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**Working Paper**

## Income Inequality by Method of Non-weighted Average Absolute Deviation: case study of Central and Eastern European Countries

Institute of Economic Research Working Papers, No. 115/2015

**Provided in Cooperation with:**

Institute of Economic Research (IER), Toruń (Poland)

*Suggested Citation:* Tureckova, Kamila (2015) : Income Inequality by Method of Non-weighted Average Absolute Deviation: case study of Central and Eastern European Countries, Institute of Economic Research Working Papers, No. 115/2015, Institute of Economic Research (IER), Toruń

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**Institute of Economic Research Working Papers**

**No. 115/2015**

**Income Inequality by Method of Non-weighted  
Average Absolute Deviation: case study of Central  
and Eastern European Countries**

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The paper submitted to

**VIII<sup>th</sup> INTERNATIONAL CONFERENCE ON APPLIED  
ECONOMICS  
CONTEMPORARY ISSUES IN ECONOMY  
*under the title*  
MARKET OR GOVERNMENT?**

Institute of Economic Research and Polish Economic Society Branch  
in Toruń

18-19 June 18-19, 2015, Toruń, Poland

**Toruń, Poland 2015**

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## **Income Inequality by Method of Non-weighted Average Absolute Deviation: case study of Central and Eastern European Countries**

**JEL Classification:** *C13, D31, I32*

**Keywords:** *income inequality; index; comparison; method of non-weighted average absolute deviation*

**Abstract:** The presented article uses the method of non-weighted average absolute deviation for expressing income inequality in the 11 selected Central and Eastern European Countries. Specifically, the analysis of income inequality is done for Poland, Czech Republic, Slovak Republic, Austria, Slovenia, Hungary, Romania, Bulgaria, Latvia, Lithuania and Estonia. Based on the determination of income inequality in the article there is made an analysis of development of income inequality, including the subsequent inter-regional comparison in the context of the degree of income inequality in a given human society and economy. The text of this article is organized in 4 parts, after Introduction follows the analytic chapter where is primarily the method of non-weighted average absolute deviation explained. The third part contains the empirical analysis of income inequality and the Conclusion highlights some major conclusions of detailed analysis made in chapter 3. The analysis of income distribution of 11 European households between years 2005-2013 and its order is made in deciles based on empirical data from the Statistics on Living Conditions and Welfare published by Eurostat.

### **Introduction**

Income inequality was and also is a natural part of every economy and its society. Income inequality in essence means that different people or different groups of people will reach different income and this income dispersion determines how much the great range of individual income in society at the economy is. (Turečková & Kotlánová, 2014a, pp. 240-247) Phenomenon of poverty and inequality accompanies human society, almost

from the very beginning of its existence. (Lapáček, 2007) By Samuelson and Nordhaus (2010) is the invisible hand of the market very effective at allocation of resources and production of goods and services, but can produce simultaneously very unequal distribution of income. Stiglitz (2007) also admits that between efficiency and equality, there is a substitution relationship and therefore to achieve equality is usually required to give up parts of effectiveness. There are many possibilities how to look on or measure standards of living in selected countries. One of the best known is GDP per capita. Despite the fact that this indicator could reach relatively large value, it does not predicate differences of incomes in society. Another indicator we could hear about very often is average wage. Not even its amount is guarantee of economic well-being. It is usual that over 50% of working population of the country cannot reach this amount. One of the best known and used measures of income inequality is Gini coefficient and its graphical representation through Lorenz curve. It could be supplemented by Robin Hood Index and S80/S20 Ratio which are used as other methods of comparison of income inequality. (Turečková & Kotlánová, 2014b, pp. 1063-1057)

The ability to measure and define income inequality is essential for the subsequent analysis of the determinants of income inequality which is given to the context. For example imperfect financial institution causes income inequality as well as inefficient capital allocation (Daisaka et al., 2014, p. 4) or technological changes are often identified as one of the driving forces behind recent rises in inequality. (Lemieux, 2008, pp. 21-48) This can be given in context of Rosen (1981, pp. 757-775) who take the view that one reason that impact of technological changes on income distribution is the well-known “economics of superstars” because technologies enable the top talents to capture increasingly large share of the market. For more information about relationship between income inequality and the knowledge economy see Peng (2014).

