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Forschungsinstitut
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ABSTRACT

Does Size Matter? The Impact of Changes in Household Structure on Income Distribution in Germany*

In Germany, two observations can be made over the past 20 years: First, income inequality has been constantly increasing while, second, the average household size has been declining dramatically. The analysis of income distribution relies on equivalence-weighted incomes which take into account household size. Therefore, there is an obvious link between these two developments. The aim of the paper is to quantify how the trend towards smaller households has influenced the change in income distribution. In order to do so, we are using a decomposition of changes in inequality measures over time allowing for a separation between wage and demographic effects respectively. We propose similar decompositions for the change in poverty and richness as well and compare them with results that were obtained by a re-weighting procedure. Our results show that the income gap would also have increased without the demographic trend. But its level would be lower than it actually is. In addition, the demographic effect turns out to be larger for incomes before tax and benefits.

JEL Classification: D31, D63, J11

Keywords: income distribution, demography, household size, decomposition, Germany

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1 Introduction

Since reunification in 1990, inequality as well as poverty and richness of the equivalent disposable income distribution in Germany have increased considerably (OECD, 2008; Peichl, Schaefer, and Scheicher, 2008; Bach, Corneo, and Steiner, 2009). The German government is concerned with this development and is designing policies to counteract it (Bundesregierung, 2008). However, from a policy perspective it is important to understand the driving forces behind this development. If, for instance, the rise in inequality is caused by widening of the distribution of market incomes due to a weakening of bargaining power of unions, the appropriate answer might differ from the one in a situation where rising inequality is predominantly caused by a structural change in household formation. The latter is linked to rising inequality, since a declining average number of individuals living together in a household is affecting the income distribution as well. This is due to the fact that the analysis of income distributions is normally based on equivalence-weighted income as a proxy for individual well-being. Equivalence scales account for number and age of household members. Therefore, everything else equal, the income distribution changes if the household structure changes.[1]

The aim of this paper is to quantify the effect of demographic change on income distribution in Germany. The case of Germany is of special interest for the analysis of the impact of changing household structure as the demographic development is not only characterized by incremental aging, but also by a sharp fall in average household size, which is now – together with Sweden – lowest among OECD countries (OECD, 2008, p. 59). Especially the proportion of one- and two-person households has increased dramatically.[2] The increase in the number of one-person households

[1] For instance, according to the Federal Statistical Office, average real income per household has *decreased* by about two per cent since 1991, while equivalence-weighted average income has *increased* by two per cent (Statistisches Bundesamt, 2008b, p. 147).

[2] The average number of individuals living together in a household has decreased from 2.27 to 2.11 between 1991 and 2005 (by about 7 per cent) according to the German Micro Census 2005. In East Germany this decrease was even twice as large: While average household size was 2.31 in 1991, there were only less than two individuals (1.98) sharing a household on average in 2005. This corresponds to a decrease by 14.3 per cent. While population size increased by 3.1 per cent between 1991 and 2005 (from 80.2 to 82.7 million), the number of private households increased by 11.1 per cent to 39.2 million. This was solely caused by the rising number of households with two members at most. The number of one- and two-person households increased by 23.9 and

can be primarily explained by a higher risk of divorce and a lower frequency of marriages. The increase in two-person households is related to two developments: First, the number of childless couples has grown and, second, the increase in life expectancy has led to a growing number of elderly two-person households.

Against the background of its very pronounced development towards smaller households it is striking that there has not been much research that systematically analyzes the effect of demographic trends on income distribution for Germany. The Organisation for Economic Co-Operation and Development reports in its recent study on inequality (OECD, 2008) that a share of 88 per cent of total (absolute) change in the Gini coefficient of disposable incomes in West Germany from 1985 to 2005 is due to changing population structure with respect to household characteristics.[3] This share is by far the highest among OECD countries and implies that the total increase in inequality is nearly completely related to changing household formation patterns. Moreover, it raised a public policy debate in Germany over the underlying causes of the growing income gap in Germany after the government had published its Third Report on Poverty and Richness (Bundesregierung, 2008) which came to very different conclusions than the OECD report.[4] However, in the course of our analysis we were not nearly able to replicate the OECD's result. In the meantime, the authors of the OECD study upon request confirmed that the result of 88 per cent we refer to is *not* correct and a misprint.[5] Therefore, it is necessary

