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Economic polarization between regions and national economic growth. Research based on EU countries in the years 2007–2015

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ECONOMIC POLARIZATION BETWEEN REGIONS AND NATIONAL ECONOMIC GROWTH. RESEARCH BASED ON EU COUNTRIES IN THE YEARS 2007–2015

ABSTRACT

The objective of this paper is determining whether income disparities between regions affect national economic growth in the EU countries in the period 2007–2015. In the study were used measures of economic polarization. Their values were calculated for the countries that have five or more regions at the NUTS 3 level, so states like: Luxembourg, Malta and Cyprus were omitted in the research. The different estimation procedures were applied such as first-difference generalized moments method estimator, the system GMM estimator or fixed effect and random effect models. It was introduced to the models other explanatory variables like the Gini index, investments rate or human capital. The data used in the models was taken form database of Eurostat. The research found the disparities between regions, calculated as economic polarization and bipolarization, had negative impact on economic growth in the UE countries.

Key words: economic polarization, economic growth, income distribution, spatial inequality.

JEL classification: D30, R11.

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1. INTRODUCTION

The distribution of national income is a philosophical problem of economic policy in each country. The existing groups of developed regions, with high level of GDP per capita, can be a result of high productivity or accumulation of production factors and translates into higher rate of economic growth in the national economy. So in this case the promotion of these areas, in the context of distribution of national income, could be a form of incentive for further development. For example, according to Perroux (1964) and Boudeville (1966) the nature of economic growth is unbalanced and appears in growth pole (*pôle de criossance*), characterized by higher GDP rate than national one. The economic growth rate above average in these areas states the basis for dynamic growth for the whole economy. On the other hand the existing of lagged regions can be a source of social tension which does not create favorable conditions for development [Esteban and Ray (1994; 2011)]. Besides, the low rate of economic growth in some area may lead to migration process towards developed regions. In that case the mechanism of "vicious circle" may occur. Not invested legging regions lose human capital for developed areas what deprives them of the possibility of higher development [Myrdal (1957); Hirschman (1958)].

In this study was undertaken the issue of the impact of economic polarization between regions on economic growth at national level. The study should prove, whether the existing disparities between regions, expressed by the level of GDP per capita, affecting national economy. The measures of economic polarization were calculated at regional level (NUTS 2). In case of countries like: Croatia, Ireland, Latvia, Lithuania, Slovenia, Slovakia and Estonia, countries without regions at NUTS 2 level or having such regions less than five, the data at NUTS 3 level was used. Three countries: Luxemburg, Malta and Cyprus were not taken into account in the research, due to the lack of regions at NUTS 3 level. Hence, data of 25 EU countries were used, 14 of them joined to EU until 1995 and they are called "old members" of

EU. The other 11 countries (new members) constitute a part of Community from the year 2004.

It was built several dynamic panel data models. For their estimation were used the first-difference GMM estimator (FDGMM) and a system GMM estimator (SGMM) but satisfactory results were obtained by using of two-step first difference GMM estimator (FDGMM2). Besides, they were introduced to the models other explanatory variables affecting economic growth like: the Gini index, investment rate, human capital or share of each sector in GDP. If their signs turned out to be inconsistent with the theory of economics or statistically insignificant, they were removed from analyzes.

The study consists of several parts. After introduction in the second part the concept of economic polarization was characterized, it was explained the differences between the measures of inequality and economic polarization. Then there is a description of polarization measures, both for two (bipolarization) and more intervals. In the third part the used data, econometric model and results were presented. The study ends with the conclusions.

2. CONCEPT OF ECONOMIC POLARIZATION

The concept of the economic polarization was introduced to the economic literature by following works by: Esteban and Ray (1994), Esteban et al. (1999); Esteban et al. (2004). They treated the economic polarization problem as the main reason for the appearance of social conflict. They proposed alternative measures versus a wide range of existing inequality measures, elaborated by Gini (1921), Theil (1967), Atkinson (1975) or Sen (1973). First of all, they assumed the division of society into groups localized around the poles and they put special attention to the size of groups and distances existing between poles. Economists dealing with the problem of economic polarization noted that the situation is possible, when the measure of inequality showed a reduction value, which stands for an increase of egalitarianism of income distribution, but at the same time a creation of the poles of income

group take place. For example Wolfson (1994), having researched the example of Canada in the years 1973-1981, showed a decrease value of inequality indices or keeping them unchanged, while the value of the economic polarization index was increasing.

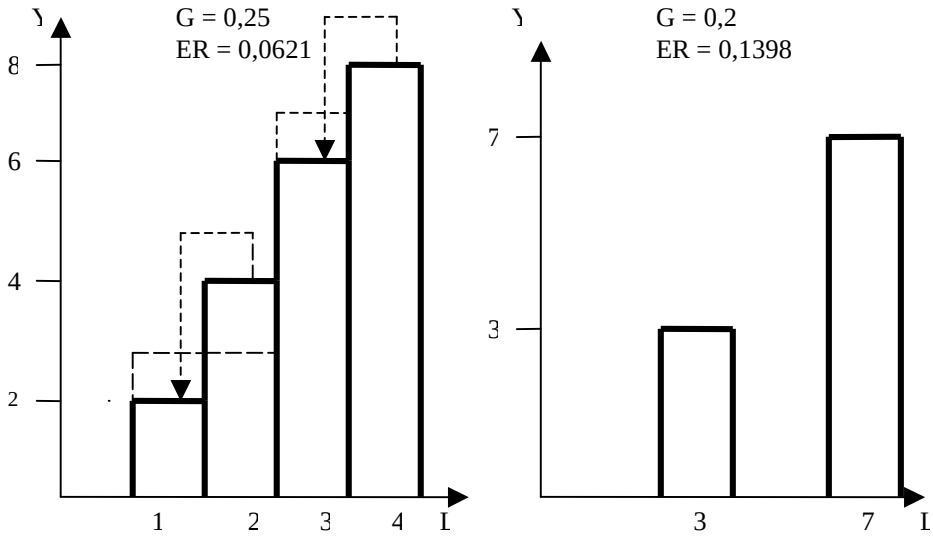

Fig. 1 Economic polarization versus inequality

Source: Author's elaboration.

