Measuring Inequality of Opportunity: Does Inequality Index Matter?

Zulfiya Ibragimova[1] | *Bashkir State University, Ufa, Russia*
Marina Frants[2] | *Ufa State Aviation Technical University, Ufa, Russia*

Abstract

The equal opportunity theory is based on the idea that it is important to distinguish between two sources of inequality: the inequality caused by factors outside an individual's control (inequality of opportunity) and the inequality generated by factors within an individual's control (inequality of effort). The aim of this study is to assess the impact of choosing an inequality index on the results of measuring the inequality of opportunity. The empirical analysis was carried out based on the data from Life in Transition III sociological survey. Important findings suggest that: 1) the choice of inequality measure has a significant impact on the outcome of measuring the inequality of opportunity; 2) within the methodology under consideration, when using the Gini index, the contribution of inequality of opportunity to the inequality in labor income turns out to be much greater than when using other measures of inequality with the direct method of assessment, and vice versa, noticeably less with the indirect method of assessment; 3) the L-Theil and T-Theil indices look more preferable to use; 4) a country's ranking in terms of absolute and relative inequality of opportunities changes depending on the choice of the measure of inequality and on the choice of the assessment method, sometimes quite significantly; 5) the ranking position for absolute inequality of opportunity may differ significantly from the ranking position for relative inequality.[3]

Keywords

Inequality, inequality of opportunity, inequality indices

JEL code

D31, D63

INTRODUCTION

The subject of socio-economic inequality is currently a very popular line of research. This is due to the fact that the level of inequality, which was gradually declining in the developed capitalist countries after the Second World War until the 80s of the 20th century, started to grow steadily again (Atkinson, 2018), creating conditions for the growth of social tension.

[1] Bashkir State University, Institute of Economics, Finance and Business, 32 Zaki Validi, 450076 Ufa, Russia. Corresponding author: e-mail: badertdinova@mail.ru, phone: (+7)3472299608.
[2] Institute of Economics and Management, Ufa State Aviation Technical University, 12 Karl Marx, 450000 Ufa, Russia. E-mail: tan-marina@mail.ru.
[3] This manuscript follows the prior research "Transition report 2016–17. Inequalty of opportunity" conducted and published by the European Bank for Reconstruction and Development – online at: <*https://2016.tr-ebrd.com/inequality-of-opportunity*>.

The term «inequality» is rather ambiguous. One can understand it in a mathematical, emotionless sense simply as a statement of the fact that the amount of benefit an individual has (e.g. income) differs from subject to subject. In this case, the terms «inequality» and «variation» can be regarded as synonyms. But the concept of inequality is far more likely to hold a negative narrative, reflecting inconsistencies between the actual distribution of some benefit in society and the distribution of the benefit according to a certain kind of «ideal of justice». This in mind, the «ideal of justice» does not necessarily imply that all individuals should have equal amount of benefit; on the whole, there exists a public consensus that some people deserve a bigger share of the public pie. For example, with respect to income, there exist at least two arguments: the needs and the merit. It is commonly agreed, for example, that in order to achieve the same quality of life, families with a large number of children or people with disabilities are in need of higher income than single or healthy people; therefore, as a matter of common justice, a higher income should be made available to the former than to the latter. Besides, a public consensus also exists in respect of prominent figures being eligible to more benefit than others – because they «deserve it». Said otherwise, in the context of variation, all differences are equal to each other, while in terms of inequality some differences look natural and even fair, whereas others are unfair or even shameful.

An innovative vision of the «ideal of justice» as regards the distribution of benefit was put forward by the theory of equal opportunity originated in the Western social philosophy at the end of the 20th century. This theory stems from the idea that an individual should be responsible for what he is in full control of. Therefore, the differences in the amount of benefit arising from the factors dependent on different individuals (called effort-factors) are reasonable. On the contrary, the differences in the amount of benefit arising from the factors beyond an individual's control (called circumstance-factors) are unjust and subject to compensation. Thus, according to the theory of equal opportunities, the «ideal of justice» is to ensure that the inequality caused by circumstances beyond an individual's control (called inequality of opportunity) should be fully compensated, and the efforts, on the contrary, should be adequately rewarded.

Currently, a wide range of methods for measuring inequality of opportunity has been developed and tested on the microdata from various countries. In terms of describing the relationship between circumstances, efforts and achievements, the distinguished parametric and non-parametric approaches are applied. A specific type of the relationship function is selected in the parametric approach, of which the parameters are evaluated by means of regression analysis, whereas the function in the nonparametric approach is considered unknown. As to the way the equality of opportunity is understood, there exist two approaches: ex-ante and ex-post. The ex-ante approach builds upon the idea that equality of opportunity is considered achieved if the average achievement is the same for individuals in all groups that are homogeneous by circumstance-factors. The ex-post approach implies that the equality of opportunity is considered achieved when the achievements of individuals making equal efforts are the same.

Finally, methods for assessing inequality of opportunity vary depending on the measures of inequality they use. There is a wide choice of inequality indices in case of a continuous variable of achievement, given a plethora of measures developed and applied for measuring inequality, the best known of which being the Gini index, the Atkinson and Dalton indices families, and generalized entropy measures.

The aim of this work is to fill a gap in the empirical research on the assessment of inequality of opportunity related to the study of the impact of the choice of an inequality measure on the measurement result. The reason to do this work was necessitated by the results of the assessment of opportunity inequality in the Russian Federation presented in the EBRD's work Transition report (2016–17), performed by the European Bank for Reconstruction and Development (EBRD) based on the microdata of the sociological survey LiTS III (Life in Transition). This study measures inequality of opportunity

in 33 countries (mainly economies in transition countries). Parents' educational background, their membership in the Communist Party, gender, nationality and place of birth of the respondent are taken as circumstance-factors. As reflected in the results obtained the contribution of inequality of opportunity to income inequality in the Russian Federation accounts for 34.5%. Our estimates of inequality of opportunity in the Russian Federation (Ibragimova and Frants, 2019; Ibragimova and Frants, 2020; Pauhofová et al., 2020), received on the basis of the RLMS data (wave 2011), are almost twice as small (19.2%) despite the fact that a set of circumstance-factors taken into consideration in our work is broader than in the EBRD study. Such a wide gap encouraged us to compare the EBRD results with other researchers' studies on the same countries, carried out using similar methods. The results of the comparison are shown in Table 1.

Table 1 Comparative analysis of the EBRD results with other researchers' studies on the same countries

Comparison	Transition report 2016–17	Marrero and Rodriguez (2012)	Brzeziński (2015)	Checchi et al. (2010)
Assessment methodology	Parametric, based on ex-ante approach	Parametric, based on ex-ante approach	Parametric, based on ex-ante approach	Parametric, based on ex-ante and ex post approaches
Applied measures of ineaquality	Gini index	L-Theil index	L-Theil index	L-Theil index
Countries	33 post-socialist states	23 European countries	23 European countries; the list of the countries is identical (Marrero and Rodriguez, 2012)	25 European countries
Assessment results	From 19.5% (Montenegro) up to 47.1 (Estonia), as well as Germany – 23.0%, Slovakia – 40.4%, Czech Republic – 41.9%	From 1.89% (Denmark) up to 22.22% (Portugal), as well as Germany – 2.07%, Slovakia – 3.60%, Czech Republic – 5.85%	2004: from 2.00% (Denmark) up to 18.00% (Portugal), as well as Germany – 2.5%, Slovakia – 2.5%, Czech Republic – 6.0% 2010: from 1.88% (Sweden) up to 18.00% (Greece), including Germany –3.1%, Slovakia – 7.3%, Czech Republic – 8.0%	Ex-ante: from 3.0% (Norway) up to 35.5% (Cyprus), ex post: from 15.8% (Slovenia) up to 48.6% (UK), including ex-ante: Germany – 21%, Slovakia – 14%, Czech Republic – 13%, ex-post: Germany – 33.3%, Slovakia – 31.4%, Czech Republic – 39.20%
Circumstance- factors	Parents' educational background and membership in Communist Party, birth place, gender, nationality	Parents' educational background, father's occupational status, the country of an individual's birth, welfare of the family where the individual was raised	Parents' educational background, father's occupational status, the country of an individual's birth	Gender, parents' educational background, father's occupational status, the country of an individual's birth, type of locality where the individual lives
Income measure	Self-reported incomes over the last 12 months, which come from a variety of different types of employment	Disposable equivalent income	Disposable equivalent income	Post-tax individual earnings
Informational basis	LITS III (end of 2015–beginning of 2016)	EU-SILC (2005)	EU-SILC (2005, 2011)	EU-SILC (2005)
Size of the sample serving as the basis for making calculations	≈ 500	From 1 159 up to 8 638	From 1 133 up to 8 338	From 2 104 up to 15 562

Source: Own construction

As can be seen from Table 1, a similar wide gap both between our estimates and those of the EBRD can often be found when comparing the estimates of the EBRD for a number of countries with the estimates made in other researchers' studies on the same countries. A comparative analysis indicates that the gap may arise due to a number of causes. Firstly, the EBRD study uses, unlike other works, the Gini index rather than the L-Theil index as a measure of inequality. Secondly, various measures of income are applied. Thirdly, the gap in the assessments may be related to the amount and time of data collection. Fourthly, the set of the circumstance-factors involved differs.