22.1 per cent respectively while the number of households with at least three members has been decreasing (Statistisches Bundesamt, 2005). For a large part, this development can be explained by the drastic and continuous decline of Germany's birth rate. In 1991, the number of live births was 830.019, while there were only 685.795 in 2005. This corresponds to a decrease by 17.4 per cent. The number of births reached its maximum of 1.357.304 in 1964 (Statistisches Bundesamt, 2008a). In addition, one can assume that the trend towards individualization also accounted for a large part of this observation.

[3] I.e. the number of household members and the age of the household head (OECD, 2008, p. 66).

[4] See e.g. Sinn (2008). There is also evidence for disagreement within the Federal Government concerning the appropriateness of measures to be followed in answer to the growing income gap: While the Ministry of Labor and Social Affairs (BMAS), which is responsible for the Report, proposed minimum wages and higher government transfers, the Ministry of Economics and Technology (BMWi) among other things questions the necessity of such measures and emphasizes the development of the population structure as the main contributor to increasing income inequality, referring to OECD (2008).

[5] However, so far they were not able to produce a corrected number for Germany. In our analysis, we find a value of 64% for pre fisc incomes and 14% for disposable incomes when restricting our sample to West Germany 1985–2005 and applying the same selection criteria and equivalence scales as in the OECD report.

to re-assess the effect of changing household structures on inequality in Germany.

A priori, it remains unclear in which direction demographic change affects measures of income distribution because of two opposing effects. On the one hand, the noticeable decline of the number of births, for example, means that couples nowadays tend to stay childless. This leaves them with higher equivalence-weighted incomes than in a situation with a higher birth rate, i.e. more children, and alleviates double-earnership. On the other hand, the increase in the number of single households results in a growing number of individuals with lower equivalence-weighted incomes, since they cannot share fixed costs of living expenses. Therefore, the shrinking average household size has contradictory effects on income distribution. The net-effect depends on whether the relevant population subgroups have incomes rather above or below average.[6]

In order to assess the impact of the changing household structure between 1991 and 2007, in principle, it is possible to use two different methods. The first one comes from labor economics and follows the tradition of the Oaxaca-Blinder decomposition (Oaxaca, 1973; Blinder, 1973). A re-weighting procedure is applied in order to obtain new counterfactual income distributions while keeping the marginal distributions of other characteristics fixed (Di Nardo, Fortin, and Lemieux, 1996). These procedures have already been applied to other contexts that are related to wage and wealth inequality respectively (Lemieux, 2006; Bover, 2008) and it is also the approach that has been chosen in the OECD report. In order to check the sensitivity of the results with respect to the underlying method, we compare the results from the re-weighting approach with an exact decomposition of the distributional change by population subgroups, which is more common in the literature on inequality (Shorrocks, 1980; Mookherjee and Shorrocks, 1982; Shorrocks, 1984). It follows similar studies analyzing the effect of demographic change on inequality for the United Kingdom (Jenkins, 1995) and the United States (Martin, 2006). For Germany, this decomposition technique has been applied to regional differences in income inequality after reunification (Schwarze, 1996). Similar approaches that do not depend on a specific choice of summary index were described by Jenkins and

[6] Decreasing (increasing) population shares lead to a reduction of (an increase in) inequality, if the related average income is above average and vice versa.

Van Kerm (2005). Other approaches aim at decomposing the effects of tax-benefit reforms on income distribution (Bargain and Callan, 2008).

In addition to quantifying the impact of changing household structure on inequality, our paper contributes to the existing literature by deriving similar decomposition techniques for changes in poverty and richness measures. Using these additional decomposition methods enables us to conduct a more detailed analysis of the tails of the income distribution. Based on data of the German Socio-Economic Panel Study (GSOEP), we analyze the effect of the demographic change of the German population on income inequality, poverty, and richness.