The figure 1 presents the difference between economic polarization and inequality. On the vertical axis are placed the value of the income, while on the horizontal axis there are successive citizens. First person receives two units of income. The other person has four units, while the fourth person has eight units of income. For that income distribution the average income is equal to five, and the Gini coefficient is $G = 0{,}25$. The measure of economic polarization Esteban-Ray is $ER = 0{,}0621$. If it is assumed the richest person, fourth person, transfers one unit of income to the third person, and second person transfers one unit of income to the poorest person, first person, then it appears two groups with incomes equal to three and seven. Inequality indicators suggest more egalitarian distribution of income. Gini coefficient falls to $G = 0{,}2$. However, the realized transfers led to the creating of two groups, spaced to each other. Also, it can be notice a disappearance of the middle class with an increase of the value of the economic polarization index $ER = 0{,}1398$.

The researches undertook the issue of what impact on economic growth has egalitarianism in the income distribution [Alesina and Rodrik (1994); Forbes (2000)]. However their studies neglected the problem of the existence of social groups, separated by income level. Esteban and Ray (1994; 2011), authors of the original measure of economic polarization, found the growing economic polarization causes a social conflict, which does not create favorable conditions for economic growth. According to other authors the social conflict or political instability may create negative consequences for economic development [Benhabib and Rustichini (1996); Keefer and Knack (2002)]. Then Esteban et al. (2012) proved that ethnic polarization is positively related to the intensity of social conflict. On the other hand, the rise of middle class contributes to economic growth through political stability, increased savings or improved access to education [Easterly (2001); Banerjee and Duflo (2008)].

The empirical studies focused on the dynamics of economic polarization indices over time. Esteban (1996) found that economic polarization between countries in the 1980's decreased, but at the regional level increased. Gradín and Rossi (2006) pointed to the increasing economic polarization in Uruguay. In the case of Colombia and Argentina the level of economic polarization grew too [Birchenall (2001); Paraje (2001)]. The other studies analyzed the dynamic of economic polarization in Russia [Fedorov (2002)], China [Zhang and Kanbur (2001)], Italy [Massari et al. (2009)], UK [Jenkins (1995)] with kernel analyzes.

As regards to the research concerning the relationship between economic polarization and economic growth, Ezcurra (2009) used several indices of polarization in order to investigate the impact of income disparities in EU regions on economic growth. His study found the economic polarization, measured in 1993, affected negatively the regional economic growth in the period 1993–2003. Brzeziński (2013) examined empirically the impact of income polarization on economic growth in an unbalanced panel of more than 70 countries during the

1960–2005. The results of his study suggest that income polarization has negative impact on economic growth in the short term.

2.1. MEASURES OF ECONOMIC POLARIZATION

The concept of economic polarization is associated with a tendency for the middle class to disappear, which was the main subject of several studies [Rosenthal (1985); Horrighan and Haugen (1988)]. However, their analysis showed a lack of consensus, of how the disappearance of the middle class should be measured. According to Kot (2008) there are two approaches for a quantitative description of economic polarization. The first one is nonparametric and consists in tracking changes in the empirical density function over time. While the second method uses quantitative measures to express the degree of economic polarization for a single income distribution.

Esteban and Ray (1994) (the abbreviation ER) proposed an axiomatic approach to the problem of economic polarization. According to them, the society has certain attributes. Individuals with certain characteristics are grouped in clusters. If two persons belong to one cluster differ from persons belong to another cluster. The authors assume that society is precisely polarized in this way. ER emphasize the polarization of distributions of individual attributes must satisfy three features:

- there must be a high degree of homogeneity within each group,
- there be a high degree of heterogeneity across groups,
- there must be a small number of groups of significantly size. In particular, a group of small size (single) carry little weight.

Then ER specify what they mean by income distribution. It is an n-spike representation of income, expressed as the logarithm of income $(\pi, y) \equiv (\pi_1,...,\pi_n; y_1,...,y_n)$, where y_i means a logarithm of income, $\pi_i > 0$ express the number of y_i, for $i = 1,...,n.$ Then, the total

population for a distribution (π, y) is given by $\sum_{i=1}^{n} \pi_i$. If *D* is the space of all such distributions then a measure of economic polarization (MP) is a mapping $P : D \to R_+$.

In addition, ER postulate homothetic property of the economic polarization measure (MP). This means that the economic polarization measure is invariant because of the size of the population, which is standard for the inequality measurement. This condition ER present in this way:

Condition H: If $P(\pi, y) \geq P(\pi', y')$ for two distributions (π, y) and (π', y'), then for all $\lambda > 0, P(\lambda\pi, y) \geq P(\lambda\pi', y')$.

According to ER, person *y* identifies with people having the same income, and a sense of identification is the greater, when the more numerous is the number of person's *p* in given group. ER introduce continuous identification function $I : R_+ \to R_+$, and they assume that $I(p) > 0$ for $p > 0$, and $I(p)$ is an increasing function of the argument *p*. This property considers that the economic polarization increases with the rising homogeneity of the group.

