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Equivalence scales reconsidered – an empirical investigation

Timm Bönke und Carsten Schröder

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Timm Bönke

Free University Berlin, Department of Economics, Boltzmannstr. 20

14195 Berlin, Germany

Carsten Schröder*

Christian-Albrechts-University of Kiel, Olshausenstr. 40

24098 Kiel, Germany

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Abstract.

Income-expenditure surveys typically provide incomes on the household level. As households can differ in size and needs, a reliable assessment of inequality in living standards, therefore, necessitates the conversion of the original heterogeneous into an artificial quasi-homogeneous population. Ebert and Moyes (2003) and Shorrocks (2004) theoretically explore the properties of two alternative conversion strategies: a weighting of household equivalent incomes by size and by needs. We use data from the Luxembourg Income Study for examining the sensitivity of the Gini and the Theil index to the chosen conversion strategy, and explain our results by means of an inequality decomposition by population subgroups.

Key words: income distribution, inequality, inequality decomposition, equivalence scale.

JEL codes: D31, D63, I32

* Author of correspondence. Email: carsten.schroeder@economics.uni-kiel.de.

1 Introduction

Researchers and the public are eager to know about the distribution of living standards across individuals in a society. The living standard is determined by the material comfort goods and services available to each person provide. Usually, 'household income' serves as a proxy for the level of material comfort. Yet, this proxy is biased when comparisons involve household types that are heterogeneous. The concept of equivalent incomes masters this problem. Equivalent incomes are incomes that equalize the level of material comfort of persons living in different household types. Dividing the income of a household by the equivalent income of the one-member household gives the (relative) equivalence scale of the former household. Accordingly, an equivalence scale quantifies household needs relative to an 'equivalent (single) adult.'

Based on household-level income data, the one-member-household equivalent income can be assigned to each household member and all individuals of an economy can be viewed as living in separate one-member households. The consequent artificial quasi-homogeneous distribution of one-member-households' equivalent incomes captures the inequality of living standards among individuals. Still, even if one imposes income independent equivalence scales, such a conversion is not innocuous from a normative perspective (cf. Ebert and Moyes (2003) and Shorrocks (2004)). Especially, it does not meet the condition that an income transfer, which reduces the difference in living standards of two households, must not increase inequality (cf. Ebert and Moyes (2003)). To meet this condition, Ebert and Moyes (2003) suggest an alternative conversion procedure; i.e., to weight the equivalent income of any household unit by a factor that is equal (proportional) to its equivalence scale. The outcome is a quasi-homogeneous distribution that depicts inequality of livings standards among equivalent adults.

In this article, we contrast inequality estimates derived from size- and needs-weighted distributions. Inequality is measured by means of the Theil and the Gini index, both being among the most popular inequality measures in applied research. Estimates are provided for an extensive set of countries, also varying equivalence scales. Theil and Gini indices turn out to be sensitive to the chosen conversion procedure, and differences in the estimates are sufficiently large to change country inequality rankings – including reasonable levels of household-size economies. An inequality decomposition by household types reveals that this is due to an empirical regularity: compared to smaller household units, equivalent incomes of larger units tend to be distributed more equally.

Here is a roadmap to our paper. In Section 2, we suggest a useful benchmark scenario for investigating why needs-weighted inequality estimates are higher, and introduce the key concepts underlying our empirical analysis. In Section 3, we briefly explain our database and present our empirical results. Section 4 concludes the paper.

2 Preliminary considerations

2.1 A useful benchmark

To account for the dependence of peoples' living standards on household size and composition, household incomes are converted into equivalent incomes. Equivalence scales serve as the conversion device. Taking the one-member household as the reference, an equivalence scale gives the percentage change in household income required to maintain the living standard of each household member as further members are added. If household-size economies are achieved, the percentage change in household income which holds the living standard of a household's members constant is less than the percentage increase in family size. In practice there is no consensus about what the 'correct' equivalence scale is. For this reason, we apply a parametric equivalence scale suggested in Buhmann et al. (1988) that is rather flexible and allows for the variation of household-size economies through a single parameter. According to Buhmann et al. (1988), an equivalence scale can be written as $ES_i = (h_i)^\theta$, where $i = 1,...,n$ denotes the household type and h_i is its number of members. Household-size economies are represented by the catch-all parameter θ, with $0 \leq \theta \leq 1$, the 'equivalence-scale elasticity.'

From this specification it follows that $y_{\kappa,i} = x_{\kappa,i} / (h_i)^\theta$ is the one-member household's equivalent income of a household κ of type i with household income $x_{\kappa,i}$. A distribution of one-member-households' equivalent incomes (DOMHEI) is derived from the original household-income distribution by calculating, for each household unit, one-member household equivalent income and assigning this number to each household member. Consequently, we use the acronym 'size-weighting' to describe the conversion of the heterogeneous population into the DOMHEI. Compared with this, the conversion strategy of Ebert and Moyes (2003) requires that the equivalent income of any household unit is assigned to the number of equivalent adults living in the same household (alias the household's equivalence scale). The outcome is a 'distribution of equivalent adult households' equivalent incomes' (DEAHEI), and we refer to this type of conversion as 'needs-weighting.'[1]

Two special cases can be considered. First, the within-household production technology is such that full household-size economies are achieved ($\theta = 0$). Then household income equals

[1] Albeit its appealing properties from a normative perspective, the information content of such a distribution is open to debate. As O'Higgins, Schmaus and Smeeding (1990, p. 26) stressed and Podder and Chatterjee (2002, p. 11) later re-

equivalent income, and ‘h household members live as cheap as one.’ In this scenario, the equivalence scale is the same for all household types. Therefore, needs-weighting implies that all household incomes are weighted by the same factor, whereas, in case of size-weighting, household income is assigned to each household member. Second, the within-household production technology is such that household-size economies achieved are zero ($\theta = 1$), and ‘h household members live as cheap as h.’ In this case, the DOMHEI and the DEAHEI are equivalent concepts. Hence, this scenario may be seen as an eligible benchmark for investigating how DOMHEI- and DEAHEI-based inequality estimates differ when household-size economies go up.

2.2 Implications for inequality

Let K_i denote the number of households belonging to type i. Then, the number of artificial one-member households in the size-weighted distribution is $\sum_{i=1}^{n} h_i K_i$. Again, we focus on household unit κ of type i. Accordingly, $p_{\kappa,i}^{DOMHEI} = h_i \Big/ \sum_{i=1}^{n} h_i \mathrm{K}_i$ is the population share of all artificial one-member households formerly belonging to household unit κ, and $p_{\kappa,i}^{DOMHEI}$ is the *population share of κ in the DOMHEI*. The equivalent-income share of all artificial one-member households derived from household unit κ in total equivalent income equals $\pi_{\kappa,i}^{DOMHEI} = y_{\kappa,i} h_i \Big/ \sum_{i=1}^{n} \mu_i h_i \mathrm{K}_i$; with μ_i being the mean equivalent income of all households of type i. Compared to this, needs-weighting implies that κ is decomposed into ES_κ artificial equivalent-adults, $\sum_{i=1}^{n} ES_i K_i$ is the total number of equivalent-adult households, and $p_{\kappa,i}^{DEAHEI} = ES_i \Big/ \sum_{i=1}^{n} ES_i \mathrm{K}_i$ is the *population share of κ in the DEAHEI*. The equivalent-income share of all equivalent-adult households constructed from κ equals $\pi_{\kappa,i}^{DEAHEI} = y_{\kappa,i} ES_i \Big/ \sum_{i=1}^{n} \mu_i ES_i \mathrm{K}_i$.

These differences have immediate implications for inequality estimates elicited from the two quasi-homogeneous populations. For example, think of a heterogeneous population with many equally rich one-member households (in terms of equivalent income), and one poor multi-member household. Then the DEAHEI Lorenz dominates the DOMHEI, and size-weighted relative inequality estimates would indicate more inequality than needs-weighted estimates. Yet, the conversion procedure (and also the level of θ) does not affect the degree of relative inequality

echoed: “Equivalent adults do not exist, unlike families or individuals, although a family or an individual may have an among incomes of a quasi-homogeneous subgroup originating from the same household type. The ratios of population shares and equivalent-incomes of any such two households always equal $p_{1,i}^{DOMHEI} / p_{2,i}^{DOMHEI} = p_{1,i}^{DEAHEI} / p_{2,i}^{DEAHEI} = 1$ and $y_{1,i} / y_{2,i} = x_{1,i} / x_{2,i} = constant$. Hence, for this subgroup, a scale invariant, relative inequality index is not affected by the chosen conversion strategy. Yet, what will typically change is inequality between subgroups. An inequality decomposition by household types may, therefore, help in determining the effects that the two conversion strategies have on inequality.

2.3 Decomposing inequality by subgroups

Decomposability of an inequality measure implies a coherent relationship between inequality in the whole population and inequality in its constituent mutually exclusive subgroups. The basic idea is to express overall inequality as a function of inequality within and between its subgroups. An index is additively decomposable if it can be written as a weighted sum of the within-subgroup inequality indices plus a between-subgroup inequality term based on mean incomes and subgroup sizes. Obviously, it is quite exceptionable that an inequality index possesses such properties, but the Theil coefficient is a pleasant example. Other measures including the Gini coefficient are only decomposable, and a residual term remains.

