The influence of income-dependent equivalence scales on income inequality: an empirical analysis for Germany since 1993

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Erstveröffentlichung / Primary Publication
Arbeitspapier / working paper

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The Influence of Income-Dependent Equivalence Scales on Income Inequality

– An Empirical Analysis for Germany since 1993

FaMa-Diskussionspapier 6/2010

FaMa
Neue Frankfurter Sozialforschung
Nikolausstraße 10
D-65936 Frankfurt/Main

August 2010

Herausgeber und Verlag:
FaMa
Neue Frankfurter Sozialforschung
Nikolausstraße 10
65936 Frankfurt am Main
Tel.: 069/34409710
Fax: 069/34409714
E-Mail: info@fama-nfs.de
http://www.fama-nfs.de

ISSN 1869-1935

Zusammenfassung*

Das Diskussionspapier beschäftigt sich mit Sensitivitätseinflüssen auf die bundesdeutsche personelle Einkommensverteilung in Zeitverlaufsperspektive. Hierbei werden erstmals expressis verbis einkommensabhängige Äquivalenzskalen in einer bundesdeutschen Verteilungsanalyse genutzt. Außerdem werden in diesem Zusammenhang einkommensstrukturelle und demografiebezogene Sensitivitätseffekte auf Basis der bundesdeutschen Einkommens- und Verbrauchsstichproben analysiert. Hinsichtlich der Äquivalenzskaleneinflüsse zeigt sich eine gewisse Ergebnis-Robustheit, was die Rangordnung zwischen den einzelnen Untersuchungsjahren anbelangt. Darüber hinaus ergeben sich in den einzelnen Beobachtungsjahren beachtliche Ungleichheitserhöhungen durch die genannte Annahme einkommensabhängiger Äquivalenzskalen. Es zeigen sich auch Ungleichheitserhöhungen aufgrund der im Zeitablauf zu beobachtenden haushaltsstrukturellen Veränderungen in Deutschland. Ebenfalls offenbaren sich gegenüber einem Referenzzustand Ungleichheitserhöhungen durch einkommensstrukturelle Einflüsse. Alles in allem verweisen die vorgenommenen Analysen auf die Notwendigkeit einer überaus sorgfältigen methodischen Fundierung von Verteilungsstudien, insbesondere hinsichtlich der Wahl eines Sets von (möglichst einkommensabhängigen) Äquivalenzskalen.

Summary*

The discussion paper deals with sensitivity influences upon the German personal income distribution in a time perspective. For the first time income-dependent equivalence scales are explicitly applied in a distributional analysis of German data. Furthermore, the effects of income-structural and demographic changes are analysed. With respect to the influences of alternative equivalence scales some robustness of the results becomes apparent when it comes to the ranking between the different observation years. In addition, the increases in inequality, which are caused by the mentioned assumption of income-dependent equivalence scales, are significant in each analysed period. Compared with a status of reference, the author also found impacts towards increases in inequality generated by changes of household structure and by income-structural changes in Germany over time. All in all, the analyses refer to the necessity of a rigorous methodological foundation for distributional studies, especially concerning the selection of a set of (preferably income-dependent) equivalence scales.

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Content

1. Introduction[1]

1.1 Preliminary considerations

In this paper I will argue – along the lines of FaMa discussion paper #1-2010[2] – that income-dependent equivalence scales, which belong to different income areas, are more appropriate for distributional purposes than determinations for the whole spectrum of incomes. In order to demonstrate in detail the consequences that such a procedure has, I will use a decomposable inequality measure (the normalized coefficient of variation).

The paper is organized as follows. After describing the data set (Section 1.2) and discussing the concept of equivalence scales (Section 1.3), Section 2 is concerned with the theoretical aspects of measuring inequality with different equivalence scales. In Section 3 an empirical reference scenario is created by varying the household net equivalent incomes on the basis of several equivalence scales that are valid across the whole income range (so-called income-independent equivalence scales). As a next step in Section 4, for the first time using German data, income-dependent equivalence scales are applied in order to compute inequality levels. In addition, the sensitivity effects of income-structural and demographic influences concerning inequality are the subject of Section 5 where, once more, income-dependent equivalence scales are the analytical basis. Finally, concluding remarks are the topic of Section 6.

1.2 The database and its limitations

The database used in this paper is from the official German Income and Expenditure Survey *(EVS: Einkommens- und Verbrauchsstichprobe)* for the years 1993, 1998 and 2003;[3] the most recent *EVS* – conducted in 2008 – is available for scientific purposes, but only since a short time ago. The *EVS* is collected by the German Statistical Office as a cross-sectional database since 1962 in intervals of approximately five years. It comprises roughly between 45,000 and 60,000 households and about 100,000-120,000 persons. The participants of the surveys give detailed information on their incomes and expenditures.[4]

There are some analytical limitations to the *EVS* database on income distribution:

1. Institutionalised and homeless persons are not in the *EVS* database.
2. Households with a non-German head were not included until 1988; however, since then (beginning with the 1993 *EVS*) such households have been still clearly underrepresented in the *EVS*.
3. The *EVS* database is not a randomized but a quota sample, and very high and very low incomes are not part of the *EVS* database (so-called “middle-class bias”).
4. Since 1998 the participants have not been asked about their expenditures and incomes during a complete year but only – in a procedure of rotation – during a quarter.

Whereas in my eyes points 1 to 3 tend to reduce the revealed degree of income inequality, point 4 probably has a tendency to the opposite effect. This is because there are special payments in single quarters like Christmas bonuses in the fourth quarter. Nevertheless, it

[1] The author would like to especially thank Prof. Dr. Wolfgang Glatzer, University of Frankfurt am Main, for providing the opportunity to work with the database used as part of the project *“Untersuchungen zum sozialkulturellen und sozioökonomischen Wandel in Deutschland”*. Furthermore, the author is very grateful to the German Statistical Office – the *Statistisches Bundesamt* in Wiesbaden – for allowing the scientific community in Germany access to the database as anonymized micro-data files (so-called “scientific-use files”). Last but not least the author would like to thank Paul Martin Lauer (M. A.), University of Lüneburg, for his refinements concerning the paper’s grammar and style.

[2] See Faik 2010a.

[3] Concretely, I used 80-percent samples of the corresponding surveys.

[4] With regard to the conceptual framework of the *EVS* see e. g. Becker and Hauser 2003, pp. 71-81.

may be that such special payments in particular quarters offset each other over a one-year period, so that the assumed bias would not take effect (at least not to a large extent).

These data restrictions should be kept in mind in the discussion that follows. Thus, in light of the serious differences between the 1993 *EVS* and both the 1998 and the 2003 *EVS*, the conclusions drawn concerning German income inequality over time should be handled with caution.

1.3 General equivalence scale approaches[5]

In order to capture the sensitivity of the distributional results as "purely" as possible, it is meaningful to make use of general equivalence scale formulas.

