

A Web Appendix

This *Web Appendix* (not for publication) provides additional material discussed in the unpublished manuscript *The Decomposition of Income Inequality in the EU-28*.

A.1 Theil index

The Theil index, $T(1)$, can be written as

$$T(1) = \frac{1}{N} \sum_{i=1}^N \left(\frac{y_i}{\mu} \right) \ln \left(\frac{y_i}{\mu} \right) \quad (2)$$

with

- N size of the population
- y_i individual income
- μ mean income of the population

In the case of perfect equality each individual in the sample has exactly the same income and the Theil index is zero, which represents its minimum value. On the other hand, if there is total inequality one individual has all the income and the Theil index equals $\ln(N)$, its maximum value. Bourguignon (1979) points out that Theil indices have several favourable characteristics as they “[...] (a) are continuous and differentiable in all individual incomes; (b) are symmetric; (c) are income-homogeneous of degree zero; (d) satisfy the symmetry axiom for population; (e) satisfy the Pigou-Dalton condition; and (f) are decomposable” (Bourguignon 1979, p. 902).¹⁷ Due to the last property $T(1)$ can be expressed as the sum of a within- and between-group component, which is shown in equation 1. This is what Cowell (2000) describes as the “accountant’s approach”, which does not only take an individual country’s inequality into consideration but also the heterogeneity between countries.

As an alternative to the Theil index, Hoffmeister (2009) calculates the Mean Logarithmic Deviation (MLD), which uses purely population based weights instead of income share based weights. However, this study follows the argumentation of Beblo & Knaus (2001), who underline that income share based weights are more convenient because they reflect each country’s economic standing in Europe. Thus, this study uses the Theil instead of the MLD.

¹⁷For more information about the nature of additive decomposable inequality measures see, among others, Shorrocks (1980).

A.2 Sensitivity analyses

For a robustness check two sensitivity analyses are carried out. The first replicates the results in section 3 and 4 by using the Mean Logarithmic Deviation (MLD). This approach investigates if the conclusions in section 3 and 4 change when population based weights are used instead of income share based weights. In a second sensitivity analysis, old age benefits are added to market incomes. This approach should take the effect of old age benefits on income inequality into account.

A.2.1 Mean Logarithmic Deviation

As discussed in section A.1, the Mean Logarithmic Deviation (MLD) is calculated which is defined as

$$T(0) = \frac{1}{N} \sum_{i=1}^N \ln \left(\frac{\mu}{y_i} \right) \quad (3)$$

with

- N size of the population
- μ mean income
- y_i individual income

According to Bourguignon (1979), Cowell (1980) and Shorrocks (1980) $T(0)$ can be decomposed as follows

$$T(0) = \underbrace{\sum_{k=1}^K p_k \times T(0)_k}_{\text{within component}} + \underbrace{\sum_{k=1}^K p_k \ln \left(\frac{\mu}{\mu_k} \right)}_{\text{between component}} \quad (4)$$

with

- K population subgroup
- p_k population share of subgroup k
- $T(0)_k$ MLD of subgroup k
- μ mean income
- μ_k mean income of subgroup k

From equation 4 it is seen that the MLD uses population based weights, p_k , for calculating each country's contribution to overall inequality, compared to income share based weights when calculating the Theil index. The main results of this study remain unaltered when using

the MLD, rather than the Theil index. However, some results are sensitive to the choice of measure used to calculate inequality. First, the use of population based weights of the MLD changes the contribution of single countries. For example, Romania has an income share of 1.2% but represents around 3.9% of the EU-28 population. Therefore, when using the MLD, Romania's contribution to the aggregated inequality of the EU-28 more than doubles from 2.3% (Theil) to 4.9% (MLD). However, the MLD indicates an income inequality of 0.229 points in 2014 for the EU-28, which is slightly higher than the finding of Hoffmeister (2009), who calculates a MLD of 0.216 points for the EU-25 in the year 2000. Second, the results show that the relative contribution of between-country inequality increases from 21.7% (Theil) to 24.7% (MLD) for disposable income but decreases sharply from 10.1% (Theil) to 2% (MLD) for market incomes. Third, when the MLD is decomposed by demographic groups results change. It is shown that households with hh older than 59 years of age show the lowest, while households with hh without children show the highest income inequality. Fourth, after transfers and taxes inequality decreases more using the MLD (−92.9%) compared to the Theil (−59.7%). Moreover, the results find no significant relationship between post-transfer annual mean incomes and the reduction of inequality on country group level.