Identifying subgroups of quasi-homogeneous households originating from equally typed households is the basic idea underlying our empirical analysis. This identification enables us to quantify how features of household-type specific income distributions affect inequality in living standards among artificial homogeneous units. Suppressing the DOMHEI/DEAHEI superscript, a decomposition of the Theil index, T, by population subgroups can be written as

$$(1) \qquad T = \underbrace{\sum_{i=1}^{n} T_i p_i \frac{\mu_i}{\mu}}_{W^T} + \underbrace{\sum_{i=1}^{n} p_i \frac{\mu_i}{\mu} \ln\left(\frac{\mu_i}{\mu}\right)}_{B^T},$$

where W^T is the within-subgroup component, B^T is the between-subgroup component, and

$$(2) \qquad T_i = \frac{1}{\mathrm{K}_i} \sum_{\kappa_i=1}^{\mathrm{K}_i} \frac{y_{\kappa,i}}{\mu_i} \ln\left(\frac{y_{\kappa,i}}{\mu_i}\right)$$

is the Theil index of the subgroup constructed from household type i.[2] The within-subgroup component of equation (1) is the sum of the subgroup specific Theil indices (equation (2)), whereby each T_i is weighted by the population share p_i times μ_i / μ. The latter expression captures how far type-i's deviates from overall mean equivalent income. Inequality between subgroups is measured

equivalent income."

[2] See Cowell (1995), pp. 149-154, for details.

by the second term on the right hand side of (1), and is determined by the weighted sum of relative deviations of subgroup specific from overall mean equivalent income.

Decomposing the Gini index, G, by population subgroups, gives,

$$(3) \qquad G = \underbrace{\sum_{i=1}^{n} G_i p_i \pi_i}_{W^G} + \underbrace{\sum_{i=1}^{n}\sum_{j>i}^{n}\left(\frac{\mu_j - \mu_i}{\mu_i}\right)\pi_i p_j}_{B^G} + O,$$

where G_i is the Gini index of the subgroup originating from type-i households,[3] π_i is the equivalent income share of i in total equivalent income ('economic weight'), and O is the 'overlap term.' Correspondingly to the Theil decomposition, within-group inequality, as captured by the first term of equation (3), is represented by the weighted sum of subgroup specific Gini coefficients. Between-subgroup inequality is given by the sum of relative differences in mean equivalent incomes of any two subgroups, i and j, weighted by $\pi_i p_j$, whereby subgroups are ranked by mean equivalent income such that $\mu_j > \mu_i$. Abstracting from $\pi_i p_j$, addends are the larger the bigger the relative difference in two subgroups' mean equivalent incomes is, viz. comparing 'rich' and 'poor' subgroups. Finally, the third term of (3) measures the overlap of subgroups' equivalent income distributions: ceteris paribus, the overlap is the higher the closer together the subgroup means of equivalent incomes are (see Lambert and Aranson (1993), p. 1226).[4]

In (1-3), some elements are invariant to the way the quasi-homogeneous population is constructed from the underlying heterogeneous one, namely μ_is, G_is, T_is, and O. Others, listed below, are sensitive to the type of conversion:

$$(4) \qquad p_i^{DOMHEI} = \frac{h_i \mathrm{K}_i}{\sum_{i=1}^{n} h_i \mathrm{K}_i}, \quad \pi_i^{DOMHEI} = \frac{\mu_i h_i \mathrm{K}_i}{\sum_{i=1}^{n} \mu_i h_i \mathrm{K}_i}, \text{ and } \mu^{DOMHEI} = \sum_{i=1}^{n} \mu_i p_i^{DOMHEI}$$

$$(5) \qquad p_i^{DEAHEI} = \frac{ES_i \mathrm{K}_i}{\sum_{i=1}^{n} ES_i \mathrm{K}_i} \text{ and } \pi_i^{DEAHEI} = \frac{\mu_i ES_i \mathrm{K}_i}{\sum_{i=1}^{n} \mu_i ES_i \mathrm{K}_i}, \text{ and } \mu^{DEAHEI} = \sum_{i=1}^{n} \mu_i p_i^{DEAHEI},$$

with:

- p_i^{DOMHEI}: fraction of one-member households in the DOMHEI originating from type i households;
- p_i^{DEAHEI}: fraction of equivalent adults in the DEAHEI originating from type i households;
- π_i^{DOMHEI}: equivalent income share in the DOMHEI originating from type i households;

[3] See Pyatt (1976) for details.
[4] For a more detailed discussion on the decomposability of the Gini and the properties of its different components see, for example, Lambert and Decoster (2005) and references cited therein.

- π_i^{DEAHEI} : equivalent income share in the DEAHEI originating from type i households;
- μ^{DOMHEI} : mean equivalent income per capita in the DOMHEI;
- μ^{DEAHEI} : mean equivalent income per equivalent adult in the DEAHEI.

3 Sensitivity analysis

3.1 Data

Our empirical examination is based on data from the Luxembourg Income Study (LIS). For 30 countries and several years, the LIS provides representative micro-level information on private households' incomes and demographic characteristics (i.e., number, age and gender of each family member). To keep the empirical analysis tractable, only 20 countries (the US and 19 European countries) from a single LIS wave (1999/2000; see the Appendix Table A1 for details) are considered.[5] Additionally, only data from nine household types are taken into account: one- and two-adult households with zero up to three children, and childless three-adult households.[6]

Equivalent incomes are based on the LIS variable 'household disposable income' (*DPI*). *DPI* is harmonized across countries, covers labor earnings, property income, and government transfers in cash minus income and payroll taxes.[7] As *DPI*s are denoted in local currencies and prices, they are transformed into PPP adjusted Dollars. *DPI*s from year 1999 are also growth-adjusted and deflated by inter-temporal price indices to the year 2000. All deflators and conversion factors are summarized in Table A1. To meet the restrictions on the income domain imposed by Ebert and Moyes (2003) and Shorrocks (2004), only households with positive *DPI*s are considered. For each household type and country separately, Table 1a provides the number of observations (not weighted),[8] the fraction of the country-wide populations living in the same household type (weighted), and the average disposable household income per month (weighted, PPP adjusted in USD in 2000). In addition, Table 1b summarizes sum further aggregate features of the resulting country data bases, including the total number of observations (non-weighted), average household income, average household size and the fraction of the country population belonging to the nine distinguished household types (column label: 'coverage'). It turns out that the coverage is satisfactory well in all 20 countries we study, never falling below 75 percent.

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[5] Bönke and Schröder (2007) used wave V.1 in an earlier version of this paper.

[6] We use the LIS variables 'd4' and 'd27' to distinguish adults from children, where 'd27' gives the number of household members of age below 18 and 'd4' denotes the total number of household members.

[7] For the exact *DPI* definition see Luxembourg Income Study (2006), and for its cross-country comparability Burkhauser et al. (1996) and references therein.

[8] We provide the unweighted number of observations to give the reader a clear picture of the actual numbers of observations provided by LIS. Of course, all calculations are conducted to the base of weighted distributions.

[Table 1a about here]
[Table 1b about here]

3.2 Descriptive statistics of country-specific quasi-homogeneous distributions

This section summarizes several features of the country equivalent-income distributions, all of them constituting elements of Theil and Gini indices. Figure 1 depicts the ratio $p_i^{DOMHEI} / p_i^{DEAHEI}$ along the dimension of θ. The figure shows how much size- and needs weighted subgroup population shares differ. Estimates referring to the same country are connected by an interpolated line. Symbols and formats of lines (dashed vs. solid) distinguish estimates across countries. As the Buhman et al. (1988) equivalence scale makes no distinction between adults and children, only the number of household members matter. Hence, $p_i^{DOMHEI} / p_i^{DEAHEI}$ estimates coincide for A1C1 and A2C0, for A1C2, A2C1 and A3C0, as well as for A1C3 and A2C2. Accordingly, the five graphs in Figure 1 convey all the empirical findings.

