

INCOME INEQUALITIES BETWEEN WOMEN AND MEN IN SELECTED EUROPEAN COUNTRIES

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Abstract

Research background: Income inequalities between women and men often constitute an important area of research related to social inequalities. Differences in incomes between genders are frequently analyzed in the context of gender equality, social justice, and economic equity. Disparities in wages between women and men are observed in many societies. A key tool in studying wage and income distributions, as well as income inequalities, is the approximation of theoretical models to empirical data. Another important tool is the use of income inequality measures. Research on income distributions between women and men is significant for various reasons, including facilitating an understanding of social and economic inequalities.

Purpose: In Europe, there is diversity in economic models, with individual countries adopting different approaches to organizing their economic systems. The paper considers four European countries representing diverse economic approaches. A comparative analysis of income inequality between men and women was conducted in the countries under consideration.

Research methodology: The study used data from the Central European Bank from 2017. All analyzes were based on the Dagum model. The maximum likelihood method was used to estimate the model parameters. The Theil coefficient decomposition was also applied.

Results: The analysis reveals that men earn the highest incomes in all countries. Visualization of the Lorenz and Zenga curves, along with calculated inequality indices, showed that the greatest income inequalities occur in women's incomes in all cases. Interestingly, it was found that men's incomes make the largest contribution to the overall income inequalities.

Novelty: The paper explores the topic of income inequality, which is a significant and contemporary socioeconomic challenge. It utilizes statistical information from the Eurosystem Household Finance and Consumption (HFCS) to examine and assess the financial status of households, focusing on both genders, in Finland, Germany, Poland, and Spain.

Keywords: income distribution, Dagum model, Gini index, Zenga index, Theil index, decomposition, Lorenz curve, gender inequality

JEL classification: C4, C10, C13, C15, J16

Introduction

The concept of inequality is a complex issue. Inequality manifests in various dimensions, aspects, and forms. The grounds for social inequalities may be various, but most often they arise from differences in wealth and income. Research on income inequality is important for understanding socioeconomic structure and economic efficiency. Income and wealth inequalities contribute to an increased risk of poverty and social exclusion. It is crucial for income inequality research to be conducted systematically and comprehensively to enable the analysis of trends over time and comparisons between different regions and social groups. The first tool in researching wage and income distributions and income inequality is the approximation of theoretical models to empirical data. The second important tool is measures of income inequality. Inequality measures such as the Gini index, Theil index, Zenga index, Lorenz curve, or Zenga curve allow for quantifying the degree of inequality in income distribution (Bárcena, Imedio, 2008; Radaelli, 2010). They provide the opportunity to compare inequalities between different social groups, regions, or countries.

The incomes of women and men are an important area of research related to social inequalities. The gender income gap is often analyzed in the context of gender equality, social and economic justice. In many societies, there is a pay gap between women and men (Bonaparte et al., 2023). These differences may result from many factors, such as occupational segregation, gender discrimination, and differences in education and work experience (Picatoste et al., 2023; Quadlin et al., 2023). Women often work in traditionally low-paying sectors, while men dominate in better-paying sectors (Meriküll, Kukk, Rõõm, 2021). Women may encounter challenges in career advancement and attaining high-level positions in certain industries. Women frequently take career breaks related to childcare or caregiving for other family members, which can affect their incomes. There are also significant differences in the level of education between the genders (Williams, 2017). Research on the incomes of women and men is important for understanding the structure of socio-economic inequalities and

for undertaking actions aimed at improving gender equality in various areas of social and professional life (Figari et al., 2011; Gallego-Granados, Geyer, 2015; Doorley, Keane, 2024). The European Union initiates a range of initiatives and actions for gender equality promotion, aiming to advocate for equal opportunities and treatment for both women and men. Studies on the income distributions of women and men are significant for several reasons. They enable the understanding of social and economic inequalities and the identification of potential differences in earnings between women and men. This can help uncover cases of gender discrimination in the labor market. Such analysis enables the identification of factors such as occupational segregation, disparities in access to education, career breaks, or lack of equal access to advancement, which contribute to income disparities between genders. The findings of research on the incomes of women and men are important for shaping public policies and legislation aimed at promoting gender equality in various areas of social and economic life (Avram, Popova, 2022). Research on the incomes of women and men is therefore essential for monitoring progress toward gender equality, identifying areas for improvement, and developing effective strategies and policies that support social and economic equality (Boll, Lagemann, 2019). In Europe, there is a diversity of economic models, and individual countries adopt different approaches to organizing their economic systems. The article considers four European countries representing different economic approaches. Each of these countries uses different economic models that affect social policy, labor market, and income redistribution. Examining income inequality in these four countries in the context of their different economic approaches can provide information on how different economic policies affect gender inequality and what policies may be most effective in reducing it. In addition, each country uses unique policies to reduce income inequality, such as social policies and labor market regulations. Examining these countries can reveal which approaches are more effective in reducing inequalities and which may exacerbate them. A comparative analysis of income inequalities between women and men in the countries under consideration was conducted.