To summarise, the main conclusions regarding the composition of income inequality in the EU-28 remain unaltered, whether using the MLD or the Theil index. However, there are some differences which are driven due to the use of population based weights instead of income share based weights. It is shown that the use of the MLD changes the contribution of single countries, the relative contribution of between-country inequality, the results regarding demographic subgroups and the reduction of inequality after transfers and taxes.

A.2.2 The effect of old age benefits on income inequality

According to results of Eurofound (2017), pensions are the most important element of social benefits with regard to redistribution. They state that notably in BC, EEC and MC the pension system has a significant role in reducing inequality. Therefore, old age benefits are added to market incomes to illustrate their importance on income inequality. However, it is necessary to mention that this analysis cannot reflect the full redistributive effect of the pension system as it only considers the influence of old age benefits. The results show that inequality for market income decreases from 0.533 to 0.346, when old age benefits are taken into account. However, Table 20 indicates that the relative contribution of between-country differences increases from 10.1% to 14.7%. The same holds true when considering country groups in Table 21, where the relative contribution of between-country-group inequality increases from 8.6% to 12.7%. Therefore, the results show that the inclusion of old age benefits in market incomes lowers inequality but increases the relative contribution of between-country and between-country-group inequality. This findings illustrate that in most countries old age benefits depend on earnings in the past. Thus, former differences in incomes are reinforced due to the pension system.

TABLE 12 — Sensitivity analysis: Sources of income inequality in the EU-28 by country, 2014

Country	MLD	Annual Mean Income in thd EUR	Inequality Share ^a (%)	Population weight ^b (%)
AT	0.140	24	1.0	1.7
BE	0.117	21.9	1.1	2.2
BG	0.246	8.9	1.6	1.4
CY	0.191	18.4	0.1	0.2
CZ	0.106	13.3	1.0	2.1
DE	0.159	23.4	11.1	15.9
DK	0.140	23.8	0.7	1.1
EE	0.207	13.4	0.2	0.3
EL	0.219	10.6	2.1	2.2
ES	0.220	17.3	8.9	9.2
FI	0.108	21.3	0.5	1.1
FR	0.144	22.8	7.9	13.0
HR	0.170	9.7	0.6	0.8
HU	0.139	9.1	1.2	1.9
IE	0.151	22.2	0.6	0.9
IT	0.195	18	10.4	12.0
LT	0.251	11	0.6	0.6
LU	0.139	33.2	0.1	0.1
LV	0.221	10.4	0.4	0.4
MT	0.131	19.1	0.0	0.1
NL	0.125	21.9	1.8	3.3
PL	0.166	11.1	5.5	7.5
PT	0.209	12.7	1.9	2.1
RO	0.283	5.4	4.9	3.9
SE	0.120	22	1.0	1.9
SI	0.104	16.5	0.2	0.4
SK	0.114	11.1	0.5	1.1
UK	0.167	20.6	9.3	12.7
Between countries	—	—	24.7	—
Europe	0.229	18.4	100	100

Source: Own calculations, EU-SILC 2014 & 2015

Notes: Income is defined as equivalised disposable household income and PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

^a The inequality share represents the contribution of a country to the overall inequality of the EU-28.

^b The population weight describes the population share of a country with regard to the overall population of the EU-28.

TABLE 13 — Sensitivity analysis: Sources of income inequality in the EU-28 by country group, 2014

Country group	MLD	Annual Mean Income in thd EUR	Inequality Share ^a (%)	Population weight ^b (%)
BC	0.237	11.3	1.3	0.8
CEE	0.147	23	23.2	45.0
EEC	0.227	9.9	19.1	10.4
LME	0.167	20.8	9.9	15.3
MC	0.219	16.7	24.7	23.5
SDC	0.123	22.3	2.2	5.1
Between country group	0.045	—	19.6	—
Europe	0.229	18.4	100	100

Source: Own calculations, EU-SILC 2014 & 2015

Notes: Income is defined as equivalised disposable household income and PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

^a The inequality share represents the contribution of a country group to the overall inequality of the EU-28.

^b The population weight describes the population share of a country group with regard to the overall population of the EU-28.