[Figure 1 about here]

For subgroups originating from households with at a minimum three members, $p_i^{DOMHEI} / p_i^{DEAHEI}$ -curves are always downwards sloped. For two-member households (A1C1 and A2C0), there is no clear relationship between $p_i^{DOMHEI} / p_i^{DEAHEI}$ and θ: In most countries, the relationship is positive, but u-shaped in others. For the one-member household, $p_i^{DOMHEI} / p_i^{DEAHEI}$ -curves are upwards sloped. These patterns can be explained by country demographics. Average household size in a country is,

$$(6) \qquad \bar{h} = \frac{\sum_{i=1}^{n} h_i K_i}{\sum_{i=1}^{n} K_i},$$

and average equivalence scale is,

$$(7) \qquad \overline{ES} = \frac{\sum_{i=1}^{n} ES_i K_i}{\sum_{i=1}^{n} K_i}.$$

This gives

(8) $$\frac{p_i^{DOMHEI}}{p_i^{DEAHEI}} = \frac{h_i}{ES_i} \cdot \frac{\sum_{i=1}^{n} ES_i K_i}{\sum_{i=1}^{n} h_i K_i} = \frac{h_i}{ES_i} \cdot \frac{\overline{ES}}{\overline{h}}.$$

The term $\overline{ES}/\overline{h}$ is smaller than 1.0 if $\theta < 1$ and if there is at least one multi-member household. Moreover, $\overline{ES}/\overline{h}$ is *increasing* in θ as $\partial ES_i/\partial\theta > 0$ for $i \neq A1C0$. As $h_{A1C0}/ES_{A1C0} = 1$, $p_{A1C0}^{DOMHEI}/p_{A1C0}^{DEAHEI}$ is strictly monotonically increasing in θ. For multi-member households, a θ variation, per se, has an ambiguous effect on $p_i^{DOMHEI}/p_i^{DEAHEI}$ as h_i/ES_i is *decreasing* in θ, thus mitigating the $\overline{ES}/\overline{h}$ effect. It turns out that $\overline{ES}/\overline{h}$ is more sensitive to a θ variation than h_i/ES_i if $h_i >> \overline{h}$: For A2C1-A2C3 and A1C2-A1C3 and also for A3C0, $p_i^{DOMHEI}/p_i^{DEAHEI}$ is strictly *decreasing* in θ. For subgroups A1C1 and A2C0, h_i is less or almost equal to $\overline{h}$. If $h_i << \overline{h}$, $p_i^{DOMHEI}/p_i^{DEAHEI}$ is strictly monotonically increasing in θ. For $h_i \approx \overline{h}$ the $p_i^{DOMHEI}/p_i^{DEAHEI}$-curve is u-shaped: This especially applies to Norway ($\overline{h} = 1.99$) and Finland ($\overline{h} = 2.01$).

Observed $p_i^{DOMHEI}/p_i^{DEAHEI}$ relationships have immediate implications for inequality, as can be seen from equations (1-3). Consider, for example, the between-subgroup component. Here we have that the weights assigned to differences in subgroup-specific mean equivalent incomes are contingent upon the type of conversion. But subtle differences even arise concerning the classification of 'rich' or 'poor' subgroups.' Following equation (1), one can call subgroup i

- 'rich' if $\mu_i/\mu^{DOMHEI} > 1$; respectively if $\mu_i/\mu^{DEAHEI} > 1$,
- 'poor' if $\mu_i/\mu^{DOMHEI} < 1$; respectively if $\mu_i/\mu^{DEAHEI} < 1$.

Figure 2 encompasses such ratios in nine separate graphs, containing six lines each. Solid lines are estimates of equivalent-income ratios derived from the DOMHEI; dashed lines from the DEAHEI. For both types of conversion, three lines are provided. The upper line gives the cross-country maximum of the equivalent income ratio, and the lower line the respective minimum. The line in between represents the cross-country mean. With the exception of the needs-weighted A2CO subgroup, lines referring to subgroups originating from one- or two-member households are always upward sloping. Hence, these subgroups become 'richer' as θ goes up. For all other subgroups, downward sloping lines imply that they become relatively 'poorer' as θ goes up. According to our definition of 'rich' and 'poor,' A1C0-A1C3 subgroups are notably poor. Across all countries, average equivalent income of the A1C1 subgroup (A1C3 subgroup) is about 28 percent (50 percent) below the average when $\theta = 0.6$ (=0.55) – irrespective of whether households are needs or size weighted.

[Figure 2 about here]
[Figure 3 about here]

Subgroups' population and equivalent income ratios again determine the overall mean equivalent income ratio: mean equivalent income per one-member household divided by mean equivalent income per equivalent adult. Figure 3 depicts this ratio, $\mu^{DOMHEI} / \mu^{DEAHEI} = \sum_{i=1}^{n} \mu_i p_i^{DOMHEI} \Big/ \sum_{i=1}^{n} \mu_i p_i^{DEAHEI}$, again as functions of θ. For all countries, the $\mu^{DOMHEI} / \mu^{DEAHEI}$-curve is downward-sloping for low values of θ, intersects the 1.0-threshold line from above at some medium level of θ, and then converges against the threshold line from below. This pattern is the aggregate outcome of the relationships presented in Figures 1 and 2.

Finally, Figure 4 gives the equivalent-income share ratios,

(9) $$\frac{\pi_i^{DOMHEI}}{\pi_i^{DEAHEI}} = \frac{h_i}{ES_i} \cdot \frac{\sum_{i=1}^{n} \mu_i ES_i \mathrm{K}_i}{\sum_{i=1}^{n} \mu_i h_i \mathrm{K}_i} = \frac{h_i}{ES_i} \cdot \frac{\mu^{DEAHEI}}{\mu^{DOMHEI}} \cdot \frac{\overline{ES}}{\overline{h}} = \frac{p_i^{DOMHEI}}{p_i^{DEAHEI}} \frac{\mu^{DEAHEI}}{\mu^{DOMHEI}},$$

plotted against θ. For all countries, the $\pi_i^{DOMHEI} / \pi_i^{DEAHEI}$-curves are positively sloped for subgroups A1C0, A1C1 and A2C0, and negatively sloped else. As can be seen from equation (9), this pattern is caused by the interaction of the relationships presented in Figures 1 and 3.

[Figure 4 about here]

3.3 Sensitivity of inequality estimates

3.3.1 Theil index

Figure 5 presents our main results on the sensitivity of the Theil index. The upper left graph depicts the ratio T^{DOMHEI} / T^{DEAHEI} plotted against admissible values of θ. In a predominant number of countries, T^{DEAHEI} exceeds T^{DOMHEI} and the ratio T^{DOMHEI} / T^{DEAHEI} falls with θ. Only in Poland, Norway and Sweden and for high values of θ, $T^{DOMHEI} / T^{DEAHEI} > 1$. Relative differences between T^{DOMHEI} and T^{DEAHEI} can be substantial. For example, the index ratio is about 0.83 for $\theta = 0.10$ in Slovenia, Belgium and Ireland. Moreover, ratios differ substantially across countries. For example,

$T^{DOMHEI}/T^{DEAHEI} = 1.02$ in Poland and 0.93 in Ireland for $\theta = 0.60$. As we will show in Section 3.4, these cross-country differences are sufficiently large to affect country inequality rankings.

To understand the relationship presented in the upper right graph of Figure 5, we also depict the ratios of size- and needs-weighted within- and between-subgroup component ratios. The within-subgroup component ratio, $W^{T,DOMHEI}/W^{T,DEAHEI}$, is depicted in the lower left graph. Like the T^{DOMHEI}/T^{DEAHEI}-ratio, the $W^{T,DOMHEI}/W^{T,DEAHEI}$-ratio increases in θ, and is usually smaller than 1.0. Compared to the DEAHEI, the population share of inequality-diminishing groups, therefore, must be higher in the DOMHEI. As size-weighting attaches larger weights to multi-member household units, equivalent-incomes of 'large' households should be distributed more equally. Indeed, subgroup-specific Theil indices – provided in Table 2 – give empirical support: Especially children tend to have an inequality-reducing effect. Only Poland, Norway and Sweden deviate from this empirical regularity. And, exactly in these three countries, the $W^{T,DOMHEI}/W^{T,DEAHEI}$-ratio is *non*-increasing in θ.

[Figure 5 about here]
[Table 2 about here]

Finally, turning to the between-group component of the Theil index, the lower left graph of Figure 5 gives the $B^{T,DOMHEI}/B^{T,DEAHEI}$- ratio. For small values of θ, $B^{T,DOMHEI}/B^{T,DEAHEI}$ is substantially smaller than 1.0. For example, across all countries, $B^{T,DOMHEI}/B^{T,DEAHEI} \leq 0.74$ at $\theta = 0$. The $B^{T,DOMHEI}/B^{T,DEAHEI}$-ratio is s-shaped in θ, crossing the 1.0-threshold line for medium levels of θ (reaching a cross-country peak of ≈ 1.15 for $\theta = 0.55$ in Luxembourg), and then again converging to $B^{T,DOMHEI}/B^{T,DEAHEI} = 1$ for $\theta \to 1.0$. This relationship is due to mutually enforcing and mitigating effects resulting from the patterns depicted in Figures 1-4.

3.3.2 Gini index

Analogously to the Theil-index ratios presented in Figure 5, Gini-index ratios are plotted in Figure 6. The graph top left gives the Gini-index ratio, G^{DOMHEI}/G^{DEAHEI}; up right depicts the between-subgroup ratio, $B^{G,DOMHEI}/B^{G,DEAHEI}$; down left the within-subgroup ratio, $W^{G,DOMHEI}/W^{G,DEAHEI}$; down right the overlap-component ratios, O^{DOMHEI}/O^{DEAHEI}. Several parallelisms to the results concerning the Theil index occur. First, with the only exception being Poland, G^{DEAHEI}, like T^{DEAHEI}, signals more inequality than its DOMHEI analogue, and this effect intensifies as θ

decreases (see upper left graph of Figure 6). The ratios T^{DOMHEI} / T^{DEAHEI} and G^{DOMHEI} / G^{DEAHEI} are even similarly sized. Second, the within- and the between subgroup ratios of the Theil and the Gini index change in a likewise manner: the increase of the within-subgroup component ratio in θ (see graph bottom left) as well as the s-shape of the between-subgroup-component ratio (see graph up right) is reconfirmed.

