Jürgen Faik

Variable Equivalence Scales and German Income Inequality, 1992-2010 (SOEP)

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Zusammenfassung*

Das Arbeitspapier untersucht den Einfluss einkommensabhängiger (variabler) Äquivalenzskalen auf die personelle Einkommensverteilung in Deutschland. Auf Basis des Sozioökonomischen Panels (SOEP) 1992-2010 zeigt sich, dass die Verwendung variabler Äquivalenzskalen deutliche Ungleichheitssteigerungen im Vergleich zur Verwendung einkommensunabhängiger, konstanter Äquivalenzskalen mit sich bringt. Außerdem führt die Verengung des Abstandes zwischen den Einkommensgrenzen der oberen und der unteren Einkommensregionen ebenfalls zu einem Anstieg in der Einkommensungleichheit.

Das vorliegende Arbeitspapier steht in inhaltlicher Nähe vor allem zu den FaMa-Diskussionspapieren 6/2010, 1/2011, 2/2011 und 3/2011.

Summary*

This paper examines the impact on German personal income distribution of income-dependent (variable) equivalence scales. On the basis of the Socio-Economic Panel (SOEP), the use of variable equivalence scales causes distinctive increases in income inequality compared with income-independent, constant equivalence scales. Moreover, the narrowing of income limits between the upper and lower income region also leads to an increase in income inequality.

The paper at hand is contentually interrelated especially to FaMa discussion papers 6/2010, 1/2011, 2/2011, and 3/2011.

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Content

1. Introduction[1]

In order to compare incomes for different household types, household net incomes must be divided by "normalizing" values called equivalence scales. The resulting variable is equivalent household net income. Thus, an equivalence scale is used as a "well-being deflator" by dividing (e. g.) household incomes by such scale values.

Equivalence scales capture different needs (e. g., between children and adults) as well as economies of scale which are the result of household members' joint household "consumption activities" (e. g., concerning accommodation costs). The impact on personal income distribution of different equivalence scales with different levels of economies of scale depends on two opposing effects: Assuming a positive correlation between household size and household income, on the one hand, decreasing economies of scale lead to higher equivalence scale values for larger households and result in a levelling concerning the equivalent household incomes, and measured inequality decreases ("concentration effect"). On the other hand, decreasing economies of scale produce reductions of larger households' equivalent incomes, and this generates an increase in the measured inequality at some point ("re-ranking effect").[2, 3]

Typically, studies of personal income distribution refer to equivalence scales which hold for the entire income spectrum; these scales are called constant equivalence scales and are based on the assumption that equivalence scales and therefore the needs of different household types are independent of a base level of income or utility.[4] They contrast to income-dependent, variable equivalence scales which vary with the income level of the different households. There are good reasons for basing distributional analyses on such flexible equivalence scales, e. g.:[5]

1. In the higher income ranges the underlying consumption levels (e. g., concerning accommodation costs) would be high so that a new household member's appearance (e. g., the "adding" of a child) would increase the corresponding costs only slightly, and this would lead to low relative costs, i. e. flat equivalence scales for larger households in the upper income range compared with the lower incomes.
2. Prices of commodities can differ from each other across income groups such that members of the upper income classes obtain price advantages.
3. Credit constraints for households in the bottom income range may shift the consumption bundles of these households towards lower expenditure shares of durables which are connected with relatively high economies of scale.

The paper is organized as follows. After discussing the concept of variable equivalence scales theoretically, calculations of such scales for Germany, found in literature, are presented. On this basis, present author's own empirical sensitivity findings for German personal income distribution 1991/1992-2009/2010 are considered.

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[1] The data of this paper rest upon the German Socio-Economic Panel (SOEP) of the German Institute for Economic Research (DIW Berlin). As a reference for the SOEP data base see, e. g., Wagner, Frick, and Schupp 2007.

[2] For a detailed discussion of this issue see especially Cowell and Mercader-Prats 1999, pp. 25-26; see also Coulter, Cowell, and Jenkins 1992, Figini 1998, pp. 7-9, Lancaster, Ray, and Valenzuela 1999, Creedy and Sleeman 2004, and Bönke and Schröder 2008.

[3] If a negative correlation between household size and household income occurs, increasing inequality corresponds with decreasing levels of economies of scale since the re-ranking effect does not take place in this case.

[4] See, e. g., Lewbel 1989.

[5] See Schröder 2004, p. 42, and Koulovatianos, Schröder, and Schmidt 2005, p. 969.

2. Microeconomic specifications of variable equivalence scales

In the context of utility-based, microeconomic estimations of equivalence scales especially two methods for functionalizing an equivalence scale by different reference income levels exist: the Barten und the Translating approach.[6]

In Barten's approach[7] it is assumed that higher commodity-specific scale values m_j represent higher household needs for the corresponding commodity compared with the reference household type. Thus, the normalized commodity-specific quantities q_j/m_j (j = 1, 2, …, n) in the direct utility function have the same amount for the different household types:

(1) $$U = U\left[\frac{q_1}{m_1}, \frac{q_2}{m_2}, ..., \frac{q_n}{m_n}\right].$$

The socio-demographic standardizations of the Translating approach result from subtractions of socio-demographically functionalized quantity elements l_j from the overall consumption quantities q_j (j = 1, 2, …, n):

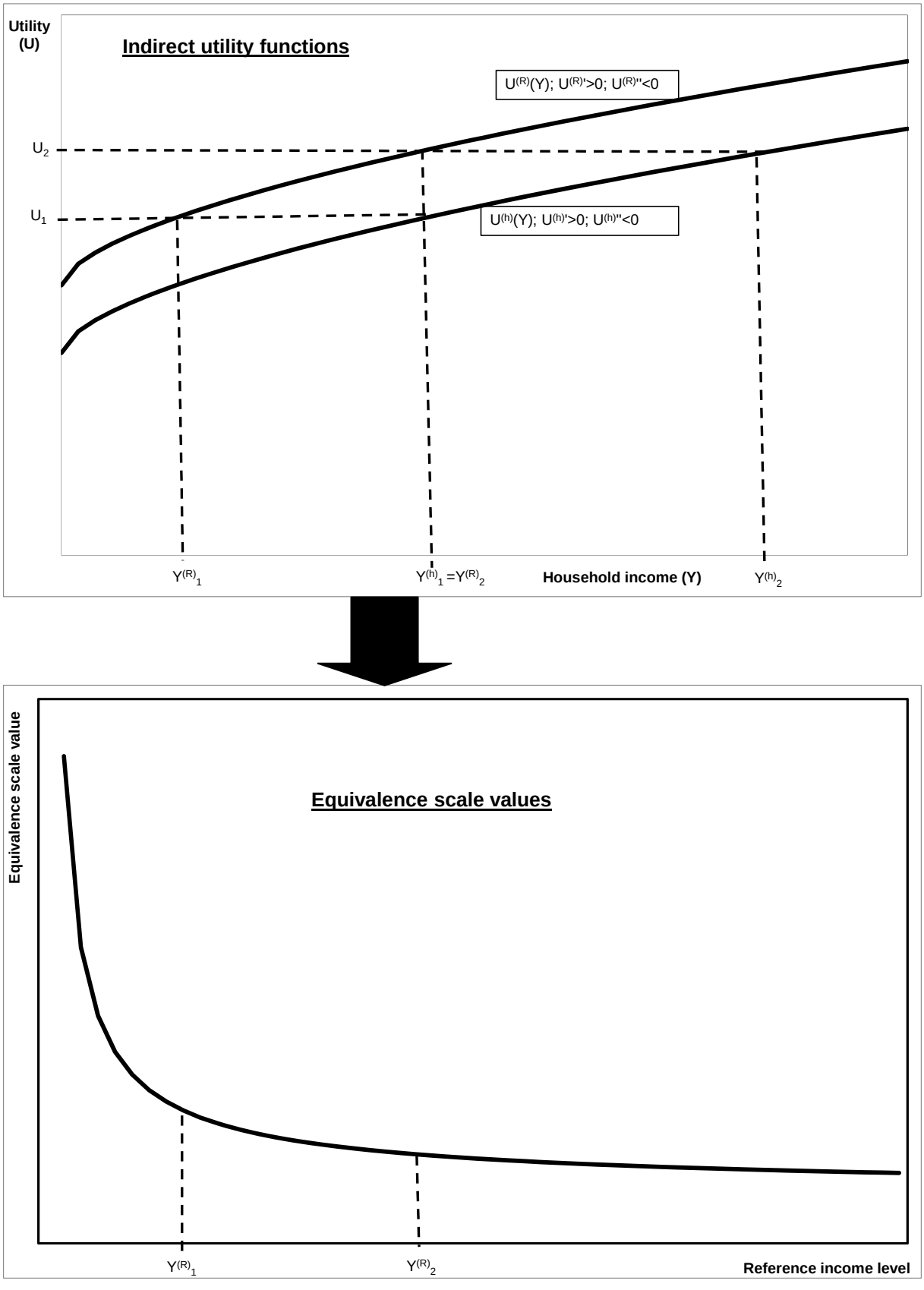
(2) $$U = U[q_1 - l_1, q_2 - l_2, ..., q_n - l_n].$$

Unlike Barten's approach, the Translating approach can describe a situation in which the reference household does not buy a special commodity in contrast to other households.[8] (see Bradbury 1992, pp. 15-16).