Moreover, ER imply that person with certain income feels alienation against people that are "*far away*" from him, with other income. Authors introduce a continuous no decreasing alienation function $a : R_+ \to R_+$, with $a(0) = 0$. According to ER, a person with income *y* feels alienation $a(\delta(y, y'))$ to a person with income y', where $\delta(y, y')$ stands for an absolute distance between the logarithms of income. This property of economic polarization assumes its increase with the rising heterogeneity of the groups.

Then ER combine an identification function and alienation function in a single function of an effective antagonism $T(I, a)$. The authors assume this function is continuous and strictly increasing in *a*, whenever $(I, a) >> 0$ and $T(I, 0) = 0$.

Thus, the polarization of society is the sum of effective antagonism and is expressed as follows:

$$P(\pi, y) = \sum_{i=1}^{n}\sum_{j=1}^{n} \pi_i \pi_j T(I(\pi_i), a(\delta(y_i, y_j))) \tag{1}$$

Next, authors specify the function $T(\cdot,\cdot), I(\cdot)$ and $a(\cdot)$ in order to be used for empirical data. For this purpose, ER present four axioms. The fulfillment four axioms and *condition H* makes that a measure of economic polarization takes the following form:

$$P^*(\pi, y) = K\sum_{i=1}^{n}\sum_{j=1}^{n} \pi_i^{1+\alpha} \pi_j \left| y_i - y_j \right| \tag{2}$$

for some constants $K > 0$ and $\alpha \in [1;1.6]$. It can be remarked, that for $\alpha = 0$, the measure of economic polarization corresponds to the Gini coefficient.

ER characterizing the property of economic polarization assume that a person identifies with people who earn the same income, but it can be a point value or bounded interval. However ER do not explain that problem, using the concept of “clusters”. On the other hand, Kot (2008) noted the concept of "clusters", introduced by the ER, is not "*clear*". Esteban (1996) in his work showed that one way of grouping data are quantiles, but this method "*sterilizes*" economic polarization. Quantiles divide the population into equal parts. From period to period they change only the boundaries of classes without changing the probability which is equal to the rank of quantile.

Esteban-Gradín-Ray (1999) (the abbreviation: EGR) improve the primary measure of economic polarization. They introduced to the analysis a continuous income distributions. EGR assume the income distribution of population could be expressed by the continuous random variable of a density function *f*, which is contained in bounded interval [a, b] with the average value $\mu = 1$. An n-spike representation of income distribution is a collection ρ of numbers $(y_0, y_1, ..., y_n; \pi_1, ..., \pi_n; \mu_1, ..., \mu_n)$ such that $a = y_0 < ... < y_k = b$, where:

$$\pi_i = \int_{y_{i-1}}^{y_i} f(y)dy, \mu_i = \frac{1}{\pi_i} \int_{y_{i-1}}^{y_i} yf(y)dy, i = 1, ..., k.$$

(3)

Therefore the primary measure of economic polarization takes the form:

$$ER(\alpha, \rho) = \sum_{i=1}^{n} \sum_{j=1}^{n} \pi_i^{1+\alpha} \pi_j \left| \mu_i - \mu_j \right|. \quad (4)$$

Now authors are moving away from the concept of "*clusters*" and openly propose to group the data in income groups. However the bounded interval [a, b] can be divided in many ways, giving only one possible representation of the income distribution and this representation is flawed by approximation error, which is denoted by $\varepsilon(f, \rho)$. In addition, in this form the measure $ER(\alpha, \rho)$ takes into consideration only the size of groups and their average income, at the same time losing information about the dispersion of income in each group. Now the measure of extended polarization is given by:

$$P(f; \alpha, \beta) = ER(\alpha, \rho) - \beta \in (f, \rho) \quad (5)$$

The value of the measure $P(f; \alpha, \beta)$ is contained in bounded interval [0, 2]. β is a free parameter which measures the weight attached to the „*measurement error*". The value of β is contained in bounded interval [0, 1]. For $\beta = 0$, the measure $P(f; \alpha, \beta)$ becomes the primary measure $ER(\alpha, \rho)$. In order to minimize an approximation error, authors propose the

decomposition of the Gini coefficient as the difference between Gini coefficient for continuous distributions and Gini coefficient for an n-spike representation:

$$\in (f,\rho) = G(f) - G(\rho) \tag{6}$$

In addition EGR propose the following algorithm that allows finding the optimal endogenous division for two adjacent intervals:

$$y_i^* = \frac{\pi_i^* \mu_i^* + \pi_{i+1}^* \mu_{i+1}^*}{\pi_i^* + \pi_{i+1}^*} \tag{7}$$

Hence, the final extended polarization measure takes the form:

$$P(f;\alpha,\beta) = ER(\alpha,\rho^*) - \beta[G(f) - G(\rho^*)] \tag{8}$$

In case of bi-polarization the society is divided into two groups $k = 2$. First group is characterized by the income below average and second group has an income above average $(P_\mu = f(\mu))$. The proposed measure of bi-polarization takes the form:

$$ER(\alpha,\rho) = [\pi^\alpha + (1-\pi)^\alpha][\pi - L(\pi)] \tag{9}$$

An approximation error is expressed as:

$$\varepsilon(f,\rho) = G - [\pi - L(\pi)] \tag{10}$$

Combining (9) and (10) the bi-polarization measure can be written as:

$$P(f;\alpha,\beta) = [\pi^\alpha + (1-\pi^\alpha)][\pi - L(\pi)] - \beta\{G - [\pi - L(\pi)]\} \tag{11}$$

where G is the Gini coefficient for continuous distributions, $[\pi - L(\pi)]$ is the relative mean deviation $D = \frac{1}{2}\int \left|\frac{x}{\mu} - 1\right| dF(x) = \pi_\mu - L(\pi_\mu)$, equal to *Schutz-Pietra's* index. Hence, we can rewrite (11) as:

$$P(f;\alpha,\beta) = [\pi^\alpha + (1-\pi)^\alpha]D - \beta(G - D) \tag{12}$$

If we assume $\alpha = 1$, (12) takes the form:

$$P(f;\alpha = 1,\beta) = (1+\beta)D - \beta G \tag{13}$$

For $\alpha = \beta = 1$ the bi-polarization measure is:

$$P(f;\alpha = 1,\beta = 1) = 2D - G \tag{14}$$

Wolfson (1994) developed a measure of polarization *W*, where the median, not an average, is the point that divides the populations into two parts $(P_m = f(Me))$. It has form:

$$W = (T - \frac{G}{2})\frac{\mu}{Me} \tag{15}$$

where $T = 0{,}5 - L(0{,}5)$ denotes the income share of the bottom half of the population and is synonymous with the relative median deviation:

$DM = \frac{1}{2}\int \left| \frac{x}{Me} - 1 \right| dF(x)$, G is the Gini coefficient, μ is the average income, *Me* is the median.

In order to obtain the value of Wolfson's index contained in bounded interval [0, 1], the following formula should be used:

$$W = 2(2T - G)\frac{\mu}{Me} \tag{16}$$

The main difference between the Wolfson measure and the EGR measure is a choice of the center point of the income distribution. The Wolfson measure uses the median, which divides the population into two equal parts. In turn EGR use the average of income distribution. Then, the *W* measure is used only to study the bi-polarization, while the EGR measure allows establishing several poles of income. Also, the *W* index is based on the Lorenz function, and the ERG measure has its source in the density function.

3. DATA AND EMPIRICAL MODEL

The study used the annual data of 25 countries taken from Eurostat database. The measures of economic polarization between regions were calculated for each country in the years 2007–2015. Countries without regions at NUTS-3 level and countries that have less such regions than five were omitted in the research (Cyprus, Luxembourg and Malta). Regions were divided in 3 groups: poor regions with GDP per capita below the national

average, regions with GDP per capita at national average (middle class of regions) and rich regions with GDP per head of population above national level. In turn, the measures of bipolarization divide regions into two groups: with GDP per capita below an above national level. The value of the Gini index was taken from database of World Bank.

In the empirical analysis of the study the dependent variable is the rate of economic growth of each country Δy_i expressed in the logarithmic value in euro in purchasing power standard. The control variables selection was based on economic literature which indicates other factors that influence economic growth, both at national and regional level, such as: human capital resources [Romer (2000); Aghion and Howitt (1992); Rodríguez-Pose and Vilalta-Bufi (2005)], stock of physical infrastructure [Arrow (1962); Romer (1986); Gil et al. (2002)], externalities located in regions [Frankel (1962); López-Bazo et al. (2004)], the level of technical innovation [Foray et al. (2009); Bilbao-Osorio and Rodríguez-Pose (2004)] or social capital [Field (2008); Beugelsdijk and van Schaik (2005)].

The following list contains all explanatory variables which were included in the models. If their signs turned out inconsistent with the theory of economics or due to the collinearity statistically insignificant, they were omitted from the analysis:

1. GDP per capita in euro in purchasing power standard y_t,
2. The value of economic polarization $ER(1.6)$ calculated as:

$$ER(\alpha,\rho)=\sum_{i=1}^{n}\sum_{j=1}^{n}\pi_i^{1+\alpha}\pi_j\left|\mu_i-\mu_j\right|,$$

   where π_i and μ_i denote relative population and GDP per capita of the region i, $i=1,...,n,$ respectively, $\alpha=1{,}6$.
3. Extended measure of economic polarization $P(1.6)$.
4. Bipolarization measures: $BiP(1.6)$ and Wolfson index W.
5. Gini index $Gini$, as the measure of income inequalities.

6. Investments as a share of GDP *invest_gdp*.
7. Human capital *hum_cap* as a share of employees with higher education in the total number of employees
8. The share of i-sector (agriculture-*agri_sect*, industry-*indu_sect*, construction-*const_sect*, services-*serv_sect*) in national GDP.

All variables were standardized by using their logarithmic values, which is a standard procedure in building a model to describe the determinants of economic growth. The initial model has the form:

$$\ln y_{it} - \ln y_{i,t-1} = a + \ln X_{it}\delta + e_{it} \tag{17}$$

where X_i - matrix of explanatory variables.

The estimation of the model by using the OLS estimator assumes that there are no period and country specific effects. Another problem is the exogeneity of the explanatory variables. If the independent variable is correlated with the error term the regression estimators can be biased and inefficient.

The estimations were based on the panel data model. The combination of time and cross-sectional data into one sample (panel) allows both to increase significantly the number of degrees of freedom and to take into account specific effects for individual countries. In the study were used the first difference GMM estimator developed by Arellano and Bond (1991) and the system GMM estimator elaborated by Blundella and Bond (1998) for dynamic panel models. The first difference GMM method consists in presenting the regression equation in a dynamic form with an endogenous delayed variable. Thus, the equation (17) can be written in the form:

$$\gamma_{it} = a + \beta \ln(y_{i,t-1}) + \ln X_{it}\delta + \eta_i + \nu_t + e_{it}, \tag{18}$$

where: $\gamma_{it} = \ln\left(\frac{y_{i,t}}{y_{i,t-1}}\right)$ - the economic growth rate, $X_{i,t}$ - the matrix of exogenous variables, η_i - the individual effect for the i-th country, v_t - the periodic effect for the period *t*, e_{it} - error.

