# Gender Inequality under Different National Welfare Regimes: An Empirical Evaluation with Entropy Measures from Information Theory

**Georg P. Mueller**[a]

## Abstract

This article analyzes the effects of welfare regimes on gender discrimination and inequality. In order to facilitate comparisons between different types of inequality and welfare regimes, the article departs from major concepts of information theory like entropy and transinformation in order to show their relation to traditional concepts of the sociology of inequality. This way it becomes possible to formulate hypotheses about the effects of liberal, conservative, and socialist regimes, as defined by Esping-Andersen. Since the regime-typology of Esping-Andersen is continuous and not categorical, it is possible to use linear regression analysis for testing the respective hypotheses with data from only 13 European countries about the hierarchical positions of men and women at work. Whereas the observed effects of liberal regimes fit perfectly well to our theoretical expectations, this is less the case for socialist regimes and even less for conservative welfare states.

## Keywords

gender inequality, welfare regimes, international comparisons, entropy, transinformation

In spite of some progress, which has been achieved in recent years, gender discrimination of women is still a problem, even in relatively modern countries (OECD 2013). Among others there are still "invisible ceilings" to women's professional careers, which result in an overrepresentation of men at the higher ranks of many private or public organizations. This article aims at comparing and explaining the extent of the problem in different European countries.

In order to tackle the first of these goals, i.e. a *comparative description* of the current gender inequalities, the author introduces a set of social indicators based on *information theory* (Shannon and Weaver 1962; Mathar 1996; Stone 2015), which offers for this purpose two major advantages: (i) it allows to explore the relations between these inequality-indicators by pure, precise mathematical reasoning; (ii) it offers for the mentioned indicators a common unit of measurement, i.e. the *bit.* Both advantages facilitate comparisons between countries as well as between different social indicators.

The *explanation* of gender inequality – which is the second goal of this article –

[a] University of Fribourg

**Corresponding Authors:**
Georg P. Mueller, University of Fribourg, Faculty of Economics and Social Sciences, Blvd de Pérolles 90, CH-1700 Fribourg, Switzerland
E-mail: Georg.Mueller_Unifr@bluewin.ch

is based on the analysis of welfare regimes, as originally proposed by Esping-Andersen (1990: 74). Welfare regimes define among others the role of the state, the family, and especially of the women in the production of welfare for the aged, the young, and the frail. Moreover they mirror the societal principles of the attribution of privileges and their correction by the state in order to maintain distributive justice. Thus it makes sense to use the type of the national welfare regime for explaining country-specific gender inequalities.

## INEQUALITY MEASURES FROM INFORMATION THEORY

On the basis of conventional inequality-indicators, there is hardly any commensurability between the inequality of a privilege distribution and the inequality of the group-specific opportunities for getting access to these privileges. The first of the mentioned concepts is generally measured by GINI-indices or inter-quartile ranges (Mitchell 1993: chap. 6; Coulter 1989: chap.3), whereas the second is often operationalized by measures describing the dissimilarity of group-specific privilege-distributions like chi-square (Everitt 2006: 76) or the Duncan

Index of Dissimilarity (Coulter 1989: chap. 7). In order to increase the comparability between the mentioned two concepts, the author proposed in an earlier article to use entropy-measures from information theory (Mueller 2004).

In information theory (Mathar 1996), entropy is usually defined as [1]

$$H = -\Sigma_{i=1...n} [p_i * ld(p_i)] \qquad (1a)$$

where $p_1$, $p_2$, $p_3$, ... are the relative frequencies of the categories i = 1, 2, 3, ... of a population attribute. If the attribute is a privilege with only *two* levels P = *low* and P = *high* and the respective population shares $p_{lo}$ and $p_{hi}$, the previous formula (1a) becomes

$$H = -[p_{lo} * ld(p_{lo}) + p_{hi} * ld(p_{hi})] \quad (1b)$$

Thus, if *everyone* is at the same privilege-level, i.e. either P = low or P = high, formula (1b) yields H = 0 [2], which corresponds to the *minimum* of entropy or uncertainty about the privileges of a stranger, randomly chosen from a *totally equal* society. If the analyzed population is *uniformly* distributed over the privilege categories P = low and P = high, the respective probabilities $p_{lo}$ and $p_{hi}$ are both equal to 1/2 and the entropy reaches the value H=1 [3] (see Figure 1). In this case we have a *maximum of entropy* or uncertainty about the privileges in a *totally unequal* society. The
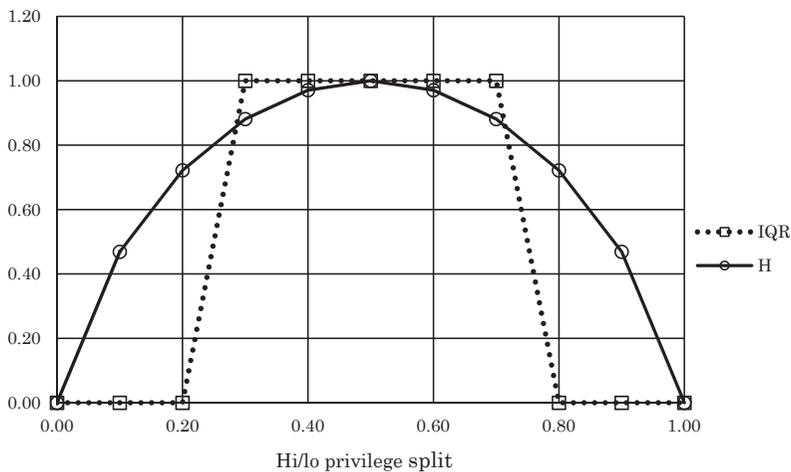


**Figure 1.** The Correspondence between IQR and H for Different Privilege Distributions
*Note:* Hi/lo privilege split = $p_{lo}$ = share of persons with P = low = 0; $p_{hi}$ = 1-$p_{lo}$ = share of persons with P = high = 1; IQR = Interquartile range; H = Entropy = Inequality as defined by formula (1b).

value H for this type of society varies with the number n of privilege categories and is equal to -ld(1/n).

