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Full Length Research Paper

Analysis of gender discrimination using the Gini index multiple decomposition method

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Income inequality is a frequent research theme in economical literature, due to its importance in rendering the condition of economical cohesion within society. Income inequality has multiple causes: resource endowment, skills, competences, attitude towards risk, chances etc. Problems appear when income inequalities are casued by various forms of discrimination. A consecrated instrument used for analysing income inequality is the Gini index. This research aims at analysing the inequalities amongst incomes subject to gender, according to the Dacum decomposition of the Gini index, using a Visual Basic Application macro-order. The purpose of this research is to analyze wage discrimination based on gender in the labour market using the Gini index, a consecrated instrument in analysing income inequality. As research methodology we used the Dacum decomposition of the Gini index, employing a Visual Basic Application macro-order. In order to carry out this study we used as a database two polls performed at the national level, namely Economical and Social Cohesion and Access on the Labour Market – A Chance for You. The conclusion of the research is that income inequality, in Romania, between women and men is not very high; only for Romany population, the inequality is particularly high within each group. This situation shows the existence of a lack of homogeneity in the distribution and the characteristics of the workplaces occupied by women.

Key words: Discrimination, wage differentials, non-labour discrimination, human capital, inequality.

INTRODUCTION

This paper aims to analyze the wage discrimination on labour market using the Gini index decomposition. By discrimination, one means any distinction, exclusion, restriction, preference, different treatment that puts a person or a group at disadvantaged compared to other persons/groups in similar situations. Modern economic theory of discrimination started with Becker (1957) and was later developed by Arrow (1973). They consider that people have certain attitudes towards their co-workers, towards people they supervise and also towards people they buy things from. Consequently they demand some sort of compensation for working with the members of the discriminated group. Phelps (1972) and Arrow (1973) were the first to study the statistical discrimination that is based on imperfect information in the labour market; imperfection that prevents the employer to know exactly the workers productivity.

Income inequality can be measured using the Gini index (1921), which provides a general measure of the unequal distribution of the incomes amongst the members of a society. Nevertheless, in order to detect certain abnormalities in the manifestation of the cause-related factors that bring forth income differentiations, an adaptation of this instrument to structured populations of individuals is called for.

The problem of structuring populations of individuals for

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detecting certain forms of discrimination is an older one. The first population decomposition into subgroups was performed by Solow (1960). Blattacharya and Mahalanobis (1967) made a decomposition of the Gini index in order to study the regional disparities of India. Rao (1969) studied for the first time the Gini decomposition in subgroups and income sources. The former method supposes measuring the inequality both within each subgroup and amongst subgroups. If the population is divided into several subgroups (for instance men and women, urban and rural etc.) then, the within-group index shows us the intensity of the inequality within each subgroup. The inter-groups coefficient measures the income inequality amongst subgroups. The latter method analyses each source of income (derived from labour, capital, fees etc.) and their contribution to the creation of the inequalities in the income distribution.

Oaxaca and Ransom (1994) suggested a method of decomposing salary according to an econometrical equation of the individual incomes revealed by certain samples. This was done with an aim of determining the situations where there is an advantage for men and a disadvantage for women. The decomposition is based on the labourers’ features and on their position at their workplace. Given these components, the possible degree of discrimination may vary, indicating certain gender advantages or disadvantages on the manpower market.

Dagum (1997a, 1997b) suggested a new decomposition of the Gini index into three indices: the inequality within each subgroup, the mean inequality amongst the subgroups and the inequality of the trans-variation amongst the subgroups. This method has got certain advantages: it allows the analysis of the income differentiations on a wider range of distributions (including the case of aleatory variables that resulted from different sampling procedures), it shows each subgroup’s contribution to the general value of the Gini index and the third component (the trans-variation) derives from overlapping the distributions of the incomes belonging to various subgroups.

Mussard et al. (2007) studied the income inequality in Luxembourg by means of Dagum’s decomposition method. They split the population into four subgroups: Luxembourg nationals living in the urban environment, foreigners living in the urban environment, Luxembourgers living in the rural environment and people having another nationality who live in the rural environment. The most pronounced income inequality was recorded amongst the Luxembourg nationals from the rural (0.312) and urban (0.307) environment. On analysing the Gini index at the level of subgroups, a more pronounced inequality amongst the Luxembourg nationals and those having another nationality, but who live in the rural environment, was noticed.