I will concentrate on the very prominent general equivalence scale formula of Buhmann et al. that only depends on household size:

(1) $m_h = S^{\theta} \quad (0 \leq \theta \leq 1)$.[6]

In Equation (1) the symbols have the following meaning: m_h is the abbreviation for the equivalence scale of household type h (with respect to the reference household type, in this case a single-person household[7]), S represents household size, and θ is the elasticity of the equivalence scale with regard to household size, and therefore it also reflects the degree of economies of scale. The extreme cases $\theta = 0.0$ and $\theta = 1.0$ correspond with a per-household weighting and with a per-capita weighting of household incomes.

Since the Buhmann et al. formula already encompasses a broad range of possible equivalence scales,[8] my reference scenario in Section 3 – as a preliminary stage for comparing results with the income-dependent equivalence scales in Section 4 – is exclusively based on the Buhmann et al. approach.[9]

By the way, concerning the Buhmann et al. scale formula sufficient approximations exist at $\theta = 0.6$ for the well-known "new OECD scale" and at $\theta = 0.8$ for the "old OECD scale".[10]

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[5] See also Faik 2009, pp. 6-11.
[6] See Buhmann et al. 1988, p. 119.
[7] For the dependency of equivalence scales on the chosen reference household type see Ebert and Moyes 2003.
[8] Nevertheless, the Buhmann et al. scales are only some possibilities from a spectrum of a principally infinite number of equivalence scales (at least if we assume, for theoretical reasons, that arbitrary small decreases in the scale values are possible).
[9] Test calculations have shown that the results of the Buhmann et al. approach are not substantially altered by some alternative general formulas (see Faik 2009, pp. 16-17). Such an alternative proposal was made by Citro and Michael 1995, p. 161, including a differentiation between the number of adults (A) and of children (C): $m_h = (A + \alpha \cdot C)^{\theta} \quad \left(0 \leq \theta \leq 1,\ 0 \leq \alpha \leq 1\right)$ [α = needs of children compared with the needs of adults]. Another general proposal is the formula derived by Faik 2009, p. 9, via an expenditure-based, micro-econometric approach [with ß as sensitivity parameter]: $m_h = 1 + \beta \cdot ln(S) \quad \left(0 \leq ß \leq \frac{1}{ln(2)}\right)$.
[10] See Faik 2009, p. 8 [weights of the "new OECD scale" for further persons aged 15 years or older: 0.5 and for further persons aged until 14 years: 0.3; weights of the "old OECD scale" for further persons aged 15 years or older: 0.7 and for further persons aged until 14 years: 0.5].

2. Hypotheses concerning the connections between inequality and equivalence scales and demographic changes[11]

2.1 The normalized coefficient of variation

In order to assess (socio-)demographic and economic influences as well as the influences of equivalence scales upon income inequality it seems natural to use a decomposable inequality measure. In this context the class of Generalized Entropy (GE) measures seems to be appropriate. A GE measure allows for disjoint groups the differentiation between group-specific inequality (within-group inequality) and inequality between the groups (between-group inequality). The group's population shares together with the relative income positions of the groups serve as weighting factors.[12]

A well-known member of the class of GE measures is the normalized coefficient of variation (CV), which is defined as half of the squared coefficient of variation, where the coefficient of variation is given as the standard deviation relative to the mean of incomes. In a decomposed manner, CV can be written as the sum of both mentioned components of inequality:[13]

$$(2)\quad CV = \sum_{g=1}^{G} v_g^2 \cdot w_g^{-1} \cdot CV_g + \frac{1}{2} \cdot \left\{ \left[\sum_{g=1}^{G} w_g \cdot \left(\frac{\mu_g}{\mu} \right)^2 \right] - 1 \right\}$$

within-group inequality   between-group inequality

[CV = normalized coefficient of variation, w_g = population share of group g, v_g = group-specific income relation, CV_g = normalized coefficient of variation within group g, μ_g = mean income of group g, μ = overall mean income].

The weighting factors w_g (= n_g/n) represent the population shares of the several groups of persons g (g = 1, 2, …, G), and v_g (= w_g μ_g/μ) denotes the group-specific income relation compared with the aggregate income [n = overall population size, n_g = number of persons within group g].

2.2 Overall equivalence scales and inequality[14]

When computing the inequality of equivalent incomes, the correlation between household size and household income is important. Typically, the correlation between these two variables is positive. For the *EVS* data sets and for Germany as a whole, the following Pearson's correlation coefficients have been computed: 1993 *EVS*: +0.415, 1998 *EVS*: +0.414, and 2003 *EVS*: +0.497.[15] Starting with the assumption of greatest economies of scale and thus starting with equivalence scale values in the amount of 1.0 for all household types, subsequently the degree of economies of scale is reduced in increments. This corresponds with

[11] See Faik 1995, pp. 322-326. Comparable sensitivity considerations might be made in the field of poverty. Faik 1995, pp. 362-363, discussed possible theoretical relationships in this field (particularly with regard to relative income poverty); empirical examples are given in Zaidi and de Vos 1994 and in de Vos and Zaidi 1997.

[12] A more comprehensive consideration of the class of GE measures can be found in Faik 1995, pp. 326-330, which is primarily based on Cowell 1980, Shorrocks 1980, Mookherjee and Shorrocks 1982, and Jenkins 1991; see also Faik 2010a, pp. 6-14.

[13] For a more detailed discussion of CV (and its characteristics concerning the decomposition of inequality) see Faik 2010a, pp. 13-14.

[14] See also Faik 2010a, pp. 15-16.

[15] Author's own calculations. The corresponding values for western versus eastern Germany are: Western Germany: 1993 *EVS*: +0.452, 1998 *EVS*: +0.433, 2003 *EVS*: +0.445; eastern Germany: 1993 *EVS*: +0.570, 1998 *EVS*: +0.521, 2003 *EVS*: +0.539 (author's own calculations).

higher equivalence scale values for larger households and means a levelling concerning the equivalent household incomes. Briefly, the measured inequality decreases (“concentration effect”). But the further decrease in the larger household’s equivalent incomes will lead to an increase in the measured inequality at some point (“re-ranking effect”). As a consequence of this process, a U-shaped curve[16] for the inequality levels, as a function of the range of economies of scale, is realistic.[17]

If a negative correlation between household size and household income occurs, it is probable that the inequality curve will have a positive slope across the whole area or most of the area of scale values beginning with the “per-household situation” and ending with the “per-capita situation”. Ideally, the relatively low (equivalent) incomes of the larger household sizes, compared with the smaller household sizes, are continuously reduced, and as a result the inequality between the different household sizes increases.[18]

Referring to CV, the formal influence of equivalence scales on the measured inequality is as follows:[19]

(3) $$\mu_* = \sum_{g=1}^{G} \frac{\mu_g}{m_g} \cdot \frac{n_g}{n},$$

$$\sigma^2_{*,within} = \sum_{g=1}^{G} \frac{\sigma_g^2}{m_g^2} \cdot \frac{n_g}{n},$$

$$\sigma^2_{*,between} = \sum_{g=1}^{G} \left(\frac{\mu_g}{m_g} - \mu_* \right)^2 \cdot \frac{n_g}{n}$$

$$\Rightarrow CV = \frac{1}{2} \cdot \frac{\sum_{g=1}^{G} \frac{\sigma_g^2}{m_g^2} \cdot \frac{n_g}{n} + \sum_{g=1}^{G} \left(\frac{\mu_g}{m_g} - \mu_* \right)^2 \cdot \frac{n_g}{n}}{\left(\sum_{g=1}^{G} \frac{\mu_g}{m_g} \cdot \frac{n_g}{n} \right)^2}$$

[with: μ_* = arithmetic mean of equivalent incomes, μ_g = arithmetic mean of group g’s incomes (g = 1, 2, …, G), m_g = equivalence scale for group g, n_g = number of persons within group g, n = number of all persons, $\sigma^2_{*,within}$ = within-group variance of equivalent incomes, σ_g^2 = variance of group g’s incomes, $\sigma^2_{*,between}$ = between-group variance of equivalent incomes, CV = normalized coefficient of variation].