The results show to what extent the demographic trend has affected the development of over-all inequality, poverty, and richness. We find that the growth of the income gap in Germany (East and West, 1991–2007) is partly related to changing household structure. For inequality of incomes before taxes and transfers we find a fraction of 43 per cent. The result for incomes after taxes and transfers is 15 per cent which is dramatically lower than the numbers reported by OECD (2008). Without the demographic trend towards smaller households the income gap would also have increased. However, its level would be lower than it actually is. The same holds for the change in poverty and richness measures. These results are in line with the counterfactual re-weighting procedure, which in addition reveals that fiscal costs would be quite considerable if the federal government aimed at reducing inequality to the level that would have been achieved without changes in household structure.

The paper is further organized as follows: Section 2 gives a review of relevant definitions and methods. In Section 3 these methods are applied to German survey data. The results are presented in Section 4. The paper is concluding in Section 5.

2 Methodology: Re-weighting and Decomposition

In this section, we first describe the rationale for the equivalence weighting of incomes and then describe methods for re-weighting and for the measurement and decomposition of inequality, poverty, and richness.

2.1 Equivalence Weighting of Incomes

In general, economic well-being is considered as an "individual experience". So, at first sight, for the analysis of income distribution it would be sufficient to look at actually and individually received incomes. However, this would leave dependent persons without incomes on their own (like spouses or children). Moreover, one would consider individuals as poor even if they happen to live in an affluent household. One would systematically ignore that income recipients usually share their resources with their fellow household members, which is considered as a form of private transfers (Canberra Group, 2001, p. 32).

Looking at pure household per-capita incomes, however, would leave economies of scale in household consumption unconsidered. These result from decreasing average fixed costs when household size increases. That is why the individual welfare of persons with the same amount of income depends on whether they live alone or together with others. Cohabitation reduces the individual share of fixed costs of living expenses and hence contributes to a higher level of material comfort of individuals.

Therefore, empirical measurement of income is subject to an equivalence weighting procedure. In this way, individual incomes can be compared to each other independent of household size. For example, if one computes equivalence-weighted incomes for members of a multi-person household, the resulting sum informs about how much monetary income a single person needs in order to derive the same – i.e. the equivalent – level of utility. So, what one actually measures is the distribution of "living standards among artificial quasi-homogeneous individuals" (Bönke and Schröder, 2008, p. 2). In empirical research, equivalence-weighted incomes result from dividing the sum of total household income by a value in proportion to its needs which depends on number of household members and further household characteristics (Atkinson and Bourguignon, 2000, p. 93 f.). These values are assigned with the help of equivalence scales.

An illustrative example: Consider a situation with four individuals with an income of 10 monetary units each. Two of them live in single-households and the two others share a household (without children). The level of living standard of the two singles is simply determined by their incomes since it is divided by the accord-

ing equivalence weight which is just one in these cases.[7] The living standard of the couple household members is however determined by division of the sum of their incomes (20) by the sum of their equivalence weights (1.5 according to the OECD scale), because of the economies of scale in household consumption. Hence, their equivalent income is 13.33 each. This distribution of equivalent incomes (10, 10, 13.33, 13.33) is characterized by some inequality: the Gini coefficient is about 0.07. If the two single adults would decide to cohabitate in order to pool their income resources, we arrive at a second two-adult household with total household income of 20. Of course equivalence weights must be adjusted accordingly and we have a distribution of equivalent incomes with for individuals with the same income of 13.33 each, i.e. perfect equality. Hence, the change in household structure – from two single-households and one two-adult household to two two-adult households – leads to a higher average standard of living and a reduction of inequality. Note that values of the monetary incomes remained unchanged throughout this illustration. This means, there is a relationship between household structure and individual welfare. We analyze the reverse movement of more and more multi-person households splitting into several smaller households.

2.2 Re-weighting Procedure

In order to assess the impact of the changing household structure between 1991 and 2007, we need to compare the counterfactual distribution of 2007 incomes and 1991 household structure with the observed 2007 income distribution. In order to do so, we follow the approach suggested by Di Nardo, Fortin, and Lemieux (1996) to estimate the counterfactual density function using a re-weighting technique.