Figure 1 illustrates, in a general way, the concept of variable equivalence scales which implies a degressive indirect utility function concerning marginal utility rates. In this example, the reference household type R is a smaller household than the other household type h. Thus, at a given utility level the larger household needs more income Y to satisfy needs of additional household members. It is shown that a higher reference income level ($Y^{(R)}_2 > Y^{(R)}_1$) implies shrinking equivalence scale values ($Y^{(h)}_2/Y^{(R)}_2 < Y^{(h)}_1/Y^{(R)}_1$) which simply is the meaning of variable equivalence scales.

[6] By the way, a synthesis of Barten's and Translating approach is from Gorman 1976.
[7] See Barten 1964.
[8] See Bradbury 1992, pp. 15-16.

Figure 1: Microeconomic foundation of variable equivalence scales



Source: Present author's own illustration

3. Variable equivalence scales in distributional analyses

The incorporation of variable equivalence scales into distributional studies is, generally, confronted with the initial problem of separating the upper from the bottom (and the middle) range of equivalent incomes. In order to do this, a concrete equivalence scale for the whole income range may be assumed as a starting point which would be a normative decision.[9]

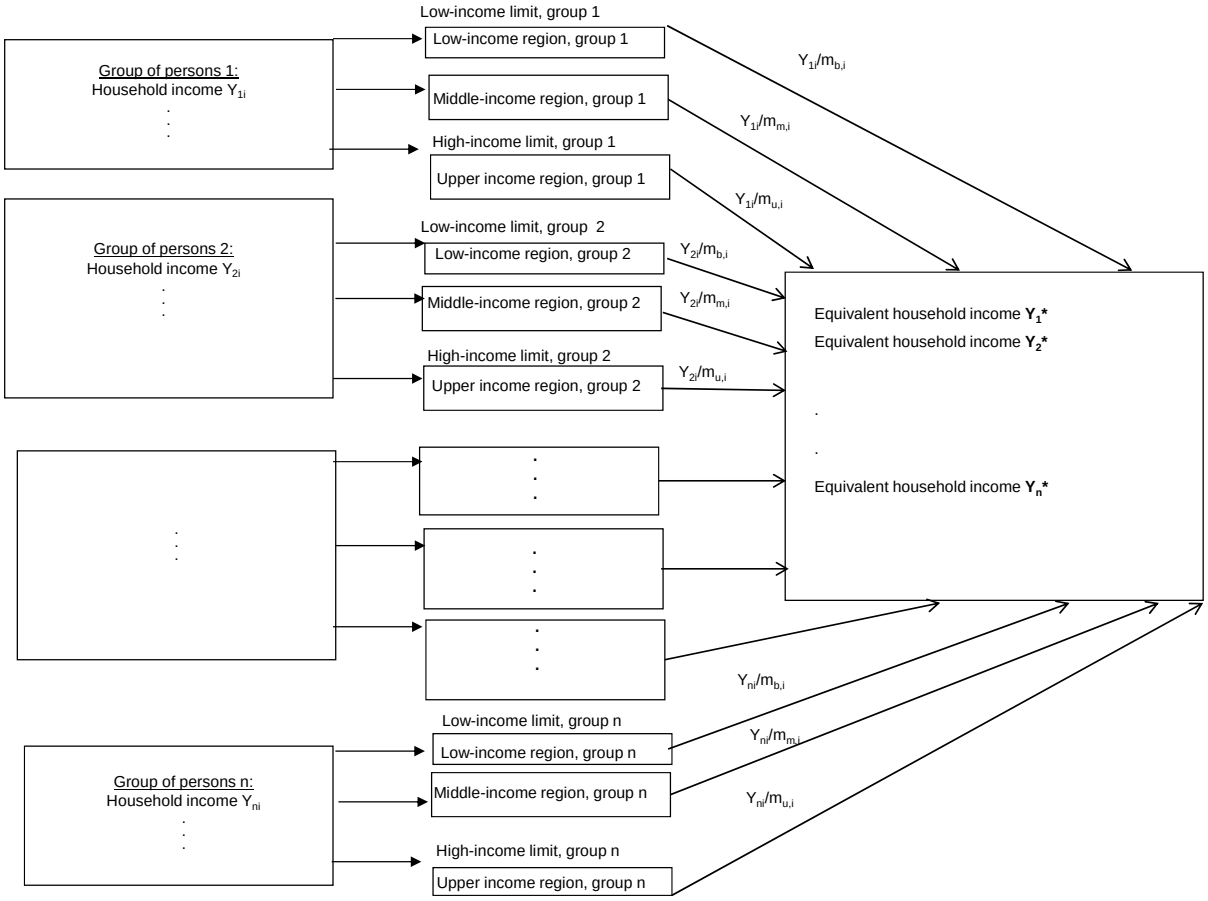
To some degree this normative (identification) problem can be circumvented by a "decomposition approach". Let us assume two or more income regions and that these income regions will be separately generated for each household type so that – because of homogeneity of each group – no overall equivalence scale must be specified afore. This means an orientation of welfare levels only on the behaviour of one's own group of households, and it is based on socio-psychological approaches like Festinger's theory of social comparisons.[10] A number of empirical socio-psychological findings point towards this direction.[11]

Since such welfare comparisons refer to household incomes and since households are (very) different with respect to size and composition, it seems to be a Herculean task for each individual to consider all these aspects in the context of his/her well-being rankings. It seems much easier for individuals to compare themselves with household types which are similar to their own type. This implies a kind of bounded rationality[12] since people do not have (or do not want to have) complete information on society's entire income situation.

According to the idea of variable equivalence scales, the scale values in the lowest income region are highest, and those in the upper income region are lowest, i. e.: The income values in the lowest income region are divided by higher scale values than the incomes in higher income regions. This is sketched in Figure 2 for three income regions (low-, middle- and high-income region).

[9] See Faik 1995, pp. 286-287.
[10] See Festinger 1954.
[11] See e. g. Clark and Oswald 1996, or Frey and Stutzer 2002, pp. 88-90; contrary: Koulovatianos, Schröder, and Schmidt 2010.
[12] See e. g. Simon 1957 or Leibenstein 1976.

Figure 2: A “decomposition approach” for measuring income inequality



Y_{gi}: income of unit of analysis i in group g (g = 1, 2, …, n), m_b = equivalence scale value in the bottom income region, m_m = equivalence scale value in the middle-income region, m_u = equivalence scale value in the upper income region; $m_b > m_m > m_u$; $\mathbf{Y_g}^*$: vector of equivalent household incomes within group g (g = 1, 2, …, n)