The within- and the between-component ratios for the two indices, however, differ slightly. For most countries and values of θ, $W^{G,DOMHEI} / W^{G,DEAHEI} < W^{T,DOMHEI} / W^{T,DEAHEI}$ and $B^{G,DOMHEI} / B^{G,DEAHEI} < B^{T,DOMHEI} / B^{T,DEAHEI}$. This can be explained by the overlap-component ratio, O^{DOMHEI} / O^{DEAHEI}, capturing some of the variation. Overlaps are sensitive to the transformation procedure as equivalent-income distributions' overlaps of any two subgroups are weighted differently, by p_i^{DOMHEI} vs. p_i^{DEAHEI}.

[Figure 6 about here]

3.4 Inequality parades

Figure 7 illustrates the implications of size vs. needs weighting for cross-country comparisons of inequality. Two 'inequality parades' for each index are provided – one for the DOMHEI and one for the DEAHEI. Parades are obtained by sorting countries according to their index.[9] The country with equivalent incomes being most equally distributed is assigned a '1,' the country with the most unequal distribution a '20.' The upper two graphs give country rankings by the Theil index, the graphs below by the Gini index. As demonstrated in previous literature (cf. for example Coulter et al. (1992), Burkhauser et al. (1996), Aaberge and Melby (1998), Duclos and Makdissi (2005)), rankings are sensitive to the chosen index and equivalence-scale elasticity. In addition, it turns out that the conversion method itself has an impact on the inequality parade.

[Figure 7 about here]

Let the sequence of ranks reported be $\left[T^{DOMHEI}, T^{DEAHEI}, G^{DOMHEI}, G^{DEAHEI}\right]$. Then, taking Germany as an example, the numbers are $[7,8,8,9]$ when $\theta = 0.4$, and $[6,7,9,10]$ when $\theta = 0.2$; $[10,10,9,8]$ and $[8,9,6,4]$ in case of Switzerland. Size- and needs-weighted rankings, by

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9 Such a ranking ignores the possibility that average equivalent-income levels differ across countries. So, a country – such as the US – is at the bottom of the ranking although average equivalent income in the US is among the highest.

definition, coincide for $\theta = 1.0$, Yet, in case of the Theil (Gini) index, rankings already become different for $\theta \leq 0.95$ ($\theta < 0.80$). This is illustrated by Table 3, where the frequency and size of country re-rankings is summarized. Consider, for example the entry in column labeled '1' ('-2') and row $\theta = 0.25$ in case of the Theil index. Here we have a value of '4' ('2'). This entry means that four (two) countries ascend (descend) one rank (two ranks) in the parade when switching from a conversion by size to needs.[10] The last column of Table 3 ('Sum') gives the sum of the following product: number of ascends times frequency of occurrence. This is an aggregate measure of the rankings' sensitivity. For example, consider the entry in row '$\theta = 0.20, G$.' There we have the value $5 \cdot 2 + 2 \cdot 1 = 12$ as five countries ascend two and two one rank. In case of the Theil index (Gini index), parades become more sensitive when θ goes down as long as $\theta \geq 0.25$ ($\theta \geq 0.15$). A further lowering of θ does not lead to a further increase of re-rankings. In sum, these results show that the conversion procedure has significant effects for cross-country inequality rankings for typical values of θ.

4 Conclusion

For 20 countries, we have presented inequality estimates for a size and a needs weighted quasi-homogeneous equivalent-income distribution. The theoretical properties of both distributions have been explored in Ebert and Moyes (2003) and Shorrocks (2004). Our empirical examination reveals that country inequality rankings are conversion sensitive for equivalence scales implying reasonable within-household size economies. By means of a decomposition analysis, we have investigated the mechanisms and identified the key source that make needs and size weighted inequality estimates diverge. That inequality estimates are typically lower in the DOMHEI is driven by two effects: Higher weights of large household units in case of size weighting in combination with low income inequality among households with children.

[10] Ascending (descending) means that the number assigned to a country in the ranking becomes smaller (bigger).

Table 1a. Sample description and coverage by subgroups

Country		A1C0	A1C1	A1C2	A1C3	A2C0	A2C1	A2C2	A2C3	A3C0
AT	Av. Income	1,470	1,598	1,873	1,704	2,699	3,008	3,109	3,234	3,702
	N	577	45	24	2	671	157	221	61	201
	Coverage	31.44	2.58	1.02	0.08	27.73	8.87	9.27	1.87	6.80
BE	Av. Income	1,299	1,513	1,908	1,889	2,819	3,234	3,451	3,883	3,694
	N	595	33	24	7	625	164	251	96	91
	Coverage	35.45	2.01	1.18	0.45	29.70	6.64	10.91	3.80	4.06
EE	Av. Income	359	520	516	494	723	991	1,097	1,075	968
	N	1,102	180	82	24	1,636	641	569	153	556
	Coverage	28.03	3.74	1.15	0.31	27.20	11.81	8.24	1.74	7.16
FI	Av. Income	1,109	1,530	1,754	2,057	2,354	2,812	3,158	3,362	3,181
	N	2,047	157	89	26	3,524	1,032	1,221	532	782
	Coverage	37.87	2.34	1.15	0.37	30.98	7.10	7.70	3.23	4.44
FR	Av. Income	1,366	1,525	1,637	1,872	2,429	2,800	3,053	3,276	3,299
	N	2,640	219	125	35	3,278	879	1,086	417	659
	Coverage	28.83	2.13	1.25	0.32	30.69	9.00	9.83	3.75	6.07
DE	Av. Income	707	680	663	813	1,358	1,510	1,682	1,666	1,748
	N	3,016	220	104	21	3,573	1,029	1,082	304	688
	Coverage	40.55	2.06	0.79	0.13	29.72	7.42	6.84	1.74	4.94
GR	Av. Income	885	1,184	1,208	3,318	1,351	2,262	2,355	1,992	2,175
	N	676	16	14	1	1,071	295	447	71	490
	Coverage	19.19	0.51	0.41	0.03	26.91	7.27	12.47	1.67	12.92
HU	Av. Income	406	434	734	424	742	1,042	1,034	988	967
	N	416	20	7	2	578	160	187	41	232
	Coverage	25.40	1.00	0.27	0.09	27.05	8.07	8.83	1.84	11.74
IE	Av. Income	1,261	1,112	1,259	1,162	2,255	3,034	3,234	3,763	3,198
	N	480	37	25	8	565	156	242	163	175
	Coverage	24.97	3.20	1.55	0.75	22.28	7.43	10.88	5.72	6.26
IT	Av. Income	1,211	1,699	1,584	1,491	2,118	2,456	2,405	2,368	2,902
	N	1,454	53	19	6	2,157	667	759	141	1,078
	Coverage	20.75	0.77	0.24	0.12	27.43	9.56	9.41	1.78	12.73
LU	Av. Income	2,404	2,400	2,481	1,388	3,794	4,036	4,521	4,573	5,127
	N	583	30	13	2	735	270	255	96	190
	Coverage	27.89	1.08	0.59	0.04	30.25	9.96	10.02	3.71	6.80
NO	Av. Income	1,469	2,142	2,288	2,573	3,168	3,800	4,246	4,659	4,625
	N	2,811	299	128	32	3,670	1,114	1,514	703	1,008
	Coverage	41.27	3.45	1.51	0.33	25.09	6.42	8.42	3.64	4.31
PL	Av. Income	470	662	663	654	849	1,005	1,034	888	1,050
	N	4,285	544	300	112	7,205	3,394	3,673	1,306	2,909
	Coverage	15.96	1.74	0.89	0.34	24.16	10.50	11.33	4.07	9.16
RU	Av. Income	176	336	293	154	369	530	543	795	469
	N	611	122	29	2	775	417	235	30	244
	Coverage	20.13	3.77	0.92	0.07	24.26	13.28	8.79	0.99	7.76
SI	Av. Income	587	839	933	0	1,142	1,488	1,674	1,576	1,683
	N	366	29	11	0	844	304	389	57	566
	Coverage	16.06	1.09	0.41	0.00	22.34	8.92	11.69	1.54	12.98
ES	Av. Income	1108	1,203	1,487	2,124	1,976	2,455	2,719	3,039	2,670
	N	818	22	11	3	1,368	462	474	80	522
	Coverage	16.83	0.45	0.29	0.07	28.95	9.58	9.90	1.72	11.12
SE	Av. Income	1139	1,550	1,834	1,998	2,485	2,849	3,310	3,346	3,499
	N	4694	237	150	43	4,772	979	1,332	446	797
	Coverage	46.45	2.81	1.78	0.51	24.96	5.80	7.91	2.65	3.08
CH	Av. Income	2115	2,261	2,469	2,360	3,572	3,565	3,660	3,831	4,139
	N	895	45	40	9	1,192	307	509	172	189
	Coverage	31.33	0.89	0.82	0.15	33.35	7.10	10.43	3.27	5.90
UK	Av. Income	1500	1,453	1,598	1,636	2,854	3,259	3,776	3,574	4,034
	N	7,181	804	659	268	8,035	1,852	2,354	802	1,254
	Coverage	28.61	2.67	2.14	0.89	32.91	6.75	8.47	2.89	6.71
US	Av. Income	2,029	2,117	2,266	1,886	3,995	4,511	4,870	4,672	4,935
	N	12,442	1,337	914	348	14,902	4,231	4,758	1,929	2,850
	Coverage	25.99	2.78	1.91	0.72	30.50	8.68	9.56	3.65	5.68

Note. Disposable household incomes per month (weighted), PPP adjusted in USD. *N*s are non-weighted numbers of observations. Coverage gives the percentage of the total weighted population that is covered by the respective household type. A denotes adult; C denotes child. The adjacent figure gives the respective number of household members.