1. Inequality measures and statistical data

Since Pareto proposed his first income distribution model in 1896, many economists and mathematicians have tried to describe empirical distributions using density functions with a small number of parameters. This approach is useful for many reasons. The use of a theoretical model simplifies the analysis; the characteristics can be determined using the same parameters. Moreover, approximating the empirical distribution of wages and income

using theoretical curves can smooth out irregularities resulting from data collection which is often the case with income data. The latest works consist of very high accuracy with empirical distribution for the three-parameter models income (Sulewski, Szymkowiak, 2023; Trzcińska, 2020; Trzcińska 2021; Wałęga, Wałęga, 2021).

Camilo Dagum, in the 1970s, introduced a density function that fits well with the empirical income and wealth distributions. The Dagum model was based on empirical observations. After decades of applications to empirical data, the Dagum model has proven to be suitable for modeling the income distribution of men and women (Greselin et al., 2023). Its probability density function (pdf) is given by the following formula (Kleiber, Kotz, 2003):

$$f(x; a; b; p) = \frac{apx^{ap-1}}{b^{ap} \left[1 + \left(\frac{x}{b} \right)^a \right]^{p+1}}, \quad x > 0 \quad (1)$$

where $a, b, p > 0$.

The cumulative density function of the model is described by the equations:

$$F(x; a; b; p) = \left[1 + \left(\frac{x}{b} \right)^a \right]^{-p}, \quad x > 0 \quad (2)$$

where $a, b, p > 0$. The parameter b is a scale parameter, while a and p are shape parameters.

The Lorenz curve (1905) and the Zenga curve (2007), are widely recognized as key tools for assessing inequality. One common measure of inequality derived from the Lorenz curve is the Gini index, formulated by Gini in (1914). It is important to note that the calculation of this coefficient can be described by the formula:

$$G = 1 - 2 \int_0^1 L(p) dp \quad (3)$$

Increased Gini coefficient values denote heightened levels of income disparities within a society. The Gini index associated with the Dagum model can be represented by the subsequent equation:

$$G = \frac{\Gamma(p) \Gamma\left(2p + \frac{1}{a}\right)}{\Gamma\left(p + \frac{1}{a}\right) \Gamma(2p)} - 1 \quad (4)$$

The Zenga curve (2007), is the latest addition in this field. While it shares a connection with the Lorenz curve, its versatile shapes enable the discernment of various inequality scenarios. (Greselin, Pasquazzi, 2009; Radaelli, 2010; Langel, Tillé, 2012; Greselin, Pasquazzi, Zitikis, 2013; Arcagni, Porro, 2014). The curve has the following form:

$$I(p) = 1 - \frac{(1-p) \int_0^p F^{-1}(t) dt}{p \int_p^1 F^{-1}(t) dt}, \quad p \in (0, 1) \quad (5)$$

The association with the Lorenz curve can be summarized as:

$$I(p) = \frac{p - L(p)}{p[1 - L(p)]}, \quad p \in (0, 1) \quad (6)$$

The Zenga index for the Dagum model can be expressed by the following formula:

$$I = \int_0^1 \frac{k - \beta \left(\frac{1}{k^p}; p + \frac{1}{a}; 1 - \frac{1}{a} \right)}{k \left[1 - \beta \left(\frac{1}{k^p}; p + \frac{1}{a}; 1 - \frac{1}{a} \right) \right]} dk \quad (7)$$

where β is the incomplete Beta function ratio.

