), 249-276.

Sarlin, P., Yao, Z., & Eklund, T. (2011). Probabilistic modeling of state transitions on the self-organizing map: Some temporal financial applications. Turku Centre for Computer Science Technical Report, No. 1023, Turku, Finland.

Vesanto, J., Himberg, J., Alhoniemi, E., & Parhankangas, J. (2000). SOM toolbox for Matlab 5, Report A57. Helsinki University of Technology, April.

Voitchovsky, S. (2005). Does the profile of income inequality matter for economic growth? *Journal of Economic Growth, Springer, 10*(3), 273-296.

***Eviews 8.1

***Indexmundi dataset

http://www.indexmundi.com/facts/indicators/SI.DST.04TH.20/compare#country=ro

***IMF cross country macroeconomic statistics

https://www.quandl.com/data/ODA/ROU_NID_NGDP-Romania-Total-Investment-of-GDP

***Trade and Development Report, 2012, United Nations Conference on Trade and Development Geneva: Prosperity for All;

http://databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=poverty-and-inequality-database

http://hdr.undp.org/en/content/table-1-human-development-index-and-its-components

http://unctad.org/en/PublicationsLibrary/dom2013d1_en.pdf