Table 1b. Sample description and coverage for whole sample

Country	Average income	N	Coverage	Average household size
AT	2,386	1,959	89.67	2.11
BE	2,386	1,886	94.2	2.11
EE	693	4,943	89.38	2.16
FI	2,002	9,410	95.19	2.01
FR	2,257	9,338	91.87	2.21
DE	1,118	10,037	94.19	1.91
GR	1,619	3,081	81.38	2.39
HU	733	1,643	84.29	2.21
IE	2,256	1,851	83.03	2.37
IT	2,082	6,334	82.8	2.32
LU	3,578	2,174	90.33	2.23
NO	2,635	11,279	94.43	1.99
PL	838	23,728	78.15	2.51
RU	379	2,465	79.99	2.28
SI	1,244	2,566	75.02	2.46
ES	2,057	3,760	78.93	2.37
SE	1,937	13,450	95.95	1.89
CH	3,113	3,358	93.25	2.14
UK	2,575	23,209	92.03	2.16
US	3,543	43,711	89.46	2.24

Note. Average disposable household incomes per month (weighted) of the household types taken into account, PPP adjusted in USD. N is the non-weighted number of observations per country. Coverage gives the percentage of the total weighted population that is covered by the 9 household types.

Table 2. Theil coefficients by subgroups

Country	A1C0	A1C1	A1C2	A1C3	A2C0	A2C1	A2C2	A2C3	A3C0
AT	11.77	5.52	8.30	2.21	13.37	9.36	9.26	11.03	8.46
BE	16.82	8.15	9.82	2.03	81.51	14.50	11.15	9.17	12.32
EE	23.88	19.06	12.03	13.41	25.75	23.59	19.03	20.15	17.95
FI	14.38	7.25	4.19	4.38	15.22	9.03	8.74	14.49	8.26
FR	17.35	11.93	9.91	10.10	14.18	10.17	10.70	11.10	11.35
DE	17.66	8.77	14.71	2.70	13.89	10.32	13.37	8.84	9.90
GR	28.80	22.11	21.28	0.00	21.87	15.66	15.81	12.96	14.20
HU	22.84	17.15	3.82	7.36	16.11	20.02	13.11	14.67	8.14
IE	41.41	6.91	6.35	4.95	21.28	19.88	9.57	19.55	12.31
IT	22.99	12.20	14.68	15.78	23.78	15.31	16.07	35.64	18.06
LU	14.63	7.07	11.31	2.22	12.22	8.59	10.54	9.43	8.72
NO	14.33	11.82	5.79	2.68	17.36	7.44	12.82	26.18	11.60
PL	14.35	16.99	12.13	12.73	13.50	16.04	16.46	16.38	14.22
RU	41.17	45.63	35.57	0.00	52.46	51.95	31.95	60.62	24.87
SI	14.32	10.66	13.76	---	14.00	8.96	8.15	7.15	10.58
ES	27.61	14.69	22.06	20.92	23.35	16.38	19.60	35.24	15.44
SE	13.01	9.54	5.62	4.28	10.36	8.85	19.25	10.44	5.97
CH	22.32	5.59	12.37	4.97	15.90	22.71	9.52	11.18	14.40
UK	32.85	10.06	9.36	6.06	22.60	16.25	23.69	19.90	15.79
US	29.67	24.41	29.68	23.75	23.94	23.05	21.04	22.10	17.49

Note. A denotes adult; C denotes child. The adjacent figure gives the respective number of household members.

Table 3. Re-rankings

θ	Index	Frequencies of re-rankings of specific magnitude									Sum
		5	4	3	2	1	-1	-2	-3	-4	
0.00	*T*					7	5	1			7
	G				3	3	3	3			9
0.05	*T*					7	5	1			7
	G		1		2	2	4	3			10
0.1	*T*					7	4		1		7
	G	1			2	1	3	2	1		10
0.15	*T*				1	3	3	1			5
	G			2	2	2	5	2	1		12
0.2	*T*				1	4	6				6
	G				5	2	4	2		1	12
0.25	*T*			1		4	3	2			7
	G				1	6	2	1		1	8
0.3	*T*			1		4	1	3			7
	G				1	5	3			1	7
0.35	*T*					5	3	1			5
	G				2	2	3		1		6
0.4	*T*					5	3	1			5
	G			1	2	2	3	3			9
0.45	*T*					7	3	2			7
	G			1	2	2	4	1	1		9
0.5	*T*				1	4	4	1			6
	G			1	2	1	2	3			8
0.55	*T*				2	1	1	2			5
	G			1		1	2	1			4
0.6	*T*				1	2		2			4
	G				1	1	1	1			3
0.65	*T*				1	2		2			4
	G				1	1	1	1			3
0.7	*T*					4		2			4
	G					2	2				2
0.75	*T*					3	1	1			3
	G					1	1				1
0.8	*T*					1	1				1
	G										0
0.85	*T*					1	1				1
	G										0
0.9	*T*					1	1				1
	G										0
0.95	*T*					1	1				1
	G										0

Note. ‘Sum’ is a sum of five products. Each product is: magnitude of ascends times its frequency of occurrence.

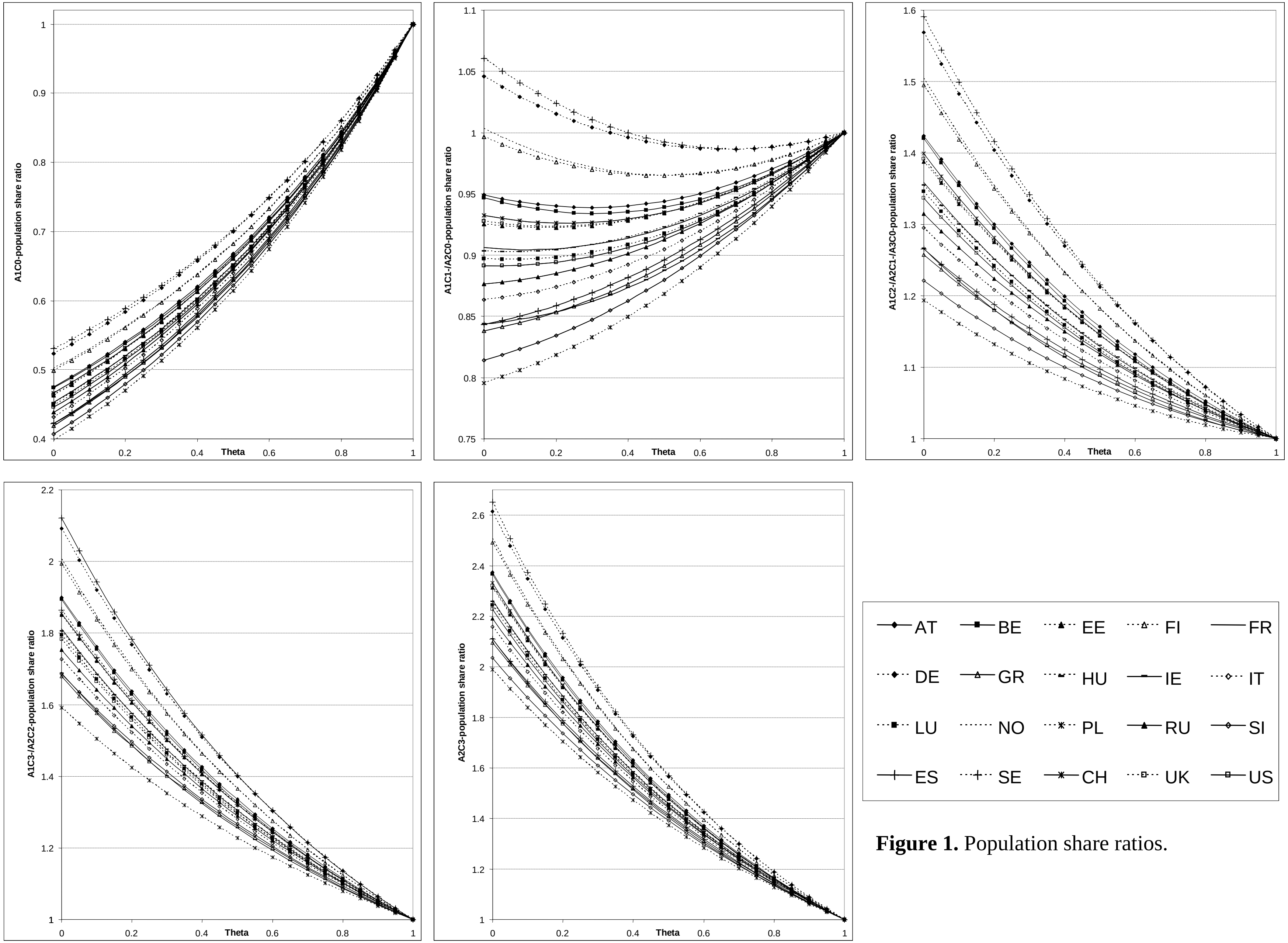


Figure 1. Population share ratios.