Source: Present author’s own illustration

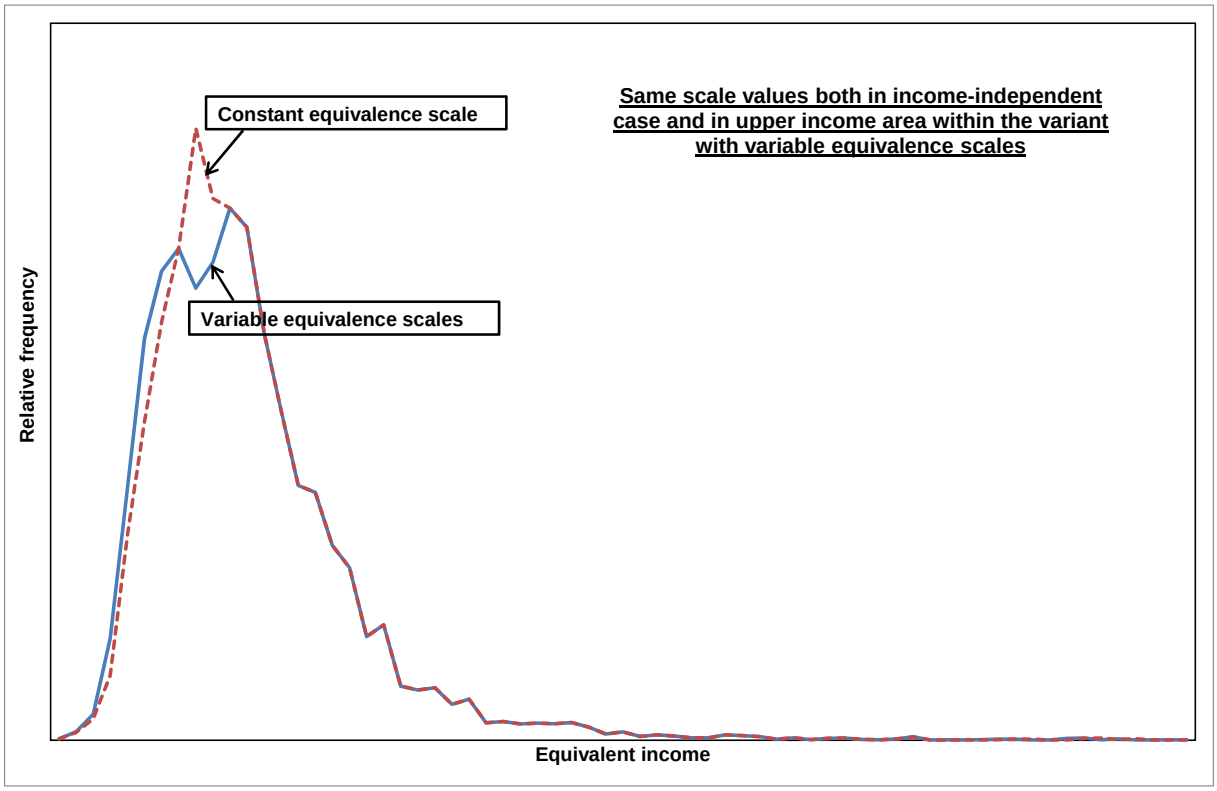
If variable equivalence scales with lower values are used for the upper income region, the differences of the equivalent incomes between the bottom and the upper income classes become larger than they would be without using variable equivalence scales. Thus, the measured inequality would increase. In this sense, Figure 3 compares the application of variable equivalence scales with the alternative method which uses income-independent, constant equivalence scales. For illustrative purposes, both figures are characterized by only two income regions, a bottom and an upper region.

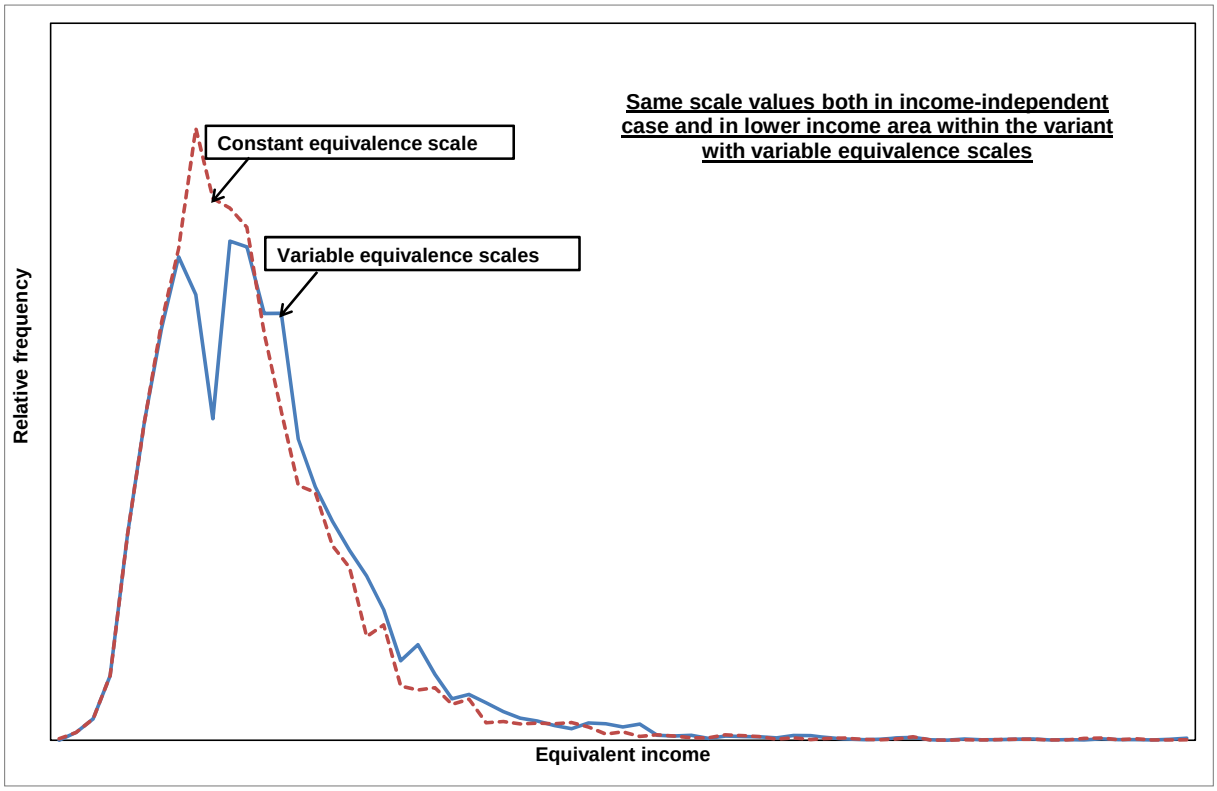
In the upper part of Figure 3 the overall equivalence scale in the income-independent case is set to the same level as in the upper income region in case with variable equivalence scales. This congruence leads to more inequality because of a more right-skewed income distribution in the latter variant of measuring inequality. The reason for this result is that in the variant with variable equivalence scales the incomes of multi-person households in the lower income region are diminished by higher scale values than in the variant with constant equivalence scales.

In the bottom part of Figure 3 an alternative assumption is made: The equivalence scales in the income-independent case and in the lower income region of the variant with variable equivalence scales shall equal each other. This corresponds with higher equivalent incomes

of the multi-person households within the upper income region in the case with variable equivalence scales and, thus, generates a higher degree of income dispersion.

Figure 3: Constant versus variable equivalence scales and their impact on the distribution of income





Source: Present author's own calculations (based on 2010 Socio-Economic Panel)

4. Estimates of variable equivalence scales in Germany

4.1 Income regions as a basis

Faik[13] has estimated income region-dependent equivalence scales on the basis of cross-sectional data from the 1983 German Income and Consumption Survey (so-called Einkommens- und Verbrauchsstichprobe; *EVS*). He divided the entire income spectrum into three regions: a low-, a middle-, and a high-income region. Furthermore, he made use of an expenditure-based method for estimating equivalence scales: the Engel approach. This method accounts well-being (utility) levels of different household types to being equal if their budget shares of (bundles of) goods, specified beforehand, are of equal amount.[14]

In order to separate the three income regions from each other (i. e., to "solve" the identification problem), Faik used a special equivalence scale. As a starting point he chose constant equivalence scale values in two variants, one based only on the expenditures for food and the other resting on the expenditures for a bundle of goods consisting of the categories food, housing, clothing & shoes, and body & health; each of these alternative scales was estimated via a linear Engel curve.

In a next step (and in both variants), Faik defined the upper limit of the low-income region as half the arithmetic mean of equivalent incomes and the lower limit of the high-income region as 1.5 times the arithmetic mean of equivalent incomes. For each of the three income regions defined in the way afore-mentioned, Faik estimated – via Engel curves' (OLS) regressions – iteratively new equivalence scales – up to the point where the scale values converged.

In variant 1 (using food's expenditures as dependent variable in the regressions), relatively small differences between the three income regions emerged across the different household types (household members) considered – especially for adults. For the younger age groups the scale decreases from low- to middle-income region (however, comprising an implausible low value for children in the age until six years; see Table 1). Variant 2 (based on the expenditures for a bundle of goods) reveals a much clearer picture of the income dependence of equivalence scale values: Within all age classes the scale values drop in case of transition from low- to middle-income region (with the exception of age class 7-11 years). Thus, in this sense there was a tendency towards income (region)-dependent equivalence scales in accordance with the theoretical considerations stated above.

For the transition from middle- to high-income region such a clear tendency did not emerge in variant 1. But in the more plausible variant 2 – i. e., basing well-being (utility) levels on a more exhaustive bundle of goods than only using the expenditures for food as a welfare indicator –, in three of five cases (age classes) the scale values dropped, and for both adults' age classes the non-negative changes did not vary (60+ years) or did not vary very substantial (20-59 years).

Thus, we can conclude that there is some evidence in favour of income-dependent equivalence scales especially for the transition from low- to middle-income region and also, less pronounced, for the transition from middle- to high-income region in Germany.

[13] See Faik 1995, pp. 285-289.
[14] See also Table A.3 in the Appendix.