In the model (18), one of the explanatory variables has a delayed (endogenous) variable by one period, which means the autoregressive nature of the proposed model (dynamic panel model), so also can be written:

$$y_{it} = a + (1+\beta)\ln(y_{i,t-1}) + \ln X_{it}\delta + \eta_t + v_t + e_{it} \tag{19}$$

For the period $t-1$ the equation (18) will take the form:

$$y_{i,t-1} = a + (1+\beta)\ln(y_{i,t-2}) + \ln X_{i,t-1}\delta + \eta_i + v_{t-1} + e_{i,t-1} \tag{20}$$

This model can be presented in the form of the first differences:

$$\Delta y_{it} = (1+\beta)\Delta\ln(y_{i,t-1}) + \Delta\ln X_{it}\delta + \Delta v_t + \Delta e_{it} \tag{21}$$

In the model of the first differences (21) there are no individual effects and the condition of no correlation between exogenous variable and individual effects is no longer required. In turn, the system GMM method consists in including lagged levels as well as lagged differences. The including equations in levels makes that the individual effects remain in the model and the assumption is necessary to met: $E(a_i \Delta y_{i2}) = 0$ for $i = 1,...., N$.

The models were verified by using the Arellano-Bond (AR) serial correlation test and the Sargan test. The first order serial correlation AR (1) is expected and allowed. If it turns out that the second order serial correlation AR (2) takes places, it would mean either the moment conditions are not fulfilled or the instruments are chosen incorrectly. In the Sargan test the null hypothesis states the model's instruments were selected correctly. The rejection of the null hypothesis indicates the problem of over-identifying restrictions.

3.1. RESULTS

In order to estimate the impact of economic polarization at the regional level on economic growth, several models were built. For their estimation it was used first differences GMM estimator and system GMM estimator. However, the results of the empirical analysis were not satisfactory. The Sargan test indicated a problem of instruments validity. In addition, the AR(2) test proved the second order serial correlation occurred. However, satisfactory results were obtained by using of two-step first differenced GMM estimator (FDGMM2) with the Windmeijer (2005) correction. The Sargan test confirmed instrument validity. In turn, the Arellano-Bond tests indicated that there is no first and second order serial correlation. It can be concluded, therefore, the conditions of a generalized method of moment (GMM) were met.

The table 1 contains results of estimating model (21) with the two-step first differenced GMM estimator for 25 countries of EU. The results within table 1 suggest the impact of economic polarization as measured by *P(1.6)* on economic growth is negative and this relationship is statistically significant at the 10% significance level at least. In case of bipolarization *BiP(1.6)* the estimation confirm their negative affect on economic growth too. The indices of economic polarization *ERG(1.6)* and bipolarization *W* have negative signs, which means they affect negative on economic growth but the impact is not statistically significant. The impact of income inequality as measured by the Gini index is positive but statistically insignificant. The positive and statistically significant value of GDP per capita variable (y_{t-1}) confirm the β-convergence took place across EU countries. Economies with a lower income per head of population (poor countries) developed faster than rich ones, so the catching up effect occurred. According to the results there was positive and statistically significant impact between investments *invest_gdp* and stock of human capital *hum_cap* on economic growth. The signs of the variables *serv_sect* states that there was negative relationship (expected value) between the share of service sector in GDP and economic

growth which may follow from neutralization of the impact of changes in the production structure on its effectiveness (Oguchi 2004). Overall the estimates suggest the increase in the economic polarization indices reduces the rate of growth rate. So the disparities between regions affected adversely economic growth in EU countries.

Table 1 Two-step FDGMM estimates, all European Union countries

	(1)	(2)	(3)	(4)	*(5)*
y_{t-1}	0.6400***	0.6319**	0.6449***	0.6274***	*0.6320***
	(0.1096)	(0.1164)	(0.1084)	(0.1166)	*(0.1207)*
P(1.6)	–0.0100*				
	(0.0059)				
ERG(1.6)		–0.0011			
		(0.0570)			
BiP(1.6)			–0.0457**		
			(0.0223)		
W				–0.0274	
				(0.0237)	
Gini					*0.0179*
					(0.1622)
invest _ gdp	0.0735**	0.0740**	0.0568	0,0691**	*0.0752***
	(0.0372)	(0.0367)	(0.0357)	(0.0340)	*(0.0356)*
hum _ cap	0.2182***	0,2158***	0.2264***	0.2211***	*0.2201****
	(0.0711)	(0.0669)	(0.0748)	(0.0662)	*(0.0669)*
serv _ sec t	–0.8130**	–0.8236***	–0.8171***	–0.8266***	*–0.8242***
	(0.3172)	(0.3067)	(0.3164)	(0.3053)	*(0.3222)*
N	175	175	175	175	*175*
Countries	25	25	25	25	*25*
Instruments	33	33	33	33	*33*
AR(1)	0.2598	0.2682	0.3454	0.2638	*0.2336*
AR(2)	0.1352	0.1439	0.1702	0.1597	*0.1533*
Sargan	0.6159	0.6502	0.6599	0.6064	*0.6246*
Wald	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*

Source: Author's calculations

Note: The dependent variable is Δy_t. * p<0.10, **p<0.05, ***p<0.01. Standard errors clustered in parentheses. Two-step FDGMM(2) estimates with the Windmeijer (2005) correction. Period dummies are not included. AR(1) and AR(2) denote p-value for test of, respectively, first order and second order serial correlation.