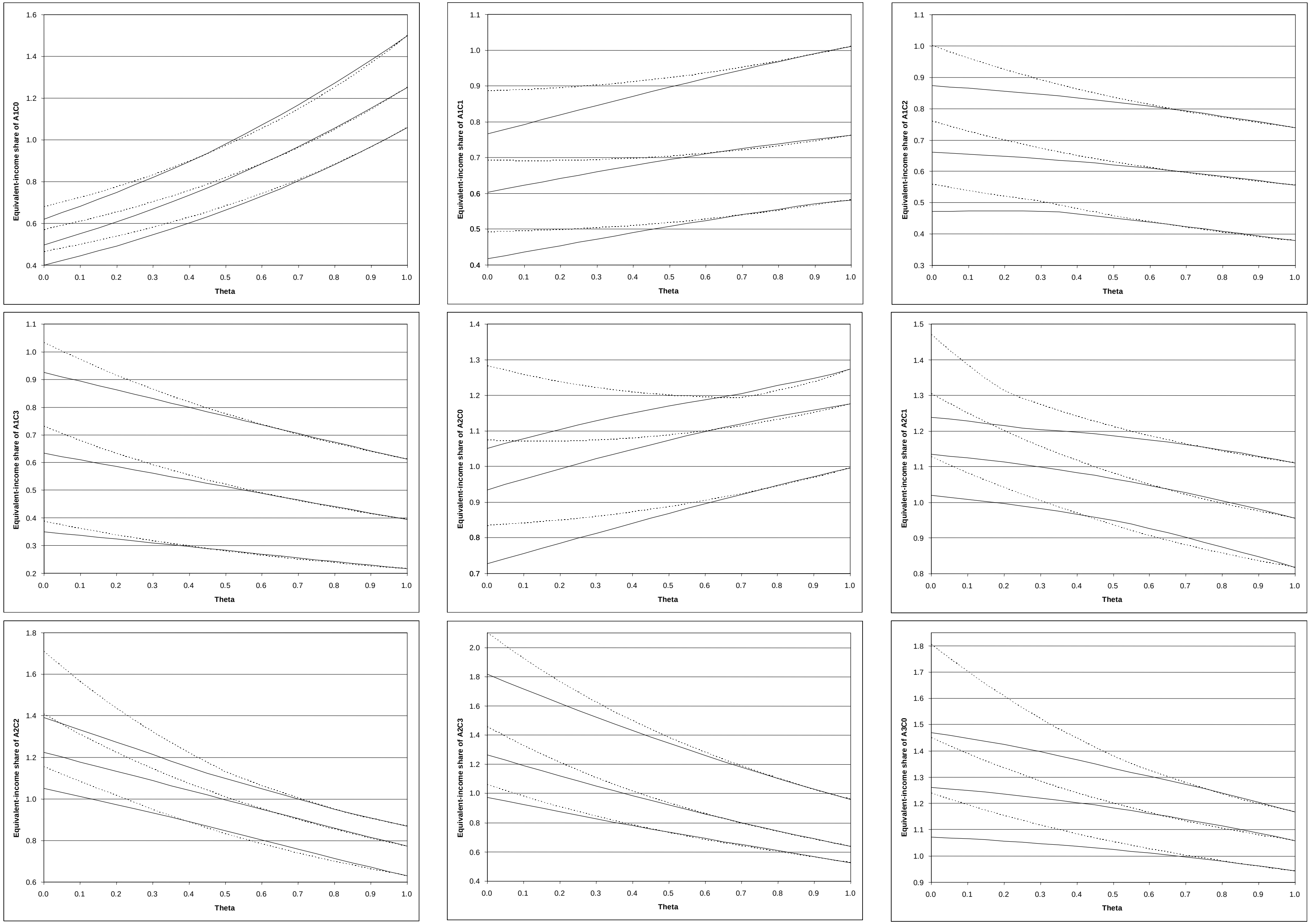


Figure 2. Equivalent-income shares. --- DEAHEI — DOMHEI *Note:* A1C3 without Greece (one HH only).

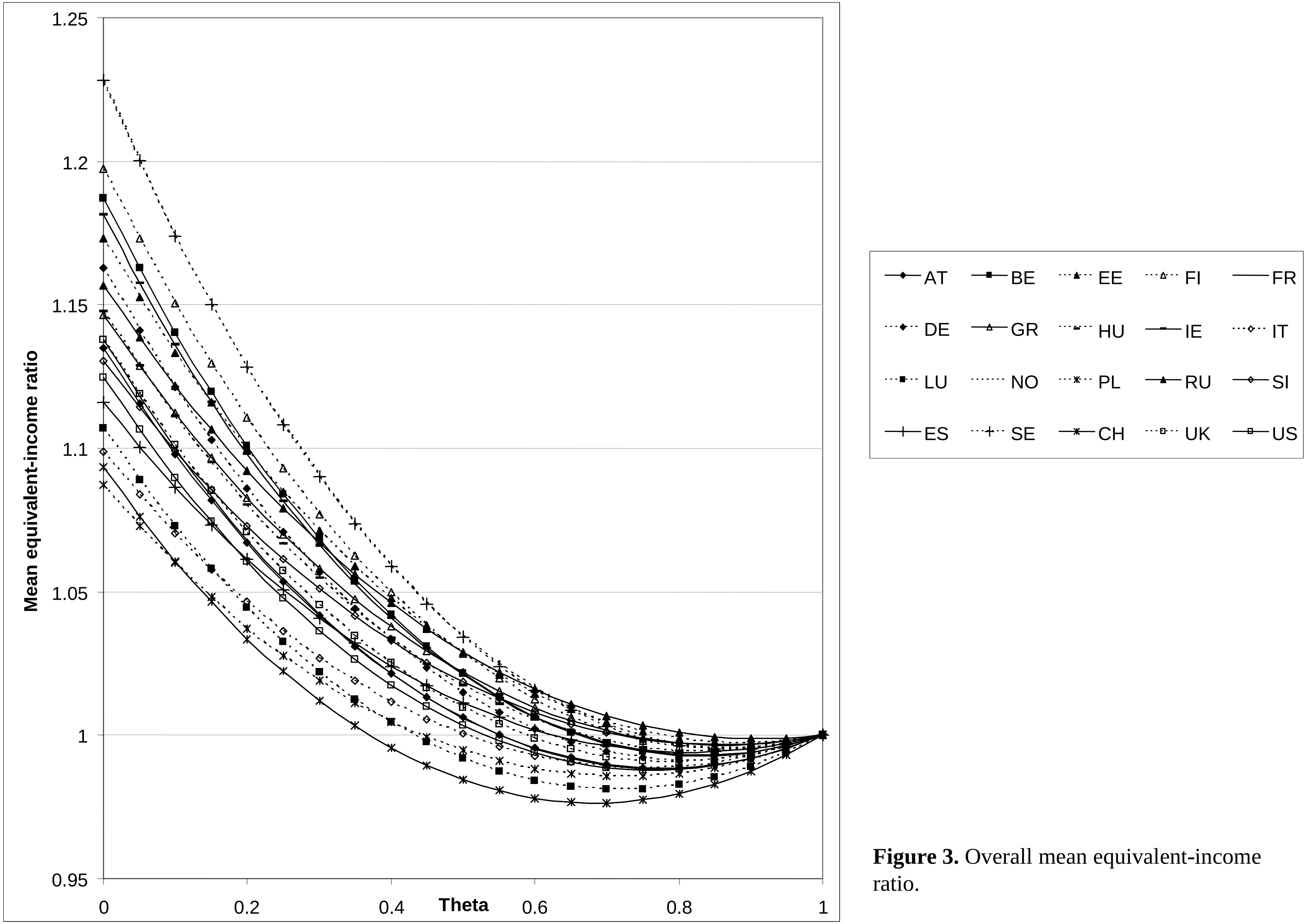


Figure 3. Overall mean equivalent-income ratio.