Table 1: Income region-dependent equivalence scales (individual scale weights, in %; 1st household member: 100%) in Germany, 1983 *EVS**

Age class	Variant**	Low-income region	Middle-income region	High-income region
Until 6 years	1	12	0 (-12; -100.0%)	0 (0; 0.0%)
	2	22	14 (-8; -36.4%)	7 (-7; -50.0%)
7-11 years	1	25	16 (-9; -36.0%)	15 (-1; -6.3%)
	2	16	25 (+9; +56.3%)	17 (-8; -32.0%)
12-19 years	1	39	28 (-11; -28.2%)	34 (+6; +21.4%)
	2	36	30 (-6; -16.7%)	25 (-5; -16.7%)
20-59 years	1	44	38 (-6; -13.6%)	42 (+4; +10.5%)
	2	50	22 (-28; -56.0%)	25 (+3; +12.0%)
60 years and older	1	41	37 (-4; -9.8%)	38 (+1; +2.7%)
	2	47	25 (-22; -46.8%)	25 (0; 0.0%)

* The values in brackets indicate the change of individual scale weights with respect to transitions from low- to middle-income region and from middle- to high-income region in percentage points as well as in percent.

** Variant 1: expenditures for food; variant 2: expenditures for food, housing, clothes & shoes, and body & health

Sources: Faik 1995, pp. 286-287, and present author's own calculations

4.2 Reference income levels as a basis

Schulte[15] and Koulovatianos, Schröder, and Schmidt[16] provide further estimates of (variable) equivalence scales for Germany.[17] In contrast to the estimates presented in Table 1, these alternative calculations of variable equivalence scales are estimated over the entire income spectrum but under the assumption of different income levels of the reference household type. That means that the definition of these additional variable equivalence scales does not refer to income regions (in the sense of discrete variables) but to (quasi-)continuous variables (like Barten's or Translating approach sketched above). The corresponding estimates are from van Praag and van der Sar (1988), Faik (1995), and from Koulovatianos, Schröder, and Schröder (2005).[18]

Van Praag and van der Sar's estimates are based on a subjective approach, the Income Evaluation Question and correspond to Germany 1979. Koulovatianos et al. also use a subjective method, the so-called consensual approach, to estimate variable scales for Germany in 1999. In both approaches people are asked for equivalent income levels belonging to their own and/or to other household types.[19]

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[15] See Schulte 2007, pp. 40-47.
[16] See Koulovatianos, Schröder, and Schmidt 2005, p. 991.
[17] Concerning the estimation of variable equivalence scales see in an international perspective, among others, Fiegehen, Lansley, and Smith 1977, pp. 105-106, van Hoa 1986, pp. 97-98, Aaberge and Melby 1998, or Donaldson and Pendakur 2003, especially pp. 194-197.
[18] Schulte 2007, p. 44, also discussed Faik (1995) scale values which referred to the 1969 *EVS* and to the so-called Rothbarth method which is based on typical adults' goods (alcohol) to calculate scale values for children (see Table A.3 in the Appendix). The corresponding scales varied with (reference) income level negatively but only by construction. Because of this artificiality, they are excluded from Table 2.
[19] See in this context Table A.3 in the Appendix.

The results of Table 2 demonstrate that the basic thesis of the concept of variable equivalence scales – i. e.: declining scale values with increasing reference income levels – was fulfilled in both studies. This finding strengthens the theoretical arguments for variable equivalence scales.

Furthermore, in Table 2 variable scales estimated by Faik (1995) are presented. Faik's estimates refer to an expenditure-based, multi-equations approach on the basis of the Functionalized Extended Linear Expenditure System (FELES).[20] He estimated Barten as well as Translating scales: Only in the Translating variant, income dependence becomes evident.

Table 2: Reference income-dependent equivalence scales (individual scale weights; in %) for Germany*

Study	Reference income level	3rd person	4th person	5th person	6th person
Van Praag & van der Sar (1988) for Germany 1979	Low/ Middle High	16 13 (-3; -18.8%)	13 10 (-3; -23.1%)	10 8 (-2; -20.0%)	10 7 (-3; -30.0%)

Study	Reference income level	2nd person	3rd person	4th person	5th person	6th person
Faik (1995; Barten) for Germany 1983	Low Middle High	48 48 (0; 0.0%) 48 (0; 0.0%)	26 25 (-1; -3.8%) 25 (0; 0.0%)	16 16 (0; 0.0%) 14 (-2; -12.5%)	11 9 (-2; -18.2%) 8 (-1; -11.1%)	-2 -5 (-3; -150.0%) -7 (-2; -40.0%)
Faik (1995; Translating) for Germany 1983	Low Middle High	48 34 (-14; -29.2%) 22 (-12; -35.3%)	26 19 (-7; -26.9%) 12 (-7; -36.8%)	16 11 (-5; -31.3%) 7 (-4; -36.4%)	11 8 (-3; -27.3%) 7 (-1; -12.5%)	-2 -1 (1; -50.0%) -1 (0; 0.0%)
Koulovatianos et al. (2005) for Germany 1999	Low Middle High	75 50 (-25; -33.3%) 39 (-11; -22.0%)	52 22 (-30; -57.7%) 10 (-12: -54.5%)	45 20 (-25; -55.6%) 10 (-10; -50.0%)	45 20 (-25; -55.6%) 9 (-11; -55.0%)	- - -

* The values in brackets indicate the change of individual scale weights with respect to transitions from low- to middle-income level and from middle- to high-income level in percentage points as well as in percent. Reference household types (with scale value = 100%): upper part: two-person household, bottom part: single-person household[21]

Source: Present author's own calculations based on Schulte 2007, p. 41, Koulovatianos et al. 2005, p. 991, and Faik 1995, pp. 244-245

[20] See Table A.3 in the Appendix.

[21] For the dependency of equivalence scales on the chosen reference household type see Ebert and Moyes 2003.

5. Empirical sensitivity analyses

5.1 The data base

In the following data from the German Socio-Economic Panel (SOEP) for the years 1992 to 2010 are used. The SOEP of the German Institute for Economic Research (DIW Berlin)[22]; see, e. g., Wagner, Frick, and Schupp 2007) has been collected since 1984 in annual intervals. The sample sizes (from 1992 on) are provided in Table A.1 in the Appendix. The participants of the surveys give detailed information on their incomes, household composition, earnings' and family's biographies, health, life-satisfaction, etc.

A number of subsamples have been drawn to capture different sub-populations:

- Sample A: German households in the Federal Republic of Germany since 1984,
- Sample B: households of foreigners in the Federal Republic of Germany since 1984,
- Sample C: private households in eastern Germany (German Democratic Republic) since 1990,
- Sample D: households of immigrants in Germany since 1994/1995,
- Sample E: complementary sample of households in Germany since 1998,
- Sample F: complementary sample of households in Germany since 2000,
- Sample G: sample of high-income receivers (households) in Germany since 2002, and
- Sample H: complementary sample of households in Germany since 2006.

For distributional analyses two central income variables are available: Monthly household income of the current year and annual household income of the previous year so that the query for the latter variable is retrospective. In this study, we use - in accordance with the Canberra Group's guidelines[23] – annual household net income which includes household's income obtained from all sources (including imputed rents) over a one year's period.

The data analysis begins with wave 1992 (with information on annual incomes in 1991) since from this period on SOEP data for unified Germany are available.

5.2 Distributional results on the basis of variable versus constant equivalence scales

In the following analyses the whole income range is divided into three regions, the bottom, the middle, and the upper income class. Current FELES regression results for Germany (2003 *EVS*) place the low-income line at 70 percent of average net incomes (see Faik 2011). Thus, for all household types considered in this paper[24] this line was used (by only referring to "pure" net incomes for the reasons stated above). The high-income lines for the different household types are determined – in accordance with other (German) studies (see e. g. Grabka et al. 2007, pp. 60-61) – as twice the group's arithmetic mean of households' net incomes (see Table A.2 in the Appendix).

The basic inequality results for Germany 1992-2010[25] are shown in Figure 4.[26] Between 1992 and 2001 income inequality in Germany did not change very much, but since 2002 it has

[22] See, e. g., Wagner, Frick, and Schupp 2007.

[23] See UN 2011, pp. 26-27.

[24] The paper's calculations are restricted to single- to six-person households since the number of cases for household sizes with seven and more persons is too low for statistical reasons, as can be seen by Table A.1 in the Appendix.