All in all there is a positive correlation between the inequality of privileges and the associated entropy H. Figure 1 illustrates this regularity by comparisons between the traditional *interquartile range IQR* (Everitt 2006: 202) and the proposed *entropy measure H* for different splits between P = lo and P = hi. As compared to the IQR, the entropy measure H has the advantage that it is also applicable to simple scales, which measure privileges not at the ratio- but rather at the interval- or ordinal-level. In this respect H outperforms also the Theil-Index (Theil 1972: 99,100; Wikipedia 2016), which is too based on entropy concepts but requires "good" scales for calculating mean privileges that are for Theil often mean incomes.

If formula (1b) is applied to a whole population, H is the total inequality with regard to a privilege P. It may however also be applied to subpopulations, like e.g. men or women. In the latter case the calculated entropy is the female intra-gender inequality $H_f$ , i.e. the inequality exclusively among women. In the former case there is an analogous concept $H_m$, i.e. the male intra-gender inequality. The synthesis of the two is the so-called intra gender-inequality

$$H_{m+f} = p_m * H_m + p_f * H_f \qquad (2)$$

where $p_m$ and $p_f$ are the respective male and female population shares. Thus $H_{m+f}$ is the weighted mean of male and female intra-gender inequality. In information theory, $H_{m+f}$ is also called *conditional entropy* (Mathar 1996: 27).
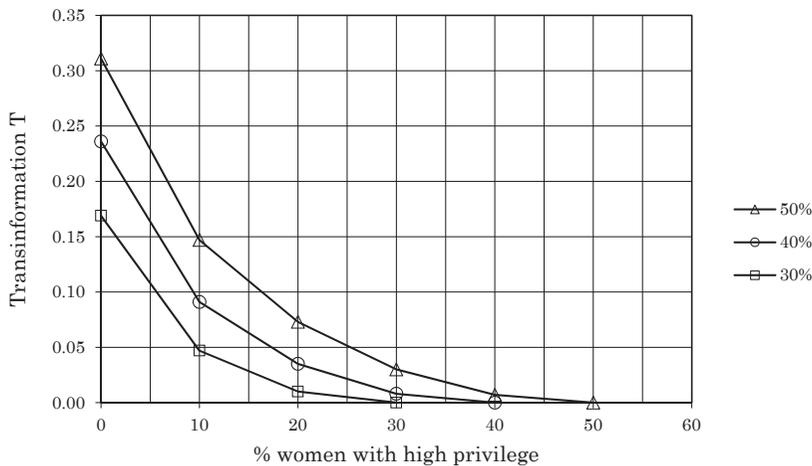


**Figure 2.** Transinformation of Gender for Different Shares of Men and Women with Higher Privileges [4]

The differences (H-$H_m$) and (H-$H_f$) are in this context in so far of special interest as they describe the change of uncertainty and information about the related privileges that results from additional knowledge about the male or the female gender of a person. The weighted sum

$$T = p_m * (H-H_m) + p_f * (H-H_f) \qquad (3)$$

is thus the average information gain for both gender groups with the respective

population shares $p_m$ and $p_f$. In information theory T corresponds to the concept of *transinformation.*[5] For mathematical reasons it always varies between the lower limit 0 and the upper limit H (Mathar 1996: 33, proposition b)). If T = 0, there is no information about privileges that can be gained from the knowledge of the gender of a person. The closer T is to its upper limit, the more information we get from the knowledge of gender. Consequently we consider T as a

measure of the *inequality of opportunities* of the two sexes. According to Figure 2 this is a reasonable interpretation: the higher the % of women with high privileges, the lower is the transinformation T. Similarly, if the share of the privileged men decreases, e.g. from 50% to 20%, women are according to Figure 2 less discriminated: the privilege gap between the two gender gets smaller and the indicator T mirrors this situation correctly.

   Obviously there is not only an information gain from gender about privileges. Similarly there are also information gains and losses $T_{lo}$ and $T_{hi}$ resulting from the knowledge of low and high privilege-ranks with regard to the "typical" gender of these positions.[6] It can be shown[7] that the inequality of opportunities T is a weighted sum of these information gains and losses

$$T = p_{lo} * T_{lo} + p_{hi} * T_{hi} \qquad (4)$$

where $p_{lo}$ and $p_{hi}$ are the respective shares of high and low ranking privilege positions. Equation (4) suggests to interpret $T_{lo}$ and $T_{hi}$ as the *privilege-specific inequality of opportunities* for the lower and higher privilege-positions.
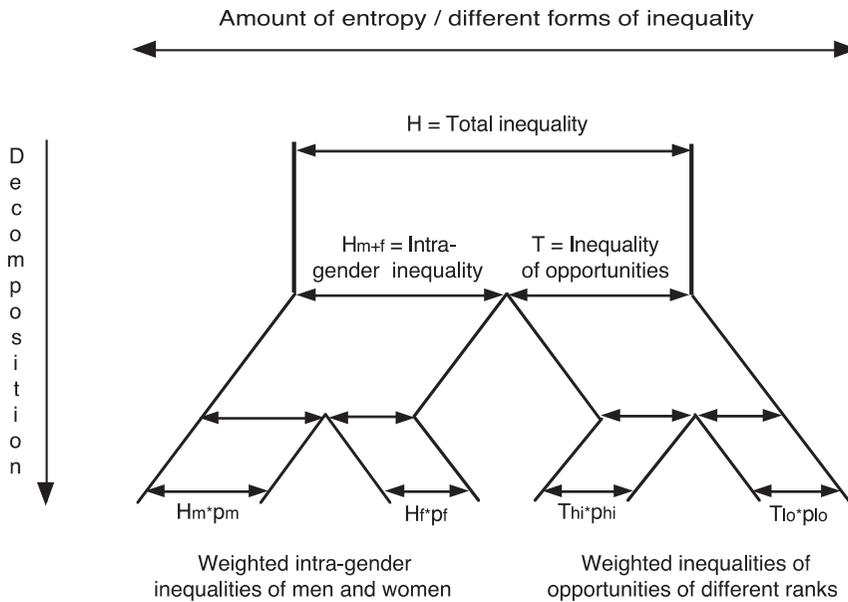