Mussard (2004) analysed the Gini index decomposition into subgroups and income sources by using the Italian consumers’ incomes between 1989 and 2000 as a database. He split the population into two subgroups – men and women – and into seven income sources (wages, bonuses, pensions, real estate incomes, financial incomes, entrepreneurship and transfers). The overall Gini index increased during the period of time analysed, due to the enhancement of the income inequality within each subgroup (within-group) and to trans-variation; whereas the inter-groups index remained approximately constant. In 1998, the inequality amongst men was greater than that amongst women. However in 2000, the order was reversed, on account of the increase of the women’s occupation level. The trans-variation intensity becomes increasingly greater, reflecting an approaching of the distributions of the two subgroups’ incomes. The main causes of the trans-variation enhancement are determined by the net wages and by the financial revenues.

Haag and Schockmel (2007) divided the Gini index into subgroups in order to highlight the intra- and inter-group (men and women) inequalities in Luxembourg in 2002, by considering the monthly gross incomes. The inequality amongst men is greater than that amongst women and the contribution of this kind of inequalities (within-group inequalities) to the total inequality is 60.8%. The inequality amongst subgroups (the net contribution of the between-group) is not great (0.11) and it represents 15.8% of the gross inequality (the gross between-group). The trans-variation determined by the women’s high wages as compared to the men’s low wages represent 23.4% of the gross inequality. The study showed that the gross inequality (which renders the wage-related difference between the two subgroups) represents approximately 40% of the total inequality.

Another indicator that measures the inequality between women and men is Gender Inequality Index. This index was developed by Seth (2009) and shows the loss in human development due to inequality between female and male in three dimensions: reproductive health, empowerment and the labour market. In 2011, Romania recorded a relatively high value of the Gender Inequality Index (0.33), ranking 55 out of 146 analyzed countries. According to this index, the rate of labour market participation of women and men is different (60% for women and 70% for men).

Meurs and Ponthieux (2000) show that wage inequality between men and women can be caused by several factors: jobs not having the same characteristics, observable skills of workers (education, professional experience), and the possibility that female workers may face a certain wage discrimination in the labour market.

**METHODOLOGY**

For measuring the income inequality between men and women we used the Gini index multi-dimensional decomposition method (Dagum, 1997a,1997b). This method supposes the existence of a sample \( Q \) with \( n \) incomes for each individual taken from the sample \( y_i (i = 1,\ldots,n) \). The population within the sample is divided into \( k \) subgroups (sub-populations) \( Q_j \) where \( j \) represents the subgroups...
\( G_y \) – the contribution of the inter-group inequality to the total inequality or How does the inequality between men (women) influence total inequality?

\[ G_y = \frac{\sum_{i=1}^{n} \sum_{j=1}^{k} |y_i - y_j|}{2n^2 \mu} \]  
(1)

where: \( y_i \) is the income of the individual \( i \); \( y_j \) is the income of the individual \( j \); \( n \) is the number of individuals; \( \mu \) is the incomes average.

The Gini coefficient that measures the incomes of the \( Q \) subpopulation (within-group) is:

\[ G_{ij} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{k} |y_i - y_j|}{2n^2 \mu} \]  
(2)

The value 0 of this index means that the incomes existing inside the group are equally distributed among its members, whereas the value 1 suggests the fact that an individual from the group owns the entirety of the existing incomes. In reality, the Gini index has usually got values ranging between 0.25 and 0.5.

The Gini inter-group coefficient enables the quantification of the income inequalities between the two groups. By definition, it measures the difference of hope for income between an individual aleatorily selected from group \( j \) and another individual aleatorily selected from group \( h \).

\[ G_{jh} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{k} |y_i - y_j|}{(\mu_j + \mu_h) n \mu} \]  
(3)

where: \( y_i \) is the income of the individual \( i \) that belongs to group \( j \); \( y_j \) is the income of the individual \( r \) that belongs to group \( h \).

Seeing the abovementioned formulæ, we may notice that the \( G_y \) index is built on the income differences within group \( Q_y \) whereas the \( G_{nh} \) index is calculated according to the income differences that exist between groups \( Q \) and \( Q_h \). When the \( G_y \) index is different from zero, the income distribution between the two subgroups is unequal. In case that the index tends to 0, the income distribution tends to become equal.