The inequality of opportunity assessment problems related to imperfect data are well known – empirical studies on assessing the inequality of opportunity use the data from ready-made sociological surveys, hence, the choice of circumstance-factors, effort-factors, as well as individual achievement measures is limited by the availability of data. We could not find any works which would carry out a data collection tailored for assessing the inequality of opportunity, or at least, would theoretically design a sociological survey focused on this task.

Neither have we seen any work dedicated to a detailed study of the extent to which the choice of a measure of inequality affects the assessment result. Most works on inequality of opportunity apply one measure of inequality, without strong reasoning of advantages of the index used. Those studies which apply a number of indices (they are discussed in detail below in Section 1.2), do it as a robustness check of the main result and do not set it as the main task of the study. In this paper, we aim at in-depth studying of this very aspect – to what extent the choice of inequality index affects the outcome of assessing the inequality of opportunity.

The work is structured as follows. The initial overview section contains, first, a brief description of concepts and approaches to assessing the inequality of opportunity, which enables to clarify the role of inequality indices in those calculations. Second, it reviews the works raising the issue of sensitivity of estimation results to the choice of an inequality measure. Third, it gives an overview of inequality indices, including their origins and properties. The second section describes the methods used to measure inequality of opportunity and the research information base. The third section presents the results of assessing the inequality of opportunity in terms of income for 16 countries based on the LiTS III survey, and discusses the effect of inequality index on the assessment result and a country's ranking by inequality of opportunity.

1 THEORETICAL OVERVIEW

1.1 Measuring the inequality of opportunity: conceptual approaches and the role of inequality indices

The research on inequality of opportunity is based on the 'equal opportunities for all members of society' concept, which at the end of the 20th century resulted from development of egalitarian theories of social justice. According to this concept, the achievements that are significant for everyone or the majority, such as income, material well-being, and the state of health, depend on two groups of factors – the circumstances for which an individual should not be responsible, and efforts, which, on the contrary, are in the area of personal responsibility. The inequality of achievement arising from the inequality of effort is treated as ethically acceptable, while the inequality arising from circumstances is unfair and therefore must be eliminated.

As scholars began attempting a mathematical formalization of this concept of equal opportunity, it quickly became clear that many related problems appear. An excellent overview of the issues of incompatibility between the principles of compensation and natural reward, as well as the incompatibility between ex-ante and ex-post approaches to determining the equality of opportunity based on the principle of compensation, is given in Ramos (2016).

The compensation principle implies that the inequality caused by inequality of circumstances must be eliminated. To date, two criteria have been proposed to assess whether the inequality of opportunity

has been compensated – the ex-ante and the ex-post. The ex-ante approach, proposed by van der Gaer, provides that the equality of opportunity is achieved if the average achievement is the same for individuals in all groups that are homogeneous by circumstance-factors. The ex-post approach proposed by Roemer is based on the idea that the equality of opportunity is achieved when the achievement of individuals with the same effort is the same. As shown in Fleurbaey and Peragine (2013), the ex-ante and ex-post approaches are incompatible.

The natural reward principle implies that inequality of achievement caused by the inequality of effort must retain. The literature discusses two approaches to the implementation of this principle – the liberal and the utilitarian ones. The liberal approach is based on the idea that the achievements of individuals with the same circumstances should not be redistributed, because they are solely due to differences in effort. The utilitarian approach says «inequalities due to unequal effort do not matter», advocating a sum-maximizing policy among subgroups with identical circumstances. The same work (Fleurbaey and Peragine, 2013) proved that the liberal and the utilitarian approaches are incompatible with each other and with the ex-post approach to compensation.

Methods of assessing the inequality of opportunity are based on the principle of compensation and can be based on both the ex-ante and the ex-post approaches.

From the ex-ante point of view, the equality of opportunity is achieved if the average achievement of individuals in all the circumstance-factor homogeneous groups is the same. Therefore, the ex-ante-assessed inequality of opportunities is based on calculating v_i scalar measure for each individual which estimates the individual's particular set of circumstances. Understandably, the v_i measures will be identical for all individuals with the same circumstances. In the case of equality of opportunities, the vi values should be the same for all individuals in general. If this is not the case, then the inequality of opportunity can be estimated through calculating some inequality index *I* by distribution $\{v_i\}$ (hereinafter, curly braces will be used to denote the distribution). Thus, when assessing inequality of opportunity based on the ex-ante-approach, it is necessary to answer two questions: what is to be used as the v_i measure, and which inequality index *I* is to be chosen for assessing the inequality of distribution $\{v_i\}$. In practice, the average value of achievement is almost always used as v_i for all individuals, for which the set of circumstance-factor values coincides with the set of circumstance-factor values for the *i*-th individual. The L-Theil index is most often used as a measure of inequality, but there are many examples of using other measures of inequality.

The ex-post approach to determining the equality of opportunity is based on the idea that the achievements of individuals with the same efforts should be the same. Within this approach, it is necessary to assess an individual's efforts, but not the circumstances. That does complicate things, since the efforts are much less observable than circumstances. However, Roemer has proposed the way to bypass the problem known as the Roemer's identification assumption. According to his idea, the efforts of individuals from the same percentile of intragroup distribution (a group is defined as a set of individuals with the same circumstances) are the same. Therefore, it is possible to form effort-homogeneous groups from groups that are homogeneous in circumstances. In the literature on inequality of opportunity, these groups are commonly referred to as tranches. According to the ex-post approach, the equality of opportunity is achieved if the intra-tranche variation of achievement is equal to 0. If this is not the case, then to assess the inequality of opportunity we must, first, calculate the inequality indices *I* for each tranche and, second, aggregate them to obtain a generalized estimator of the intra-tranche component of variation, which is a measure of inequality of opportunity in a population. Accordingly, in the case of assessing the inequality of opportunity based on the ex-post approach, it is again necessary to decide on which particular inequality index to use. As in the case of the ex-ante approach, the L-Theil index is most often used, but other measures of inequality are also used quite frequently.

Thus, the above review shows that the existing approaches to measuring the inequality of opportunity are based on the principle of compensation and can rely on either the ex-ante or the ex-post interpretation of this principle. In both the ex-ante and ex-post assessments, there exists the problem of choosing an inequality index.

1.2 A review of works addressing the sensitivity of opportunity inequality assessments to the choice of inequality measure

Empirical studies on the contribution of inequality of opportunity to economic inequality are of a wide geography, and the assessment methods applied are constantly being improved and supplemented. However, they rarely consider the effect of choosing a measure of inequality on the outcome. Most works concentrated on the assessing of inequality of opportunity, make use only of one measure of inequality, and in most cases this is the L-Theil index. In this section, we will consider several works that made use of different measures of inequality and discussed their impact on the outcome of the assessment and countries' ranking.

The paper Bourguignon et al. (2003) is concentrated on assessing the inequality of opportunity in Brazil supported by the PNAD data, National Household Survey, 1996. The evaluation technique can be described as parametric basing on the ex-post approach. The study considers the following set of circumstance-factors: race, parents' educational background, occupational status of the father. Two indicators were used as income measures: the actual hourly rate of pay and equivalent household income. The calculation was performed for seven age cohorts. The results for the measure of income, namely equivalent household income, are listed in Table 2.

Table 2 Inequality of opportunity in Brazil (based on the results from Bourguignon et al., 2003)

Years of birth		1936–1940	1941–1945	1946–1950	1951–1955	1956–1960	1961–1965	1966–1970
General inequality	Gini index	0.605	0.602	0.588	0.591	0.597	0.594	0.573
	T-Theil index	0.750	0.736	0.682	0.720	0.709	0.691	0.635
Residual inequality	Gini index	0.474	0.492	0.481	0.489	0.490	0.478	0.482
	T-Theil index	0.434	0.475	0.455	0.468	0.465	0.429	0.437
Absolute inequality of opportunity	Gini index	0.131	0.110	0.107	0.102	0.107	0.116	0.091
	T-Theil index	0.316	0.261	0.227	0.252	0.244	0.262	0.198
Relative inequality of opportunity	Gini index	21.7%	18.3%	18.2%	17.3%	17.9%	19.5%	15.9%
	T-Theil index	42.1%	35.5%	33.3%	35.0%	34.4%	37.9%	31.2%

Source: General and residual inequality (Bourguignon et al., 2003), we added the calculation of the absolute and relative inequality of opportunity in Table 3

As we can see from the Table 2, the use of the Theil index results in a higher contribution of inequality of opportunity to household income inequality than the one obtained through the Gini index, the differences being very significant.

Pistolesi (2009) explores the inequality of opportunity in the USA during the period from 1968 to 2001 based on the Michigan Panel Study of Income Dynamics. The evaluation technique is parametric and based on the ex-post approach in two modifications – with direct and indirect estimation methods. The work takes into account the following set of circumstance-factors: age and educational background of the parents, occupational status of the father, region of birth, and individual's affiliation with a black minority group. As a measure of income, the annual labor income was used: the average annual labor income over 3 years, the average annual labor income over 5 years. A whole range of inequality measures

used by the author include: T-Theil index, L-Theil index, GE (2), the standard logarithmic deviation, the Gini index. The results are presented in Table 3.