**Figure 3.** The Interdependence of the Entropy-Based Inequality Concepts

   The previously mentioned inequality (Mathar 1996: 33, proposition b)):

$$0 \leq T \leq H \qquad (5)$$

raises questions about the "nature" of the gap (H-T). Since H is the total inequality, the component (H-T) is likely to be some kind of more specific inequality. As formal reasoning proofs it is indeed a form of inequality, which we already encountered before: the *intra-gender inequality* $H_{m+f}$. Thus the following equation[8]

$$H = T + H_{m+f} \qquad (6)$$

holds, meaning that total inequality of privileges H is the sum of the inequality of opportunities T and the intra-gender inequality $H_{m+f}$.[9] According to equation (4), T can be further decomposed into the privilege-specific inequalities of opportunities $T_{lo}$ and $T_{hi}$. Similarly, equation (2) has shown that intra-gender inequality $H_{m+f}$ has male and female components $H_m$ and $H_f$. Figure 3 gives a visual summary of the mathematical interdependences of the mentioned concepts.

# WELFARE REGIMES AND THEIR GENDER POLICIES

As recent statistics show (OECD 2013: chap. 15, 16), there are still invisible ceilings to women's professional careers, which entail that the share of women in supervisory positions is generally lower than the corresponding share of the male workforce (LeFeuvre 2010: 134). This inequality of opportunities has to do with continuing time- and role-conflicts between professional careers and female family obligations as care-givers for the younger and older generation (Kan and Gershuny 2010; Chafetz 1991: chap. 2). Hence there is a direct link to the services and regulations of the welfare state, which may in the best case reconcile and in the worst accentuate this role-conflict. In the first case the welfare state organizes and subsidizes day nurseries and homes for the elderly, whereas in the second it obliges families and especially women to take not only care of their children but also of their retired parents (Daly and Rake 2003, Meyers et al. 1999).

Currently there are many different welfare state typologies (Gelissen 2002: chap. 2), some of them are better known, others less. In what follows, we are going to use the typology of Esping-Andersen (1990: 74), which has also been applied to the analysis of gender-relations, as e.g. in Sainsbury (1999a). It has the advantage of being a continuous and not a classical partitioning typology: thus a welfare regime may e.g. be a mix of socialism and liberalism, where the degree of socialism and liberalism depends on the country and historical period. Consequently it is possible to use regression analysis for investigating also small data-sets with only a limited number of countries, what would not be possible with a partitioning typology. The three basic dimensions, which constitute this continuous typology of Esping-Andersen are the degrees of (1) conservatism, (2) liberalism, and (3) socialism.

*Conservative* regimes consider the traditional family as the primary unit of society, which is responsible for the well-being of its weaker members. The conservative welfare state assumes only a subsidiary role for cases, where the traditional family fails. Under conservative regimes women are considered as the care-givers for their children and frail parents and thus have to sacrifice their professional careers for the sake of the family members in need (Esping-Andersen 1990: 27; Gelissen 2002: 31). Since this expectation exists to a much lesser degree for men, we hypothesize that

*the more conservative a welfare regime, the higher the inequality of opportunities between men and women on the lower (hypothesis 1a), the higher (hypothesis 1b) and both (hypothesis 1c) ranks of privileges.*

Moreover, conservative regimes tend to maintain and perpetuate existing privileges, especially after the transition to retirement. This points to a *general* legitimacy of inequality and suggests the following four hypotheses:

*The more conservative a welfare regime, the higher the intra-gender inequality among men (hypothesis 2a), women (hypothesis 2b) and for both sexes (hypothesis 2c) and the higher the total inequality of privileges (hypothesis 2d).*

Liberal regimes have weak states, which do not intervene into markets in order to correct the inequalities, which are created by these markets. In particular, they avoid redistributive taxes and public expenditures for underprivileged groups (Esping-Andersen 1990: 26-27; Gelissen 2002: 31). Consequently we postulate that

*the more liberal a welfare regime, the higher the intra-gender inequality among men (hypothesis 3a), women (hypothesis 3b) and for both sexes (hypothesis 3c) and the higher the total inequality of privileges (hypothesis 3d).*

However, liberal regimes also have a certain preference for *meritocratic* privilege distribution, which implies equal pay for equal performance (O'Connor 1999). With regard to the inequality of opportunities between men and women, this principle *neutralizes* the general tendency of these regimes to accept market forces, which tend

to increase inequalities. Hence we postulate that

*there is no correlation between the degree of liberalism of a welfare regime and the inequality of opportunities between men and women on the lower (hypothesis 4a), the higher (hypothesis 4b) and both (hypothesis 4c) ranks of privileges.*

Socialist regimes [10] have strong interventionist states, which use their political and economic power in order to correct every kind of inequality or injustice created by market forces (Esping-Andersen 1990: 27–28; Gelissen 2002: 31–32). Hence there are laws to ensure gender equality as well as public expenditures for day nurseries and similar institutions, which promote women's careers at work. Consequently we postulate that

*the more socialist a welfare regime, the lower is any kind of inequality, i.e. the intra-gender inequality among men (hypothesis 5a), women (hypothesis 5b) and both sexes (hypothesis 5c), the inequality of opportunities between men and women on the lower (hypothesis 5d), the higher (hypothesis 5e) and both (hypothesis 5f) ranks of privileges, as well as the total inequality of privileges (hypothesis 5g).*