By regrouping the income differences that exist within each subgroup with those that exist amongst the subgroups, we may obtain the first decomposition of the Gini index:

\[ G = \frac{\sum_{j=1}^{k} \sum_{r=1}^{n} |y_j - y_r|}{2n^2 \mu} + 2 \frac{\sum_{j=1}^{k} \sum_{r=1}^{n} |y_j - y_r|}{2n^2 \mu} = G_w + G_{gb} \]  
(4)

where: \( y_j \) is the income of the individual \( j \) that belongs to group \( j \); \( y_n \) is the income of the individual \( r \) that belongs to group \( j \); \( y_r \) is the income of the individual \( r \) that belongs to group \( h \).

\( G_w \) shows us the contribution of the inequality from within the subgroup to the total inequality (the total Gini). The gross contribution of the subgroups’ inequality (\( G_{gb} \)) to the total inequality represents the income difference among each pair of subgroups (for instance women-men, urban-rural etc.). Rao (1969) was underlying the fact that the inter-group decomposition (\( G_{gb} \)) was less common. However, it provided better information for the analysis of the Gini index, because it expressed the income differences amongst pairs of subgroups.

Dagum (1987) thought that the Gini coefficient could be decomposed into three indices. In this case he separated the gross contribution of the inter-group inequality into two components (Figure 1):

1. The net Gini inequality index amongst subgroups (\( G_{ns} \)) – which measures the inequality resulting from the greater wages received by the richer population (the men) as compared to the lower wages cashed by the poorer population (the women);
2. Transvariation (\( G_h \)) – which represents the inequality determined by the wages of the poor population (the women), which are higher than the wages of the richer population (the men).

Departing from this decomposition of the Gini index, Dagum (1997) introduced two new elements: the gross directed distance and the order 1 moment of trans-variation.

The gross directed distance, \( d_{nh} \), is a level-headed average of the income differences \( y_j - y_r \) for each income \( y_j \) of an individual belonging to subgroup \( Q_j \) that is higher to the income \( y_r \) of a
The order 1 moment of the trans-variation, $p_h$, between the $j$ and $h$ subpopulations (where $\bar{y}_j > \mu_h$) is the level-headed average of the $y_{ij}$ income differences in case of each income $y_{ih}$ of a member belonging to subgroup $Q_h$ that is higher than the income of the individual $y_i$, which belongs to subgroup $Q_j$.

$\int_0^\infty dF_j(x) \int_0^x (y - x) dF_h(x)$

(6)

The transvariation expression (Gini (1916), Dagum (1960)) is determined by the fact that the income differences are thought to be opposed to the mean difference of the subgroups to which the individuals belong (women can earn more than men at a certain moment or in certain activities, even though, as an average, men earn more than women). We may define trans-variation as being the inequality that results when the wages of the poorer population (the women) are higher than those of the richer population (the men).

Given the two enunciations, we can calculate the relative economical distance for groups $Q_j$ and $Q_h$:

$D_{jh} = \frac{a_{jh} - p_{jh}}{a_{jh} + p_{jh}}$  

(7)

Dacum (1980) estimated that $D_{jh}$ can take values in the closed range $[0,1]$ and he outlines the distance existing between subgroups $Q_j$ and $Q_h$. If the economical distance approaches 1, then the incomes distributions will be different from one subgroup to another. In other words, the highest wages of the least favoured group (the women) are not greater than the lowest wage of the most favoured group (the men). As the economical distance approaches 0, the most numerous incomes curves partially overlap, which means that the mean wages tend to be equal for men and women (Figure 2).

The intergroup inequalities are separated into two components:

1. The $G_{jh} \times D_{jh}$ expression enables the net assessment of the intergroup inequality. If the environments are equal ($\mu_j = \mu_h$), then the economical distance between $Q_j$ and $Q_h$ is void; 2. The $G_{jh}(1 - D_{jh})$ expression shows us the intensity of the transvariation between subgroups $Q_j$ and $Q_h$. Intensity is an increasing function, which depends on the income difference that exists between the two subgroups (namely the difference between the discriminated group’s highest income as compared to the favoured group’s lowest income, $y_{ij} - y_{ih} > 0$).