Table 3 Relative inequality of opportunity (based on the results Pistolesi, 2009)

	Direct method					Indirect method				
	T-Theil	**L-Theil**	**GE(2)**	**SDI**	**Gini**	**T-Theil**	**L-Theil**	**GE(2)**	**SDI**	**Gini**
Annual labour income										
Average value	23.6%	23.3%	17.2%	35.3%	32.2%	27.6%	29.4%	34.3%	27.9%	24.7%
Minimum	15.0%	16.4%	7.5%	23.9%	24.4%	7.3%	10.0%	16.9%	18.3%	14.6%
Maximum	33.7%	34.2%	25.6%	47.2%	41.9%	41.8%	48.2%	44.5%	35.6%	33.6%
Average annual labour income for 3 years										
Average value	26.0%	27.1%	19.2%	41.3%	34.6%	30.5%	32.8%	40.0%	31.7%	25.8%
Minimum	17.2%	19.0%	9.9%	31.9%	26.7%	7.9%	11.3%	20.6%	20.5%	15.0%
Maximum	37.1%	38.8%	28.7%	52.4%	44.4%	43.8%	56.5%	53.0%	40.8%	35.0%
Average annual labour income for 5 years										
Average value	27.0%	28.4%	20.1%	43.0%	35.5%	31.6%	34.3%	41.8%	32.7%	26.3%
Minimum	18.6%	20.8%	11.5%	34.9%	28.1%	8.1%	12.8%	21.9%	22.0%	15.3%
Maximum	37.5%	39.4%	29.2%	53.0%	44.7%	44.6%	55.4%	53.8%	41.1%	35.9%

Note: Average, minimum and maximum values for the years of 1968–2001.
Source: Pistolesi (2009)

As indicated in Table 3, the contribution of inequality of opportunity to income inequality significantly varies depending on the choice of the inequality measure. Comparing the results obtained with the help of the L-Theil and Gini indices, we can see that when applying the direct method, the relative inequality of opportunity obtained with the Gini index is substantially greater than with the L-Theil index. On the contrary, if the indirect method is used, the relative inequality of opportunity turns out to be considerably larger when obtained with the L-Theil index rather than with the Gini index.

Björklund et al. (2011) is another work that addresses the impact of inequality measures on the outcome of measuring inequality of opportunity. This study explores the inequality of opportunity in Sweden. The evaluation technique used can be characterized as parametric based on the ex-ante approach. The total market income, averaged over 7 years when the person was aged 37–43, is used as a measure of income. The analysis included only men born in the period of 1955–1967. The authors used a comprehensive set of circumstance-factors: income and parents' educational background, type of the family in which the individual grew up, the number of siblings, IQ and the body mass index of an individual at the age of 18 years. Four measures of inequality were used for the calculation: the Gini index, the L-Theil index, the T-Theil index, and GE (2). The results are presented in Table 4.

As follows from Table 4, the contribution of inequality of opportunity depends heavily on the choice of the measure of inequality. In this work, the result obtained with the help of the Gini index is considerably higher than the result obtained through the L-Theil index.

Hederos et al. (2017) that also deals with the assessment of inequality in Sweden, was carried out using the same evaluation technique as Björklund et al. (2011). The difference lies in the fact that the analysis included both men and women, and a somewhat different set of circumstance-factors: income and educational background of parents, type of the family, the number of brothers and sisters, IQ of an individual and his non-cognitive skills. The results are shown in Table 5.

Table 4 Inequality of opportunity (based on the results Björklund et al., 2011)

Measure of inequality	Gini index	L-Theil index	T-Theil index	GE(2)
All individuals (born in the period of 1955–1967)				
General inequality	0.263	0.158	0.183	3.946
Contribution of residual inequality	71.8%	86.9%	79.3%	58.9%
Contribution of inequality of opportunities	28.2%	13.1%	20.7%	41.1%
Individuals born in the period of 1955–1959				
General inequality	0.231	0.122	0.111	0.379
Contribution of residual inequality	73.4%	90%	85.3%	81.3%
Contribution of inequality of opportunities	26.6%	10%	14.7%	18.7%
Individuals born in the period of 1960–1967				
General inequality	0.279	0.181	0.236	6.976
Contribution of residual inequality	68.7%	82.6%	62.5%	5.7%
Contribution of inequality of opportunities	31.3%	17.4%	37.5%	94.3%

Source: Björklund et al. (2011)

Table 5 Inequality of opportunity (based on the results Hederos et al., 2017)

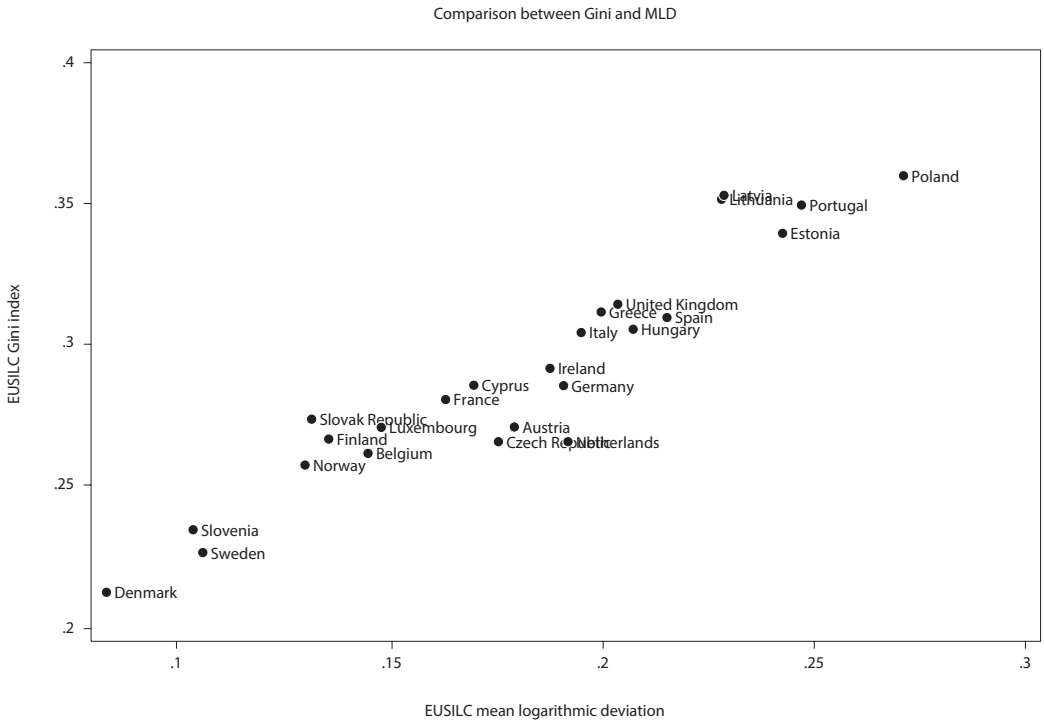
Measure of inequality	Gini index	L-Theil index	T-Theil index	GE(2)
Men				
General inequality	0.303	0.197	0.226	1.754
Contribution of residual inequality	69.0%	84.1%	78.9%	70.6%
Contribution of inequality of opportunity	31.0%	25.9%	21.2%	29.4%
Women				
General inequality	0.240	0.136	0.122	0.476
Contribution of residual inequality	75.0%	90.7%	85.5%	77.2%
Contribution of inequality of opportunity	25.0%	9.3%	14.5%	22.8%
All				
General Inequality	0.296	0.186	0.204	1.450
Contribution of Residual Inequality	62.9%	80.1%	73.5%	62.1%
Contribution of Inequality of Opportunity	37.1%	19.9%	26.5%	37.9%

Source: Hederos et al. (2017)

As shown in Table 5, the conclusions that can be made about the variation of the estimates depending on the measure of inequality are similar to the conclusions made in the previous work.

The issue of the extent to which the choice of inequality index affects a country's ranking is poorly studied. We are aware of only one work on inequality of opportunity in which some attention is paid to this aspect – Checchi (2010) compares inequality assessments using the Gini and L-Theil indices (Figure 1) in European countries. As the figure shows, the correlation between these indices is high, but the ranking of countries is different. We do not know of any studies in which inequality of opportunity would be assessed for a number of countries using several inequality indices, so we believe that this work is the first study of this kind.

Figure 1 Correlation of the Gini and L-Theil indexes



Source: Checchi (2010)

In general, the analysis of works in which the impact of a measure of inequality on the result of assessing the inequality of opportunity was addressed shows that the choice of an inequality measure affects the result of the assessment. Comparison of the results shows that sometimes the contribution of inequality of opportunity to income inequality when using the L-Theil index turns out to be much larger, and sometimes much less than when using the Gini index. What this is due to – peculiarities of assessment methodology, or information base, or income distribution in the country – remains unclear.

1.3 Inequality measures, their origin and properties

Due to our study being focused on the dependence of the inequality of opportunity assessment result on the choice of an inequality index, in this section we give a short but multi-aspect overview of inequality indices, reflecting the theoretical prerequisites for their occurrence, as well as the properties and features that are important for practical application. The below overview of measures of inequality does not claim to be complete – in writing this section we focused on the measures of inequality used to assess income inequality, since the purpose of our study is to measure inequality of opportunity in terms of earned income.