# DATA AND OPERATIONALI-ZATIONS

In order to compare countries and types of welfare regimes, we need country specific data about regime types and gender related inequalities. Regarding the first type of information, we use in this article an update of the original regime classification of Esping-Andersen (1990: 74), which was published by Scruggs and Allen (2008). It locates welfare regimes in a three-dimensional continuous regime-space with two 0 to 8 scales for the degrees of socialism and conservatism and a 0 to 12 scale for the degree of liberalism. Regarding the second type of information, i.e. the gender-related inequalities, we are relying on the European Values Study EVS (2008). Its questionnaire asked in a great number of European countries respondents with a job, whether they had at their workplace supervisory functions or not (see EVS-variable V341): no supervision of others was considered as a low privilege ranking, at least 1 supervised person as an indication of high ranking. Hence it is possible to describe the country- and gender-specific statistical privilege distributions with regard to the hierarchical positions at work, which is in turn the basis for calculating the entropy-based indicators presented in Table 1. These indicators are in so far meaningful for gender

**Table 1.** Entropy Data of Gender Inequalities

| Country | Intra-gender inequality: | | | Ineq. of opportunities: | | | Total in-equality |
|---|---|---|---|---|---|---|---|
|  | male | female | total | lo rank | hi rank | total |  |
| Austria | .952 | .728 | .823 | .035 | .001 | .025 | .849 |
| Belgium | .954 | .655 | .807 | .011 | **.112** | .039 | .847 |
| Denmark | .967 | .800 | .880 | .015 | .027 | .019 | .899 |
| Finland | .830 | .620 | .722 | .006 | .040 | .013 | .734 |
| France | **1.000** | **.860** | **.924** | .040 | .021 | .033 | **.957** |
| Germany | .930 | .732 | .825 | .015 | .026 | .018 | .843 |
| Ireland | .847 | .704 | .763 | .015 | -.021 | .007 | .769 |
| Italy | .965 | .665 | .812 | .020 | .103 | .043 | .855 |
| Netherlands | .998 | .788 | .883 | **.070** | .058 | **.066** | .949 |
| Norway | .985 | .855 | .920 | .011 | .030 | .018 | .938 |
| Sweden | .914 | .691 | .789 | .023 | .010 | .020 | .808 |
| Switzerland | .996 | .840 | .912 | .034 | .022 | .030 | .941 |
| UK | .955 | .803 | .865 | .030 | -.024 | .014 | .879 |

*Note:* Bold: highest value of an indicator. Underlined: Lowest value of an indicator.

inequality as they refer not only to the intrinsic discrimination by career blockage but also to discriminatory causes and consequences of hierarchical "glass-ceilings". Among others they are related to the unequal distribution of housework and child-care between husband and wife and explain the lower average salaries of the female workforce. Due to the limited number of countries coded by Scruggs and Allen (2008) and the exclusion of Non-European nations from the European Values Survey EVS (2008), the dataset of this article comprises in the end only a rather small number of 13 countries (see Table 1).

## EMPIRICAL RESULTS

### Intra-gender Inequalities

As summarized in Figure 3, there are three measures of intra-gender inequality, which can be deduced from information theory: *female intra-gender inequality $H_f$*, i.e. the inequality among women with regard to higher positions at work; *male intra-gender inequality $H_m$*, the analogous measure for men; *intra-gender inequality $H_{m+f}$*, i.e. a gender-weighted sum of the previous indicators.

The boxplots of Figure 4 show the median values and the spread of the three measures for the 13 European countries mentioned in Table 1. The country-data for *men* are homogeneous and rather high – with two exceptions: Finland and Ireland, which appear in Figure 4 as outliers. Intra-gender inequality among *women* is much lower than among men and displays more inter-country variability than $H_m$: women occupy rather the lower than the higher hierarchical positions and are thus more equal than men. However, in some but not all of the countries they moved up to higher positions such that the inter-country variability is increased. The intra-gender inequality $H_{m+f}$ for *both* gender-groups is by definition a mix of the tendencies observed for male and female intra-gender inequality. According to Figure 4, this holds
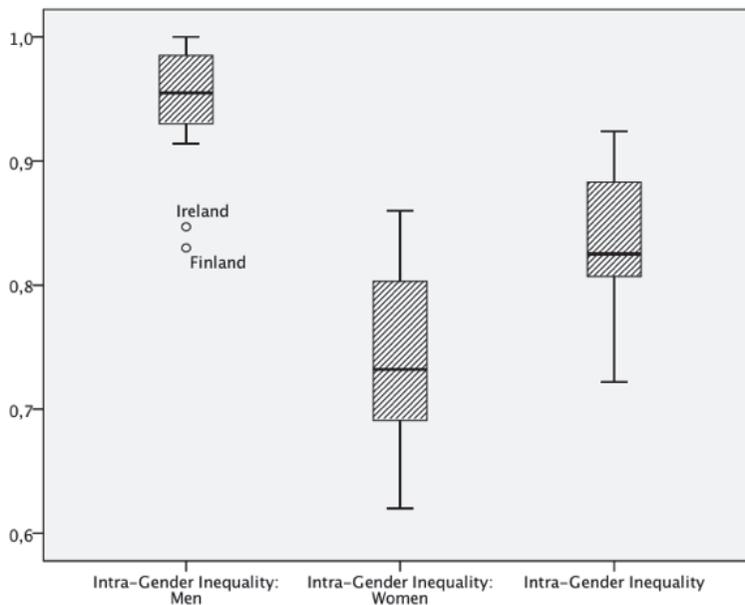


**Figure 4.** Boxplots of the Different Forms of Gender Inequality
*Note:* Interpretation of boxplots: *Top of box:* 3rd quartile; *bottom of box:* 1st quartile; *horizontal line* in the middle of the *box*: median; *top whisker:* highest case in the interval [3rd quartile , 3rd quartile + 1.5 * interquartile range]; *bottom whisker:* lowest case in the interval [1st quartile , 1st quartile - 1.5 * interquartile range]; *top circles:* outliers above the top whisker; *bottom circles:* outliers below the bottom whisker.