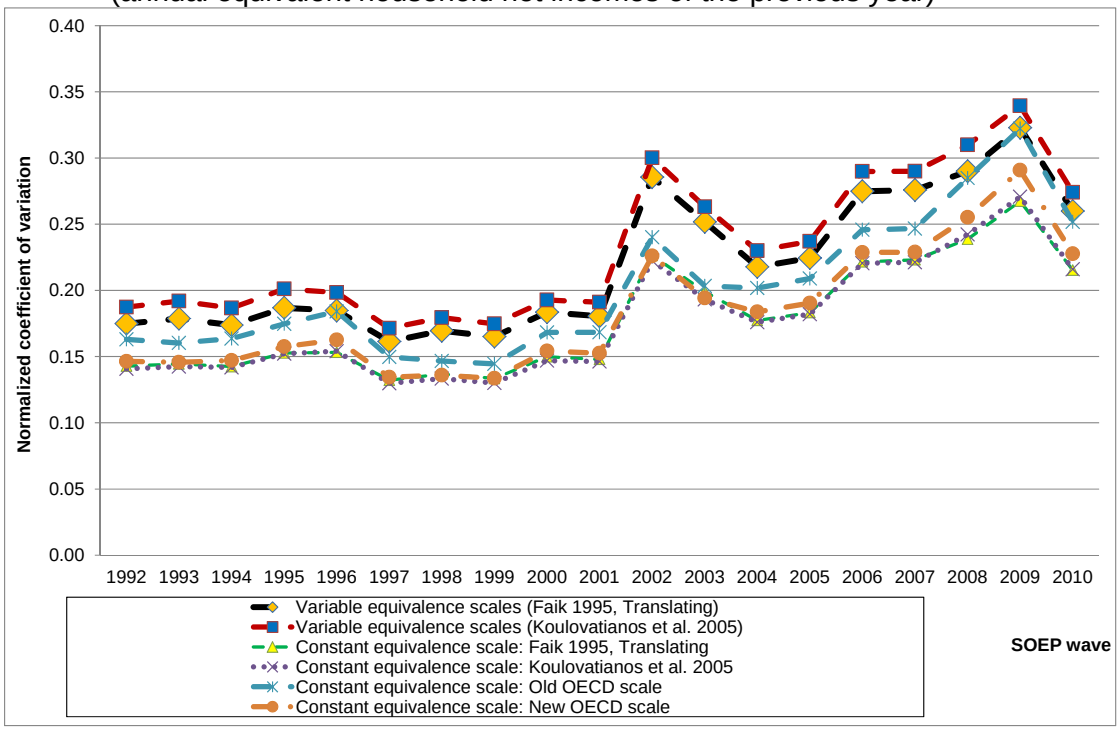
[25] To avoid largely biased inequality values because of extreme income levels ("outliers"), household net incomes are constrained up to an amount of 1,000,000 € p. a.

[26] In the Appendix, additionally, bootstrap estimates (at a 95-percent level of significance) are documented (for the case of variable equivalence scales).

been at a higher level than before, measured by the normalized coefficient of variation. This may be partly the result of a sampling effect since for the transition from 2001 SOEP to 2002 SOEP high incomes have been captured to a higher degree (by sample G; see above), which, obviously, was not corrected by adequate grossing-up factors within the SOEP samples. Because of the relatively large high-income sensitivity of the normalized coefficient of variation this sampling effect might explain at least part of the notable rise of inequality between 2001 and 2002. Moreover, the increase of income inequality might be partly caused by socio-economic developments in Germany at the beginning of the 21st century, e. g. by the increase of low-paid jobs or by a rise of individual incomes' homogamy (with respect to partner relationships in Germany)[27]. At the end of the observation period income inequality in Germany as a whole decreased. Perhaps (at least partly) this was a reflection of the diminished unemployment rates in Germany at the end of the first decade of the 21st century.

For the cases with constant equivalence scales, Figure 4 shows the same pattern of income inequality as in the case with variable equivalence scales but at lower inequality levels which is in accordance with the above theoretical considerations. Referring to the cases with variable equivalence scales, the measured value differences of the normalized coefficients of variation are within the ranges of 21 to 26 percent (comparing Faik's 1995 Translating scales with each other) and of 25 to 36 percent (concerning Koulovatianos et al.'s 2005 scales). It must be stressed that this numerical result rests upon the specification of only three income regions. Assuming more than three income regions, would have enlarged those differences. Furthermore, the variable equivalence scales presented in Figure 4 also led to higher inequality values compared to the so-called old and new (constant) OECD scales.[28]

Figure 4: Variable and constant equivalence scales in Germany as a whole 1992-2010 SOEP on the basis of the normalized coefficient of variation (annual equivalent household net incomes of the previous year)



Source: Present author's own calculations

[27] In this context see Schröder 2011.

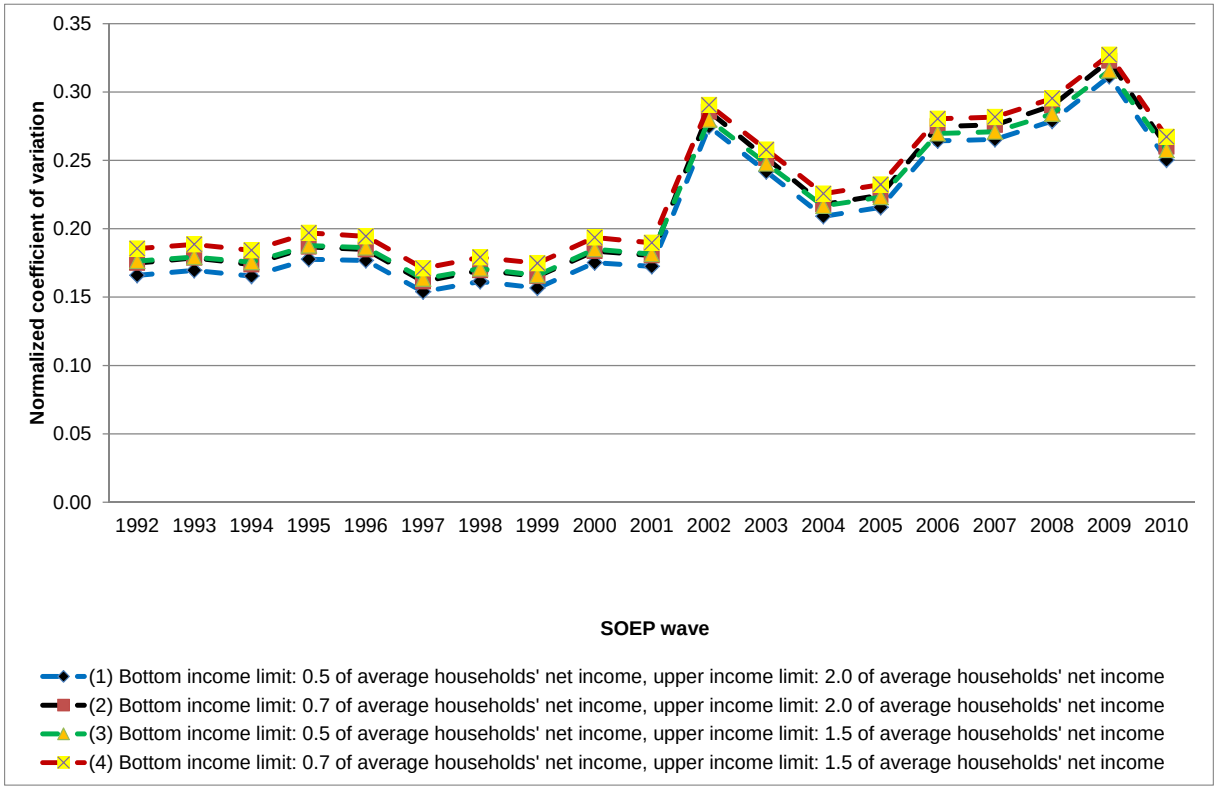
[28] The old OECD scale is characterized by the following individual weights: 1st household member: 1.00, additional adult household member (15 years and older): 0.70, and additional children (until 15 years): 0.50; the weights of the new OECD scale are as follows for the same groups: 1.00, 0.50, and 0.30 (see: http://www.oecd.org/dataoecd/61/52/35411111.pdf, accessed at 2012-01-31). In Figure 4 approximations of both OECD scales, only with respect to household size, are used.

5.3 Different income limits

Figure 5 illustrates the consequences of different reference limits for the three income regions in the sense of different fractions or multiples of the different household types' mean net incomes. As variable equivalence scale Faik's (1995) variable Translating scale is assumed.

As a rule, it becomes obvious that larger differences in income limits between the upper and the bottom income region cause lower income inequality than smaller corresponding differences. This is because of a broader middle class corresponding with identical scale values over a broader section of the entire income distribution. Despite these findings and on balance, in Figure 5 the inequality differences between the four variants are relatively small.