In the next step of the research two groups of countries were distinguished. Table 2 contains estimations based of 14 states (old member) which joined to EU to the year 1995. The impact of economic polarization, namely *P(1.6)* and *ERG(1.6)*, on economic growth is negative. However, these relationships are statistically insignificant. The same situation takes place with variables of bipolarization *BiP(1.6)* and *W*. The signs are positive, but again they are not statistically significant. Hence, the relationships between regional disparities and

economic growth could not be stated. In this group of countries the convergence process took place, faster than in the sample of 25 countries. The explanatory variables of investments and human capital resulted statistically insignificant in all models. Therefore their impact on economic growth is unknown. All models confirmed negative impact of service sector on economic growth.

Table 2 Two-step FDGMM estimates, old members European Union countries

	(1)	(2)	(3)	(4)	*(5)*
y_{t-1}	0.4598***	0.4599***	0.4155**	0.4417***	*0.4436****
	(0.1521)	(0.1523)	(0.1845)	(0.1652)	*(0.1561)*
$P(1.6)$	–0.0207				
	(0.0236)				
$ERG(1.6)$		–0.0042			
		(0.0634)			
$BiP(1.6)$			0.0234		
			(0.0279)		
W				0.0287	
				(0.0264)	
Gini					*–0.0767*
					(0.1999)
invest _ gdp	–0.0143	–0.0106	–0.0042	–0.0110	*–0.0109*
	(0.0249)	(0.0223)	(0.0209)	(0.0230)	*(0.0247)*
hum _ cap	0.1153	0.1003	0.0830	0.0829	*0.0921*
	(0.0942)	(0.1049)	(0.1016)	(0.0886)	*(0.0989)*
serv _ sec t	–1.0792***	–1.0600***	–1.1016***	–1.1160***	*–1.0690****
	(0.1471)	(0.1400)	(0.1236)	(0.0230)	*(0.1487)*
N	98	98	98	98	*98*
Countries	14	14	14	14	*14*
Instruments	33	33	33	33	*33*
AR(1)	0.8797	0.9355	0.9132	0.9546	*0.9604*
AR(2)	0.1057	0.1335	0.2140	0.1806	*0.1290*
Sargan	0.9884	0.9883	0.9897	0.9907	*0.9887*
Wald	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*

Note: see note to Table 1.

The next estimations took into consideration states that became the EU members from the year 2004. All economic polarization indices have negative signs, but only the relationship between bipolarization, namely *BiP(1.6)* and *W,* are statistically significant. Hence, the estimations proved the increasing income gap between poor and rich regions affected negatively economic growth. The impact of income inequalities, as measured by the Gini index, is negative but statistically insignificant, so it can not be confirmed its positive or negative impact on economic growth. The convergence process took place and was slower

than between old member states of the EU. The other exogenous variables have expected values of signs. The investments and human capital affected economic growth in positive way. On the other hand, there was statistically significant and negative relationship between share of service sector in GDP and economic growth.

Table 3 Two-step FDGMM estimates, new members European Union countries

	(1)	(2)	(3)	(4)	*(5)*
y_{t-1}	0.5865***	0.6020***	0.5763***	0.6240***	*0.5780****
	(0.1145)	(0.1485)	(0.1413)	(0.1018)	*(0.1460)*
P(1.6)	–0.0473				
	(0.0298)				
ERG(1.6)		–0.0588			
		(0.1639)			
BiP(1.6)			–0.0842**		
			(0.0391)		
W				–0.0474*	
				(0.0284)	
Gini					*0.1415*
					(0.2707)
invest _ gdp	0.1161*	0.0983	0.0772	0.0431	*0.0848*
	(0.0677)	(0.0777)	(0.1000)	(0.0986	*(0.0801*
hum _ cap	0.2858***	0.2754***	0.2818**	0.2184**	*0.2285***
	(0.1056)	(0.1050)	(0.1128)	(0.0848)	*(0.0900)*
serv _ sec t	–0.8548*	–0.9898**	–1.2037	–1.3432**	*–0.9951**
	(0.5109)	(0.4746)	(0.7395)	(0.6195	*(0.5389)*
N	77	77	77	77	*77*
Countries	11	11	11	11	*11*
Instruments	33	33	33	33	*33*
AR(1)	0.5079	0.4105	0.6718	0.4881	*0.2926*
AR(2)	0.5539	0.4155	0.5473	0.2053	*0.3885*
Sargan	0.9996	0.9994	0.9998	0.9999	*0.9999*
Wald	*0.0000*	*0,0000*	*0.0000*	*0.0000*	*0.0000*

Note: see note to Table 1.

3.2. ROBUSTNESS OF ESTIMATION

In order to test the robustness check, other estimation methods were used. Table 4 contains the results of estimations of the models using other methods such as generalized methods of moments (GMM), one-step first differences GMM estimator (FDGMM1), system GMM estimator (SGMM), ordinary least squares estimator (OLS), fixed effect (FE) and random effect (RE) models. The estimations, apart from SGMM estimator, confirmed the negative impact the economic polarization *P(1.6)* on economic growth, but only in case of FDGMM1 this relationship is statistically significant. However, FDGMM1 model presents problems of

second order serial correlation and invalid specification of instruments. The signs of explanatory variables are the same like in the previous models. According to all estimations there was convergence process across EU countries. The economic growth in EU countries was positively affected by investments and stock of human capital and negatively affected by share of service sector in GDP.