Each individual household can be described by a vector (y, x, t) consisting of an income y, a vector x of household characteristics, and a date t (1991 or 2007). Each observation belongs to a joint distribution function $F(y, x, t)$ of income, characteristics and date. The joint distribution of income and characteristics is the conditional

[7] In empirical research, different equivalence scales are used. All of them assign a weight of 1.0 to a single adult, e.g. the modified OECD scale. It assigns a weight of 1.0 to the first (adult) household member. Every additional adult is assigned a weight of 0.5 and every child a weight of 0.3 (OECD, 2005).

distribution $F(y, x|t)$. The density of income at one point in time, $f_t(y)$, can be written as the integral of the density of income conditional on a set of characteristics and on a date t_y, over the distribution of individual characteristics $F(x|t_x)$ at date t_x.

$$f_t(y) = \int dF(y, x|t_{y,x} = t) = \int f(y|x, t_y = t) dF(x|t_x = t) \tag{1a}$$

$$\equiv f(y, t_y = t, t_x = t). \tag{1b}$$

Since the estimation of counterfactual densities combines different dates, the notation in the last line accounts for these. Under the assumption, that the 2007 distribution of incomes, $F(y|x, t_y = 2007)$, does not depend on the 1991 distribution of characteristics, $F(x|t_x = 1991)$, the hypothetical counterfactual density is:

$$f(y, t_y = 2007, t_x = 1991) = \int f(y|x, t_y = 2007) dF(x|t_x = 1991) \tag{2a}$$

$$= \int f(y|x, t_y = 2007) \psi_x(x) dF(x|t_x = 2007), \tag{2b}$$

where the re-weighting function $\psi_x(x)$ is defined as

$$\psi_x(x) \equiv \frac{dF(x|t_x = 1991)}{dF(x|t_x = 2007)}. \tag{3}$$

The counterfactual density can be estimated by weighted kernel methods. The difference between the actual 2007 density and the hypothetical re-weighted density represents the effect of changes in the distribution of household's characteristics.

To estimate the impact of the changing household structure between 1991 and 2007, we compare measures of distribution $M(\cdot)$ for the counterfactual distribution of 2007 incomes and 1991 household structure with the observed 2007 income distribution:

$$\delta = M(f(y, t_y = 2007, t_x = 2007)) - M(f(y, t_y = 2007, t_x = 1991)) \tag{4}$$

We apply this method and compare the re-weighting with an exact decomposition technique, which is described in the next subsection.

2.3 Decomposition Techniques

2.3.1 Inequality

In the literature, there are several measures of inequality (see e.g. Atkinson and Bourguignon (2000)). In the context of our approach, for analyzing the effect of household structures on income inequality, the class of Generalized Entropy (GE) inequality measures (Shorrocks, 1980) is the most suitable one. The GE measures can be decomposed in a way such that total inequality results as the sum of inequality *within* and *between* population subgroups. The class of GE measures is defined for an income distribution $Y = (y_1, \ldots, y_n)$, where y_i denotes income of individual $i \in \{1, \ldots, n\}$, while w_i denotes individual i's population weight.[8] Finally, $\bar{y} = \sum_{i=1}^{n}(w_i/\sum_{i=1}^{n}) \cdot y_i$ denotes the arithmetic mean of individual incomes. The GE measures are defined as

$$I_c = \begin{cases} \frac{1}{c\cdot(c-1)} \cdot \sum_{i=1}^{n} \frac{w_i}{\sum_{i=1}^{n} w_i} \cdot \left[\left(\frac{y_i}{\bar{y}}\right)^c - 1\right] & \text{for } -\infty < c < +\infty,\ c \neq 0, 1, \\ \sum_{i=1}^{n} \frac{w_i}{\sum_{i=1}^{n} w_i} \cdot ln\left(\frac{\bar{y}}{y_i}\right) & \text{for } c = 0, \\ \sum_{i=1}^{n} \frac{w_i}{\sum_{i=1}^{n} w_i} \cdot \frac{y_i}{\bar{y}} \cdot ln\left(\frac{y_i}{\bar{y}}\right) & \text{for } c = 1. \end{cases} \tag{5}$$