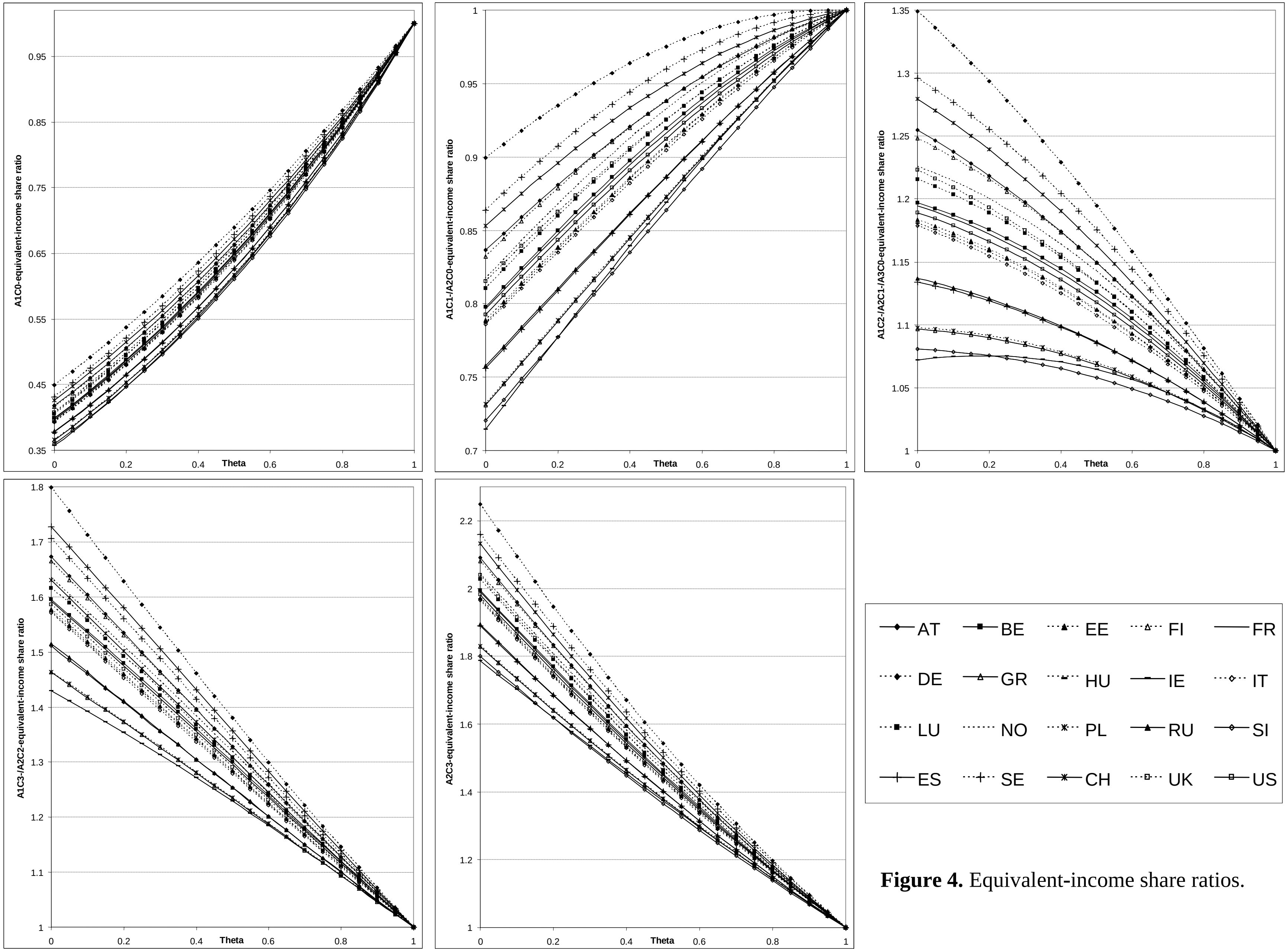


Figure 4. Equivalent-income share ratios.

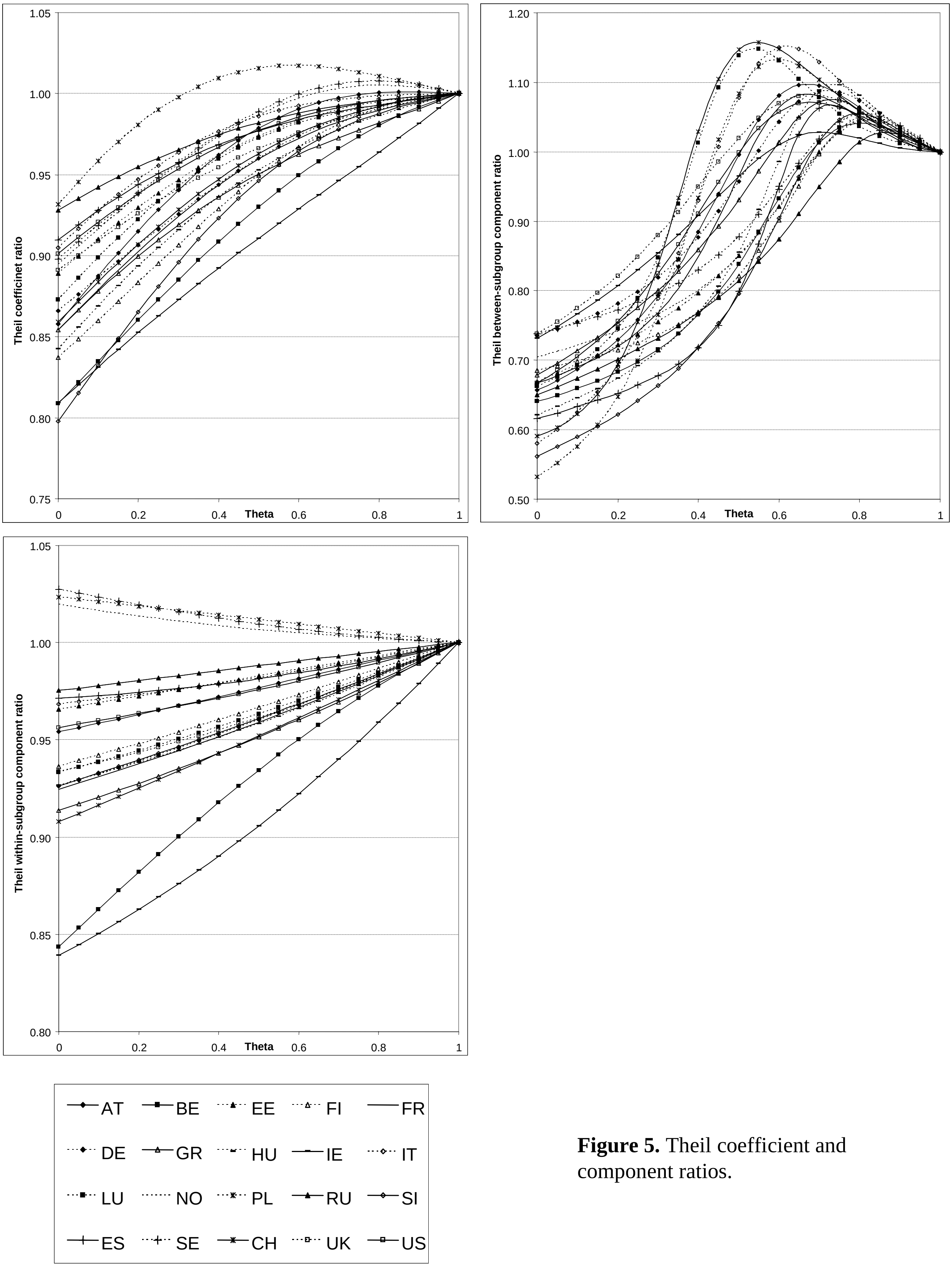
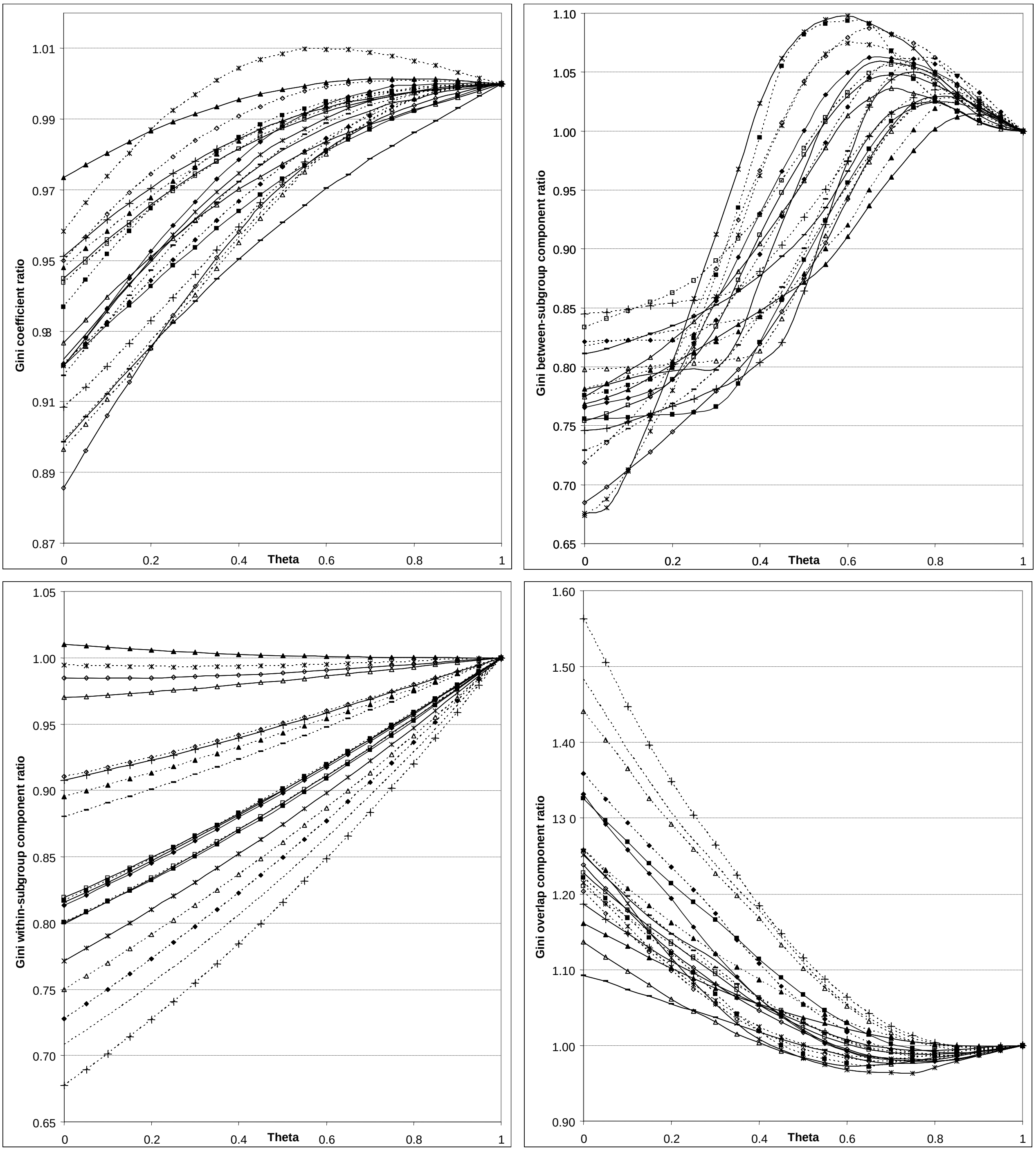


Figure 5. Theil coefficient and component ratios.