2.3 Income-dependent equivalence scales and inequality

Since the millennium a lot of studies have discussed aspects of the German personal distribution of equivalent incomes. For instance, we can name the following analyses: Becker (2000, 2005), Biewen (2000), Schüssler, Lang, and Buslei (2000), Himmelreicher (2001), Krause (2001), Hauser and Wagner (2002), Becker and Hauser (2003, 2004, 2009), Birkel (2004), Sopp (2005), Goebel and Krause (2007), Grabka and Frick (2007, 2008), Faik (2008), Frick and Grabka (2008), Grabka, Westerheide, Hauser, and Becker (2008), Faik and Becker (2009), and Becker and Faik (2010). These studies make use of data from the

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[16] Typically, the curve is at least J-curved (see e. g. Figini 1998, p. 8-9).
[17] For a detailed discussion see especially Cowell and Mercader-Prats 1999, pp. 25-26; see also Figini 1998, pp. 7-9.
[18] See also Faik 2010a, pp. 15-22.
[19] See Faik 2010, p. 15.

above mentioned *EVS* database and/or from the German Socio-Economic Panel (GSOEP). Typically, they only utilized a single equivalence scale in order to adjust the different incomes for household size and household structure effects. Explicit exceptions are Biewen (2000), Becker and Hauser (2004), and Faik (2008). Whereas Biewen and Becker and Hauser both based their calculations on only two alternative scales, Faik applied – like Faik (1995) and in principle with the international studies of Coulter, Cowell, and Jenkins (1992), Figini (1998), Cowell and Mercader-Prats (1999), Lancaster, Ray, and Valenzuela (1999), Creedy and Sleemann (2004), and Bönke and Schröder (2008) – a broad set of equivalence scales derived from the Buhmann et al. scale formula.

None of these studies applied income-dependent equivalence scales for distributional purposes, although there are good reasons for basing distributional analyses on such flexible equivalence scales. It might be argued, for example, that in the higher income ranges the reference consumption levels (e. g. concerning accommodation costs) would be fairly high so that a new household member's appearance (e. g. the "adding" of a child) would increase the corresponding costs only marginally, and this would culminate in low *relative* costs, that is flat equivalence scales for larger households in the upper income range compared with the lower incomes. Another reason for income-dependent scales might be that prices of goods can differ across income groups such that members of the upper income classes obtain price advantages.[20] Furthermore, 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.[21]

Faik (1995), Schröder (2004), and Koulovatianos, Schröder, and Schmidt (2005) estimated income-dependent equivalence scales for Germany.[22] Their results were in accordance with the arguments presented above – in the sense that lower equivalence scales in the upper income range were computed compared to the bottom income area.[23] Whereas my equivalence scales in Faik (1995) were generated by econometric, expenditure-based methods, the results of the other studies made use of survey methods.[24]

The incorporation of income-dependent equivalence scales into distributional studies is confronted with the initial problem of separating the upper from the bottom range of equivalent incomes. In order to do this we must assume a concrete equivalence scale for the whole income range as a starting point.[25] To some degree this is a normative decision.

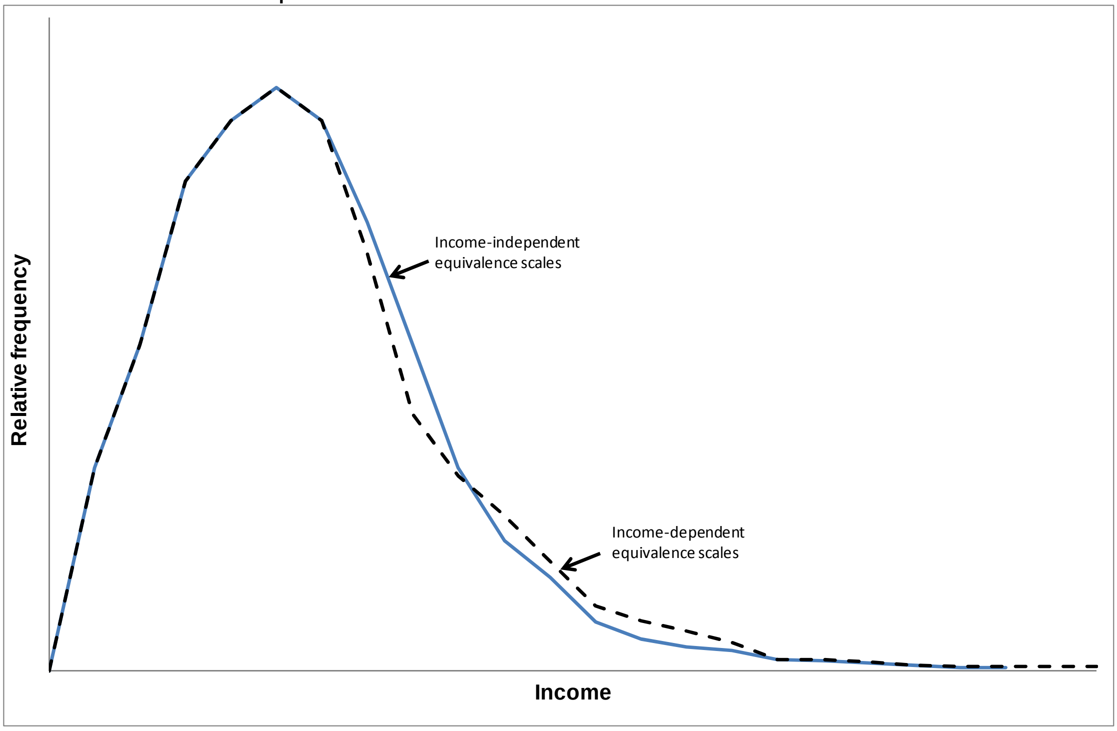
If income-dependent equivalence scales with lower values on the equivalence scale are used for the upper income area, the differences of the equivalent incomes between the bottom and the upper income classes become larger than they would be without using income-dependent equivalence scales. Thus, the measured inequality would probably increase.