The measures of inequality being used in practice have three «sources of origin» (Cowell, 2009):

1. The inequality measures «borrowed» from the list of measures of variation used in statistics

Variation in statistics means the changeability of a parameter, its ability to take different values; accordingly, the variation measures are the indicators of variability. As mentioned previously, inequality

is a concept that is similar to variation, albeit not identical; therefore, the idea of adoptig statistical measures of variation to measure inequality is plain to see. Measures of inequality borrowed from statistics comprise:

- Measures based on the percentiles of the distribution of the continuous variable, such as decile and quintile coefficients of funds, the Palma ratio, and the percentiles. The deciles (quintile) coefficients of funds is calculated as the ratio of the average income of the 10 (20%) of the richest individuals to the average income of 10 (20%) of the poorest ones. The Palm coefficient is defined as the ratio of the total income of 10% of the richest individuals to the total income of 40% of the poorest ones. The percentiles ratio, as the name implies, is calculated by dividing one percentile of distribution by another. In practice, the ratio of 90% percentile to 10% is commonly used; however, there other options are also possible.
- Measures based on the formula of variance, including the variance itself (V), coefficient of variation (c), logarithmic variance (v), variance of logarithms (v1). Formulas (1)–(4) demonstrate how the listed indicators are calculated:

$$V = \frac{1}{n} \cdot \sum_{i=1}^{n} (y_i - \bar{y})^2 , \tag{1}$$

$$c = \sqrt{V / \bar{y}} , \tag{2}$$

$$v = \frac{1}{n} \cdot \sum_{i=1}^{n} (\ln (y_i) - \ln (\bar{y}))^2 , \tag{3}$$

$$v1 = \frac{1}{n} \cdot \sum_{i=1}^{n} (\ln (y_i) - \ln (\tilde{y}))^2, \tilde{y} = \sqrt[n]{y_1 \cdot y_2 \cdot \ldots \cdot y_n} . \tag{4}$$

- Relative mean deviation (M), calculated using Formula (5):

$$M = \frac{1}{n} \cdot \sum_{i=1}^{n} \left| \frac{y_i}{\bar{y}} - 1 \right| . \tag{5}$$

- The Gini index, calculated using Formula (6):

$$G = \frac{1}{2 \cdot n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} \left| \frac{y_i - y_j}{\bar{y}} \right| . \tag{6}$$

The notation in the formulas stated above and below is as follows: y_k is the income of the k-th individual, $\bar{y}$ is the average income, n is the population size.

The Gini Index, popularized by Italian statistician Corrado Gini, is undoubtedly the most well-known measure of inequality used in practice. In spite of the fact that the index is named Gini, Gini himself recognized that it was German scientists Karl Christopher von Andre and Friedrich Robert Helmert (Atkinson, 2018) who developed the basic statistics (mean difference).

2. Measures of inequality based on the theory of social welfare functions (SWF)

A SWF is a function that links the public's satisfaction with its social well-being to the characteristics of that state. Social well-being is simply the vector of values of individual characteristics

of the members of society, reflecting their economic sustainability. The idea of measuring inequality on the basis of social welfare functions emerged as an attempt to measure inequality as the degree of satisfaction (or dissatisfaction) of society with the distribution of any individual benefit, in particular, income.

The following two families of measures of inequality stem from the SWF-functions: the Dalton and Atkinson indices. The Dalton inequality indices family is determined through Formula (7). As Formula (7) states, the Dalton index is equal to 0, if the income of all members of the society are the same; the Dalton index will increase with the growth of income inequality:

$$D(\beta) = 1 - \frac{SWF(y_1, y_2, ..., y_n)}{SWF(\bar{y}, \bar{y}, ..., \bar{y})} = 1 - \frac{\sum_{i=1}^{n} y_i^{1-\beta} - 1}{n \cdot (\bar{y}^{1-\beta} - 1)}. \quad (7)$$

The shortcoming of the Dalton indices lies in the fact that they are sensitive to multiplying by a number. Therefore, Atkinson suggested the following modification of the inequality index (Formula 8). Atkinson's idea was to calculate the average utility of an individual's income, then to obtain an income corresponding to that average utility and then to compare it with the actual average income. As it follows from Formula (8), the Atkinson indices, unlike the Dalton indices, are insensitive to the multiplication by a number:

$$A(\beta) = 1 - \frac{U^{-1}(\bar{U})}{\bar{y}} = 1 - \left[\frac{1}{n} \cdot \sum_{i=1}^{n} \left(\frac{y_i}{\bar{y}}\right)^{1-\beta}\right]^{\frac{1}{1-\beta}}. \quad (8)$$

Thus, the social welfare functions theory is the source of origin for two families of inequality indices – the Dalton and the Atkinson ones.

It is interesting to note that the Gini index was interpreted in terms of the SWF theory in Sen (1973). He has shown that the Gini index can be calculated by Formula (9) which is equivalent to Formula (6):

$$G = 1 - \frac{1}{n^2 \cdot \bar{y}} \sum_{i=1}^{n} \sum_{j=1}^{n} Min(y_i, y_j). \quad (9)$$

This form of mathematical notation leads to the following definition: if the income level of any pair of individuals is equaled to the income level of the poorer, and if the public welfare is the total of the welfare of all possible pairs, then the inequality index for such public welfare function will be determined according to the Gini index formula.

3. Measures of inequality based on the information theory

One of the key tasks of the information theory is to measure the value of information on the likeliness of a certain event among many possible ones to occur. If the probability of the event is close to 1, then the value of such information is obviously small, but if, on the contrary, the event is unlikely to happen, then the value of information should increase. Thus, the value of information h to the effect that an event will take place should decrease monotonically as its probability increases. The information theory proposes a measure of disorder of a system, which is a weighted sum of the values of the information of the events. The weights in this construction are the probabilities of the events under consideration (Formula 10):

$$\text{Entrophy} = \sum_{i=1}^{h} h(p_i) \cdot p_i. \quad (10)$$

In 1967, Theil made the following proposal: if we reformulate the problem then the concept of entropy will provide a powerful tool for measuring inequality. Consider n individuals instead of n events, use

the individual's share in the «overall pie» instead of the probability of an event, interpret the value of the information about the event as the «coordinate» of the individual that allows you to «measure the distance» between two individuals depending on their shares in the total income. Inequality measures based on the theory of information are constructed so that the change in the measure of inequality in the transfer of a part of the income from a richer individual to a poorer one should depend, firstly, on the size of the transfer, and secondly, on the «distance» between the individuals participating in a small transfer (Formula 11):

$$\Delta Inf = \Delta s \cdot (h(s_R) - h(s_P)) . \tag{11}$$

In Formula (11), *Inf* – measure of inequality generated by the theory of information, Δ*Inf* – change in the measure of inequality due to the transfer, s_j – share of the j-th individual in the «overall pie», s_R, s_P are respectively shares of the «rich» and «poor» individuals that participate in the transfer, $\Delta s = s_R - s_P$, $\Delta s < (s_R - s_P) / 2$, $h(s_R) - h(s_P)$ – «distance» between the individuals under consideration.

The choice of function $h(s)$ reflects different ways of determining the distance between two individuals. Formula (12) below determines a class of the functions appropriate for use as $h(s)$:

$$h(s, \beta) = \begin{cases} \frac{1-s^{\beta}}{\beta}, \beta <> 0 \\ -\ln(s), \beta = 0 \end{cases} . \tag{12}$$

Index of inequality *Inf*(β) is formed as the difference between the entropy that would occur if the shares of income of all individuals were equal and actually takes place (Formula 13):

$$Inf(\beta) = \frac{1}{1+\beta}\left[\sum_{i=1}^{n}\frac{1}{n}h\left(\frac{1}{n}\right) - \sum_{i=1}^{n} s_i \cdot h(s_i)\right]. \tag{13}$$

As regards the practice of measuring inequality, a number of properties are distinguished which are important for measuring inequality, whereas the first four properties are considered basic and supported by almost all researchers, the fifth one is more likely to be that of a recommendation.

Independence from multiplication by a number: if all individuals' income is multiplied by the same number, then the measure of inequality should not change.

The principle of population: if a new population is obtained by combining with the second similar one, then the measure of inequality should remain unchanged.

Decomposability: if we divide the population into several constituent subgroups, then the inequality in the entire population can be represented as a function of intra-group inequalities, intra-group averages and group sizes.

Additive decomposability is singled out separately: when the inequality index for the entire population can be represented as the algebraic sum of the intra-group and inter-group components.

Weak transfer principle: if there is a transfer of the income from the richer to the poorer individual, so that the rich individual is still richer after the transfer than the poor one, then the inequality index should decrease.

In the case of 1–4 properties, a very important theorem has been proved: for an inequality measure to exhibit properties 1–4, it can be represented in the form (14) or take the form of an ordinally equivalent transformation (14). Simple transformations result in Formula (15) in which $\beta = \alpha - 1$.

$$GE(\alpha) = \frac{1}{\alpha^2 + \alpha}\left[\frac{1}{n} \cdot \sum_{i=1}^{n}\left(\frac{y_i}{\bar{y}}\right)^{\alpha} - 1\right], \tag{14}$$

$$Inf(\beta) \cdot n^{\beta} = GE(\alpha). \quad (15)$$

A family of measures $GE(\alpha)$ is called generalized entropy measures. Two measures are most popular in this family, especially in the works on inequality of opportunity: $GE(0)$, or the Mean Logarithmic Deviation, or the L-Theil index, and $GE(1)$, or the T-Theil index, which are «special cases» that are not calculated according to Formula (14), but according to Formulas (16) and (17), respectively.

$$GE(0) = \frac{1}{n} \cdot \sum_{i=1}^{n} ln\left(\frac{\overline{y}}{y_i}\right), \quad (16)$$

$$GE(1) = \frac{1}{n} \cdot \sum_{i=1}^{n} \frac{y_i}{\overline{y}} ln\left(\frac{y_i}{\overline{y}}\right). \quad (17)$$

Finally, a strong principle of transfers: a decrease of inequality index due to transfers should depend only on the «distance» between the rich and poor individuals. This principle is desirable because it allows us to formalize the intuitive idea: the greater the difference between the two individuals in terms of income, the greater should be the leveling effect provided by a transfer between them. If the measure of inequality satisfies the strong principle of transfers, then it can be interpreted as the average distance between the individual's actual share in the «overall pie» and his share in a society of 100% income equality. It is clear from the foregoing, that the idea of distance is definitely laid down in the measures resulting from the theory of information, and therefore they satisfy the strong principle of transfer.