TABLE 14 — Sensitivity analysis: Sources of income inequality in the EU-28 by country and demographic group, 2014

Country	Age of the Household Head ^a			all
	< 60, without children	< 60, children	≥ 60	
AT	0.138	0.113	0.167	0.140
BE	0.123	0.102	0.117	0.117
BG	0.212	0.276	0.216	0.246
CY	0.198	0.165	0.233	0.191
CZ	0.104	0.120	0.066	0.106
DE	0.173	0.138	0.150	0.159
DK	0.163	0.120	0.127	0.140
EE	0.211	0.206	0.144	0.207
EL	0.227	0.245	0.164	0.219
ES	0.215	0.242	0.183	0.220
FI	0.129	0.078	0.112	0.108
FR	0.148	0.118	0.169	0.144
HR	0.168	0.143	0.186	0.170
HU	0.150	0.137	0.104	0.139
IE	0.162	0.136	0.162	0.151
IT	0.189	0.206	0.178	0.195
LT	0.240	0.292	0.165	0.251
LU	0.147	0.137	0.118	0.139
LV	0.203	0.224	0.204	0.221
NL	0.140	0.111	0.117	0.125
PL	0.170	0.169	0.145	0.166
PT	0.211	0.198	0.216	0.209
RO	0.218	0.291	0.368	0.283
SE	0.156	0.085	0.114	0.120
SI	0.103	0.096	0.116	0.104
SK	0.096	0.138	0.069	0.114
UK	0.183	0.148	0.144	0.167
Europe	0.232	0.225	0.221	0.229

Source: Own calculations, EU-SILC 2014 & 2015

Notes: Income is defined as equivalised disposable household income and PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

Malta had to be excluded because it does not report information about the age of individuals.

^a The household head is defined as the person with the highest income of at least 18 years of age. When two household members have the same income, the oldest person is chosen to be the household head.

TABLE 15 — Sensitivity analysis: Contribution to income inequality in the EU-28 by country and demographic group, 2014

Country	Contribution to Country Inequality in %			variation between hh
	Age of the Household Head ^a			
	< 60, without children	< 60, children	≥ 60	
AT	46.26	26.53	24.11	3.10
BE	43.47	32.53	21.28	2.72
BG	36.78	40.00	18.91	4.30
CY	45.03	34.53	19.92	0.52
CZ	42.19	40.52	13.05	4.25
DE	48.90	25.57	24.15	1.38
DK	47.31	30.63	21.60	0.46
EE	40.31	38.68	14.97	6.04
EL	43.12	37.34	18.79	0.76
ES	42.73	39.65	16.95	0.67
FI	48.17	25.02	25.80	1.01
FR	39.12	31.90	27.15	1.83
HR	41.79	30.65	23.46	4.10
HU	49.32	33.74	15.14	1.80
IE	36.54	43.12	19.34	1.00
IT	40.28	35.64	22.42	1.66
LT	40.89	41.57	14.15	3.39
LU	47.28	37.77	14.26	0.69
LV	38.08	38.61	18.91	4.40
NL	45.93	32.89	20.97	0.21
PL	42.15	41.45	15.60	0.79
PT	40.12	33.65	25.71	0.53
RO	31.60	39.70	26.43	2.27
SE	47.85	27.66	23.31	1.18
SI	44.12	34.46	20.59	0.83
SK	38.59	46.41	9.56	5.44
UK	44.41	33.40	18.64	3.55
Variation between countries, %	24.41	26.55	26.09	–
Europe	42.25	35.32	21.66	0.77

Source: Own calculations, EU-SILC 2014 & 2015

Notes: Income is defined as equivalised disposable household income and PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

Malta had to be excluded because it does not report information about the age of individuals.

^a The household head is defined as the person with the highest income of at least 18 years of age. When two household members have the same income, the oldest person is chosen to be the household head.

TABLE 16 — Sensitivity analysis: Sources of income inequality in the EU-28 by country group and demographic group, 2014

Country group	Age of the Household Head ^a			all
	< 60, without children	< 60, children	≥ 60	
BC	0.227	0.256	0.176	0.237
CEE	0.158	0.124	0.156	0.147
EEC	0.211	0.247	0.210	0.227
LME	0.182	0.148	0.145	0.167
MC	0.215	0.231	0.200	0.219
SDC	0.151	0.094	0.118	0.123
Europe	0.232	0.225	0.221	0.229

Source: Own calculations, EU-SILC 2014 & 2015

Notes: Income is defined as equivalised disposable household income and PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

Malta had to be excluded because it does not report information about the age of individuals.