Figure 1 compares the use of income-dependent equivalence scales with the alternative method using income-independent equivalence scales. In this illustration it becomes evident that for the given distributions both are right-skewed (which is in accordance with a huge number of empirical facts). The arithmetic mean as well as the standard deviation rise during the transition from income-independent to income-dependent equivalence scales. Whether this corresponds with a rise in the measured inequality depends on the strength of each of these two increases. In Figure 1 it is assumed – which seems to be realistic – that the rela-

[20] See Schröder 2004, p. 42.
[21] See Koulovatianos, Schröder, and Schmidt 2005, p. 969. See also Faik 2010a, p. 23.
[22] Concerning the estimation of income-dependent equivalence scales see, additionally and 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.
[23] Obviously, the definition of income-dependent equivalence scales used here refers to income areas in the sense of discrete variables, and not to incomes in the sense of (quasi-)continuous variables.
[24] For an overview about the corresponding results see Koulovatianos, Schröder, and Schmidt 2005, p. 991.
[25] See Faik 1995, pp. 286-287.

tive increase in the standard deviation (in percent) would be higher than the corresponding increase of the arithmetic mean (also in percent). As a result the measured inequality also rises.

Figure 1: Income-independent versus income-dependent equivalence scales and their impact on the distribution of income – idealized illustration



Source: Author's own illustration (see also Faik 2010a, p. 23, for a similar figure)

We can formally illustrate the differences between the two alternatives by decomposing the numerator (the variance) as well as the denominator (the arithmetic mean squared) of the normalized coefficient of variation. In the following example the income range is decomposed into two parts, into the bottom and into the upper income area.

Firstly, I consider the arithmetic mean squared (1 represents the bottom income area and 2 the upper income area, and the asterisks once more reflect equivalent income values). I obtain the following expression in which the parameter γ denotes a diminishment of the values of equivalence scales in the upper income area for two-person to G-person households compared with the bottom income area:

$$(4)\quad \mu_*^2 = \left[\frac{n_1 \cdot \mu_{*,1} + n_2 \cdot \mu_{*,2}}{n}\right]^2$$

$$\mu_*^2 = \left[\frac{\sum_{g=1}^{G} \frac{\mu_{1,g}}{m_{1,g}} \cdot n_{1,g} + \sum_{g=1}^{G} \frac{\mu_{2,g}}{m_{2,g}} \cdot n_{2,g}}{n}\right]^2$$

$$\mu_*^2 = \left[\frac{\sum_{g=1}^{G} \frac{\mu_{1,g}}{m_{1,g}} \cdot n_{1,g} + \mu_{2,g=1} \cdot n_{2,g=1} + \sum_{g=2}^{G} \frac{\mu_{2,g}}{\gamma \cdot m_{1,g}} \cdot n_{2,g}}{n}\right]^2 .$$

Secondly, the variance (of equivalent incomes) can be decomposed as follows (1 once more represents the bottom income area and 2 the upper income area):

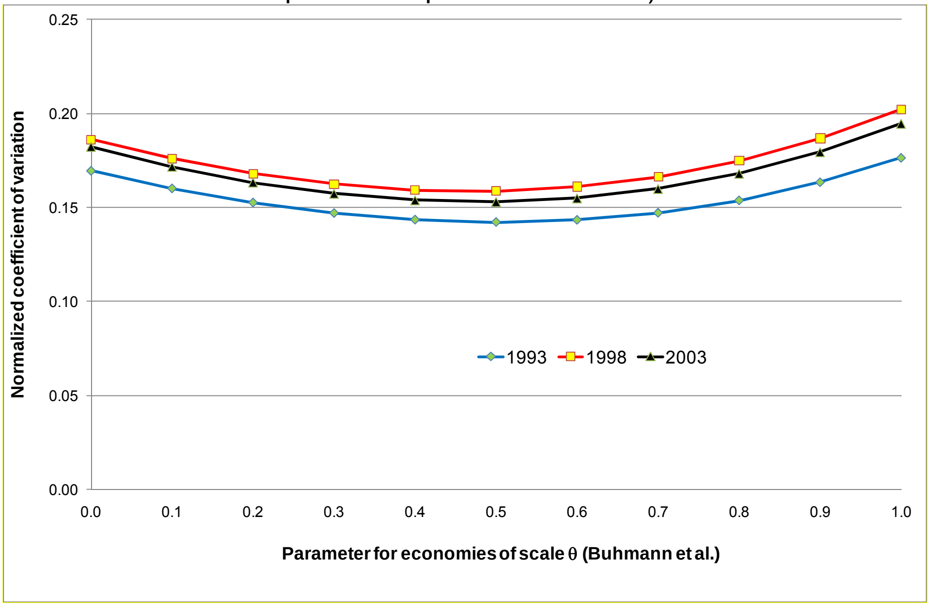
(5) $$\sigma_*^2 = \frac{n_1 \cdot \sigma_{*,1}^2 + n_2 \cdot \sigma_{*,2}^2}{n} + \frac{n_1 \cdot (\mu_{*,1} - \mu_*)^2 + n_2 \cdot (\mu_{*,2} - \mu_*)^2}{n}.$$ [26]

3. Income inequality in Germany: The reference scenario[27]

Because of the positive correlation between household size and household net income, as discussed above, the curve of the normalized coefficient of variation[28] is U-shaped across the range of θ in all years considered for Germany. The inequality difference between 1998 and 2003 appears to be very small; in contrast, in 1993 the measured inequality level was clearly lower than in the following years. To some extent this might be a consequence of the methodological differences between the 1993 *EVS* and the samples of 1998 and 2003.

Furthermore, the three periods of observation belonged to different states of the business-cycle in Germany: Whereas 1993 was a period of recession, 1998 was part of an increase in prosperity, and 2003 marked a further phase of economic weakness. It could be argued that in a boom higher incomes grow faster than lower ones. This could be one reason for the higher inequality in 1998 than in the recessional phases of 1993 and 2003.[29]

Figure 2: Normalized coefficients of variation for Germany 1993-2003 at different levels of θ (Buhmann et al. formula, household net equivalent income, income-independent equivalence scales)



Source: Author’s own calculations

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[26] See also Faik 2010a, p. 24.

[27] For similar analyses see Coulter, Cowell, and Jenkins 1992 (for the United Kingdom) or (for 20 countries) Bönke and Schröder 2008. In Section 3 the equivalent household net incomes are weighted by the number of persons in each household. This is because individuals achieve well-being and not households (see e. g. Faik 2008, p. 23). Bönke and Schröder 2008 applied an alternative weighting, the so-called needs-related weighting, i. e. weighting of the equivalent incomes by equivalence scale values. See also Faik 2009 (using the Gini coefficient as inequality indicator).

[28] An alternative sensitivity analysis refers to the choice of the inequality indicator. For a discussion of different inequality indicators and their characteristics, see e. g. Faik 1995, pp. 297-314. In Faik 1995 and in Faik 2008 the shapes of the “inequality curves” were also like U-curves for a number of inequality indicators.