**Table 2.** Standardized Beta-values of Regime-types for the Explanation of Intra-gender Inequalities by Linear Regression

| Dependent variables | Sample | Deg. of socialism | Deg. of conservatism | Deg. of liberalism | Adj. r-square |
|---|---|---|---|---|---|
| Intra-gender | Full | [-0.412] | [-0.114] | [0.050] | [0.000] |
| inequality: | Excl. Finland | **-0.518*** | **0.484*** | **0.569*** | **0.489*** |
| *Male* | | - | + | + | |
| Intra-gender | Full | [-0.150] | [-0.030] | [0.456] | [0.000] |
| inequality: | Excl. Finland | [-0.157] | 0.465* | 0.910** | 0.542* |
| *Female* | Excl. Finland | **...** | **0.510*** | **0.912**** | **0.565**** |
| | | - | + | + | |
| Intra-gender | Full | [-0.275] | [-0.042] | [0.332] | [0.000] |
| inequality: | Excl. Finland | [-0.316] | 0.534* | 0.865** | 0.608** |
| *Total* | Excl. Finland | **...** | **0.624*** | **0.869**** | **0.539**** |
| | | - | + | + | |

*Note:* Significances (1-tailed t-test): ***: 0.1%, **: 1%, *: 5%, [ ]: n.s.; Expected signs: +: Pos., -: Neg., o: No effect; ... : Variable not included; Bold: Final model; Adj. r-square: Adjusted r-square; Excl. Finland: Finland as an outlier excluded from regressions due to lowest intra-gender inequalities (see Table 1).

true for the median as well as for the spread of the data, which are both between the gender inequalities of men and women.

On the grounds of the *r-squares* of Table 2, regression analysis allows to explain all three forms of intra-gender inequalities by means of the mentioned regime variables of Esping-Andersen. However, the relatively high explanatory power of these variables requires the exclusion of the outlier Finland (see Figure 4). Moreover, not all of the previously mentioned hypotheses are confirmed in Table 2: the degree of socialism reduces only the intra-gender inequality of men but not of women and both gender-groups, such that the hypotheses 5b and 5c are not corroborated. This may have to do with the fact that labor unions as the usual allies of socialist welfare regimes are male dominated and less interested in the concerns of women (Sainsbury 1999b). Fortunately, the remaining hypotheses 3a,b,c and 2a,b,c about the negative effects of liberal and conservative regimes on all forms of intra-gender inequalities have been confirmed.

## Inequalities of Opportunities

As demonstrated earlier in this article, transinformation T is a proxy for the inequality of opportunities between men and women, which can further be decomposed in two components: the gains/losses of information $T_{lo}$ and $T_{hi}$ about the gender of an anonymous person, if his/her low or high professional rank is being disclosed (see Figure 3). For 13 European countries, the median and dispersion of all these indicators are presented in the boxplots of Figure 5.

The inequality of opportunities is for *low* professional ranks always positive and has a rather limited extension. Women are at these ranks in all countries overrepresented and since there is generally only limited political interest in changing the situation, European countries are *very similar* and have *positive* values $T_{lo}$. This is in sharp contrast to the inequality of opportunities at higher ranks $T_{hi}$, where the dispersion between the maximum and the minimum as well as the interquartile range are much higher. In certain cases (UK and Ireland) the values $T_{hi}$ are even *negative* und thus contribute to a *reduction* of the total inequality of opportunities. The different gender policies of the European countries probably explain this diversity of the inequality of opportunities at the higher professional ranks. Since the weight $p_{hi}$ of the higher ranks in the total inequality of opportunities T is rather small as compared
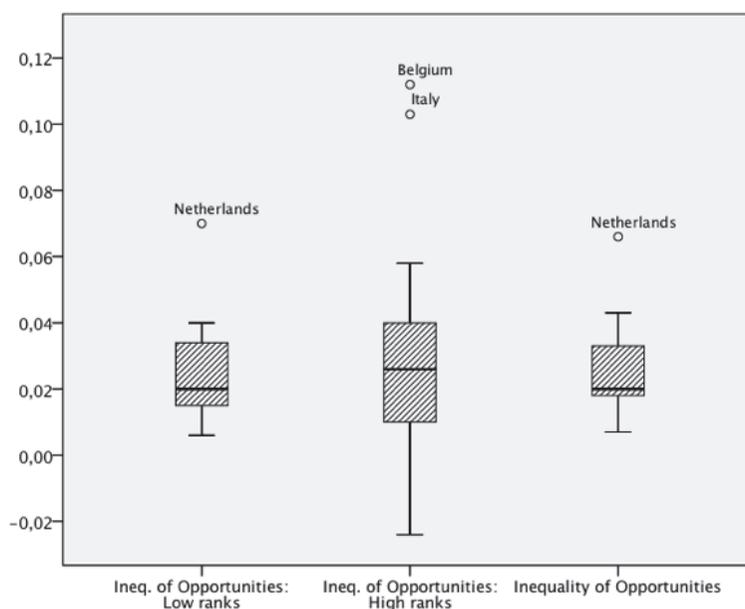
**Figure 5.** Boxplots of the Different Forms of the Inequality of Opportunities
*Note:* See note of Figure 4.