As to the Gini index, it is definitely the «atypical reaction» of it to the transfer that gives rise to the criticism of this measure of inequality. The matter is that the change in the Gini index due to a transfer between two individuals depends on the ranks of these individuals in an ascending order of incomes: the more significant difference between the ranks results in a greater reduction of the Gini index. Therefore, a transfer between two individuals in the middle results in a more significant decrease in the Gini index than a transfer between the individuals at its beginning or the end.

The properties of different measures of inequality are given in Table 6.

Thus, there is a broad range of inequality measures of different origin, set of properties, and degree of popularity among the researchers. Choosing a specific measure of inequality from the list of possible

Table 6 Properties of inequality measures

Measure of inequality	Independence from multiplying by a number	Principle of population	Decomposability	Weak transfers principle	Strong transfers principle
V	–	+	+	+	+
C	+	+	+	–	+
M	+	+	–	±	–
V	+	+	–	–	–
v1	+	+	–	–	–
G	+	+	–	+	–
D(β)	–	+	+	+	–
A(β)	+	+	+	+	–
GE(α)	+	+	+	+	+

Source: Cowell (2019)

ones is a challenging task. In this article, we will try to find out how strongly the choice of the measure of inequality affects the results of measuring inequality of opportunity and which measures of inequality are more preferable for the given task. For a more detailed study of the issue, in our calculations we will use a wide palette of inequality indices from all the sources of origin listed above: the Gini index (GINI), the Atkinson indices A(2), A(1), A(0.5), the indices from the generalized entropy measures family GE(–1), GE(0), GE(1), GE(2).

Thus, with our research we contribute to the existing publications on the assessment of inequality of opportunity by way of: 1) applying a large number of inequality indices and exploring their influence on the outcomes of the assessment; 2) performing calculations not for one country, but for a number of countries using the same assessment methods and one set of circumstance-factors; and 3) exploring the impact of selecting a measure of inequality on a country's ranking by the absolute and relative inequality of opportunity.

2 METHODOLOGY AND INFORMATION BASE OF RESEARCH

The evaluation technique we have used in this study can be characterized as parametric and based on an ex-ante approach to the interpretation of equal opportunities. The choice of evaluation technique was determined by the fact that we wanted to proceed from the results obtained in Transition report (2016–17), which encouraged us to carry out this work. Unfortunately, in Transition report (2016–17) there is no detailed description of the calculation procedure, therefore, we cannot argue that our methodology is totally identical, but in general, the brief description, that is presented there, is sufficient to understand how the calculation was done.

The method under consideration was first proposed Ferreira and Gignoux (2011), and, in our opinion, is currently the most popular tool used in measuring the inequality of opportunity. This methodology uses predicted achievement values $\hat{y}_i$ calculated on the basis of regression of individual achievements on circumstance-factors.

The use of regression analysis requires selecting a functional form of relationship between the factors and the achievement. In Transition report (2016–17) there is no information on the specification used, but, actually, all studies on inequality of opportunity that use personal income or an individual's earnings as the indicator of achievement apply the semilogarithmic form of relationship (18).

$$ln(y_i) = C_i \cdot \alpha + u_i \,. \tag{18}$$

In Formula (18) y_i is the achievement of the i-th individual, α is the vector of regression coefficients, C_i is the vector of circumstance-factor values, u_i is a random error encapsulating the influence of unobservable factors, including the efforts for individual achievement.

Variation of $\hat{y}_i$ is determined only by variation of the circumstance-factors included in the model, while variation of $\hat{u}_i$ is the variation determined by other factors affecting the individual achievement, including the effort-factors and random factors. In this regard, there exist two options for assessing the inequality of opportunity – the direct and the indirect ones. In case of the direct method using a measure of inequality I, the inequality in distribution of $\hat{y}_i$ is measured and the $I(\{\hat{y}_i\})$ value is used as an absolute measure of inequality of opportunity. To assess the contribution of inequality of opportunity to the inequality of achievement, a relative measure of inequality of opportunity is calculated by formula $\theta_d = I(\{(\hat{y}_i\}) / I(\{y_i\})$. In case of the indirect method using a measure of inequality I, the inequality in $\{\hat{u}_i\}$ is measured and the $I(\{y_i\}) - I(\{\hat{u}_i\})$ value is used as an absolute measure of inequality of opportunity. We note that Ferreira and Gignoux (2011) describe the direct method only. The possibility of using the indirect method of assessment is discussed in Ramos (2016).

So, compared to Transition report (2016–17), we have expanded the methodological aspect by, firstly, having carried out a calculation using a range of inequality indices (A(2), A(1), A(0.5), GE(–1), GE(0),

Table 7 Descriptive statistics

Indicator	BLR	BUL	CRO	CPR	CZK	EST	DEN	HAN	ITA	KAZ	LAT	LIT	MON	MNG	RUS	SVK
Father's educational background																
Lower secondary education or less	8.94	35.36	49.78	60.74	61.55	33.88	49.79	57.31	55.10	21.36	25.34	38.72	40.88	37.00	15.42	64.00
(Upper) secondary education	32.78	49.46	34.51	26.67	30.32	20.45	19.36	32.95	35.35	33.15	18.95	18.61	26.37	40.36	26.39	29.65
Post-secondary non-tertiary education	38.91	6.79	1.11	1.98	0	28.31	15.11	4.18	2.07	25.97	33.11	16.35	10.99	8.97	33.23	0
Tertiary education and more advanced	19.37	8.39	14.60	10.62	8.12	17.36	15.74	5.57	7.48	19.52	22.60	26.32	21.76	13.68	24.96	0.35
Mother's educational background																
Lower secondary education or less	10.26	35.89	55.75	63.46	66.97	31.40	54.26	61.25	58.12	22.65	25.11	37.59	42.64	45.07	14.79	65.88
(Upper) secondary education	32.62	49.46	30.31	25.43	27.80	20.66	18.94	28.31	35.67	31.68	19.86	17.67	27.69	38.79	26.87	28.71
Post-secondary non-tertiary education	36.59	4.64	1.33	2.47	0.18	26.86	8.94	6.03	2.39	27.81	29.91	13.35	10.33	8.07	30.68	0.94
Tertiary education and more advanced	20.53	10.00	12.61	8.64	5.05	21.07	17.87	4.41	3.82	17.86	25.11	31.39	19.34	8.07	27.66	4.47
Gender																
Male	44.70	51.25	47.35	48.15	45.49	43.18	58.94	52.44	54.94	41.25	42.47	44.17	50.77	51.57	38.31	43.76
Female	55.30	48.75	52.65	51.85	54.51	56.82	41.06	47.56	45.06	58.75	57.53	55.83	49.23	48.43	61.69	56.24
Birthplace																
Urban	69.04	79.64	86.50	70.62	86.64	70.04	56.81	81.21	84.87	41.99	78.31	59.77	26.15	77.58	71.70	81.88
Rural	30.96	20.36	13.50	29.38	13.36	29.96	43.19	18.79	15.13	58.01	21.69	40.23	73.85	22.42	28.30	18.12
Ethnic																
Minority	9.11	13.57	2.65	9.38	31.95	24.59	5.96	2.78	2.07	38.31	25.57	12.59	16.04	45.29	8.90	7.06
Majority	90.89	86.43	97.35	90.62	68.05	75.41	94.04	97.22	97.93	61.69	74.43	87.41	83.96	54.71	91.10	92.94
Age																
Average	40.13	43.88	41.49	41.21	42.28	44.77	39.18	43.00	42.17	40.38	42.37	43.43	38.75	39.28	38.97	43.60
Number of observations	604	560	452	405	554	484	470	431	628	543	438	532	455	446	629	425

Source: Author's calculations

GE(1), GE(2), GINI), and secondly, making calculations by both direct (similar to Transition report (2016–17), and indirect methods.

The study is based on the data of «Life in Transition III» (LITS III) sociological survey (wave 2016), conducted by the European Bank for Reconstruction and Development. The LITS III survey is conducted in 34 countries (Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Macedonia, Georgia, Germany, Greece, Hungary, Italy, Kazakhstan, Kosovo, Kyrgyzstan, Lithuania, Latvia, Moldova, Mongolia, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Tajikistan, Turkey, Ukraine, and Uzbekistan). The following factors were used in our work as circumstance-factors: parents' educational background, place of birth, gender, individual's nationality. The set of circumstance-factors used by us differs from the one used in Transition report (2016–17), our work not including the membership of respondents' parents in the Communist Party to the analysis, because firstly, this is not relevant for all the countries under consideration, and secondly, this factor turned out to be insignificant in Transition report (2016–17).