Figure 5: Different borders of income regions, variable equivalence scales (Faik's 1995 Translating scales), and their consequences for income inequality in Germany 1992-2010 SOEP on the basis of the normalized coefficient of variation (annual equivalent household net incomes of the previous year)



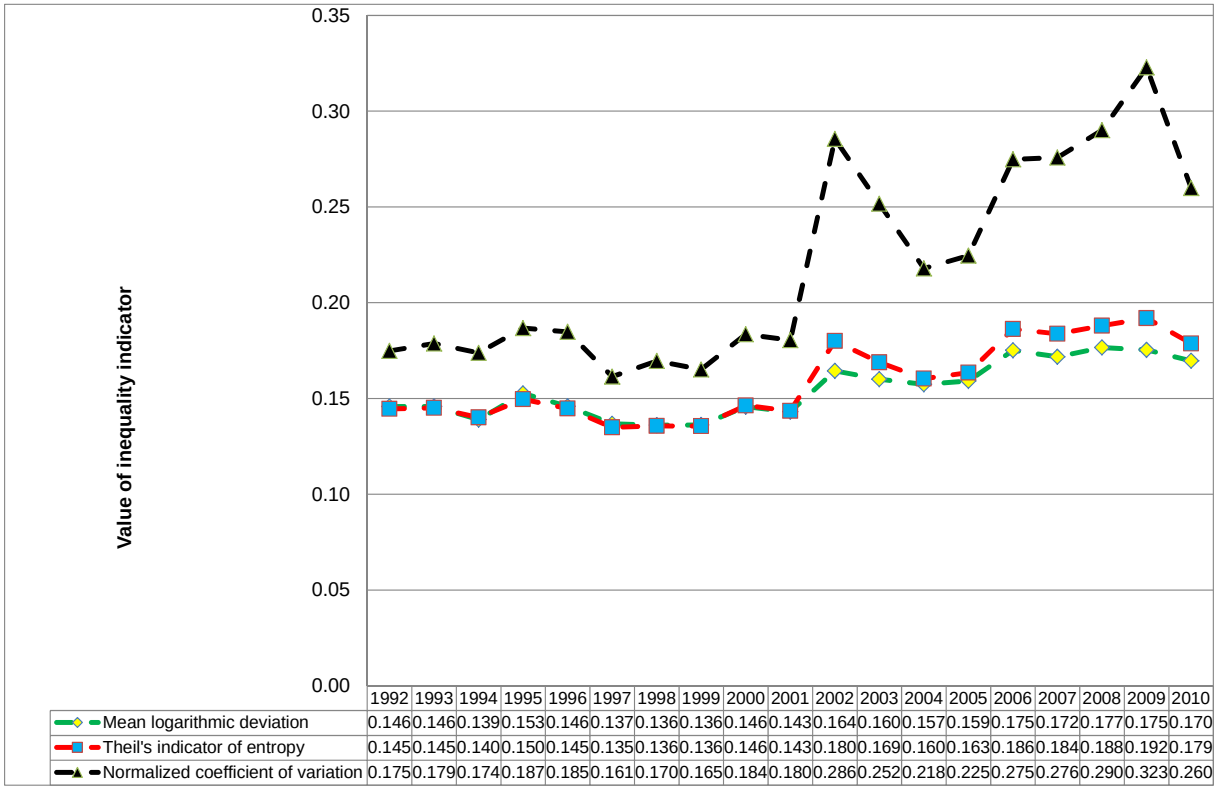
Source: Present author's own calculations

5.4 Different inequality measures

Figure 6 shows the inequality consequences of different inequality measures (mean logarithmic deviation, Theil's measure of entropy applied in this paper, and normalized coefficient of variation) for Germany 1992-2010. These three inequality indicators vary with respect to their sensitivity to changes within different income regions. Compared with the high-income sensitive normalized coefficient of variation, the mean logarithmic deviation and Theil's measure of entropy used here – both not as sensitive to changes in high-income regions as the normalized coefficient of variation – reveal a rather smoothed "inequality curve" over time.

Especially – and expectedly – this is true for the transition between 2001 and 2002, i. e.: during the period of time in which the SOEP added many high-income receivers. Additionally, the rise in income inequality between 2006 and 2009 indicated by the normalized coefficient of variation is only weakly revealed by the two other inequality indicators. Thus, the findings of rising inequality between 2001 and 2002 as well as between 2006 and 2009 can primarily be interpreted as a consequence of changes within the upper income range during these periods of time.

Figure 6. Different inequality indicators, variable equivalence scales (Faik's 1995 Translating scales), and their consequences for income inequality in Germany 1992-2010 SOEP (annual equivalent household net incomes of the previous year)



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Mean logarithmic deviation	0.146	0.146	0.139	0.153	0.146	0.137	0.136	0.136	0.146	0.143	0.164	0.160	0.157	0.159	0.175	0.172	0.177	0.175	0.170
Theil's indicator of entropy	0.145	0.145	0.140	0.150	0.145	0.135	0.136	0.136	0.146	0.143	0.180	0.169	0.160	0.163	0.186	0.184	0.188	0.192	0.179
Normalized coefficient of variation	0.175	0.179	0.174	0.187	0.185	0.161	0.170	0.165	0.184	0.180	0.286	0.252	0.218	0.225	0.275	0.276	0.290	0.323	0.260

Source: Present author's own calculations

6. Concluding remarks

The findings of the paper revealed the sensitivity of distributional results due to different methodical settings.

The analyses yielded the following conclusions:

1. In the case with variable equivalence scales the measured inequality was substantially higher than in the case with income-independent equivalence scales.
2. A narrowing of income limits between the upper and the bottom income region led to increases in income inequality (within the methodical framework presented here).
3. For Germany the usage of three alternative inequality indicators gave hints towards rising inequality between 2001 and 2002 as well as between 2006 and 2009 especially in the upper (equivalent) income region (but from 2009 to 2010 income inequality decreased indicated by all used inequality measures).

In summary, there appear to be solid theoretical and empirical justifications for using variable equivalence scales in studies of income inequality.

Other applications of variable equivalence scales include tax schemes or benefit programmes in order to study horizontal (in)equity aspects[29] and to enlarge the degree of consistency in the design of public policies[30]. This indicates the broad scope of variable scales beyond "pure" distributional analyses.

Appendix

Table A.1: Unweighted number of households in Germany 1992-2010 SOEP due to household size*

Wave	1 person	2 persons	3 persons	4 persons	5 persons	6 persons	7 persons	8 persons and more	Sum
1992	1,350	2,025	1,472	1,247	393	120	38	18	6,663
1993	1,418	2,040	1,424	1,195	395	110	34	21	6,637
1994	1,450	2,124	1,452	1,210	398	100	37	22	6,793
1995	1,484	2,181	1,467	1,274	401	102	38	20	6,967
1996	1,513	2,195	1,416	1,233	380	101	36	17	6,891
1997	1,488	2,240	1,367	1,205	373	87	33	17	6,810
1998	1,794	2,568	1,500	1,296	359	101	34	13	7,665
1999	1,730	2,536	1,405	1,227	353	95	31	11	7,388
2000	3,399	4,590	2,314	2,074	651	156	39	19	13,242
2001	3,047	4,161	2,073	1,873	601	133	43	14	11,945
2002	3,077	4,592	2,200	1,999	624	144	37	14	12,687
2003	3,026	4,398	2,048	1,839	583	128	34	15	12,071
2004	2,977	4,377	1,978	1,763	545	117	28	13	11,798
2005	3,009	4,253	1,886	1,645	513	107	29	8	11,450
2006	3,391	4,780	2,014	1,690	501	107	23	13	12,519
2007	3,212	4,445	1,902	1,554	463	88	22	10	11,696
2008	3,099	4,270	1,762	1,414	406	88	18	9	11,066
2009	3,357	4,654	1,835	1,503	424	97	22	7	11,899
2010	3,112	4,323	1,591	1,369	347	87	23	5	10,857

* Only households with positive net incomes considered

Source: Present author's own calculations

[29] See Ebert and Lambert 2004, Lambert 2004, or Muellbauer and van de Ven 2004.
[30] See Ayala, Martínez, and Ruiz-Huerta 2003, p. 599.