The coefficient c can be interpreted as a parameter of inequality aversion. The larger (smaller) c the more sensitive is the GE measure for changes in the higher (lower) tail of the income distribution (Atkinson and Bourguignon, 2000, p. 110). For the purpose of this paper we choose I_0 from the GE inequality measures, which is also known as *mean logarithmic deviation* (Mookherjee and Shorrocks, 1982, p. 889).[9]

If one divides total population into K disjoint and exhaustive subgroups that

[8] If a weight of one is assigned to every individual, i.e. $w_i = 1 \,\forall\, i$, it holds $\sum_{i=1}^{n} w_i = n$ and $w_i/\sum_{i=1}^{n} w_i = 1/n$ respectively.

[9] According to Shorrocks the features of this measure are best suitable for decomposition analysis, since total inequality can be exactly decomposed into within- and between-group inequality. Moreover, the weighting factors sum up to unity (Shorrocks, 1980, p. 625).

are denoted by $k \in \{1, \ldots, K\}$ the inequality measure I_0 can be written as

$$I_0 = \sum_{k=1}^{K} \frac{\sum_{i \in k} w_i}{\sum_{i=1}^{n} w_i} \cdot I_{0k} + \sum_{k=1}^{K} \frac{\sum_{i \in k} w_i}{\sum_{i=1}^{n} w_i} \cdot ln\left(\frac{\bar{y}}{\bar{y}_k}\right) \tag{6a}$$

$$= \underbrace{\sum_{k=1}^{K} v_k \cdot I_{0k}}_{W} + \underbrace{\sum_{k=1}^{K} v_k \cdot ln\left(\frac{\bar{y}}{\bar{y}_k}\right)}_{B}, \tag{6b}$$

where $\sum_{i \in k} w_i$ denotes the weighted number and v_k the weighted proportion of individuals belonging to population subgroup k. The mean income of subgroup k is denoted with $\bar{y}_k$ and group inequality with $I_{0k} = \sum_{i \in k}(w_i / \sum_{i \in k} w_i) \cdot ln\,(\bar{y}_k / y_i)$. Hence, total inequality can be written as a weighted sum of inequality within (W) and between (B) population subgroups. Population ratios v_k thereby serve as weighting factors. Inequality decomposition within and between population subgroups provides a basis for decomposing the change in total inequality between period t and $t+1$ into changes within population subgroups and changes that result from shifting population ratios. According to Mookherjee and Shorrocks (1982) this can be formally written as

$$\Delta I_0 = I_0^{t+1} - I_0^t \approx \underbrace{\sum_{k=1}^{K} \bar{v}_k \cdot \Delta I_{0k}}_{A} + \underbrace{\sum_{k=1}^{K} \bar{I}_{0k} \cdot \Delta v_k}_{B}$$

$$+ \underbrace{\sum_{k=1}^{K} \left[\bar{\lambda}_k - \overline{ln\,(\lambda_k)}\right] \cdot \Delta v_k}_{C} + \underbrace{\sum_{k=1}^{K} \left(\bar{\theta}_k - \bar{v}_k\right) \cdot \Delta ln\,(\bar{y}_k)}_{D}, \tag{7}$$

where Δ is the difference-operator. In addition, $\lambda_k = \bar{y}_k / \bar{y}$ denotes the ratio of population subgroup k's mean income to total population's mean income and $\theta_k = v_k \cdot \lambda_k$ the income ratio of group k. A symbol with a bar denotes the particular value averaged over periods t and $t+1$.[10] Thus, the change in total inequality from one point in time to the next can be decomposed into four components denoted by A, B, C and D. Again, one can distinguish between inequality changes within and

[10] Alternatively, it would be possible to use base or final period weights. However, Mookherjee and Shorrocks (1982) point out that this choice is unlikely to make a difference to the results (p. 896). In addition, this corresponds to the weight that would be assigned by the Shapley value algorithm (Shorrocks, 1999; Jenkins and Van Kerm, 2005).

between population subgroups (Mookherjee and Shorrocks, 1982, p. 897):

Summand A summarizes the effect of inequality changes within population subgroups (ΔI_{0k}). In particular, it contains the contribution of inequality changes that solely result from changes within population subgroups. It abstracts from changes in population composition by fixing population ratios on averaged values ($\bar{v}_k$).[11] Accordingly, changes in inequality within groups with higher proportions in population would therefore be of more importance than changes within relatively small groups.