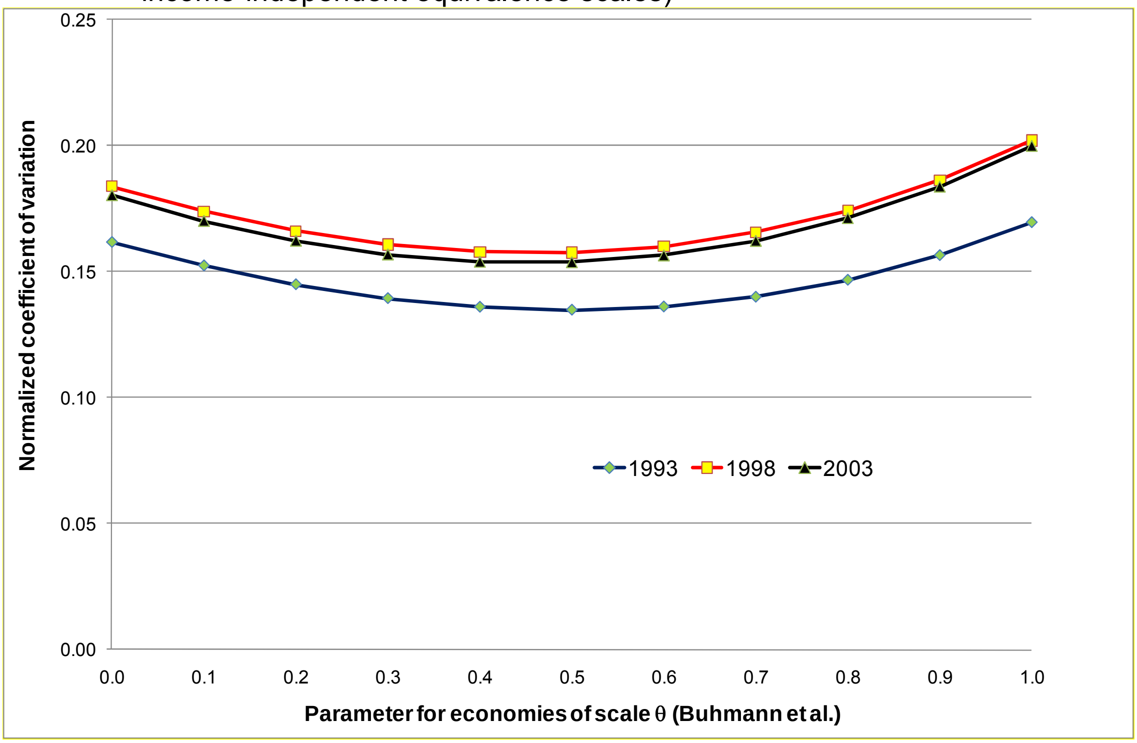
[29] This view is confirmed – at least to a certain degree – by the empirical study of Jäntti and Jenkins 2009 who found that for the United Kingdom low economic growth was associated with very small changes in inequality (measured by the Gini coefficient), whereas high growth rates caused stronger increases in inequality.

Figures 3a and 3b show findings for western and eastern Germany since 1993. For all values of θ the measured income inequality in eastern Germany is lower than in western Germany. Perhaps this reflects the "socialist uniformity" in the German Democratic Republic (GDR), which seems to continue to have an effect at least to some degree.

In eastern Germany the inequality curves of 1998 and 2003 intersect at θ = 0.4 (see Figure 3b). Up to this value of θ the measured inequality for the year 2003 is higher, after that point the opposite is the case. Because there is empirical evidence to restrict the range of θ (e. g. to a range from θ = 0.4 to θ = 0.8[30]), we can, on the basis of Figure 3b, conclude that there was a (slightly) higher inequality for 1998 than for 2003 in eastern Germany. This ranking regarding time periods is valid for western Germany across the *whole* area of θ, as can be seen in Figure 3a.

The U-shaped inequality curves in Figures 3a and 3b reveal an important divergence. Whereas in western Germany the inequality values in the per-capita variant (θ = 1.0) are higher than in per-household perspective (θ = 0.0), the opposite is valid in eastern Germany. This is consistent with the discussion in Section 2.2. The corresponding difference seems to be (at least partly) the result of the differently high values of the (positive) correlation coefficients concerning the connection between household size and household income. In western Germany this correlation is lower than in eastern Germany (see footnote 15). Thus, the increasing effects regarding income inequality (over the spectrum of values of θ) have a higher weight in western than in eastern Germany, and at the end of the spectrum of θ this causes a steeper continuous form in western Germany compared with eastern Germany.

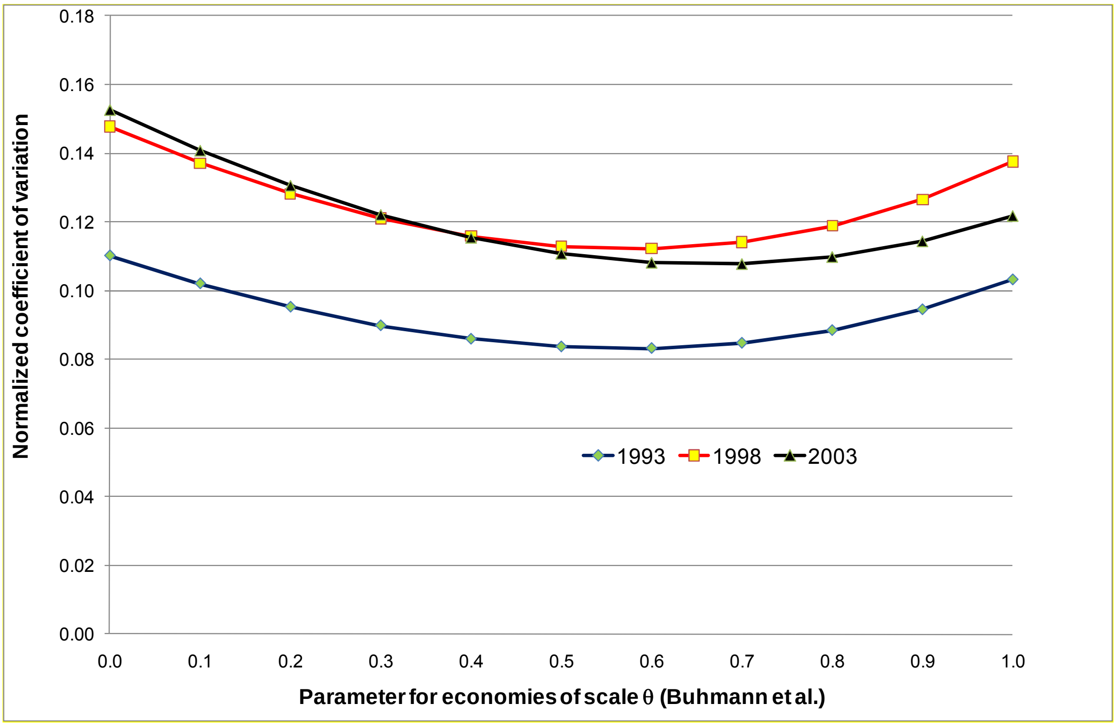
Figure 3a: Normalized coefficients of variation for western Germany in 1993-2003 at different levels of θ (Buhmann et al. formula, household net equivalent income, income-independent equivalence scales)



Source: Author's own calculations

[30] This range includes empirical, expenditure-based equivalence scales for Germany (see e. g. Faik 1995, Merz and Faik 1995, Faik and Hauser 1998, or Missong 2004) as well as the above mentioned new and old OECD scales (with approximately θ = 0.6 for the new OECD scale and θ = 0.8 for the old OECD scale, as discussed in Section 1.3).