**Table 3**. Standardized Beta-values of Regime-types for the Explanation of the Inequalities of Opportunities by Linear Regression

| Dependent variables | Sample | Deg. of socialism | Deg. of conservatism | Deg. of liberalism | Adj. r-square |
|---|---|---|---|---|---|
| Ineq. of opp.: | Full | [-0.481] | [-0.331] | [-0.089] | [0.000] |
| *Low ranks* | Excl. Netherl. | [-0.545] | [-0.146] | [0.015] | [0.000] |
| | Excl. Netherl. | [-0.501] | ... | [0.062] | [0.082] |
| | Excl. Netherl. | **-0.495*** | **...** | **...** | **0.170*** |
| | | - | + | o | |
| Ineq. of opp.: | Full | [-0.287] | [ 0.009] | [-0.305] | [0.000] |
| *High ranks* | Excl. Belgium | [-0.559] | [-0.128] | [-0.133] | [0.053] |
| | Excl. Belgium | -0.520 | ... | [-0.102] | [0.142] |
| | Excl. Belgium | **-0.536*** | **...** | **...** | **0.216*** |
| | | - | + | o | |
| Ineq. of opp.: | Full | -0.540* | [-0.291] | [-0.319] | [0.139] |
| *Total* | Full | [-0.461] | ... | [-0.229] | [0.142] |
| | Full | **-0.483*** | **...** | **...** | **0.163*** |
| | | - | + | o | |

*Note:* Significances (1-tailed t-test with rounded error probabilities): ***: 0.1%, **: 1%, *: 5%, [ ]: n.s.; Expected signs: +: Pos., -: Neg., o: No effect; ... : Variable not included; Bold: Final model; Adj. r-square: Adjusted r-square; Excl. Belgium: Belgium as an outlier excluded from regression due to the highest inequality of opportunities for high ranking jobs (see Table 1). Excl. Netherl.: Netherlands as an outlier excluded from regression due to the highest inequality of opportunities for low ranking jobs (see Table 1).

to $p_{lo}$ (see formula (4)), T has a statistical distribution that is very close to the inequality of opportunities of the lower ranks $T_{lo}$.

In order to explain the different inequalities of opportunities by linear regression, we had to remove from some of the analyses of Table 3 outliers like the Netherlands or Belgium (see Figure 5). In terms of the r-squares, the result is acceptable (see Table 3), but not as good as for intra-gender inequality (see Table 2). Moreover not all of the hypotheses about the effects of the regime variables are confirmed by the data: contrary to the hypotheses 1a,b,c the effects of conservative regimes on the different forms of inequalities of opportunities are not positive but neutral (see Table 3) – where the reasons for these anomalies are not clear. The regression coefficients of the liberal regimes are according to Table 3 not significant and had to be dropped in order to make the final model statistically acceptable. Hence the coefficients of Table 3 correspond to the hypotheses 4a,b,c, which postulate for liberalism a no-effect situation. Finally, the negative signs of the corresponding beta-values of Table 3 also show that all forms of inequalities of opportunities are reduced by

the presence of a socialist welfare regime, as predicted by the hypotheses 5d,e,f.

*Total Inequality*

According to the synoptic Figure 3, the entropy H describes the total inequality of the privilege distribution, which has in turn two additive components: the intra-gender inequality $H_{m+f}$ of both gender-groups and their inequality of opportunities T. The boxplots in Figure 6 show the statistical properties of the three indicators: *total inequality* is generally quite close to the theoretical maximum 1 and the inter-country variation is rather small. The main component of total inequality is *intra-gender inequality,* whereas the *inequality of opportunities* is comparatively low. This means that the inequality between the employees of an average national labor market is mainly influenced by the hierarchies among men as well as among women and less by the fact that men and women have different chances for getting a higher professional position.

As in the previous Tables 2 and 3, we attempted to explain in Table 4 the total inequality H by the type welfare regime.
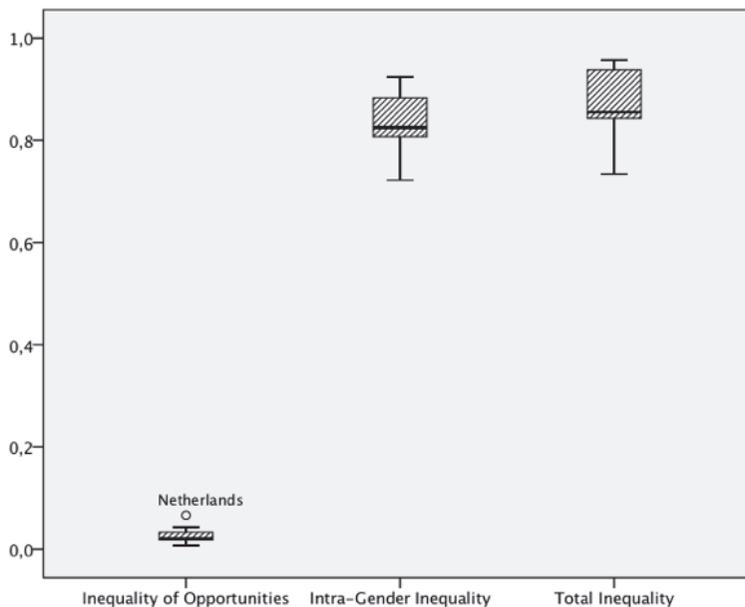


**Figure 6**. Boxplots of Total Inequality and its Components
*Note:* See note of Figure 4.

**Table 4.** Standardized Beta-values of Regime-types for the Explanation of Total Inequality

| Dependent variables | Sample | Deg. of socialism | Deg. of conservatism | Deg. of liberalism | Adj. r-square |
|---|---|---|---|---|---|
| Total | Full | [-0.368] | [-0.099] | [0.224] | [0.000] |
| inequality | Excl. Finland | -0.431* | [0.443] | 0.717** | 0.479* |
| | Excl. Finland | **-0.530*** | **...** | **0.515*** | **0.364*** |
| | | - | + | + | |

*Note:* Significances (1-tailed t-test): ***: 0.1%, **: 1%, *: 5%, [ ]: n.s.; Expected signs: +: Pos., -: Neg., o: No effect; ... : Variable not included; Bold: Final model; Adj. r-square: Adjusted r-square;  Excl. Finland: Finland as an outlier excluded from regression due to lowest value of total inequality (see Table1).

The beta-coefficients of Table 4 suggest that socialism reduces this inequality, as expected earlier in hypothesis 5g. Liberalism has the contrary effect of increasing the total inequality, which corresponds to hypothesis 3d. Table 4 falsifies only hypothesis 2d: conservatism has in reality not an increasing but a neutral effect on total inequality. In spite of this deficiency the final model without the degree of conservatism explains 36% of the total variance, which is in view of the restricted choice of the explanatory variables certainly not too bad.