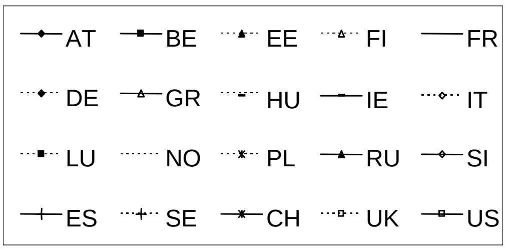


Figure 6. Gini coefficient and component ratios.

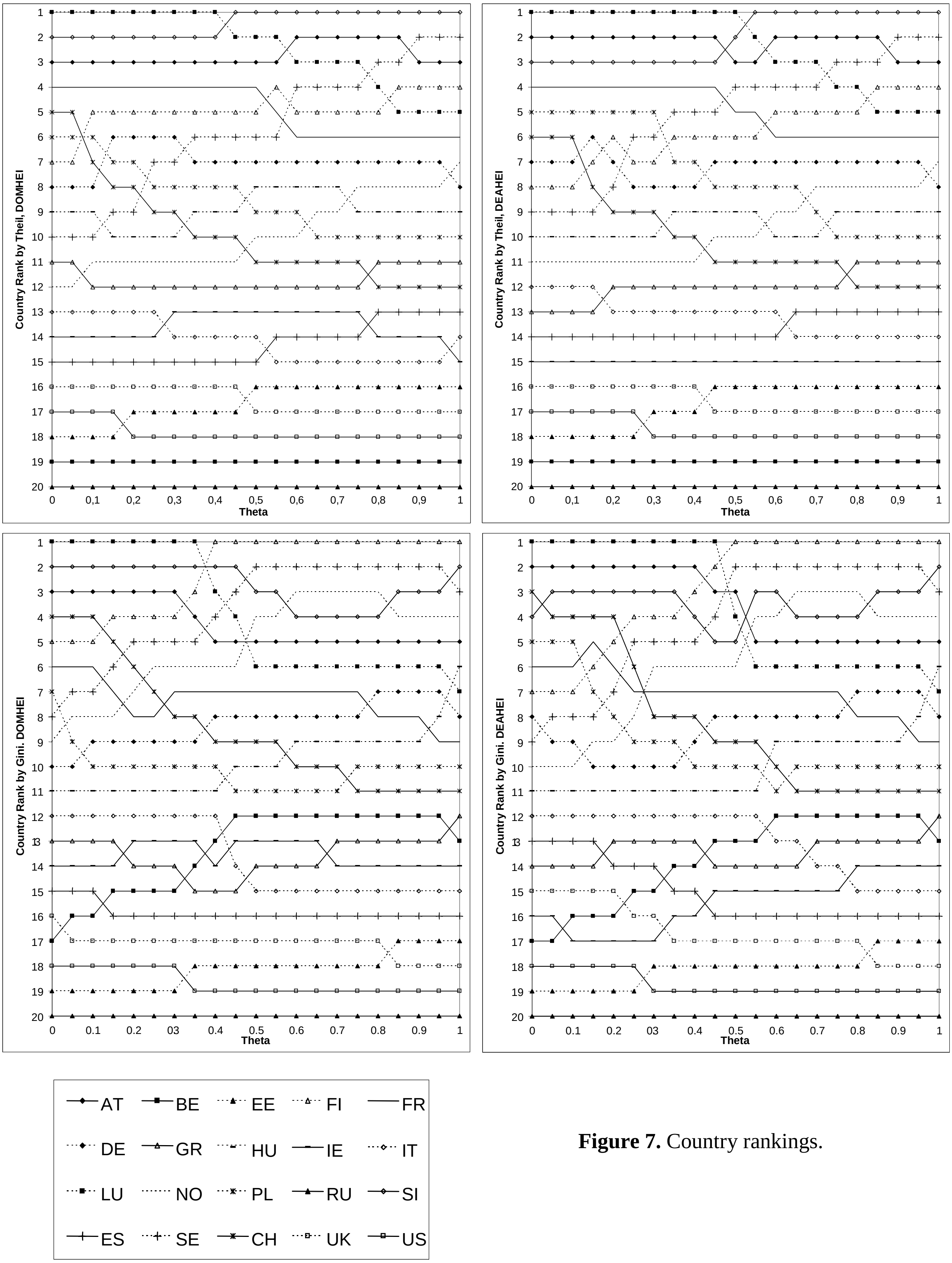


Figure 7. Country rankings.

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Appendix

Table A1. Data files

Country	Abbreviation	LIS-File	Local currency/EUR exchange rates [EMU countries only]	Growth-inflation adjustment 1999-2000	PPP in US$ 2000
Austria[a)]	AT	at00h	13.7603	1	0.914
Belgium[a)]	BE	be00h	40.3399	1	0.921
Estonia	EE	ee00h		1	7.045
Finland[a)]	FI	fi00h	5.94573	1	0.979
France[a)]	FR	fr00h	6.55957	1	0.915
Germany[a)]	DE	de00h	1.95583	1	0.981
Greece[a)]	GR	gr00h	339.170	1	0.684
Hungary	HU	hu99h		1.053	107.337
Ireland[a)]	IE	ie00h	0.78756	1	0.953
Italy[a)]	IT	it00h	1936.33	1	0.808
Luxembourg[a)]	LU	lu00h	40.3399	1	0.988
Norway	NO	no00h		1	9.010
Poland	PL	pl99h		1.026	1.820
Russia	RU	ru00h		1	7.351
Slovenia	SI	si99h		1.017	141.385
Spain[a)]	ES	es00h	166.368	1	0.742
Sweden	SE	se00h		1	9.190
Switzerland	CH	ch00h		1	1.897
United Kingdom	UK	uk99h		1.046	0.632
United States	US	us00h		1	1.000

Note. a) Countries where the PPP conversion factor is normalized with respect to the EUR. For all other countries, the PPP conversion factor refers to the country-specific currencies.

Table A2. Gini coefficients by subgroups

Country	A1C0	A1C1	A1C2	A1C3	A2C0	A2C1	A2C2	A1C3	A3C0
AT	26.43	18.31	21.33	11.09	27.84	22.37	22.99	24.75	23.00
BE	27.46	21.11	23.82	10.93	44.30	24.52	25.00	22.46	24.96
EE	35.84	32.60	26.89	29.2	36.12	35.56	34.06	33.82	32.41
FI	26.49	20.47	15.87	14.57	25.56	20.95	20.08	24.04	21.19
FR	30.91	26.65	24.05	23.83	28.54	24.53	24.96	24.76	25.77
DE	30.83	23.15	29.53	12.91	27.80	24.55	24.12	22.68	22.77
GR	40.06	36.25	38.04	0.00	35.50	31.37	30.88	28.41	29.13
HU	32.20	32.35	18.11	36.43	29.04	33.87	28.28	26.25	22.51
IE	42.68	20.62	19.37	14.08	35.19	31.77	23.56	31.71	27.22
IT	34.52	26.35	27.84	28.70	34.47	29.70	30.43	39.86	31.92
LU	27.96	21.68	25.90	11.23	27.17	23.21	25.15	24.10	23.31
NO	27.49	21.92	17.25	11.98	26.21	19.18	20.89	25.49	20.91
PL	27.50	30.86	26.87	25.73	27.07	30.11	30.05	30.23	28.46
RU	41.92	50.81	46.34	0.00	44.65	50.19	43.87	57.23	36.86
SI	29.24	24.64	30.72	---	28.43	23.29	21.35	21.56	25.20
ES	38.75	30.42	38.88	34.39	35.67	30.56	34.14	44.00	30.31
SE	26.63	21.00	16.87	14.08	24.00	20.71	22.80	21.25	18.60
CH	31.66	18.74	26.74	18.04	28.77	26.44	22.25	25.63	29.00
UK	36.96	23.73	22.22	17.96	34.99	30.37	32.73	32.20	29.32
US	40.57	35.83	39.18	35.78	36.44	34.94	33.54	34.55	31.48

Note. A denotes adult; C denotes child. The adjacent figure gives the respective number of household members.

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