^a The household head is defined as the person with the highest income of at least 18 years of age. When two household members have the same income, the oldest person is chosen to be the household head.

TABLE 17 — Sensitivity analysis: Contribution to income inequality in the EU-28 by country group and demographic group, 2014

Country group	Contribution to Country Inequality in %			variation between hh
	Age of the Household Head ^a			
	< 60, without children	< 60, children	≥ 60	
BC	39.98	40.23	15.72	4.07
CEE	45.10	28.83	25.32	0.75
EEC	39.38	41.77	17.89	0.96
LME	43.86	34.19	18.70	3.26
MC	41.47	36.54	21.05	0.94
SDC	47.60	28.20	23.36	0.85
Variation between country groups, %	19.18	20.08	21.22	–
Europe	42.25	35.32	21.66	0.77

Source: Own calculations, EU-SILC 2014 & 2015

Notes: Income is defined as equivalised disposable household income and PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

Malta had to be excluded because it does not report information about the age of individuals.

^a The household head is defined as the person with the highest income of at least 18 years of age. When two household members have the same income, the oldest person is chosen to be the household head.

TABLE 18 — Sensitivity analysis: Sources of income inequality in the EU-28 before and after government redistribution by country, 2014

Country	Pre- Transfer MLD ^a	Pre- Transfer Share ^c (%)	Post- Transfer MLD ^b	Post- Transfer Share ^c (%)
AT	2.487	1.3	0.140	1.4
BE	3.637	2.6	0.117	1.5
BG	3.468	1.6	0.246	2.1
CY	2.522	0.1	0.191	0.2
CZ	3.470	2.3	0.106	1.3
DE	2.684	13.7	0.159	14.7
DK	1.307	0.4	0.140	0.9
EE	4.070	0.3	0.207	0.3
EL	5.887	4.0	0.219	2.7
ES	2.568	7.5	0.220	11.8
FI	2.201	0.8	0.108	0.7
FR	1.526	6.1	0.144	10.5
HR	5.030	1.3	0.170	0.8
HU	4.100	2.5	0.139	1.6
IE	5.660	1.7	0.151	0.8
IT	3.201	12.4	0.195	13.8
LT	4.872	0.9	0.251	0.9
LU	2.417	0.1	0.139	0.1
LV	3.495	0.4	0.221	0.5
MT	0.923	0.0	0.131	0.1
NL	1.616	1.7	0.125	2.4
PL	4.090	9.8	0.166	7.3
PT	4.951	3.3	0.209	2.5
RO	5.205	6.6	0.283	6.5
SE	1.569	1.0	0.120	1.4
SI	2.622	0.3	0.104	0.2
SK	3.667	1.2	0.114	0.7
UK	3.985	16.0	0.167	12.3
Between countries	0.065	2.0	0.057	24.7
Europe	3.214	100	0.229	100

Source: Own calculations, EU-SILC 2014 & 2015

Notes: All income are PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

^a Income is defined as equivalised market household income.

^b Income is defined as equivalised disposable household income.

^c The share represents the contribution of a country to the overall inequality of the EU-28.

Cross-sectional weights from the EU-SILC are used.

TABLE 19 — Sensitivity analysis: Sources of income inequality in the EU-28 before and after government redistribution by country group, 2014

Country group	Pre-Transfer MLD ^a	Pre-Transfer Share ^c (%)	Post-Transfer MLD ^b	Post-Transfer Share ^c (%)
BC	4.271	1.7	0.237	1.6
CEE	2.232	25.4	0.147	28.8
EEC	4.247	25.8	0.227	23.8
LME	4.100	17.6	0.167	12.3
MC	3.339	27.4	0.219	30.7
SDC	1.678	2.2	0.123	2.8
Between country groups	0.051	1.6	0.045	19.6
Europe	3.214	100	0.229	100

Source: Own calculations, EU-SILC 2014 & 2015

Notes: All income are PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

^a Income is defined as equivalised market household income.

^b Income is defined as equivalised disposable household income.

^c The share represents the contribution of a country group to the overall inequality of the EU-28.