## CONCLUSIONS

In this article we pursued two interdependent goals: On the one hand we wanted to construct indicators of inequality, which allow to make meaningful comparisons not only between countries but also between different forms of inequalities. As shown in Figure 3, we reached this goal relatively well: by the use of information theory it is possible to explore the *interdependence* of the different indicators of gender inequality in a mathematically precise way. On the other hand we wanted to explain gender inequalities at work by means of welfare regime variables.

In order to reach the second goal of the article, we had to exclude from the regression analyses some values of Finland, Belgium, and the Netherlands. According to Table 1, these three countries represent the highest or the lowest values of the respective dependent variables. In many cases, the boxplots of Figures 4–6 identify these countries even as *statistical outliers*. Given the *small* number of observations (N = 13) available for regression analyses, these outliers tended to destroy the full models. Consequently we decided to exclude these values from many of the calculations of Tables 2–4, although the reasons for these statistical anomalies are not always clear: the impact of the country-specific business culture on the structure

**Table 5.** The Effects of Regime-Types on Different Forms of Inequality: Theory vs. Data

| Explanatory variables: | Deg. of socialism | | Deg. of conservatism | | Deg. of liberalism | |
|---|---|---|---|---|---|---|
| Dependent variables | Data | Theory | Data | Theory | Data | Theory |
| Intra-gender inequality: Men | - | - | + | + | + | + |
| Intra-gender inequality: Women | o | - | + | + | + | + |
| Intra-gender inequality: Total | o | - | + | + | + | + |
| Ineq. of opportunities: Lower ranks | - | - | o | + | **o** | **o** |
| Ineq. of opportunities: Higher ranks | - | - | o | + | **o** | **o** |
| Ineq. of opportunities: Total | - | - | o | + | **o** | **o** |
| Total inequality | - | - | o | + | + | + |
| % consistency of theory and data: | 71% | | 43% | | 100% | |

*Note:* Signs: See expected signs ("Theory") and beta-values ("Data") of Tables 2 – 4.  Bold: Theory and data are consistent. % consistency of theory and data: % of theoretical expectations, which are confirmed by the data.

of professional hierarchies is perhaps an explanation.

After excluding the mentioned extreme values, our hypotheses about the effects of *liberalism* were 100% correct (see Table 5). It seems that we understand the functioning of *socialist* regimes also relatively well: here 71% of our original hypotheses were correct. In the remaining 29% of cases we failed, possibly due to the male syndicalist influence on socialist welfare policies. What

we really do not understand are *conservative* regimes: more than half of our hypotheses are wrong. One of the possible explanations for this misfortune is the political change since the definition of these regimes by Esping-Andersen. Nowadays there probably exists a modern version of these regimes, which follows a care policy that is less women- and more state-centered, with favorable effects on the equality of opportunities between men and women.

## APPENDIX

**Table 6.** Raw Data About Welfare Regimes and Higher Professional Ranks

| Country | %-share of higher ranks among | | | Degree of the welfare regime's | | |
|---------|-------|---------|------|------|------|------|
|         | males | females | both | soc. | lib. | cons. |
| Austria | 37.2 | 20.3 | 27.5 | 4 | 4 | 8 |
| Belgium | 37.5 | 16.9 | 27.4 | 6 | 4 | 6 |
| Denmark | 39.4 | 24.3 | 31.5 | 8 | 10 | 2 |
| Finland | 26.2 | 15.4 | 20.6 | 4 | 8 | 8 |
| France | 49.0 | 28.3 | 37.8 | 2 | 6 | 8 |
| Germany | 34.5 | 20.5 | 27.1 | 4 | 6 | 4 |
| Ireland | 27.4 | 19.1 | 22.5 | 8 | 6 | 0 |
| Italy | 39.0 | 17.3 | 28.0 | 2 | 4 | 4 |
| Netherlands | 52.8 | 23.6 | 36.8 | 4 | 6 | 2 |
| Norway | 42.8 | 28.0 | 35.4 | 6 | 6 | 6 |
| Sweden | 32.9 | 18.5 | 24.8 | 6 | 4 | 2 |
| Switzerland | 46.4 | 26.9 | 35.8 | 2 | 10 | 0 |
| UK | 37.6 | 24.5 | 29.8 | 6 | 8 | 4 |

*Note:* %-share of higher ranks: % of workforce with 1 or more subordinates; soc.: Degree of socialism; lib.: Degree of liberalism; cons.: Degree of conservatism.
*Sources:* Regime types: Scruggs and Allen (2008). %-share of higher ranks: European Values Study EVS (2008), variable V341.

## Notes

1. ld = Logarithm to the base 2.
2. If everyone is P = low, then $H = -[p_{lo}*ld(p_{lo}) + p_{hi}*ld(p_{hi})]$ $= -1*ld(1) - 0*ld(0) = -1*0 + 0 = 0$. Alternatively, if everyone is P = high, then $H = -[p_{lo}*ld(p_{lo}) + p_{hi}*ld(p_{hi})]$ $= -0*ld(0) - 1*ld(1) = 0 - 1*0 = 0$.
3. If $p_{lo} = p_{hi} = 1/2$, then $H = -[1/2*ld(1/2) + 1/2*ld(1/2)]$ $= -2*1/2*ld(1/2) = (-1)*(-1) = 1$.
4. Calculations based on the assumption of equal shares of men and women: $p_m = p_f$.
5. $p_m*(H-H_m) + p_f*(H-H_f) = p_m*H + p_f*H - p_m*H_m - p_f*H_f =$ $(p_m+p_f)*H - (p_m*H_m + p_f*H_f) = H - (p_m*H_m + p_f*H_f) =$ *Transinformation* of gender according to definition 3.4 of Mathar (1996: 28), since the term $(p_m*H_m + p_f*H_f)$ is just the conditional entropy of definition 3.3 of Mathar (1996: 27).
6. Contrary to T, which is always *positive*, $T_{lo}$ and $T_{hi}$ can also be *negative,* which implies an information *loss* resulting

from the knowledge of ranks.