Table 4 Robustness to estimation methods

	GMM	FDGMM1	SGMM	OLS	FE	*RE*
y_{t-1}	0.9387***	0.6446***	1,0926***	0.9770***	0.6240***	*0.9432****
	(0.0159)	(0.1016)	(0.0297)	(0.0255)	(0.0575)	*(0.0260)*
$P(1.6)$	–0.0003	–0.0104*	0.0044	–0.0082	–0.0033	*–0.0013*
	(0.0049)	(0.0078)	(0.0062)	(0.0101)	(0.0088)	*(0.0060)*
invest _ gdp	0.0525***	0.0732**	0.0857***	–0.0122	0.1003***	*0.0481**
	(0.0122)	(0.0353)	(0.0221)	(0.0208)	(0.0329)	*(0.0251)*
hum _ cap	0.0220**	0.2279***	0.0322***	0.0315*	0.1732***	*0.0322****
	(0.0097)	(0.0562)	(0.0123)	(0.0184)	(0.0338)	*(0.0109)*
serv _ sec t	–0.1308***	–0.8025***	–0,2493***	0.0222	–0.4976***	*–0.1258****
	(0.377)	(0.3102)	(0.0689)	(0.0626)	(0.1288)	*(0.0398)*
N	200	175	200	200	200	*200*
Countries	25	25	25		25	*25*
Instruments		33	39			
AR(1)		0.1311	0.0009			
AR(2)		0.0324	0.0040			
Sargan		0.0000	0.0000			
Wald		0.0000	0.0000			
Q	0.0000					
TQ	*0.0000*					

Source: Author's calculations.

Note: see note to Table 1. Q and TQ denote GMM criterion function.

4. CONCLUSIONS

The purpose of this study was to investigate the impact of economic polarization between regions on economic growth. The panel data of 24 countries was constructed with observation from 2007 to 2015. The economic polarization indices were calculated between regions. It was introduced some variables to the models such as per capita GDP, investments, human capital or share of service sector in GDP. The study found the income disparities between regions in EU countries as measured by economic polarization indices P(1.6) and bipolarization indices BiP(1.6) had negative impact on economic growth in the years 2007–2015. In case of countries "old members" of EU the relationship between economic

polarization and bipolarization on economic growth was insignificant. On the other hand, the estimations based on the sample of "new member" countries confirmed the negative impact of bipolarization on economic growth which means that the increasing disparities between poor and rich regions did not create favorable conditions for economic growth. The relationship between economic polarization and economic growth resulted statistically insignificant. The estimations found that the convergence process took place across EU countries in analyzed period. Countries characterized by lower GDP per capita achieved higher rate of economic growth. Also it was proved the production factors such as investments and human capital positively affected economic growth. The estimations confirmed negative impact the growing share of service sector on economic growth.

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APPENDIX

Table A.1 Economic polarization between regions in EU countries in the years 2007–2015

	Bipolarization $P(f;\alpha,\beta)$ $k=2,\alpha=1{,}6,\beta=1$	Polarization $ER(f;\alpha,\rho^*)$ $k=3,\alpha=1{,}6$	Polarization $P(f;\alpha,\beta)$ $k=3,\alpha=1{,}6,\beta=1$	$G(f)-G(\rho^*)$	**W**
Austria					
2007	0,0238	0,0379	0,0177	0,0202	0,0954
2010	0,0255	0,0342	0,0202	0,0139	0,0914
2013	0,0277	0,0379	0,0010	0,0368	0,0829
2015	0,0276	0,0286	0,0171	0,0116	0,0883
Belgium					
2007	0,0298	0,0530	0,0352	0,0177	0,0814
2010	0,0376	0,0600	0,0419	0,0181	0,0897
2013	0,0352	0,0526	0,0346	0,0180	0,0889
2015	0,0354	0,0528	0,0345	0,0183	0,0858
Bulgaria					
2007	0,0722	0,0636	0,0612	0,0024	0,1141
2010	0,0768	0,0746	0,0694	0,0053	0,1357

2013	0,0610	0,0672	0,0612	0,0060	0,1138
2015	0,0656	0,0685	0,0635	0,0050	0,1164
Denmark					
2007	0,0158	0,0367	0,0329	0,0038	0,0292
2010	0,0195	0,0414	0,0369	0,0045	0,0338
2013	0,0207	0,0461	0,0349	0,0112	0,0378
2015	0,0244	0,0389	0,0324	0,0065	0,0416
Finland					
2007	0,0436	0,0457	0,0256	0,0201	0,0802
2010	0,0506	0,0489	0,0233	0,0256	0,0953
2013	0,0582	0,0331	0,0063	0,0268	0,0961
2015	0,0550	0,0334	0,0086	0,0248	0,0904
France					
2007	0,0099	0,0375	0,0166	0,0209	0,0300
2010	0,0068	0,0406	0,0194	0,0212	0,0295
2013	0,0080	0,0397	0,0191	0,0206	0,0302
2015	0,0084	0,0388	0,0185	0,0203	0,0282
Greece					
2007	0,0222	0,0532	0,0344	0,0188	0,0463
2010	0,0221	0,0515	0,0416	0,0099	0,0577
2013	0,0216	0,0542	0,0373	0,0169	0,0463
2015	0,0230	0,0480	0,0284	0,0196	0,0508
Spain					
2007	0,0256	0,0379	0,0233	0,0147	0,0555
2010	0,0241	0,0352	0,0171	0,0182	0,0532
2013	0,0322	0,0382	0,0246	0,0136	0,0673
2015	0,0335	0,0403	0,0270	0,0133	0,0690
The Netherlands					
2007	0,0285	0,0250	0,0159	0,0092	0,0527
2010	0,0248	0,0307	0,0181	0,0126	0,0562
2013	0,0448	0,0388	0,0248	0,0140	0,0977
2015	0,0399	0,0328	0,0194	0,0135	0,0774
Germany					
2007	0,0228	0,0400	0,0250	0,0150	0,0469
2010	0,0200	0,0378	0,0220	0,0158	0,0439
2013	0,0241	0,0386	0,0223	0,0162	0,0458
2015	0,0241	0,0390	0,0234	0,0156	0,0475
Poland					
2007	0,0186	0,0445	0,0262	0,0184	0,0400
2010	0,0189	0,0495	0,0404	0,0090	0,0658
2013	0,0278	0,0467	0,0300	0,0167	0,0665
2015	0,0264	0,0477	0,0253	0,0224	0,0670
Portugal					
2007	0,0377	0,0549	0,0384	0,0165	0,0405
2010	0,0367	0,0564	0,0319	0,0245	0,0154
2013	0,0239	0,0459	0,0382	0,0077	0,0343
2015	0,0284	0,0431	0,0334	0,0097	0,0346
Czech Republic					
2007	0,0953	0,0428	0,0370	0,0058	0,0859
2010	0,1049	0,0396	0,0358	0,0038	0,0809
2013	0,0888	0,0423	0,0367	0,0056	0,0699
2015	0,0843	0,0414	0,0356	0,0058	0,0822
Romania					
2007	0,0649	0,0658	0,0511	0,0146	0,1366