TABLE 20 — Sensitivity analysis: Sources of income inequality in the EU-28 before and after government redistribution by country (including old-age benefits in market income), 2014

Country	Pre- Transfer Theil ^a	Pre- Transfer Share ^c (%)	Post- Transfer Theil ^b	Post- Transfer Share ^c (%)
AT	0.267	1.8	0.141	1.5
BE	0.267	2.0	0.121	1.5
BG	0.292	0.5	0.251	0.8
CY	0.337	0.1	0.233	0.2
CZ	0.201	0.8	0.114	0.8
DE	0.284	17.4	0.162	15.3
DK	0.277	1.3	0.158	1.1
EE	0.273	0.1	0.196	0.2
EL	0.331	1.3	0.211	1.2
ES	0.347	7.8	0.195	7.9
FI	0.257	0.9	0.112	0.7
FR	0.266	11.7	0.165	12.0
HR	0.324	0.4	0.156	0.3
HU	0.221	0.6	0.138	0.6
IE	0.414	1.2	0.152	0.8
IT	0.293	10.3	0.178	9.8
LT	0.355	0.3	0.258	0.4
LU	0.242	0.1	0.143	0.1
LV	0.282	0.2	0.211	0.2
MT	0.230	0.1	0.136	0.1
NL	0.269	3.6	0.133	2.5
PL	0.231	3.1	0.163	3.5
PT	0.362	1.6	0.204	1.4
RO	0.529	1.8	0.430	2.3
SE	0.209	1.4	0.110	1.2
SI	0.234	0.2	0.102	0.2
SK	0.153	0.3	0.099	0.3
UK	0.361	14.4	0.177	11.6
Between countries	0.051	14.7	0.047	21.7
Europe	0.346	100	0.215	100

Source: Own calculations, EU-SILC 2014 & 2015

Notes: All income are PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

^a Income is defined as equivalised market household income.

^b Income is defined as equivalised disposable household income.

^c The share represents the contribution of a country to the overall inequality of the EU-28.

TABLE 21 — Sensitivity analysis: Sources of income inequality in the EU-28 before and after government redistribution by country group (including old-age benefits in market income), 2014

Country group	Pre-Transfer Theil ^a	Pre-Transfer Share ^c (%)	Post-Transfer Theil ^b	Post-Transfer Share ^c (%)
BC	0.316	0.6	0.233	0.8
CEE	0.276	36.7	0.158	33.0
EEC	0.302	8.8	0.223	10.7
LME	0.364	15.6	0.175	12.5
MC	0.327	21.8	0.198	21.7
SDC	0.245	3.7	0.125	2.9
Between country groups	0.044	12.7	0.040	18.4
Europe	0.346	100	0.215	100

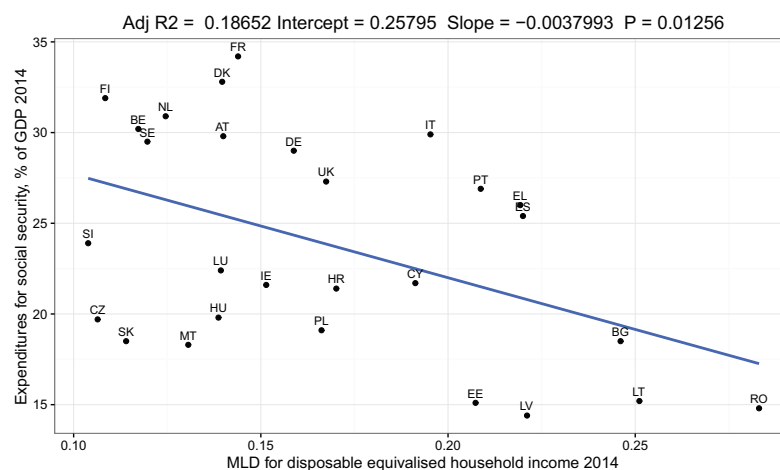
Source: Own calculations, EU-SILC 2014 & 2015

Notes: All income are PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

^a Income is defined as equivalised market household income.

^b Income is defined as equivalised disposable household income.

^c The share represents the contribution of a country group to the overall inequality of the EU-28.