The mentioned coefficients have one drawback: they cannot be easily decomposed into subgroups of the studied population (Lambert, 1993). Utilizing them does not allow us to answer the question of how much a given social subgroup contributes to overall societal inequalities and how much inequality is generated within groups versus resulting from intergroup differences. The appropriate measure to address these issues is the Theil index. It is characterized by a feature known as additive decomposability. This additivity allows for the addition of inequality components generated within individual groups and inequalities arising from differences between these groups, thereby providing an assessment of overall inequality levels. The Theil index is expressed as follows (Liao, 2016; Ulman, Wałęga, 2007):

$$T = \frac{1}{N} \sum_{i=1}^N \frac{x_i}{\bar{x}} \ln \frac{x_i}{\bar{x}} \quad (8)$$

where x_i is the income of individual i , $\bar{x}$ is the overall mean income, and N is the sample size.

Using the same notation, the Theil index in equation (8) can be decomposed into a between-group component,

$$T_b = \sum_{k=1}^K y_k \ln \frac{x_k}{\bar{x}} \quad (9)$$

where y_k is the k -th group's income share expressed as a proportion of the sample or population total income, and x_k is the mean income of group k , and a within-component,

$$T_w = \sum_{k=1}^K y_k \sum_{i=1}^{n_k} y_{ik} \ln \frac{x_{ik}}{x_k} \quad (10)$$

where y_{ik} is the income share of the i -th individual within the k -th group, and x_{ik} is the i -th individual's income within group k .

The formulas described above will be applied to analyze income inequalities. As it is easy to see, the Theil index can only be calculated for positive values of the statistical feature; therefore, all observations that do not meet this criterion will be discarded.

2. Results

In all calculations, we used total gross annual household income expressed in euro from the European Central Bank (ECB)-Eurosystème Household Finance and Consumption (HFCS) wave 2017. For methodological and interpretation reasons, households with negative or zero income were excluded from the statistical analysis. We examined households where the head of the household is a woman or a man. In this paper, data from 2017 for four European countries with different economic models were used. We considered the following countries: Spain, Germany, Finland and Poland. The sample size ranged from 4,912 observations in Germany to 10,208 observations in Finland. The analysis was based on the overall income distribution, not on specific occupational categories of women and men.

The Dagum model was fitted to income data using the maximum likelihood estimation. Tables 1–4 contain the estimates of the Dagum distribution parameters for the total gross annual household income for Spain, Germany, Finland and Poland.

Table 1. Estimation results for income distributions in Spain
based on the data coming from HFCS

Parameter of the Dagum model	a	b	p	No. of households
Female	2.2797	47,852.9	0.5428	2075
Male	2.3966	65,049.2	0.5179	4270
Total	2.3584	59,425.5	0.5203	6345

Source: own calculations.

Table 2. Estimation results for income distributions in Germany
based on the data coming from HFCS

Parameter of the Dagum model	a	b	p	No. of households
Female	2.3404	60,697.3	0.5991	1489
Male	2.8210	80,719.0	0.6248	3423
Total	2.5992	74,022.9	0.6205	4912

Source: own calculations.

Table 3. Estimation results for income distributions in Finland
based on the data coming from HFCS

Parameter of the Dagum model	a	b	p	No. of households
Female	2.7628	57,773.9	0.6633	3862
Male	3.4596	83,890.9	0.5039	6346
Total	3.1141	73,632.3	0.5594	10208

Source: own calculations.

Table 4. Estimation results for income distributions in Poland
based on the data coming from HFCS

Parameter of the Dagum model	a	b	p	No. of households
Female	2.6790	11,900.4	0.6686	2299
Male	3.2738	17,576.3	0.5431	3555
Total	2.9106	15,023.7	0.6034	5854

Source: own calculations.

Table 5 presents the average income of gross annual household income expressed in euro. The analyses show that the average income of men is higher than the average income of women. The highest incomes among both men and women are observed in Finland and Germany, where the Scandinavian and Continental economic models prevail. Men's incomes in Finland are 12% higher compared to the national average income, in Germany and Poland 11% higher than the average income, while in Spain they are 8% higher. As for women's average incomes, in Germany they are 21% lower than the national average income, in Finland and Poland 17% lower, while in Spain they are 14% lower.