2010	0,0810	0,0638	0,0467	0,0171	0,1479
2013	0,0708	0,0610	0,0478	0,0132	0,1136
2015	0,0716	0,0713	0,0581	0,0132	0,1059
Sweden					
2007	0,0214	0,0296	0,0264	0,0032	0,0240
2010	0,0217	0,0327	0,0292	0,0035	0,0424
2013	0,0209	0,0370	0,0319	0,0051	0,0343
2015	0,0408	0,0389	0,0331	0,0058	0,0351
Hungary					
2007	0,0591	0,0862	0,0800	0,0062	0,1954
2010	0,0585	0,0734	0,0564	0,0170	0,1902
2013	0,0559	0,0851	0,0762	0,0089	0,1745
2015	0,0632	0,0822	0,0737	0,0085	0,1930
The United Kingdom					
2007	0,0254	0,0546	0,0290	0,0256	0,0606
2010	0,0302	0,0527	0,0259	0,0268	0,0555
2013	0,0429	0,0525	0,0265	0,0260	0,0637
2015	0,0429	0,0542	0,0258	0,0284	0,0667
Italy					
2007	0,0473	0,0518	0,0286	0,0232	0,0768
2010	0,0437	0,0517	0,0363	0,0154	0,0583
2013	0,0439	0,0503	0,0354	0,0148	0,0558
2015	0,0437	0,0495	0,0344	0,0151	0,0555
Croatia					
2007	0,0332	0,0521	0,0290	0,0231	0,0660
2010	0,0343	0,0547	0,0382	0,0165	0,0693
2013	0,0323	0,0751	0,0323	0,0427	0,0656
2015	0,0263	0,0792	0,0477	0,0315	0,0641
Ireland					
2007	0,0478	0,0499	0,0362	0,0137	0,0919
2010	0,0574	0,0555	0,0263	0,0292	0,1120
2013	0,0577	0,0748	0,0603	0,0145	0,1562
2015	0,0682	0,0858	0,0430	0,0428	0,1448
Latvia					
2007	0,0831	0,0910	0,0806	0,0104	0,1939
2010	0,0735	0,0752	0,0670	0,0082	0,1401
2013	0,0668	0,0756	0,0687	0,0070	0,1354
2015	0,0680	0,0821	0,0720	0,0101	0,1668
Lithuania					
2007	0,0301	0,0549	0,0293	0,0256	0,0850
2010	0,0361	0,0565	0,0368	0,0197	0,0985
2013	0,0436	0,0498	0,0312	0,0186	0,0883
2015	0,0510	0,0622	0,0405	0,0217	0,0883
Slovenia					
2007	0,0201	0,0523	0,0290	0,0233	0,0532
2010	0,0231	0,0468	0,0255	0,0213	0,0579
2013	0,0145	0,0461	0,0269	0,0192	0,0431
2015	0,0154	0,0459	0,0252	0,0208	0,0442
Slovakia					
2007	0,0886	0,0738	0,0456	0,0281	0,1540
2010	0,0875	0,0626	0,0428	0,0198	0,1474
2013	0,0887	0,0646	0,0472	0,0174	0,1335
2015	0,0864	0,0620	0,0454	0,0167	0,1273
Estonia					

2007	0,0820	0,0747	0,0715	0,0032	0,1117
2010	0,0818	0,0717	0,0682	0,0035	0,0971
2013	0,0846	0,0796	0,0778	0,0017	0,1081
2015	0,0913	0,0839	0,0800	0,0039	0,1541

Source: Author's calculations. In order to obtain the data for all years, contact with the author.

RESUMEN

El objetivo de este investigación es responder a las pregunta sobre si las disparidades de ingresos entre las regiones afectan el crecimiento económico nacional en los países de la UE en el período 2007–2015. En el estudio se utilizaron medidas de polarización económica. Sus valores se calcularon para los países que tienen cinco o más regiones en el nivel NUTS 3, por lo que estados como: Luxemburgo, Malta y Chipre se omitieron en la investigación. Se aplicaron los diferentes métodos de estimación, como el estimador del método generalizado de los momentos de primera diferencia (FDGMM), el estimador del sistema GMM (SGMM) o el modelo de efectos fijos (FE) y el efectos aleatorios (RE). Se introdujeron en los modelos otras variables explicativas como el índice de Gini, la tasa de inversión o el capital humano. La investigación encontró que las disparidades entre las regiones, calculadas como la polarización económica y la bipolarización, tuvieron un impacto negativo en el crecimiento económico en los países de la UE en los años 2007–2013. Los datos utilizados en los modelos se tomaron de la base de datos de Eurostat.

Palabras clave: polarización económica, crecimiento económico, distribución del ingreso, desigualdad espacial

Clasificación JEL: D30, R11