Income inequality also resides on spatial dimension where an increase in regional integration associated with the amelioration of inequality at one level usually corresponds to a reproduction of inequality at higher geographical levels (Novotný, 2007, p. 575). For example you can also see Paredes et al. (2012, pp. 1 – 33). Williamson (1965, pp. 3-47) proposes that unequal initial endowments imply a spatial income disparity, but market mechanisms, mainly through labor and firm mobility, lead to the decline of nay regional disparity in the long run. Also interesting is the impact of income inequality between households on the housing market. This is partly due to the spatial dimensions, which according to Dewilde and Lancee (2013) there is a positive relation between inequality and

crowding and also higher income inequality is associated with lower housing quality.

This article is characterized by introducing and using alternative method for measuring, expressing and analysing income inequality in case of Central and Eastern European inhabitants in the period of years 2005–2013. Among well-known methods how to measure income inequality belong traditionally Lorenz curve, Gini coefficient, Coefficient of income inequality S80/S20 (or Quintile share ratio or S80/S20 Ratio), Atkinson index, Theil index, Robin Hood index and Variation coefficient. For more information about these methods see for example Atkinson (1970, pp. 244–263), Dalton (1920), Lapáček (2007), Litchfield (1999), Schutz (1951, pp. 107–122) or Wolff (2009). Analysis of income inequality is focused on method of non-weighted average absolute deviation that is not normally used in context of income inequality. The great advantage of using this method is its mathematical-algebraic procedure for calculating the coefficient expressing the degree of inequality directly adapted to the data format in which are data of income distribution provided by statistical organizations. In previous researches was proven extremely positive and high correlation between the results and evaluation of income inequality by here used method and standard methods, such as the Gini coefficient, index S80/S20 or Robin Hood index. (Turečková, 2015b, 2015b) Analysis of income inequality through this mentioned method will be based on empirical data of Eurostat in the chosen period of time for 11 selected European countries, namely for Poland, Czech Republic, Slovak Republic, Austria, Slovenia, Hungary, Romania, Bulgaria, Latvia, Lithuania and Estonia.

The rest of the article is structured as follows: the next section provides same theoretical introduces and propositions of method of non-weighted average absolute deviation and its decomposition. Also discusses the advantages and disadvantages of using this method in the context of measures of income inequality. Section 3 contains the analysis of the income inequality in selected European countries using the method of non-weighted average absolute deviation. There is also mention the development of income inequality during analyzed period of time with evaluation of countries and their ranking. Finally the Conclusion concludes with some general comments.

## Methodology of the research

Method of average deviation reflects the degree of variability, defined as the arithmetic average of the absolute deviations of individual values of observed indicators from the selected value (given point) (for more information about method of absolute average deviation see for example Tuleja (2009) or Babu & Rao (1990). This method can be also named as Method of mean absolute deviation. Generally, the deviation is reckoned from the ideal value, recommended value, central value that is constructed as some type of average, median, mean of the data set and other. This value chosen here understands the value for the ideal distribution of income in society, ie. the value of expressing absolute equality in income for each inhabitants. In general absolute deviation is constructed on the basis of this formula 1:

$$d_i = |x_i - (x)| \quad (1)$$

where:  $d_i$  presents the absolute deviation from i-th indicator,  
 $x_i$  presents the i-th indicator (data element, variable),  
 $(x)$  is the chosen given point.

Indicator  $(x)$  is the ideal percentage value of income which get in concrete the percentage of households in society, for example, 10% of households get precisely 10 % of total income ( $(x) = 10\%$ ). Variable  $x_i$  presents real household's money income cumulated into relevant deciles, quintiles, quartile and other. Here we can give an example, that 30% of households got 16.7% of total income in Czech Republic in 2010 ( $x_i = 16.7\%$ ). Own value of non-weighted average absolute deviation we obtained from the formula 2:

$$\bar{d}_i = \frac{\sum_{i=1}^p |x_i - (\bar{x})|}{n_i} \quad (2)$$

where:  $\bar{d}_i$  presents the average absolute deviation from i-th indicator,  
 $n_i$  presents the number of values of i-th indicator that we have available,  
 $(\bar{x})$  is the arithmetic mean of i-th indicator.