3. We indicate the percentage of individuals belonging to subgroup $Q_j$ by $\rho_j$ and the weight of the mean income owned by subgroup $j$ by $s_j$. These weights can be calculated in the following way:

$p_j = \frac{n_j}{n_i}$  

(8)

$s_j = \frac{n_j \mu_j}{n_i}$  

(9)

According to relation (8) and (9), the within-group Gini index may be written in the following manner:

$G_w = \sum_{j=1}^{k} G_{jj} p_j s_j$  

(10)

and the inter-groups net Gini index amongst the subpopulations:

$G_{ab} = \sum_{j=1}^{k} \sum_{h=1}^{k} G_{jh} D_{jh} (p_j s_h + p_h s_j)$  

(11)

The intensity of the inter-groups trans-variation can be calculated by means of the following formula:

$G_t = \sum_{j=1}^{k} \sum_{h=1}^{k} (1 - D_{jh}) (p_j s_h + p_h s_j)$  

(12)

The inter-group gross Gini index equals:

$G_{gb} = G_{nb} + G_t = \sum_{j=1}^{k} \sum_{h=1}^{k} G_{jh} (p_j s_h + p_h s_j)$  

(13)

According to the results of equations (10), (11), (12) and (13), Dagum (1997) deduced the following theorem:

$G = G_w + G_{nb} + G_t$  

(14)

The aforesaid equation can be interpreted in the following way:

- if $G_w = 0$, then there is no inequality inside the subgroup and the incomes are equally distributed;
- if $G_{nb} = 0$, then the mean incomes of all subgroups are equal and the total inequality equals: $G = G_w + G_t$;
Table 1. Gini index gender decomposition.

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total inequality (G)</td>
<td>0.240390</td>
<td>0.229545</td>
<td>0.236817</td>
</tr>
<tr>
<td>Contribution to the within-group inequality (G_w)</td>
<td>0.062459 (53%)</td>
<td>0.055131 (47%)</td>
<td>0.117590 (100%)</td>
</tr>
<tr>
<td>Contribution to the gross between-group inequality (G_w+G_t)</td>
<td>-</td>
<td>-</td>
<td>0.119227</td>
</tr>
<tr>
<td>Contribution to the net between-group inequality (G_nb)</td>
<td>-</td>
<td>-</td>
<td>0.019648</td>
</tr>
<tr>
<td>Transvariation</td>
<td>-</td>
<td>-</td>
<td>0.099579</td>
</tr>
</tbody>
</table>

- if the average of the inter-groups incomes is different, then \( G = 0 \) and the economical distance equals 1. The total inequality is determined by: \( G = G_w + G_{nb} + G_t \).

**DATA AND EMPIRICAL RESULTS**

In order to highlight the inequality between men and women on the manpower market, we used two investigations: *Economical and Social Cohesion*¹ and *Access on the Labour Market – A Chance for You*². The former investigation was carried out at the national level and the sample is representative for the more than 19-year old population of Romania. The sample encompassing this study comprised 1073 people and was aleatorily created for each start (each region). There were interview operators placed in 16 areas, who selected the people by means of a statistical pitch (25 out of 25 people who were passing thereby).

The latter investigation was also carried out nationally, but only among the Romany, within the *Access on the Labour Market – A Chance for You* project and it was composed by 530 people, by using the same methodology.

In order to apply Dagum’s decomposition we split the sample population into two groups (men - \( G_1 \) and women - \( G_2 \)) and we applied the VBA (Visual Basic Application) macro-order, which is an instrument developed by Mussard (2003)³, taking into account the monthly gross incomes.

The results of the Gini index decomposition related to the gender wage inequalities in Romania according to the ‘Economical and Social Cohesion’ investigation are displayed in Table 1.

We may notice that at the general level, inequality amongst men is higher than the one amongst women (the Gini index at the general level in men’s subgroup is 0.240390, as compared to 0.229545 in case of women). Correspondingly, the decomposition of the within-group Gini index supports this differentiation (0.0624 for \( G_1 \) and 0.0551 for \( G_2 \)):

\[
G_w = G_1 + G_2 = 0.62459 + 0.55131
\]

This situation may be accounted for by the higher rate of participation of the male manpower on the labour market and, implicitly, by its distribution on several types of activities. The contribution of the within-group inequalities amounts to 50 % of the total inequality (Table 2).