Table 5. The average income of women and men in selected European countries based on HFCS data for 2017

Country	Finland	Germany	Poland	Spain
Female	42,790.96	42,599.26	13,383.43	28,359.23
Male	57,728.91	59,517.92	17,861.66	35,508.06
Total	51,296.63	53,588.64	16,156.80	32,953.35

Source: own calculations.

Tables 6 and 7 present measures of inequality for the considered European countries. The Gini and Zenga coefficients (Langel, Tillé, 2012) were calculated based on the Dagum distribution. It is noteworthy that in all countries, both the Gini and Zenga coefficients assume the highest value for women. The greatest inequalities are observed in Spain and Germany, while the smallest are in Finland.

Table 6. Gini coefficient for the income distribution of selected countries in 2017

Country	Finland	Germany	Poland	Spain
Female	0.399054	0.477049	0.409847	0.500268
Male	0.353425	0.397809	0.362194	0.484620
Total	0.375448	0.429766	0.390365	0.490857

Source: own calculations.

Table 7. Zenga coefficient for the income distribution of selected countries in 2017

Country	Finland	Germany	Poland	Spain
Female	0.745154	0.813177	0.755024	0.832095
Male	0.704574	0.745306	0.712506	0.822016
Total	0.725685	0.774412	0.738918	0.826410

Source: own calculations.

The Lorenz curve is a useful tool for examining, analyzing and monitoring income inequality, which allows for a better understanding of the socio-economic structure of a population. Figure 1 depicts Lorenz curves for women, men, and the overall population for all of the considered countries. It is worth noting that despite the highest inequality coefficient values in Spain, all Lorenz curves are very close to each other, and practically overlapping. This means that all values of the Gini coefficients do not differ much from each other. The Lorenz curve for the overall population in each country lies between the Lorenz curves for men and women. The most distant Lorenz curves are found between women and men in Germany. This also confirms the Gini coefficient values for women and men in this country.

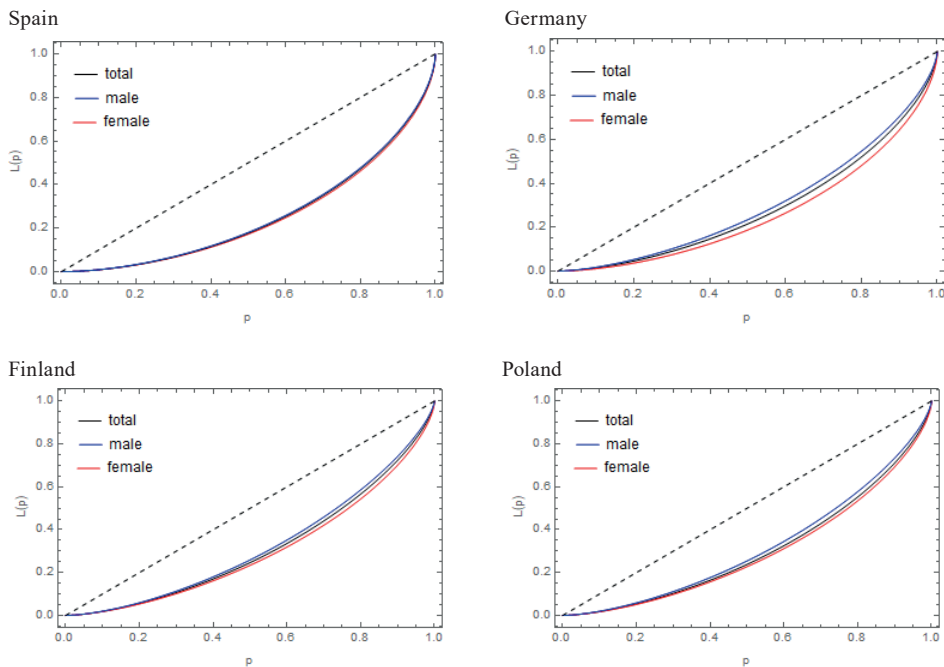


Figure 1. Lorenz curve $L(p)$ for Spain, Germany, Finland and Poland in 2017

Source: own calculations.

Figure 2 presents a visualization of income inequality using Lorenz curves for women and men in all of the considered countries. The Lorenz curves describing income inequalities for women in Finland and Poland are similar to each other, and it can also be observed that the Lorenz curves for Germany and Spain are also close to each other. As for the Lorenz curves illustrating income inequalities for men, similarly to women, the Lorenz curves for Finland

and Poland are close to each other, while the most distant curve is the Lorenz curve describing income inequalities for men in Spain.