The total number of the respondents in the LITS III survey for each country amounts approximately to 1 500 people. However, there are a lot of omissions in the data. After the removal of the respondents with gaps in the data and limiting the sample to the respondents aged 18–65, the sample size decreased threefold, in some countries the sample size decreased very significantly. In this regard, we limited ourselves to the countries the number of observations in which comprised minimum 400 respondents. Descriptive statistics for these 16 countries are shown in Table 7.

As we can see in Table 7, there are noticeable differences in the distribution of variables. Firstly, it concerns the level of the parents' education. Perhaps these differences are due to the fact that the LITS survey makes an attempt to create some universal categories of the levels of education for a whole range of countries, the educational systems of which differ significantly. Quite big differences across the countries are also noted regarding the place of respondents' birth. In most countries, there are more people born in urban areas than those born in rural areas, but there are also exceptions (Kazakhstan, Montenegro).

3 RESULTS AND DISCUSSION

Table 8 presents the results of the evaluation of Formula (18) for all the countries. As follows from Table 8, the gender factor is highly significant in relation to labor income: women earn less than men in all the countries. A higher educational level of parents makes a positive impact on the individual's income; in many countries, the coefficients of the parents' educational level often tend to be positive and significant. In this case, mother's educational status is obviously more important than the educational status of the father (since mother's educational level results in more significant coefficients than those of the father). In most countries birth in rural areas does not appear to make a significant effect on the level of labor income, but there are exceptions: birth in rural areas has a significant negative effect on the level of labor income in the Czech Republic, Estonia, Kazakhstan, Mongolia, and Russia.

Figure 2 presents a comparative analysis of the contribution of opportunity inequality to labor income inequality across the countries when direct and indirect methods as well as various measures of inequality are used.

As we can see in Figure 2, the choice of the inequality measure has a marked impact on the measurement results and consequently on the interpretation of the results. When the Gini index is used, the contribution of opportunity inequality to labor income inequality is much larger than when using other measures of inequality with the direct method of assessment, and vice versa, it is markedly smaller when the indirect method of assessment is applied. The estimates obtained through other considered measures of inequality are more uniform.

Table 8 Results of the OLS-regression of the labor income logarithm on circumstance-factors

Indicator	BLR	BUL	CRO	CPR	CHE	EST	DEN	HAN	ITA	KAZ	LAT	LIT	MON	MNG	RUS	SVK
Father's educational background																
Lower secondary education or less																
(Upper) secondary education	.046	.009	.099**	.058	.111***	.083	.074	.075	.063	.054	.108	–.015	.113	.088	.142	.189***
Post-secondary non-tertiary education	–. 033	.149	–.189	.268		–.063	.163**	.246**	.103	.033	–.018	.028	–.155	.045	.163	
Tertiary education and more advanced	.182	.133	.224***	.526***	.033	.115	.107	.032	.092	.313**	.090	.126	.068	.080	.187	.304**
Mother's educational background																
Lower secondary education or less																
(Upper) secondary education	.217**	.265**	.121***	–.131	.051	.202***	.023	.113**	.040	.158	.192**	.088	.081	.053	.043	–.021
Post-secondary non-tertiary education	.305***	.273*	.338**	–.542***	.790***	.187***	.073	.285***	.036	.037	.142	.099	.354***	.153*	.143	.140*
Tertiary education and more advanced	.362***	.307**	.141**	–.285**	.226***	.340***	.024	.300**	.047	.127	.421***	.197**	.354***	.143	.193	–.013
Gender																
Female	–.124**	–.232***	–.092***	–.252***	–.217***	–.372***	–.171***	–.217***	–.212***	–.123**	–.309***	–.303***	–.211***	–.202***	–.249***	–.211***
Birthplace																
Rural	–.167	–.095	–.063	.018	–.102**	–.076*	.005	–.055	–.006	–.163**	.044	–.032	–.189***	.051	–.197***	–.081
Ethnicity																
Minority	–.000	.263**	–.117	–.266***	–.031	–.221***	–.244**	–.225	.083	–.002	–.077	–.049	–.073	.013	.149*	–.075
Constant	15.59***	6.62***	8.41***	7.20***	9.77***	6.72***	7.68***	11.71***	7.27***	11.27***	6.35***	6.42***	13.52***	6.02***	10.44***	6.46***
N	**604**	**560**	**452**	**405**	**554**	**484**	**470**	**431**	**628**	**543**	**438**	**532**	**455**	**446**	**629**	**425**
R^2	0.089	0.087	0.150	0.153	0.135	0.262	0.071	0.137	0.110	0.061	0.162	0.107	0.133	0.086	0.094	0.139
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: * p<0.1, ** p<0.05, *** p<0.01.
Source: Author's calculations

Figure 2 Contribution of inequality of opportunity to income inequality across the countries (in %)

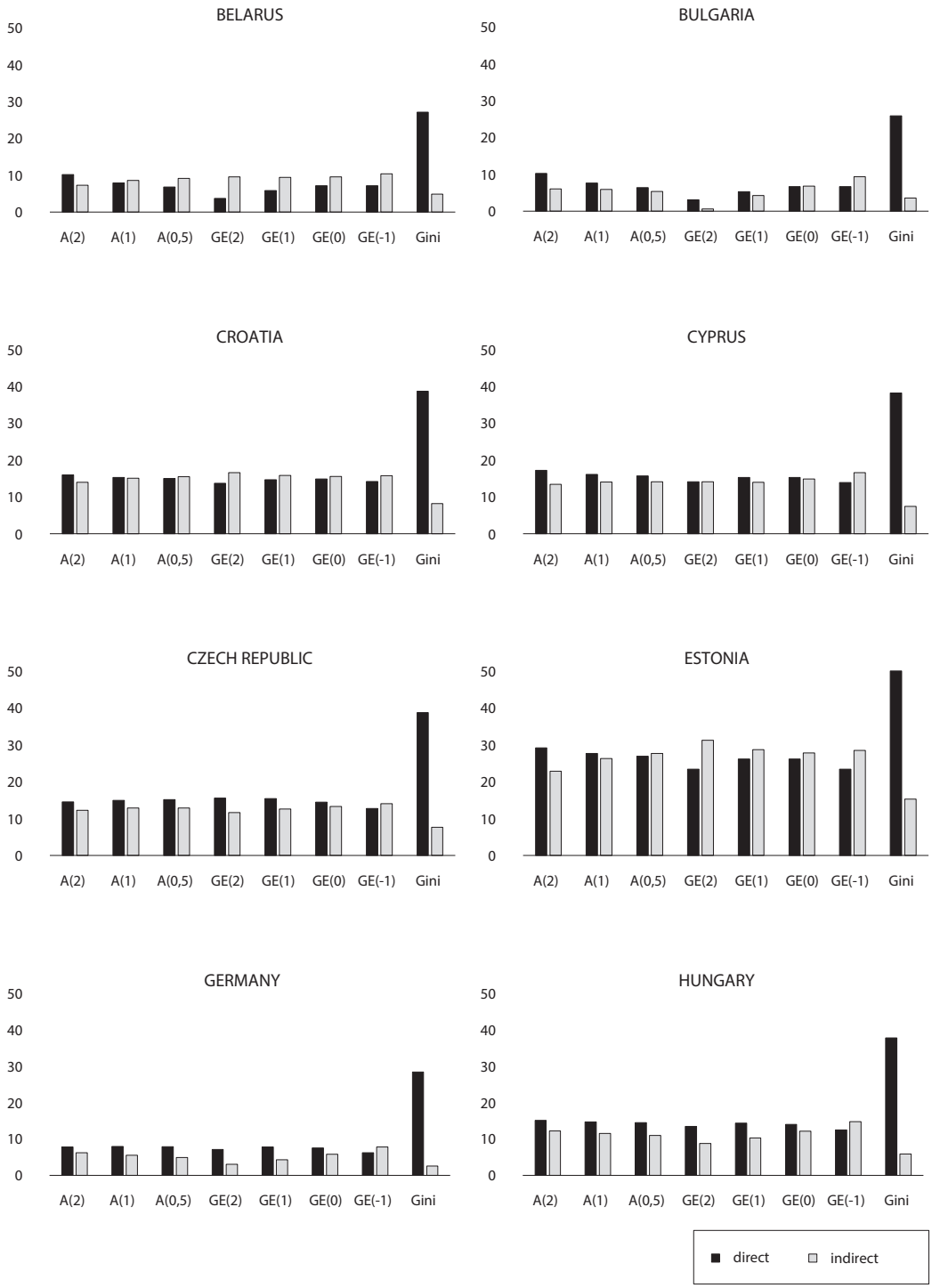
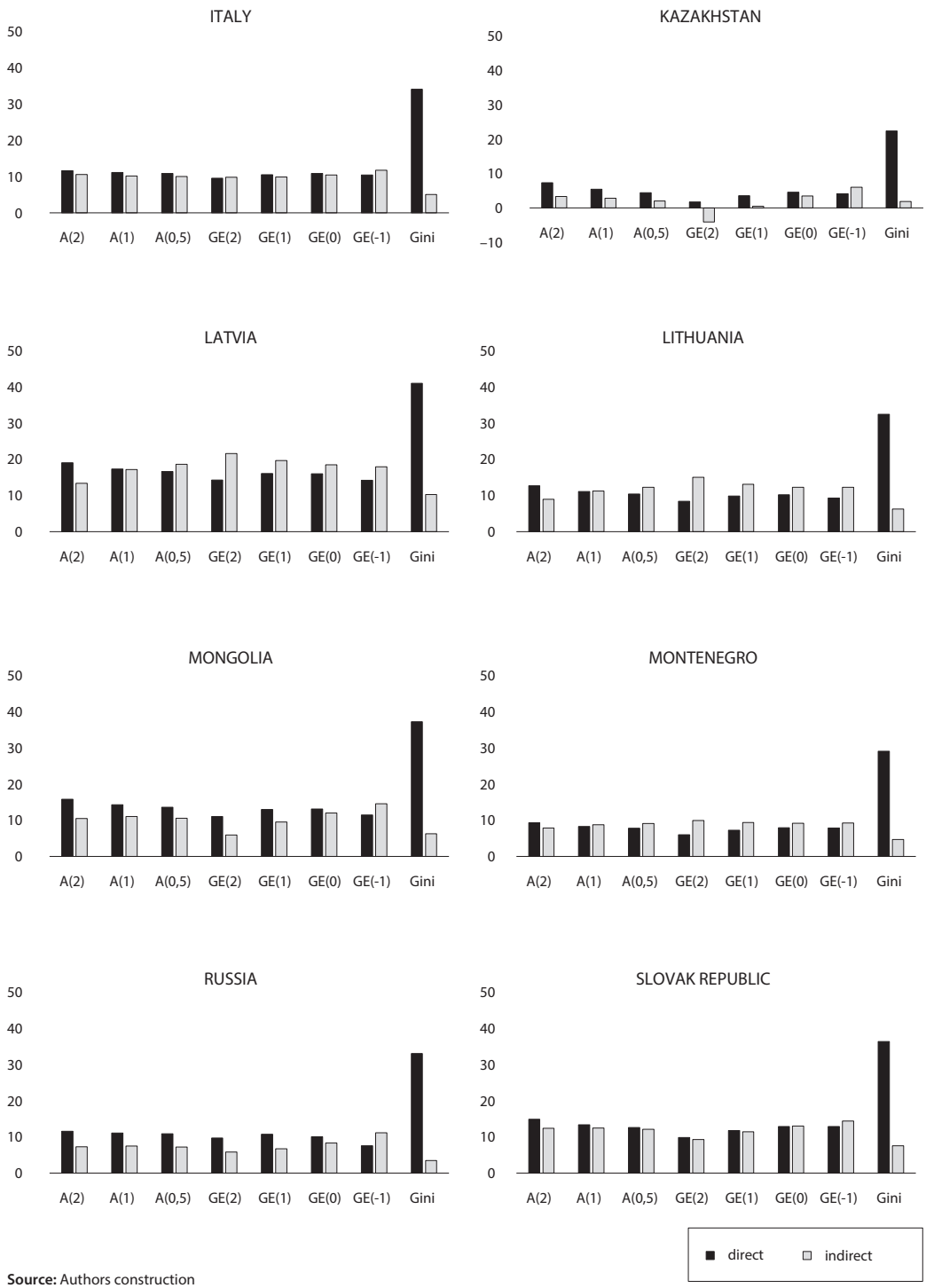