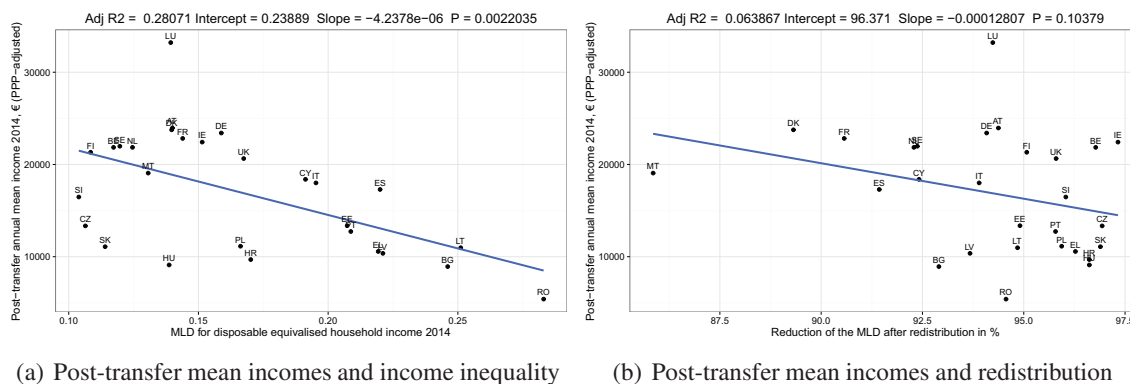


Source: Own calculations, EU-SILC 2014 & 2015, Eurostat

Notes: Income is defined as equivalised disposable household income and PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

This Figure illustrates a significant negative relationship between social expenditures for social security and the value of the MLD.

FIGURE 6 — Sensitivity analysis: The relationship between social expenditures and income inequality among countries, 2014



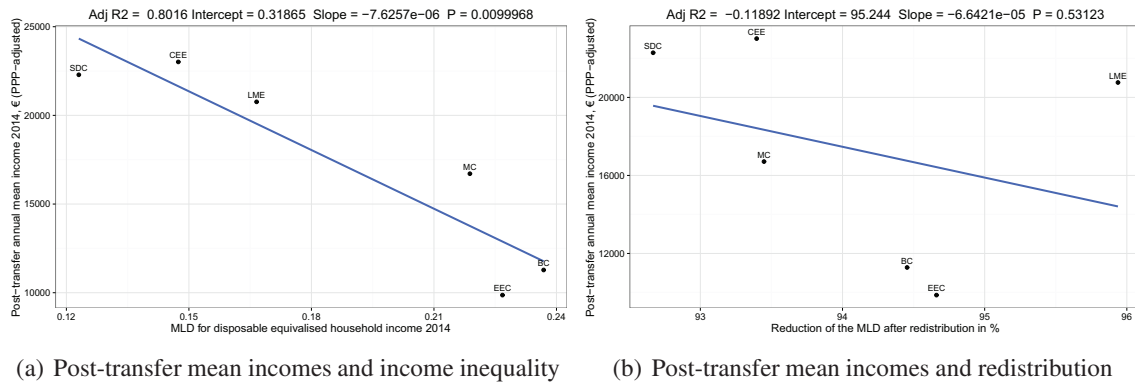
Source: Own calculations, EU-SILC 2014 & 2015, Eurostat

Notes: Income is defined as equivalised disposable household income and PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

(a) This Figure illustrates a significant negative relationship between annual mean incomes and the amount of income inequality.

(b) This Figure illustrates a not significant relationship between annual mean incomes and the reduction of income inequality due to government redistribution.

FIGURE 7 — Sensitivity analysis: The relationship between post-transfer annual mean incomes and redistribution among countries, 2014



Source: Own calculations, EU-SILC 2014 & 2015, Eurostat

Notes: Based on [Aristei & Perugini \(2015\)](#), countries are clustered into country groups with regard to similar socio-economic policies and institutions.

Income is defined as equivalised disposable household income and PPP-adjusted (EU-28=1). The income reference year for Germany is 2013. Cross-sectional weights from the EU-SILC are used.

(a) This Figure illustrates a significant negative relationship between annual mean incomes and the amount of income inequality.

(b) This Figure illustrates a not significant relationship between annual mean incomes and the reduction of income inequality due to government redistribution.

FIGURE 8 — Sensitivity analysis: The relationship between post-transfer annual mean incomes and redistribution among country groups, 2014