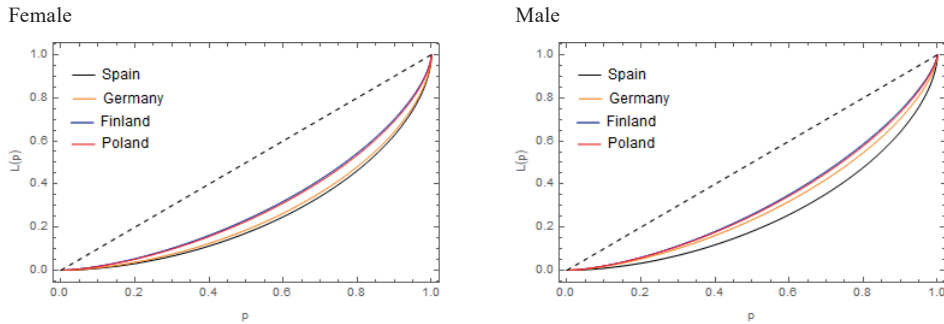


Figure 2. Lorenz curve $L(p)$ for female and male for all countries in 2017

Source: own calculations.

The Zenga curve is a tool for analyzing income inequalities that offers certain advantages compared to the traditional Lorenz curve (Zenga, 2007). Its dynamic nature and ability to accommodate different situations make it a valuable tool in income inequality research (Monti, Pellegrino, Vernizzi, 2024). Figure 3 presents a visualization of Zenga curves for the considered European countries, highlighting differences in income inequality between genders and the overall population.

In the case of Spain, similar to the Lorenz curves, the Zenga curves for women, men, and the overall population are positioned very close to one another, indicating that income inequalities are relatively uniform across these groups. Interestingly, the Zenga curve for women is slightly higher, suggesting that women experience marginally higher income inequalities compared to men, while the curve representing the overall population lies between the two, reflecting an average inequality level that incorporates both genders. Germany presents a more pronounced differentiation in income inequalities, with the Zenga curves being more distant from each other compared to Spain. The Zenga curve for women is notably the highest, indicating that women in Germany face the greatest income inequalities. In contrast, the curve for men is positioned the lowest, suggesting that income inequality is lower among men. The overall population curve remains intermediate, demonstrating that gender disparities in income are more significant in Germany than in Spain. In Finland, the Zenga curves show a similar order to those observed in Spain and Germany, with the women's curve positioned highest, followed by the overall population curve, and then the men's curve. However, the Finnish Lorenz curves

are closer together than those in Germany, indicating that although there are still noticeable differences in income inequality between the genders, these disparities are less pronounced than in Germany but slightly more than in Spain for Poland, the Zenga curves follow the same relative positioning as in the other countries, with the curve for women showing the highest level of income inequality, followed closely by the curve for the overall population. This indicates that in Poland, men experience notably less income inequality compared to women and the general population.

These observations indicate that while the overall pattern of gender income inequality is consistent across the analyzed countries, where women generally experience greater inequalities, the scale and distinction of these inequalities are different. The largest gender disparities in income inequality are found in Germany, followed by Poland and Finland, while Spain displays the smallest gender differences. This suggests that cultural, economic, and policy factors in each country may significantly influence income distribution and the extent of the gender inequalities.