Figure 3b: Normalized coefficients of variation for eastern Germany
in 1993-2003 at different levels of θ
(Buhmann et al. formula, household net equivalent income,
income-independent equivalence scales)



Source: Author's own calculations

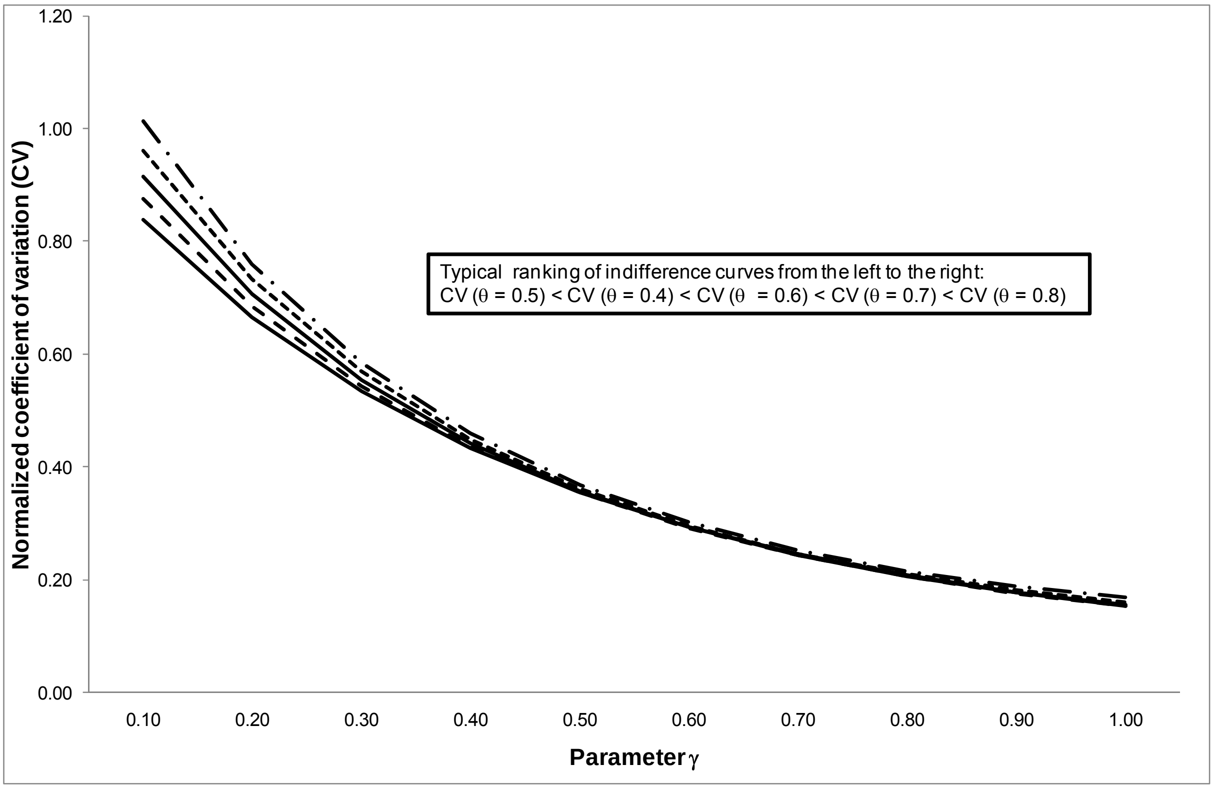
4. The development of income inequality in Germany due to income-dependent equivalence scales

As was indicated by the theoretical considerations in Section 2.3, in my following analyses with regard to income-dependent equivalence scales I divide the whole income range into two areas, the bottom and the upper income class. Exemplarily, the posited dividing line is generated by the arithmetic mean of the household net equivalent incomes. As a starting point a uniform equivalence scale is used across the whole (equivalent) income range. After that, I take this equivalence scale in order to compute equivalent incomes in the bottom income area, and in the upper income area I use reduced equivalence scales for that purpose.

Technically speaking, at every level of θ I reduce the weights for further household members in the upper income area by the factor γ compared with the equivalence scales of the bottom income area (see e. g. Equation (4)). Figure 4 reveals – for different curves with a constant value of θ respectively – the sensitivity effects of varying values of the parameter γ with respect to CV, as exemplified for the year 2003 and for values of θ between 0.4 and 0.8. Obviously, the CV values decline with increasing values of the parameter γ.[31]

[31] At γ = 1.0 the corresponding values are trivially the same as in the case discussed above with overall, income-independent equivalence scales underlying the curve in Figure 2.

Figure 4: Income-dependent equivalence scales with variation of the parameter γ in Germany as a whole 2003 ($0.4 \leq \theta \leq 0.8$, Buhmann et al. scale, household net equivalent income)



Source: Author's own illustration

In the following calculations concerning the time period 1993 until 2003, I reduce at all levels of θ the weights for further household members in the upper income area in the amount of plausible ten percent[32] compared with the equivalence scales of the bottom income area (i. e. $\gamma = 0.9$). An example shall illustrate this procedure. Let us take the Buhmann et al. scale at $\theta = 0.5$ as a starting point. We would then obtain as an equivalence scale for the different household sizes in the bottom income area: Singles: 1.00, two persons: 1.41, three persons: 1.73, four persons: 2.00, five persons: 2.24, and six persons: 2.45. Thus, the equivalence scale of the upper income area would amount to: Singles: 1.00, two persons: 1.27, three persons: 1.56, four persons: 1.80, five persons: 2.01, and six persons: 2.20.[33]

[32] Such a reduction is derived – admittedly, only an approximation – from the calculations in Faik 1995, pp. 286-287. In this publication I performed estimations of so-called Engel equivalence scales for three income ranges (bottom, middle, upper area of income). The comparison of the bottom income area with the middle/upper income range reveals – in reference to expenditures on food and semi-luxury food – indeed for the most of the displayed age groups (especially for the group of adults) equivalence scales that are about 5-15 percent higher in the bottom income range. In Faik 1995 I made an alternative estimation on the basis of the sum of expenditures for food and semi-luxury food, expenditures for clothing and shoes, accommodation costs, and expenditures for body care and health. These alternative estimations typically displayed still higher differences of equivalence scales between the bottom and the middle/upper income range. Insofar, the applied reduction of scale values in the amount of ten percent seems to be a conservative approach (in order "to be on the safe side").

[33] Obviously, this procedure can lead to lower equivalence scales for larger households (concretely in our case: for six-person households) in the upper income area compared with smaller household sizes (in the above example: five-person households) in the bottom income area (above: 2.20 versus 2.24).

Table 1 shows the distributional effects of income-dependent equivalence scales for Germany 1993-2003 (based on the Buhmann et al. formula and on the expression of CV according to Equations (4) and (5)). Obviously, the ranking between the three years is not changed compared with the illustrations in Figures 2, 3a and 3b but the inequality levels are substantially higher than in the case with income-independent equivalence scales.

For Germany as a whole the relative differences amount to about 9-17 percent (in eastern Germany this range is yet higher: circa 10-22 percent). This is an expected result and arises from higher standard deviations and higher arithmetic means compared with the case of income-independent scales where the relative increases in the standard deviations are higher than the corresponding increases in the arithmetic means.