Particular form for using this method is to set the time integrated value of the index (3) for relevant evaluation of selected indicators during

analysed period of time. Based on this calculated index we can determine the intertemporal ranking of the chosen regions or countries or identify differences between them. The value of intertemporal integrated index we compile by following formula:

$$INI_p = \frac{\sum_{i=1}^p |\bar{d}_i|}{n_i} \quad or \quad D_{ii} = \frac{\sum_{i=1}^p |\bar{d}_i|}{n_i} \quad (3)$$

where:  $INI_p$  is an integrated index calculated using the average absolute deviation, where  $INI_p \in \langle 0, 100 \rangle$ ,  
 $D_{ii}$  integral index for income inequality (special label).

Integrated index ( $INI_p$ ) express the average value of variable  $\bar{d}_i$  during analysed period of time. Integrated index in context of measuring income inequality will be marked as  $D_{ii}$  (deviation of income inequality). Both value of non-weighted average absolute deviation and amount of integrate index can have values from 0 to 100 and if value of non-weighted average absolute deviation and amount of integrate index is lower (the more close to 0) than less income inequality is between the richest and poorest households in society. Perfect income equality in the society would occur in a situation where both values would come out zero.

The intertemporal integrated index based on methods of non-weighted average absolute deviation is useful for simple comparison of income inequality in large number of societies (communities) together during a long period of time. It is also much easier to use and apply the method of non-weighted average absolute deviation to express income inequality than count Gini coefficient because the results of both methods are essentially identical (Turečková, 2015a, 2015b). As it was mentioned in Introduction there were done another two studies. There were compared results of the level of income inequality measured through 3 methods, using new methods of non-weighted average absolute deviation and two standard methods: Gini coefficient and S80/S20 Ratio. The correlation between them was very high which means that there is a high significant dependence between selected variables. Since the correlation between the results obtained with the method of non-weighted average absolute deviation and Gini coefficient is significant, it is advisable to use the method of non-weight average absolute deviation to express the deviation in income inequality instead of Gini coefficient which calculation is considerably more difficult. The negative of using the intertemporal integrated index is that the value of this index does not tell us anything

about the development (or the trend) of income inequality in the society during the time.

From a methodological perspective, the work is based on secondary data gained by Eurostat, concretely from the Population and social conditions, Living conditions and welfare, Income distribution and monetary poverty, Distribution of income by deciles as a share of national equivalised income for 11 European countries: Poland, Czech Republic, Slovak Republic (Slovakia), Austria, Slovenia, Hungary, Romania, Bulgaria, Latvia, Lithuania and Estonia. The covered period includes years 2005-2013 because of missing credible data which is not available for a longer period.

Income is understood as a total disposable income of a household that is calculated by counting personal income received by all members of the household plus income received at household level. Disposable household income includes all income from work (employee wages and self-employment earnings), private income from investment and property, transfers between households and all social transfers received in cash including old-age pensions. (Eurostat, 2015)

Calculations of value of non-weighted average absolute deviation and integrated index ( $D_{ii}$ ) are based on calculations using formulas (1), (2) and (3). All these measures of income inequality were described in the text above. The software used was MS Excel. All calculations and graphical analysis is author's own.

## **Empirical analysis and findings**

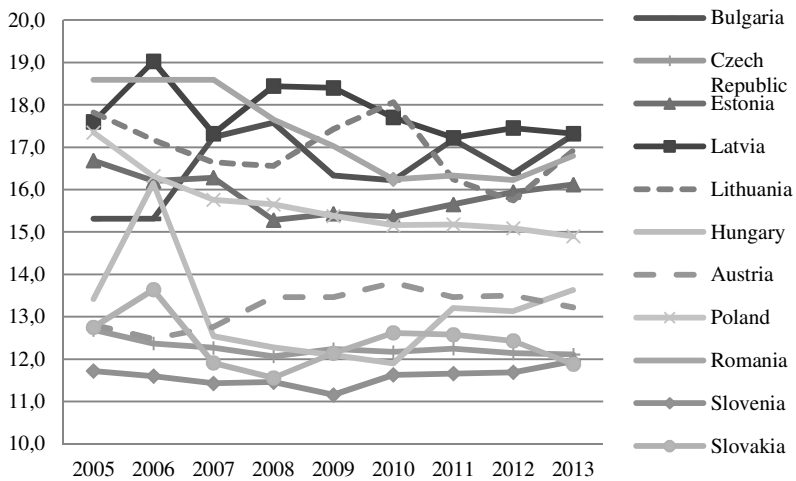
Empirical analyses were made on the basis of the share of national equivalised income of 11 Central and Eastern European countries household's data from Eurostat (2015). Subsequently on the basis of the data we compute through method of non-weighted average absolute deviation the values that by the set way characterize income inequality. We can also compare these values to determine the income inequality between countries or characterize development of income inequality in relevant country over the period of time.