Table A.2: Arithmetic mean values of household net incomes (€ p. a.) for Germany 1992-2010 SOEP due to household size*

Wave	1 person	2 persons	3 persons	4 persons	5 persons	6 persons
1992	13,075	22,762	28,157	31,192	33,068	35,445
1993	13,997	24,569	29,973	33,939	35,412	35,530
1994	14,562	26,125	32,047	34,955	35,579	37,832
1995	14,774	26,435	32,103	34,521	35,898	36,818
1996	15,411	26,949	32,616	35,143	36,840	38,756
1997	15,441	27,460	33,152	35,748	39,449	39,743
1998	15,534	28,251	33,792	36,765	38,063	40,187
1999	16,004	29,263	35,525	37,665	39,491	43,323
2000	16,478	30,464	35,823	39,096	41,611	43,432
2001	17,123	30,886	36,662	40,869	42,152	43,035
2002	17,709	31,653	37,144	42,230	44,060	44,888
2003	18,111	32,319	38,073	42,905	45,491	45,816
2004	17,982	32,595	38,328	42,715	44,572	46,457
2005	18,545	33,219	38,063	43,953	44,232	46,084
2006	18,676	33,778	38,931	44,477	45,347	46,963
2007	18,749	33,775	39,133	46,075	48,040	48,793
2008	19,365	35,022	40,311	47,028	50,054	45,289
2009	19,601	36,078	40,365	48,541	49,744	45,846
2010	19,886	36,356	43,278	48,642	51,963	47,203

* Only households with positive net incomes and up to size of six household members considered

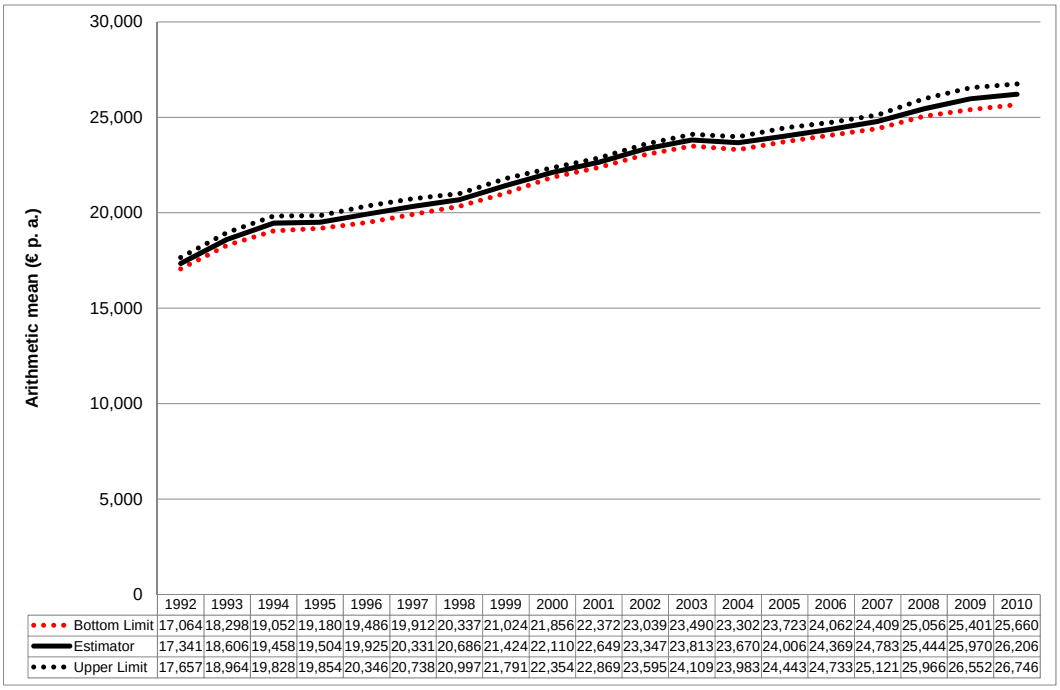
Source: Present author's own calculations

Table A.3: Overview over different approaches for estimating equivalence scales

I. Expert-based approaches
The scale values are determined by experts, e. g. using nutritional knowledge. Typically, the corresponding approaches are concerned with minimum needs.
II. Subjective approaches
Subjective evaluations with respect to needs of different household types are used to obtain indirect utility functions. Equal utility levels constitute equivalence scale values.
In the framework of the *societal variant* (another label: consensual variant) interviewees are asked for several income levels, specified in advance, concerning different household types which lead to same utility/well-being levels (e. g., to determine poverty lines).
The *individual variant* (other labels: "Leyden approach" or Income Evaluation Question) is characterized in the way that interviewees construct an ordinal well-being classification for different income levels only with respect to their own household type (e. g., on a scale from 0: "lowest well-being level" to 10: "highest well-being level"). The ordinal values are, in a next step, transformed into cardinal indirect utility functions, and on this basis – for equal utility levels – income-related equivalence scales are calculated.
III. Expenditure-based approaches
Here observed consumption patterns of different household types are the basis for exploring consumers' preferences. The corresponding approaches can be differentiated into two main variants: Single-equation variants (Rothbarth and Engel method) and multi-equations variants (demand systems without and alternatively with price substitution effects).
The *Rothbarth method* is characterized by equal absolute consumption levels of so-called adults' goods like alcohol for households with children versus households without children. This allows the calculation of individual scale weights for children.
Contrastively, the *Engel method* refers to equal budget shares as a criterion for deducing equivalence scales. Within the Engel model the budget share of a defined bundle of commodities is regressed by household income and by household's characteristics (socio-demographically modified Engel curves).
The *multi-equations variant without price substitution* (so-called Prais & Houthakker variant) refers to all goods a household consumes creating demand equations for all goods. The implied direct utility function does not allow price substitution effects between the several commodities. For every good specific equivalence scale values are computed which, in a next step, are used as weighting factors in the different cost functions. Dividing the socio-demographically specified cost function of a specific household type by the cost function of the reference household type generates the overall equivalence scale. Since the Prais & Houthakker model is under-identified, it is necessary to start with a normatively specified overall scale to determine good-specific scale values and then to calculate the "new" overall equivalence scale values, typically in an iterative procedure.
Within the *multi-equations variant with price substitution effects* substitutionality between the different goods is allowed. Manifestations of this alternative multi-equations variant are Barten's or Translating operationalisations for socio-demographically modified utility functions. Assuming, on this basis, a concrete utility function, good-specific scale values can be calculated. They serve as weights in the cost functions which enable the estimation of overall scale values. In literature a lot of concrete utility functions exist – leading to different demand systems, e. g. to the Functionalized (Extended) Linear Expenditure System, to the Functionalized Quadratic Expenditure System, or to the Functionalized Almost Ideal Demand System.

Source: Present author's own compilation on the basis of Faik 1995, pp. 45-54 and pp. 79-155, and of Schulte 2007, pp. 7-39

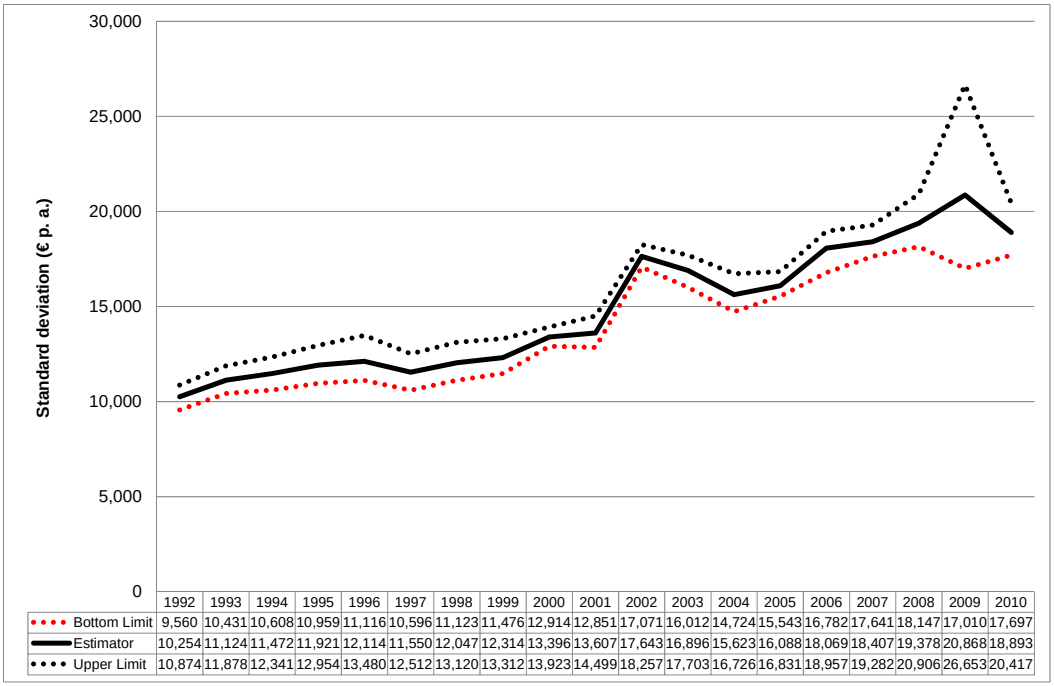
Figure A.1a: Bootstrap estimations for arithmetic means
of equivalent household net incomes in Germany 1992-2010 SOEP
(95-percent confidence intervals; number of bootstrap's cases per wave:
200 samples) based on Faik's (1995) variable Translating scales