Table 1: Normalized coefficients of variation in Germany as a whole and in western versus eastern Germany in 1993-2003 based on income-dependent equivalence scales (Buhmann et al. formula, household net equivalent income) and relative deviations to the application of the Buhmann et al. formula across the whole income range (in parentheses, in percent)

θ	Germany as a whole			Western Germany			Eastern Germany		
	1993	1998	2003	1993	1998	2003	1993	1998	2003
0.0	0.1949 (14.9)	0.2132 (14.5)	0.2084 (14.3)	0.1858 (14.9)	0.2106 (14.5)	0.2062 (14.3)	0.1303 (18.3)	0.1712 (15.8)	0.1765 (15.6)
0.1	0.1850 (15.5)	0.2024 (15.0)	0.1973 (14.9)	0.1760 (15.5)	0.1999 (14.9)	0.1955 (14.9)	0.1218 (19.4)	0.1597 (16.5)	0.1638 (16.3)
0.2	0.1770 (16.0)	0.1938 (15.3)	0.1882 (15.2)	0.1681 (16.0)	0.1915 (15.3)	0.1871 (15.3)	0.1146 (20.4)	0.1500 (17.0)	0.1527 (17.0)
0.3	0.1710 (16.4)	0.1876 (15.5)	0.1816 (15.4)	0.1622 (16.4)	0.1855 (15.4)	0.1809 (15.4)	0.1088 (21.2)	0.1420 (17.3)	0.1435 (17.6)
0.4	0.1670 (16.5)	0.1838 (15.4)	0.1774 (15.3)	0.1584 (16.5)	0.1819 (15.3)	0.1774 (15.2)	0.1045 (21.7)	0.1360 (17.3)	0.1359 (17.8)
0.5	0.1653 (16.3)	0.1825 (15.0)	0.1758 (14.9)	0.1567 (16.3)	0.1810 (14.9)	0.1765 (14.8)	0.1018 (21.7)	0.1322 (17.1)	0.1304 (17.8)
0.6	0.1659 (15.8)	0.1840 (14.3)	0.1770 (14.2)	0.1575 (15.8)	0.1827 (14.1)	0.1785 (14.1)	0.1009 (21.3)	0.1306 (16.4)	0.1270 (17.5)
0.7	0.1690 (14.9)	0.1884 (13.3)	0.1810 (13.2)	0.1607 (14.9)	0.1874 (13.1)	0.1833 (13.0)	0.1019 (20.3)	0.1315 (15.2)	0.1257 (16.8)
0.8	0.1749 (13.7)	0.1959 (12.0)	0.1881 (12.0)	0.1668 (13.7)	0.1950 (11.9)	0.1913 (11.7)	0.1049 (18.7)	0.1352 (13.8)	0.1268 (15.5)
0.9	0.1837 (12.3)	0.2065 (10.6)	0.1984 (10.5)	0.1757 (12.2)	0.2060 (10.5)	0.2024 (10.2)	0.1104 (16.9)	0.1419 (12.1)	0.1303 (14.0)
1.0	0.1957 (10.8)	0.2207 (9.1)	0.2121 (8.9)	0.1877 (10.7)	0.2203 (9.0)	0.2171 (8.6)	0.1184 (14.8)	0.1515 (10.1)	0.1365 (12.1)

Source: Author’s own calculations

5. Decomposition analyses

In the following I will decompose the overall income inequality into a within-group and into a between-group component. Moreover, I will assess the impacts of changes in the income structure and in the population structure. This analytical procedure offers additional, deeper insights into the forces driving German personal income distribution. Because of the preference for income-dependent equivalence scales all underlying distributions of equivalent incomes are split into a bottom and into an upper income area.

5.1 Within-group versus between-group inequality

A differentiation between within-group and between-group inequality is in the context of income-dependent equivalence scales possible in at least two ways. Firstly, we can distinguish between the upper and the bottom income area as a criterion of group-wise differentiation. Secondly, we can construct groups of persons according to the criterion household size.

Table 2 presents corresponding results. Concerning the criterion income area the share of within-group inequality belongs to the range of values between 40 and 48 percent. Inversely that means – not very much surprisingly – that the income differences between both income areas are notable. Due to the criterion household size, the within-group inequality reaches values between 78 and 99 percent in all observed years. The latter result is the consequence of neglecting household structures e. g. due to age of the several household members.

Table 2: Normalized coefficients of variation for Germany as a whole 1993-2003 based on income-dependent equivalence scales (Buhmann et al. formula, household net equivalent incomes) – The share of within-group inequality (in percent)

θ	Income areas			Household sizes		
	1993	1998	2003	1993	1998	2003
0.0	40	41	41	81	81	78
0.1	40	42	42	85	85	83
0.2	40	42	42	89	89	87
0.3	40	43	43	92	93	91
0.4	41	43	43	95	96	94
0.5	41	44	44	97	97	97
0.6	42	44	45	97	99	98
0.7	42	46	46	97	98	98
0.8	43	47	46	95	96	97
0.9	43	48	47	93	93	94
1.0	44	48	48	89	90	91

Source: Author's own calculations

5.2 The impact of income-structure changes and of changes in the population structure on income inequality in Germany

In what follows I present a static analysis of incidence of demographic and income-structure effects upon income inequality, i. e. without considering interactions between demography and income structure and without feedbacks of inequality on the two factors.[34]

In order to control for demographic effects upon the measured income inequality over time, in the following constant population shares are assumed across all examined samples. Concretely in Table 3 (columns in the centre) the population structure of the year 1993 was fixed

[34] See in this context Faik 2010b.

for the 1998 *EVS* as well as for the 2003 *EVS*; all these estimates are related to the demographic "indicator" household size. In the next step these theoretical findings were compared with the real inequality values. The diminishing effect, that was found,[35] indicates an impact towards increasing income inequality caused by the reductions in the (mean) household size in Germany across the observed time periods.[36] This impact has a magnitude of 2.1 to 2.7 percent in 1998 and of 3.0 to 4.7 percent in 2003. In 1998 as well as in 2003 there was a tendency for the "demographic effect" to decrease with an increasing level of θ. This tendency works via the within-group value of CV as well as via the between-group value of CV, as can be seen by Equations (2) and (3) above.