Figure 1 is showing the development of values of average absolute deviation for selected eleven European countries for the years 2005-2013. It shows that the best income equality from analysed group of countries has Slovenia. Through the graphical interpretation of income inequality shown in Figure 1 clearly see the natural division of the countries analysed in two groups. Group of countries with higher income equality forms already



mentioned Slovenia, followed by Slovakia, Austria, Czech Republic and Hungary, whose development in income inequality has a considerable dynamism, which is not desirable. Group of countries with higher income inequality, whose values of income inequality calculated by non-weighted average absolute deviation are higher than the first group, consists of all three Baltic States, Poland, Romania and Bulgaria.

**Figure 1.** Development of values of income inequality calculated by non-weighted average absolute deviation ( $\bar{d}_i$ ) in selected European countries (11), (2005-2013)



Source: own calculations based on Eurostat (2015).

The Figure 1 shows that only Poland achieved continuous decline in income inequality (by 2.5 point) during the period. How we can see also from this graph, there were not any significant changes in income inequality/income equality in other 9 selected countries (except Bulgaria, where its increased value indicating income inequality by 2 points) in the set period of time.

Table 1 complements Figure 1 and presents a value of income inequality calculated by non-weighted average absolute deviation in analyzed European countries for years 2005-2013. Table 1 is supplemented with a multicolored range where the darker the tint value in the cell is given by the country for that year characterized by higher income inequality. Countries with a light tint are doing in the context of income equality better than those for which it is darker tint values.

**Table 1.** Values of income inequality calculated by non-weighted average absolute deviation ( $\bar{d}_i$ ) in selected European countries (11) for each year supplemented with a multicolored range

Geo/Year	2005	2006	2007	2008	2009	2010	2011	2012	2013
Bulgaria	15.3	15.3	17.2	17.6	16.3	16.2	17.2	16.4	17.3
Czech Republic	12.7	12.4	12.3	12.1	12.2	12.2	12.3	12.1	12.1
Estonia	16.7	16.2	16.3	15.3	15.4	15.4	15.7	15.9	16.1
Latvia	17.6	19.0	17.3	18.4	18.4	17.7	17.2	17.5	17.3
Lithuania	17.8	17.2	16.6	16.6	17.4	18.1	16.2	15.7	16.9
Hungary	13.4	16.2	12.5	12.3	12.1	11.9	13.2	13.1	13.6
Austria	12.8	12.5	12.8	13.5	13.5	13.8	13.5	13.5	13.2
Poland	17.4	16.3	15.8	15.7	15.4	15.2	15.2	15.1	14.9
Romania	18.6	18.6	18.6	17.7	17.0	16.2	16.3	16.2	16.8
Slovenia	11.7	11.6	11.4	11.5	11.2	11.6	11.7	11.7	12.0
Slovakia	12.8	13.6	11.9	11.6	12.1	12.6	12.6	12.4	11.9
Mean	15.2	15.4	14.8	14.7	14.6	14.6	14.6	14.5	14.7

Source: own calculations based on Eurostat (2015).

There is also data about a mean value for each year. Comparing these values, we find that in the course of 9 years, income inequality across groups of countries as a whole declined (from 15.2 point to 14.7 point). If you simply compare values between year 2005 and year 2013 then there is an improvement in income equality in the Czech Republic, Estonia, Latvia, Lithuania, Poland, Romania and Slovak Republic. Deepening income inequality occurred in Bulgaria, Hungary, Austria and Slovenia.