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bottom Limit	17,064	18,298	19,052	19,180	19,486	19,912	20,337	21,024	21,856	22,372	23,039	23,490	23,302	23,723	24,062	24,409	25,056	25,401	25,660
Estimator	17,341	18,606	19,458	19,504	19,925	20,331	20,686	21,424	22,110	22,649	23,347	23,813	23,670	24,006	24,369	24,783	25,444	25,970	26,206
Upper Limit	17,657	18,964	19,828	19,854	20,346	20,738	20,997	21,791	22,354	22,869	23,595	24,109	23,983	24,443	24,733	25,121	25,966	26,552	26,746

Source: Present author's own calculations

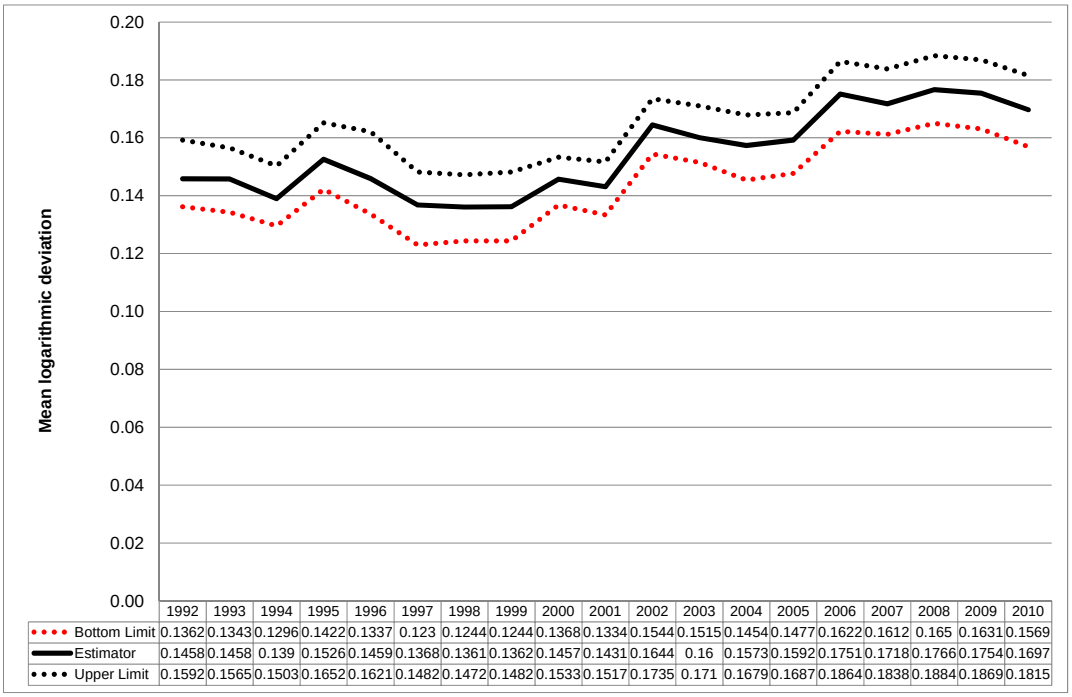
Figure A.1b: Bootstrap estimations for standard deviations
of equivalent household net incomes in Germany 1992-2010 SOEP
(95-percent confidence intervals; number of bootstrap's cases per wave:
200 samples) based on Faik's (1995) variable Translating scales



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bottom Limit	9,560	10,431	10,608	10,959	11,116	10,596	11,123	11,476	12,914	12,851	17,071	16,012	14,724	15,543	16,782	17,641	18,147	17,010	17,697
Estimator	10,254	11,124	11,472	11,921	12,114	11,550	12,047	12,314	13,396	13,607	17,643	16,896	15,623	16,088	18,069	18,407	19,378	20,868	18,893
Upper Limit	10,874	11,878	12,341	12,954	13,480	12,512	13,120	13,312	13,923	14,499	18,257	17,703	16,726	16,831	18,957	19,282	20,906	26,653	20,417

Source: Present author's own calculations

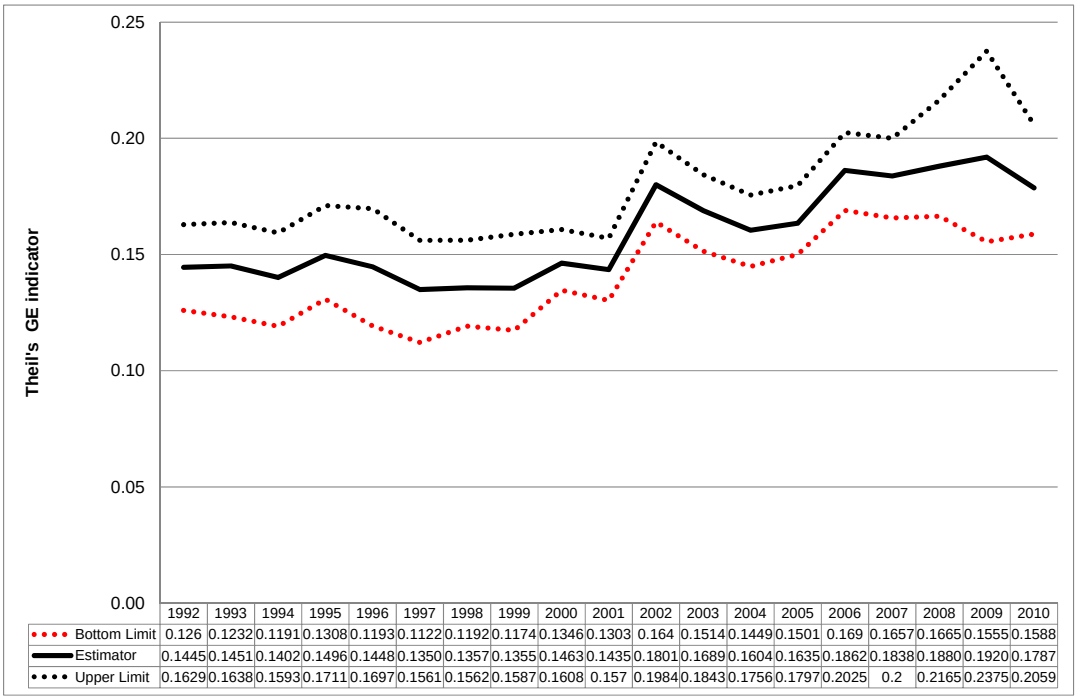
Figure A.1c: Bootstrap estimations for mean logarithmic deviations of equivalent household net incomes in Germany 1992-2010 SOEP (95-percent confidence intervals; number of bootstrap's cases per wave: 200 samples) based on Faik's (1995) variable Translating scales



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bottom Limit	0.1362	0.1343	0.1296	0.1422	0.1337	0.123	0.1244	0.1244	0.1368	0.1334	0.1544	0.1515	0.1454	0.1477	0.1622	0.1612	0.165	0.1631	0.1569
Estimator	0.1458	0.1458	0.139	0.1526	0.1459	0.1368	0.1361	0.1362	0.1457	0.1431	0.1644	0.16	0.1573	0.1592	0.1751	0.1718	0.1766	0.1754	0.1697
Upper Limit	0.1592	0.1565	0.1503	0.1652	0.1621	0.1482	0.1472	0.1482	0.1533	0.1517	0.1735	0.171	0.1679	0.1687	0.1864	0.1838	0.1884	0.1869	0.1815

Source: Present author's own calculations

Figure A.1d: Bootstrap estimations for Theil's entropy indicator values of equivalent household net incomes in Germany 1992-2010 SOEP (95-percent confidence intervals; number of bootstrap's cases per wave: 200 samples) based on Faik's (1995) variable Translating scales



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bottom Limit	0.126	0.1232	0.1191	0.1308	0.1193	0.1122	0.1192	0.1174	0.1346	0.1303	0.164	0.1514	0.1449	0.1501	0.169	0.1657	0.1665	0.1555	0.1588
Estimator	0.1445	0.1451	0.1402	0.1496	0.1448	0.1350	0.1357	0.1355	0.1463	0.1435	0.1801	0.1689	0.1604	0.1635	0.1862	0.1838	0.1880	0.1920	0.1787
Upper Limit	0.1629	0.1638	0.1593	0.1711	0.1697	0.1561	0.1562	0.1587	0.1608	0.157	0.1984	0.1843	0.1756	0.1797	0.2025	0.2	0.2165	0.2375	0.2059

Source: Present author's own calculations

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