Table 3: Normalized coefficients of variation for Germany as a whole 1993-2003 based on a constant demographic structure (of 1993, only household size; Buhmann et al. formula, household net equivalent income) and based on a constant income structure (of 1993; Buhmann et al. formula, household net equivalent income), and deviations to variable demographic structures and variable income structures (in parentheses, in percent) under the assumption of income-dependent equivalence scales

θ	"Baseline": 1993	"Demographic effect": Constant demographic structure of 1993		"Income structure effect": Constant income structure of 1993	
		1998	2003	1998	2003
0.0	0.1949	0.2075 (-2.7)	0.1986 (-4.7)	0.1975 (-7.4)	0.1964 (-5.8)
0.1	0.1850	0.1973 (-2.5)	0.1884 (-4.5)	0.1877 (-7.2)	0.1871 (-5.2)
0.2	0.1770	0.1891 (-2.5)	0.1805 (-4.1)	0.1798 (-7.2)	0.1791 (-4.8)
0.3	0.1710	0.1831 (-2.4)	0.1746 (-3.9)	0.1739 (-7.3)	0.1733 (-4.6)
0.4	0.1670	0.1794 (-2.4)	0.1710 (-3.6)	0.1705 (-7.2)	0.1696 (-4.4)
0.5	0.1653	0.1783 (-2.3)	0.1696 (-3.5)	0.1693 (-7.3)	0.1684 (-4.2)
0.6	0.1659	0.1799 (-2.2)	0.1710 (-3.4)	0.1707 (-7.3)	0.1696 (-4.2)
0.7	0.1690	0.1843 (-2.2)	0.1752 (-3.2)	0.1745 (-7.4)	0.1733 (-4.3)
0.8	0.1749	0.1916 (-2.2)	0.1822 (-3.1)	0.1812 (-7.5)	0.1797 (-4.5)
0.9	0.1837	0.2022 (-2.1)	0.1924 (-3.0)	0.1907 (-7.7)	0.1890 (-4.8)
1.0	0.1957	0.2156 (-2.3)	0.2057 (-3.0)	0.2037 (-7.7)	0.2015 (-5.0)

Source: Author's own calculations

[35] See Peichl, Pestel, and Schneider 2009, pp.17-19, for a similar consideration (using the GSOEP database and the mean logarithmic deviation as inequality indicator).

[36] The mean household sizes were: Germany as a whole: 1993: 2.25 persons, 1998: 2.16 persons, 2003: 2.11 persons; western Germany: 1993: 2.23 persons, 1998: 2.15 persons, 2003: 2.12 persons; eastern Germany: 1993: 2.30 persons, 1998: 2.19 persons, 2003: 2.05 persons (author's own calculations; maximum of household size: six persons). For a more detailed discussion of this issue see Faik 2010b, pp. 18-20.

The right columns of Table 3 show that in the years 1998 and 2003 and in the case of constant income structures the normalized coefficients of variation are also lower compared with the actual values for 1998 and 2003. These diminishing effects, caused by changes of mean incomes and of standard deviations of incomes across the observed time periods, amount to 7.2 to 7.7 percent in 1998 and to 4.2 to 5.8 percent in 2003. As can be seen by the above Equations (2) and (3), the income structure effect has – similar to the demographic effect – an influence via the within-group value of CV as well as via the between-group value of CV. Compared with the demographic effects, the assessed income-structure effects are greater in absolute values.

The baseline values of 1993 are also displayed on the left of Table 3. These values are still lower than the inequality values for 1998 and 2003 in the sensitivity variants (in the centre and on the right of Table 3). That simply means that neither the demographic nor the income-structure effect can solely explain the differences of inequality relative to the base year 1993. In other words, the higher actual inequality values of the years 1998 and 2003, compared with the inequality level of 1993, appear to be the result of simultaneous interaction between demographic and income-structural effects.

The underlying changes of population and (equivalent) income structures between 1993 and 2003 are shown in the appendix in Table A1. In this context it must be considered that in case of income-dependent equivalence scales – here based on two (equivalent) income areas – the population shares vary with the parameter θ. This is a difference to the usage of income-independent equivalence scales. The reason for this difference is that the composition of both (equivalent) income areas varies with the parameter θ. By the way, because of this variation Table A1 exemplarily refers to θ = 0.5.

6. Concluding remarks

The results of the paper reveal the sensitivity of distributional results due to different equivalence scales but also due to demographic and income-structural effects.

My analyses yield a number of relatively strong general conclusions:

1. For a spectrum of equivalence scales I obtained a U-shaped curve for the measured inequality as a function of the degree of economies of scale. In this context many popular equivalence scales like the new or the old OECD scale could be captured by adequate settings of parameters.
2. In the case of income-dependent equivalence scales the measured inequality was substantially higher than in the case of income-independent equivalence scales.
3. The income-structure effect led – ceteris paribus – to increasing inequality at each level of economies of scale (in the analysed years 1998 and 2003).
4. Also the demographic effect increased – ceteris paribus – inequality at all levels of economies of scale (in 1998 and in 2003), with weaker intensity than the income-structure effect.[37]

All in all, my sensitivity analyses provide evidence for the proposal to measure (income) inequality on the basis of a set of equivalence scales or at least on the basis of two different equivalence scales. This would allow the ranking of different distributions to be assessed reliably, and in the case of unambiguous rankings the probability for “true” statements concerning different distributional situations would rise, at least over a broad range of equivalence scales. Furthermore, because there are good reasons for the usage of income-dependent equivalence scales, such welfare elements should be applied in distributional

[37] That demographic variables play a rather secondary role in explaining income inequality (directly), was confirmed by Brandolini and D’Alessio 2001, especially p. 21 (see also the literature cited there).

studies, as was done in this paper, for the first time empirically for Germany. In future research the concept presented here might be refined e. g. in the direction of more than two income areas (perhaps by functionalizing general equivalence scale formulas like the Buhmann et al. approach for some income intervals).

Appendix

Table A1: Population shares and relative (equivalent) income positions for Germany as a whole 1993-2003 (only household size, Buhmann et al. formula, household net equivalent income) at θ = 0.5 under the assumption of income-dependent equivalence scales (in percent)

Household size	1993	1998	2003	Change from 1993 to 1998	Change from 1993 to 2003
Population shares:					
Bottom income area:					
1 person	18.5	20.5	22.1	+10.8	+19.5
2 persons	27.1	29.6	31.1	+9.1	+14.4
3 persons	20.0	18.9	18.1	-5.3	-9.3
4 persons	23.0	22.0	19.4	-4.4	-15.5
5 persons	8.5	6.8	7.2	-20.0	-14.6
6 persons	2.9	2.2	2.1	-23.9	-29.3
Upper income area:					
1 person	9.2	9.9	10.2	+7.2	+10.2
2 persons	30.6	34.5	35.1	+12.8	+15.0
3 persons	26.3	22.3	22.5	-14.9	-14.4
4 persons	24.3	23.3	22.4	-4.3	-7.9
5 persons	7.8	7.9	8.0	+1.5	+3.1
6 persons	1.8	2.1	1.8	+14.9	-2.6
Relative income positions:					
Bottom income area:					
1 person	88.0	89.2	87.2	+1.3	-0.9
2 persons	98.2	101.2	100.1	+3.1	+1.9
3 persons	105.3	102.6	102.8	-2.6	-2.4
4 persons	105.4	104.4	108.3	-1.0	+2.7
5 persons	102.9	105.3	107.1	+2.3	+4.1
6 persons	104.5	101.8	107.0	-2.6	+2.4
Upper income area:					
1 person	87.6	94.4	94.9	+7.8	+8.3
2 persons	106.6	105.5	105.1	-1.0	-1.4
3 persons	99.8	99.0	99.5	-0.8	-0.3
4 persons	97.8	96.7	96.2	-1.1	-1.6
5 persons	96.8	96.3	97.1	-0.6	+0.2
6 persons	97.8	96.7	95.9	-1.1	-1.9

Source: Author's own calculations

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Folgende FaMa-Diskussionspapiere sind bisher erschienen (Stand: 17. August 2010):

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