Figure 2 (continuation)



Source: Authors construction

In our view, the Gini index is a poor choice for the following reasons: firstly, the estimates based on this index obtained using the direct method are much higher than those obtained with other measures of inequality; secondly, when using the Gini index, the discrepancy between the estimates obtained with the help of the direct and indirect methods is enormous. The use of the L- and T-Theil indices is more preferable: the estimates obtained through the direct and indirect methods using these indices are close to each other; besides, these estimates are comparable to those obtained through other measures of inequality.

The correlation of inequality indices is shown in Table 9; the ranking of the countries according to the level of inequality obtained through different inequality indices is given in Table 10.

Table 9 Correlation of inequality indices

	A(2)	A(1)	A(0,5)	GE(2)	GE(1)	GE(0)	GE(–1)	Gini
A(2)	1	0.975157	0.944105	0.817974	0.905825	0.966176	0.989257	0.975224
A(1)		1	0.993271	0.916432	0.975362	0.998701	0.984187	0.993019
A(0,5)			1	0.955099	0.994259	0.99695	0.965879	0.979455
GE(2)				1	0.980792	0.93435	0.876497	0.878689
GE(1)					1	0.983948	0.94018	0.953935
GE(0)						1	0.982415	0.986783
GE(–1)							1	0.969477
Gini								1

Source: Author's calculations

Table 10 Ratings of the countries according to the level of inequality

Country	A(2)	A(1)	A(0.5)	GE(2)	GE(1)	GE(0)	GE(–1)	Gini	min	max
BLR	4	3	3	3	3	3	4	3	3	4
BUL	2	2	2	2	2	2	2	2	2	2
CRO	15	15	14	14	14	15	15	14	14	15
CPR	9	9	9	9	9	9	9	9	9	9
CZE	14	14	15	15	15	14	14	15	14	15
EST	8	8	8	8	8	8	8	8	8	8
DEU	10	11	11	13	12	11	10	12	10	13
HAN	11	10	10	12	10	10	11	10	10	12
ITA	16	16	16	16	16	16	16	16	16	16
KAZ	1	1	1	1	1	1	1	1	1	1
LAT	6	7	7	6	7	7	6	7	6	7
LIT	7	6	6	5	5	6	7	6	5	7
MON	5	5	5	4	4	5	5	4	4	5
MNG	12	12	12	10	11	12	12	11	10	12
RUS	3	4	4	7	6	4	3	5	3	7
SVK	13	13	13	11	13	13	13	13	11	13

Source: Author's calculations

Table 11 Ratings of the countries by absolute inequality of opportunity

Country	Direct method										Indirect method									
	A(2)	A(1)	A(0.5)	GE(2)	GE(1)	GE(0)	GE(−1)	Gini	min	max	A(2)	A(1)	A(0.5)	GE(2)	GE(1)	GE(0)	GE(−1)	Gini	min	max
BLR	9	9	9	10	9	9	9	9	9	10	8	5	4	3	3	5	8	6	3	8
BUL	5	5	6	7	7	5	5	6	5	7	9	7	7	14	7	6	5	11	5	14
CRO	13	13	13	13	13	13	13	12	12	13	11	11	11	7	9	12	12	8	7	12
CPR	6	6	7	6	6	6	6	7	6	7	4	6	6	5	6	7	9	5	4	9
CZE	12	12	12	12	12	12	12	13	12	13	12	12	12	12	13	13	13	9	9	13
EST	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DEU	14	14	14	14	14	14	14	15	14	15	14	16	16	15	15	16	14	16	14	16
HAN	10	10	10	9	10	10	10	10	9	10	7	9	9	11	11	9	10	10	7	11
ITA	16	16	16	16	16	16	16	16	16	16	16	15	15	13	14	15	16	14	13	16
KAZ	8	8	8	8	8	8	8	8	8	8	13	13	14	16	16	10	7	15	7	16
LAT	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
LIT	7	7	5	5	5	7	7	5	5	7	6	4	3	4	4	4	6	4	3	6
MON	3	3	3	3	3	3	3	3	3	3	3	3	5	6	5	3	4	3	3	6
MNG	15	15	15	15	15	15	15	14	14	15	15	14	13	8	12	14	15	13	8	15
RUS	4	4	4	4	4	4	4	4	4	4	5	8	8	9	8	8	3	12	3	12
SVK	11	11	11	11	11	11	11	11	11	11	10	10	10	10	10	11	11	7	7	11

Source: Author's calculations

Table 12 Ratings of the countries by relative inequality of opportunity

Country	Direct method										Indirect method									
	A(2)	A(1)	A(0.5)	GE(2)	GE(1)	GE(0)	GE(−1)	Gini	min	max	A(2)	A(1)	A(0.5)	GE(2)	GE(1)	GE(0)	GE(−1)	Gini	min	max
BLR	13	13	14	14	14	14	13	14	13	14	12	12	11	9	11	11	12	11	9	12
BUL	12	15	15	15	15	15	14	15	12	15	15	14	14	15	15	14	13	13	13	15
CRO	4	4	5	5	5	4	2	4	2	5	2	3	3	3	3	3	4	3	2	4
CPR	3	3	3	4	4	3	4	5	3	5	3	4	4	5	4	4	3	6	3	6
CZE	8	5	4	2	3	5	6	3	2	8	6	5	5	6	6	5	8	4	4	8
EST	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DEU	15	14	12	12	12	13	15	13	12	15	14	15	15	14	14	15	15	15	14	15
HAN	6	6	6	6	6	6	7	6	6	7	7	7	8	11	8	8	5	9	5	11
ITA	10	9	9	10	10	9	9	9	9	10	8	10	10	8	9	10	10	10	8	10
KAZ	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
LAT	2	2	2	3	2	2	3	2	2	3	4	2	2	2	2	2	2	2	2	4
LIT	9	10	11	11	11	10	10	11	9	11	10	8	6	4	5	7	9	7	4	10
MON	5	7	7	7	7	7	8	7	5	8	9	9	9	12	10	9	6	8	6	12
MNG	14	12	13	13	13	12	11	12	11	14	11	11	12	7	12	12	14	12	7	14
RUS	11	11	10	9	9	11	12	10	9	12	13	13	13	13	13	13	11	14	11	14
SVK	7	8	8	8	8	8	5	8	5	8	5	6	7	10	7	6	7	5	5	10

Source: Author's calculations

As it follows from Tables 9–10, the country ranking depends on the choice of the measure of inequality despite the coefficients of the inequality indices correlation being high and positive. In some cases, the difference can be significant: 4 positions (Russia), 3 positions (Germany). This outcome seems to be related to the fact that inequality measures are not ordinary equivalent.