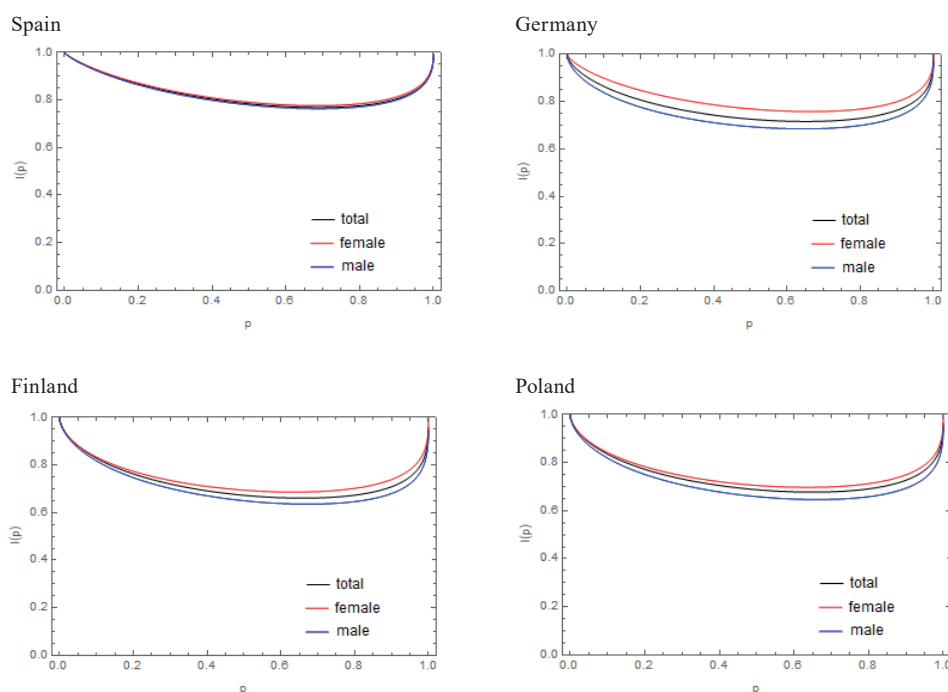


Figure 3. Zenga curve $I(p)$ for Spain, Germany, Finland and Poland in 2017

Source: own calculations.

Figure 4 illustrates the positioning of Zenga curves for women and men in all of the considered countries. The Zenga curves for women in Finland and Poland are similar to each other, suggesting that these two countries have comparable levels of income inequality among women. This indicates similarities in income structures for women in both countries. The Zenga curves for women in Germany and Spain are also positioned similarly, indicating a comparable pattern of income inequality among women in these two countries. Similarly, the Zenga curves for men in Finland and Poland are close to each other, indicating that income inequalities among men in these two countries are also similar. This may reflect comparable employment structures for men. However, in the case of Germany and Spain, significant changes in the positioning of the Zenga curves for men compared to women can be observed. This means that the differences in income inequalities among men in these countries are more varied than among women. The greatest income inequalities, for both women and men, are found in Spain. This suggests that the income structure in this country is more stratified, which could be the result of large wage disparities, high unemployment rates, or specific economic conditions that lead to greater income inequalities. In contrast, Finland shows the smallest income inequalities. This could be due to social policies, strong labor unions, or high access to education and public services, which promote a more even distribution of income. The analysis of the Zenga curves indicates that while there are some similarities between countries regarding income inequalities among women and men, significant differences in income distribution exist and may result from various socio-economic factors. Spain stands out as the country with the highest income inequalities, while Finland demonstrates that it is possible to achieve a more balanced income distribution.

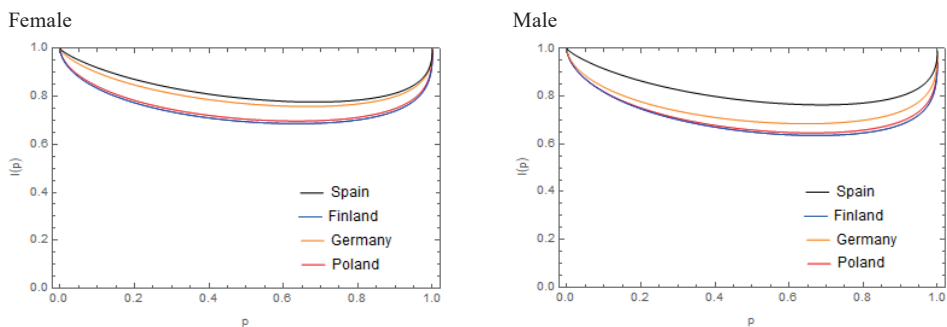


Figure 4. Zenga curve $I(p)$ for female and male for all countries in 2017

Source: own calculations.

In addition to examining income inequalities using the Lorenz and Zenga curves as well as the Gini and Zenga coefficients, Theil coefficient decomposition was conducted. The decomposition of the Theil coefficient is a tool for analyzing income inequalities that helps understand the structure and causes of inequalities in the population. The decomposition of the Theil coefficient for households where the head of the family is a man or where the head of the family is a woman in the considered countries can be seen in Table 8.