7. Proof based on Mathar (1996), p. 31, lemma 3.2b and p. 27, definition 3.3:
   $p_{lo}*T_{lo} + p_{hi}*T_{hi} = p_{lo}*(H'-H'_{lo}) + p_{hi}*(H'-H'_{hi}) =$
   $(p_{lo}+p_{hi})*H' - [p_{lo}*H'_{lo} + p_{hi}*H'_{hi}] = H' - [p_{lo}*H'_{lo} + p_{hi}*H'_{hi}]$
   $= T,$
   where H' is the entropy of the gender distribution and $H'_{lo}$ and $H'_{hi}$ are the respective entropies of the gender distribution of the <u>lo</u>w- and the <u>hi</u>gh-privilege positions.
8. Proof:
   $H_{m+f} + T =$
   $[p_m*H_m + p_f*H_f] + [p_m*(H-H_m) + p_f*(H-H_f)] =$
   $[p_m*H_m + p_f*H_f] + [p_m*H - p_m*H_m + p_f*H - p_f*H_f] =$
   $p_m*H + p_f*H = (p_f + p_m)*H$
   $= H$
9. Expression (6) corresponds to the decomposition of income-inequality into within- and between-group inequality by

Theil (1972: 100–102). However, Theil uses a different standardization of the data for calculating his entropy measures. Moreover, he does *not* interpret his *between-set inequality* as an *information gain* from group identification, which points to an *inequality of opportunities,* as this paper does when revealing the sociological meaning of T.

10. *Degree of socialism* refers to the original terminology of Esping-Andersen (1990). The related welfare regimes are generally not Marxist but rather *social-democratic*.

# References

Chafetz, Janet. 1991. *Gender Equity: An Integrated Theory of Stability and Change.* Newbury Park: Sage.

Coulter, Philip. 1989. *Measuring Inequality: A Methodological Handbook.* Boulder: Westview Press.

Daly, Mary, and Katherine Rake. 2003. *Gender and the Welfare State: Care, Work, and Welfare in Europe and the USA.* Cambridge: Polity Press.

Esping-Andersen, Gosta. 1990. *The Three Worlds of Welfare Capitalism.* Cambridge: Polity Press.

Everitt, Brian. 2006. *The Cambridge Dictionary of Statistics (3rd edition).* Cambridge: Cambridge University Press.

EVS. 2008. *European Values Study 2008.* (http://www.gesis.org/ unser-angebot/daten-analysieren/umfragedaten/european-values-study/4th-wave-2008/) (accessed on 4/5/13).

Gelissen, John. 2002. *Worlds of Welfare, Worlds of Consent?: Public Opinion on the Welfare State.* Leiden: Brill.

Kan, Man, and Jonathan Gershuny. 2010. "Gender Segregation and Bargaining in Domestic Labour: Evidence from Longitudinal Time-Use Data." Pp. 153–173 in *Gender Inequalities in the 21st Century,* edited by Jacqueline Scott, Rosemary Crompton, and Clare Lyonette. Cheltenham: Edward Elgar.

LeFeuvre, Nicky. 2010. "Feminising Professions in Britain and France: How Countries Differ." Pp. 126–149 in *Gender Inequalities in the 21st Century,* edited by Jacqueline Scott, Rosemary Crompton, and Clare Lyonette. Cheltenham: Edward Elgar.

Mathar, Rudolf. 1996. *Informationstheorie: Diskrete Modelle und Verfahren (Information Theory: Discrete Models and Procedures),* pp. 22–42. Stuttgart: Teubner.

Meyers, Marcia, Janet Gornick, and Katherin Ross. 1999. "Public Childcare, Parental Leave, and Employment." Pp. 117–146 in *Gender and Welfare State Regimes,* edited by Diane Sainsbury. Oxford: Oxford University Press.

Mitchell, Deborah. 1993. *Income Transfers in Ten Welfare States.* Aldershot: Avebury.

Mueller, Georg. 2004. "Entropy Measures for Comparative Analyses of Social Justice and Discrimination." Pp. 15–31 in *Inequality: New Analytical Approaches*, edited by Gerd Grözinger and Anne van Aaken. Marburg: Metropolis-Verlag.

O'Connor, Julia. 1999. "Employment Equality Strategies in Liberal Welfare States." Pp. 47–74 in *Gender and Welfare State Regimes,* edited by Diane Sainsbury. Oxford: Oxford University Press.

OECD 2013. *Closing the Gender Gap.* Paris: OECD Publishing.

Sainsbury, Diane (ed.). 1999a. *Gender and Welfare State Regimes.* Oxford: Oxford University Press.

Sainsbury, Diane. 1999b. *Gender and Social Democratic Welfare States.* Pp. 75–114 in *Gender and Welfare State Regimes,* edited by Diane Sainsbury. Oxford: Oxford University Press.

Scruggs, Lyle, and James Allan. 2008. "Social Stratification and Welfare Regimes for the Twenty-First Century." *World Politics* 60 (4): 642–64: Tab. 2 (col. latest), Tab. 3 (col. latest), Tab. 4 (col. 2002).

Shannon, Claude, and Warren Weaver. [1949] 1962. *The Mathematical Theory of Communication.* Urbana: University of Illinois Press.

Stone, James. 2015. *Information Theory: A Tutorial Introduction.* Sheffield: Sebtel Press.

Theil, Henri. 1972. *Statistical Decomposition Analysis: With Applications in the Social and Administrative Sciences.* Amsterdam: North-Holland Publishing Company.

Wikipedia. 2016. *Theil-Index. (https://en.wikipedia.org/wiki/ Theil_index)* (accessed on 6/16/2017).

**Georg P. Mueller** is retired senior lecturer of the Faculty of Economics and Social Sciences at the University of Fribourg (Switzerland). His research interests and publications are in the fields of social indicators and the mathematical modeling of social processes, with a special focus on comparative international data.