Table 11 shows the ranking of countries by the absolute inequality of opportunity depending on the measure of inequality and the method of assessment.

As can be seen from Table 11, a country's ranking by the absolute inequality of opportunity varies depending on the choice of both the measure of inequality and the assessment method. Given that, when using the direct method the rating position looks more resilient to the choice of the measure of inequality than when the indirect method is used.

The ranking of the countries according to the relative inequality of opportunity depending on the measure of inequality and the method of assessment is presented in Table 12.

As can be seen from Table 12, the country's ranking by relative inequality of opportunity also changes depending on the choice of the measure of inequality, and on the choice of the assessment method. The ranking position by the absolute inequality of opportunity can significantly differ from the ranking position by the relative inequality, which raises the question of what should be focused on when comparing the countries in terms of inequality of opportunity.

Table 13 shows the correlation between the indicators of inequality and the absolute inequality of opportunity when different measures of inequality are used.

Table 13 Correlation of inequality indices

	Direct method of assessment							
	A(2)	A(1)	A(0.5)	GE(2)	GE(1)	GE(0)	GE(–1)	Gini
R	0.519	0.420	0.353	0.164	0.286	0.390	0.431	0.546
	Indirect method of assessment							
	A(2)	A(1)	A(0.5)	GE(2)	GE(1)	GE(0)	GE(–1)	Gini
R	0.251	0.235	0.166	–0.509	0.018	0.316	0.565	0.086

Source: Author's calculations

As follows from Table 13, in most cases the relationship between the inequality and the inequality of opportunity is direct (except for the case when the GE(2) index and the indirect assessment method were used), but the strength of relationship varies sensibly. The strength of relationship is usually higher with the direct assessment method (except for the case when the GE(–1) index was used).

The conducted analysis of the relationship between inequality and inequality of opportunity allows the important conclusion that the general level of inequality does not predetermine the level of inequality of opportunity. This is important with regard to the ongoing discussion in economics about the relationship between inequality and economic growth. No consensus on the issue has been reached yet; a lot of arguments have been proposed by the scientists in support of both the positive and negative relationship between these indicators (Bradbury and Triest, 2016). Numerous empirical studies also produce inconsistent results, fueling a long-standing debate (Henderson et al., 2015; Babu et al., 2016; Fang et al., 2015; Rubin and Segal, 2015). The equal opportunity theory gave rise to the hypothesis that the inconsistency of results from assessing the effect of inequality on economic growth is due to the «multi-component origin» of inequality being disregarded. The inequality attributable to inequality of opportunity adversely affects the economic growth, while the inequality resulting from inequality of effort, on the contrary, shows a positive influence. The negative impact of inequality of opportunity on the economic growth

as a whole is explained by the fact that the barriers it forms result in incomplete realization of the human potential, which reduces the resources and lowers the aggregated economic performance. The inequality in income due to inequality of effort, on the contrary, stimulates individuals to self-realization, thereby contributing to the growth of aggregated economic achievements. The absence of a strong relationship between inequality of opportunity and general inequality allows the conclusion that the level of inequality of opportunity is an independent socio-economic indicator and a potentially significant factor affecting the aggregated economic and social results.

On the whole, among various lines of economic research in the area of inequality, the analysis from the equal opportunity standpoint is interesting because it takes into consideration the ethical categories of justice and responsibility, unusual and alien to economists. Traditionally, economic models are built on the assumption that the behavior of economic agents is determined exclusively by their own selfish preferences. At the same time, real people are not alien to justice, responsibility, sympathy, compassion, and pity. These components affect the behavior of real people along with their preferences, and therefore the real economic behavior can differ greatly from that predicted by the theoretical model. Hence, the inclusion of such categories as justice and responsibility in the analysis may allow economists to move towards building models that are more adequate to the real world and therefore better explain the processes taking place in it.

CONCLUSION

The calculations made have confirmed the proposed hypothesis that the choice of the measure of inequality makes a significant contribution to the variance in assessments of inequality of opportunity. The resulting differences are so significant that they lead to different meaningful interpretation of the outcome. For example, the 33% share of the contribution made by inequality of opportunity to the inequality of labor income in the Russian Federation, as obtained using the Gini index, looks very impressive, given that far from all of the circumstance-factors are taken into account, and pushes to the conclusion that there is little that can be achieved through personal efforts in Russia. The 10% contribution of inequality of opportunity to the inequality of earned income, as obtained using the L-Theil index, on the contrary, inspires some optimism - after all, it turns out that 90% of everything depends on one's own efforts.

If the described calculation method is applied, the use of the Gini index in case of direct method of measuring the inequality of opportunity results in the assessments being much higher than when other measures are used. Besides, it has been established that when the Gini index is used, the differences in assessments obtained through the direct and indirect methods are much greater than those obtained using other measures of inequality. The estimates obtained through direct and indirect methods are closest to each other when the L- and T-Theil indices are used.

Also, our calculations show that the selection of inequality index may significantly affect a country's ranking by the inequality of opportunity. Given the popularity of all kinds of ratings in the modern world, this conclusion further emphasizes the relevance of the issue under consideration and proves the necessity of further efforts by the scientific community to solve it.

ACKNOWLEDGMENTS

The reported study was funded by RFBR according to the research project No. 19–010–00453.

References

ATKINSON, E. *Inequality: What about It?* Moscow: Delo, RANKhiGS, 2018.

BABU, M., BHASKARAN, V., VENKATESH, M. Does inequality hamper long run growth? Evidence from emerging economies. *Economic Analysis and Policy*, 2016, 52(4), pp. 99–113.

BJÖRKLUND, A., JÄNTTI, M., ROEMER, J. E. Equality of opportunity and the distribution of long-run income in Sweden. *Social Choice and Welfare*, 2011, 39(2–3), pp. 675–696.

BOURGUIGNON, F., FERREIRA, F. H. G., MENENDEZ, M. *Inequality of Outcomes and Inequality of Opportunities in Brazil.* William Davidson Institute Working Paper No. 630, World Bank Working Paper No. 3174, 2003.

BRADBURY, K. AND TRIEST, R. Inequality of Opportunity and Aggregate Economic Performance. *The Russell Sage Foundation Journal of the Social Sciences*, 2016, 2(2), pp. 178–201.

BRZENZIŃSKI, M. *Inequality of opportunity in Europe before and after the Great Recession.* Working Paper No. 2/2015 (150), University of Warsaw, 2015.

CHECCHI, D., PERAGINE, V., SERLENGA, L. *Fair and Unfair Income Inequalities in Europe.* IZA Discussion Papers 5025, Institute of Labor Economics (IZA), 2010.

COWELL, F. *Measuring Inequality. Handbook of Economic Inequality.* Oxford: Oxford University Press, 2009.

FANG, W., MILLER, S., YEH, C. The effect of growth volatility on income inequality. *Economic Modelling*, 2015, 45(1), pp. 212–222.

FERREIRA, F. AND GIGNOUX, J. The Measurement of Inequality of Opportunity: Theory and an Application to Latin America. *Review of Income and Wealth*, 2011, 57(4), pp. 622–657.

FLEURBAEY, M. AND PERAGINE, V. Ex Ante Versus Ex Post Equality of Opportunity. *Economica*, 2013, 80(317), pp. 118–130.

HEDEROS, K., JÄNTTI, M., LINDAHL, L. Gender and inequality of opportunity in Sweden. *Social Choice and Welfare*, 2017, 49(3–4), pp. 605–635.

HENDERSON, D., QIAN, J., WANG, L. The inequality–growth plateau. *Economics Letters*, 2015, 28(1), pp. 17–20.

IBRAGIMOVA, Z. F. AND FRANTS, M. V. Inequality of opportunities in the Russian Federation: factor analysis (in Russian). *Economics and management*, 2019, 149(5), pp. 10–15.

IBRAGIMOVA, Z. F. AND FRANTS, M. Inequality of opportunity: theory and practice of measurement using micro-data of RLMS-HSE. *Economic Policy*, 2020, 15(1), pp. 64–89.

MARRERO, G. AND RODRÍGUEZ, J. *Macroeconomic determinants of inequality of opportunity and effort in the US: 1970–2009.* ECINEQ Working Paper 249, Society for the Study of Economic Inequality, 2012.

PAUHOFOVÁ, I., BUKHARBAEVA L., IBRAGIMOVA, Z., FRANTS, M. Measuring of Inequality of Opportunity: Parametric Approach. *Ekonomický časopis/Journal of Economics*, 2020, 68(5), pp. 455–476.

PISTOLESI, N. Inequality of opportunity in the land of opportunities, 1968–2001. *The Journal of Economic Inequality*, 2009, 7(4), pp.411–433.

RAMOS, X. AND VAN DE GAER, D. Approaches to Inequality of Opportunity: Principles, Measures and Evidence. *Journal of Economic Surveys*, 2016, 30(5), pp. 855–883.

RUBIN, A. AND SEGAL, D. The effects of economic growth on income inequality in the United States. *Journal of Macroeconomics*, 2015, 45, pp. 258–273.

SEN, A. *On Economic Inequality.* Oxford: Clarendon Press, 1973.

Transition report 2016–17 [online]. London: European Bank for Reconstruction and Development, 2016. [cit. 7.5.2020]. <http://2016.tr-ebrd.com/inequality-of-opportunity>.