The value of (intertemporal) integrated index  $D_{ii}$  representing the level of income inequality in society in each country is shown in Table 2. This index averages the values obtained by the non-weighted average absolute deviation for the whole analysing time series. Based on the amount of this index we can compile the ranking of countries based on their uniform distribution of income in the society.

**Table 2.** Amount of intertemporal - integral index for income inequality and the ranking of countries in context of income inequality for selected European countries (11), lined up

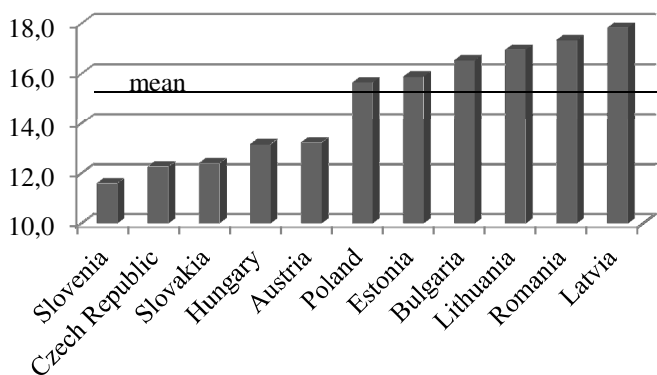
Index/Geo	Slovenia	Czech Republic	Slovakia	Hungary	Austria
$D_{ii}$	11.59	12.26	12.39	13.15	13.22
Ranking	1	2	3	4	5

Index/Geo	Poland	Estonia	Bulgaria	Lithuania	Romania	Latvia
$D_{ii}$	15.64	15.88	16.54	16.95	17.34	17.83
Ranking	6	7	8	9	10	11

Source: own calculations based on Eurostat (2015).

Graphs of the results (see Figure 2) of the index  $D_{ii}$  are more easily legible and complete Table 2. The income inequality was lowest in Slovenia during years 2005-2013, where the intertemporal integrated index was 11.59. About 0.67 points after Slovenia, in second place with the lowest income inequality, was Czech Republic and about 0.8 points, in third place was Slovakia (Slovak Republic) within the selected group of countries followed by other analysed European countries. Average value of the index, mean, is 14.8 points. The worst situation in context of income inequality was in Latvia where the amount of integrated index was 17.83 points for time period 2005-2013.

**Figure 2.** Development of values of income inequality calculated by non-weighted average absolute deviation ( $\bar{d}_i$ ) in selected European countries (11), (2005-2013)



Source: own calculations based on Eurostat (2015).

Figure 2 shows another interesting fact. From a geographic point of view, countries with higher income equality concentrated in the central European region while countries with higher income inequality make up the group Baltic countries, along with Poland, Romania and Bulgaria, it means the Eastern European countries acceding to the European Union at the end of the integration process and countries in transition problematic process. For further research, the question is whether that income inequality is not related to the geographic location, which in turn determines the other factors involved in the distribution of income in society.

## Conclusion

There is a lot of methods, procedures and approaches to measurement and describing income inequality in our economy and our society. In this paper is paid attention to new (alternative) method of measuring and expressing income inequality through method of non-weighted average absolute deviation. It was used to map changes in income inequality of eleven Central and Eastern European countries, concretely of Poland, Czech Republic, Slovak Republic (Slovakia), Austria, Slovenia, Hungary, Romania, Bulgaria, Latvia, Lithuania and Estonia between years 2005-2013. There was also assembling the ranking of these countries in context of a more equal distribution of income in a given society. It was done on the basis of intertemporal integrated index. The highest income equality reached Slovenia from the analyzed group of countries; the worst income inequality was in Latvia.

The second conclusion presented in this paper is that non-weighted average absolute deviation method can expand the existing portfolio of methods for measuring and expressing income inequality between households in society because of its comparatively simple feasibility while the results are comparable to standard and traditional methods of measuring income inequality.

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### **Acknowledgements**

This paper was supported by the project SGS/13/2015 "Influence of Selected Macroeconomic and Microeconomic Determinants on the Competitiveness of Regions and Firms in Countries of the Visegrad Group Plus".