The gross inequality amongst the groups is mostly supported by the trans-variation intensity. Thus the inter-group net Gini index is not very high (0.019648), which means that the wage-related difference between men and women is small (as an average, men earn approximately RON 2162.167 and women RON 1998.67, according to the investigation data). This kind of inequality contributes, in a 8 % rate, to the gross inequality amongst the groups (the gross between-group inequality contribution). The intensity of the trans-variation between men and women is 0.099579 and it contributes, in a 42% rate, to the gross inequality amongst the groups (the gross between-group inequality contribution). In this case, the incomes distribution between the two groups is very close and the inequality is determined by the existence of higher wages from the part of women as compared to men, even though on average, men earn better. Women however earn more than men in the following fields of activity: constructions (where women usually have a better hierarchical position than men, even though in terms of number this sector is dominated by the latter), professional, scientific and technical activities, administrative services-related activities and support services activities (which are branches of activity occupationally dominated by women).

The two forms of inequality (intra-group and between-group) equally contribute to the total inequality. The economical distance that separates the incomes distribution between the two groups is 0.146. So there is no clear separation of women’s and men’s incomes distribution, but mostly an overlapping.

In Table 3 we will present the results obtained after the decomposition of the Gini index by using the data obtained by the *Access on the Labour Market – A Chance for You* investigation.

The total value of the Gini index is 0.4960 (0.4721 for men and 0.5174 for women). The first decomposition of

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³ http://www.lameta.univ-montp1.fr/Fr/Programmes/ginivfr.htm and s-mussard@lameta.univ-montp1.fr.
the Gini index is the contribution of the within-group inequalities, which amounts to 0.2469 ($G_w$).

$$G_w = G_1 + G_2 = 0.1242 + 0.1227$$

We may notice that the incomes inequality is a bit higher in case of women than in case of men, which could point to the existence of a lack of homogeneity in the distribution and the characteristics of the workplaces occupied by women. From Table 4 we notice that inequality amongst women (0.1242) represents 50.3 % of the within-group inequality, and that in case of men (0.1227) it represents 49.7 % of the within-group inequality.

The second component of the Gini index decomposition is the net contribution of the between-group inequality and it shows us the inequality between the two groups (men and women). In our case, $G_{nb}$ is 0.0256 and it represents 5 % of the gross inequality. The value of this index shows us that the incomes inequality between men and women is not high or, in other terms, the wage-related difference between men and women is low (as an average, men earn RON 707 and women RON 638, according to the investigation data).

Instead, the trans-variation intensity (the third component of the Gini index decomposition) is 0.2235 and it represents 45 % of the gross inequality. This means that in case of this ethnic group too there are women that earn better than men and the incomes distributions according to subgroups mostly overlap, even though, as an average, men earn better than women (the economical distance that separates the incomes distribution between the two groups is 0.216).

**DISCUSSION AND CONCLUSION**

The analysis of the income inequalities by the multidimensional method (Dagum,1997) of decomposing the Gini index enables a clearer ‘X-ray’ of the gender wage-related difference, by the separation of the sign inequalities contribution, contrary to the basic hypothesis (which supposes higher wages for men than for women).

The analysis performed for the situation in Romania shows that in the context of a continuous diminishment of the gender wage-related difference (after 1990), the hypothesis of a wage discrimination between men and women is weakly supported, since the contribution of the trans-variation intensity is dominant in the decomposition of the between-group Gini index.

This paper contributes to a more detailed analysis of household incomes by gender, because it analyzes earnings of workers both within each group and between groups.

The results obtained by the opinion poll carried out at
the national level and by the one performed amongst the Romany ethnic citizens support the conclusion of a weak gender racial discrimination in Romania, with a few interesting nuances:

1. Income inequality among men is higher than among women, because of the greater participation rate of the manpower in the labour market (a conclusion also validated by the Gender Inequality Index). In case of the Romany ethnics we deal with a reversal of this trend (even though in a much smaller degree), which could signal out a larger dispersion of the kinds of workplaces occupied by the female manpower;

2. If at the national level men’s contribution to incomes inequality is higher than that of women, this indicates a greater participation rate in the manpower market.

3. In both polls the trans-variation intensity plays an important part in accounting for the gross inequality amongst the subgroups. This means that the wages obtained by the discriminated group (women) are higher in case of certain professions than the ones received by the discriminating group (men), even though, on average, men earn more than women;

4. The net inequality amongst the subgroups shows us the wage-related difference between men and women. In case of both investigations the inequality is not very pronounced and this situation suggests the existence of a small discrepancy between the wages cashed by men and the ones cashed by women.

5. The economical distance that separates the incomes distribution between the two groups in case of both polls approaches zero, which means that the incomes distributions according to subgroups overlap pretty much.

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