Table 8. Theil decomposition for the income distribution of selected countries in 2017

Country	Finland	Germany	Poland	Spain
Theil index (T)	0.263868	0.345509	0.260570	0.366528
Between-group factor	0.010577	0.011769	0.009293	0.005530
Within-group factor for women	0.097290	0.115109	0.091139	0.124342
Within-group factor for men	0.155213	0.218632	0.160138	0.236656
The percentage impact of inequality between groups on the overall Theil index value	4.31	3.41	3.57	1.51
The percentage impact of inequality among women on the overall Theil index value	36.87	33.32	34.98	33.92
The percentage impact of inequality among men on the overall Theil index value	58.82	63.28	61.46	64.57

Source: own calculations.

The greatest impact on income inequality in each country comes from within-group inequalities. Between-group inequalities have the smallest influence on the emergence of income inequality, accounting for about 4.00% in Finland, Germany, and Poland, while in Spain, they only have a 1.50% impact. The largest influence on generating income inequality in all of the considered countries comes from within-group inequalities among men, accounting for 58.82% in Finland, 63.28% in Germany, 61.46% in Poland, and 64.57% in Spain. Within-group income inequalities among women are similar in all of the countries, accounting for 36.87% in Finland, 33.32% in Germany, 34.98% in Poland, and 33.92% in Spain, indicating that incomes within this group are less varied compared to men. Note that, although income disparities among women are significant, they have a smaller impact on overall inequality compared to the disparities among men.

The Theil index analysis suggests that the most significant impact on overall income inequality comes from within-group disparities, particularly among men. Inequalities between groups have a relatively small impact, suggesting that policies aimed at reducing income inequality should focus primarily on reducing income disparities within groups, particularly among men.

The analysis reinforces the importance of using different tools, such as the Dagum model, Lorenz curves, Zeng curves and Theil decomposition to gain a comprehensive understanding of income inequality. The research findings highlight the need for targeted policies to address within-group income inequalities, particularly among men, as these contribute significantly to overall income inequality in the studied countries.

Conclusions

The analysis was conducted using data from the Eurosystem Household Finance and Consumption (HFCS) from 2017 for Spain, Germany, Finland, and Poland, each representing different economic models. The Dagum model was employed for fitting income data, providing estimates of distribution parameters and average household incomes for each country.

The findings reveal notable disparities between the average incomes of men and women across the examined countries. In general, men tend to earn higher incomes than women, with the highest incomes being observed in Finland and Germany. Specifically, men's incomes are notably higher compared to the national averages in these countries, while women's incomes are lower, particularly in Germany.

The utilization of the Lorenz and Zenga curves proved instrumental in comprehensively examining income inequality dynamics. Despite variations in inequality coefficients, the Lorenz and Zenga curves for Spain exhibited remarkable proximity, indicating similar income distributions across gender lines. Notably, the overall population's Lorenz and Zenga curves are consistently positioned between those of men and women, emphasizing the interconnectedness of gender-based income disparities. Moreover, the analysis highlighted the predominant influence of within-group inequalities on income inequality within each country. Between-group inequalities exerted minimal impact, underscoring the significance of addressing disparities within demographic subgroups. Particularly noteworthy is the substantial contribution of within-group income inequalities among men to overall income inequality across all of the considered countries.

In summary, the study underscores the complex interplay of socio-economic factors contributing to income inequality and emphasizes the importance of employing diverse analytical tools, such as the Dagum model, Lorenz and Zenga curves, to comprehensively assess and address these disparities. Furthermore, the findings underscore the critical need for targeted policies aimed at mitigating within-group inequalities to foster greater socio-economic equity within diverse populations. The limitations of this study include focusing on only four

countries, which may limit the generalizability of the results to other regions. The study also relies on the analysis of income inequality at a single point in time, which may not fully reflect the dynamics of inequality over a longer period of time. Future research could extend the analysis to additional countries to obtain more comprehensive results on global income inequality trends. Furthermore, it is advisable to conduct research that tracks changes in income inequality over time. Including other factors, such as education or age, could also provide a more comprehensive description of the dynamics of inequality. Examining the impact of specific policies on reducing inequality could help in developing more effective strategies to address income inequality. Finally, additional research in this area is necessary.

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