Summand B on the other hand contains the effect of changes in population composition (Δv_k) on inequality *within* population subgroups. It analogously abstracts from changes in within-group inequality by fixing it on averaged values ($\bar{I}_{0k}$), since changes in population ratios are crucial for summand B. If, for example, the proportions of groups with relative high levels of inequality increase, total inequality will increase accordingly and vice versa.

Summand C describes the effect of changes in population composition (Δv_k), though, contrary to summand B, on inequality *between* population subgroups. Again, changes in population ratios are crucial for the direction of change. It fixes the ratio of group mean incomes to total mean income (λ_k), which becomes apparent in the term in squared brackets, although it has no intuitive interpretation for it. So, summand C sums up the contribution to total inequality change that results when proportions of groups with relative high or low mean incomes (compared to total mean income) increase or decrease.

Summand D finally represents the contribution of changes in population subgroup mean incomes ($\Delta ln\left(\bar{y}_k\right)$). It fixes the difference between group proportions of total income and population respectively. The change in the logs of population subgroup mean income is of importance here. The higher the income ratio of a group relative to its population ratio the larger the effect on total income inequality when the mean income of that group changes.

In summary: summand A represents changes in pure inequality within popu-

[11] Especially for smaller time intervals (e.g. two consecutive years), summand A can be interpreted as a change in "pure" inequality, since the distribution of population subgroups in general does not change ad hoc (Jenkins, 1995, p. 38).

lation subgroups. Since all individuals belonging to a particular group are identical with respect to certain characteristics, summand A displays changes in inequality that result from other characteristics (e.g. differences in education levels affecting wage and hence income inequality). Summands B and C together represent the contribution to inequality change resulting from demographic change, since they are based on shifting population ratios. Summand D represents the effect of changes in the distribution of population subgroup mean incomes. With respect to the purpose of this paper, the relative importance of summands B and C compared to total change in inequality ΔI_0 is of prior interest.

2.3.2 Poverty

A well-known and widely used measure of poverty, which is decomposable by population subgroups, was introduced by Foster, Greer, and Thorbecke (1984). In addition to only counting the number of poor within a population (which results in the so-called head-count poverty index) it is based on the concept of relative deprivation, which depends on the relative distance between a poor person's income and the poverty line. However, the FGT poverty measure comprises the head-count index as a special case (see below). Like the GE inequality measures it is defined for an income vector Y. Total poverty P_α is defined as

$$P_\alpha(y; z) = \sum_{i=1}^{q} \frac{w_i}{\sum_{i=1}^{n} w_i} \cdot \left(\frac{g_i}{z}\right)^\alpha \text{ for } y_i \leq z, \tag{8}$$

where $\alpha \geq 0$ is a parameter of poverty aversion[12] and $g_i = z - y_i$ denotes the income shortfall between individual i's income y_i and a poverty line z. The number of poor is denoted by q. They receive an income not exceeding the poverty line z (Foster, Greer, and Thorbecke, 1984, p. 761 f.). Population weights are again denoted with w_i (see above).

Among other things, the derivation of this measure was also motivated by its properties of decomposability for population subgroups while, at the same time, not violating the basic properties for poverty measures proposed by Sen (1976, 1979).

[12] For a larger α there is more emphasis on the "poorest poor" (Foster, Greer, and Thorbecke, 1984, p. 763). For $\alpha = 0$ the measure reveals the head-count index.

If one divides the population into K disjoint and exhaustive population subgroups, one can write the FGT measure as (Foster, Greer, and Thorbecke, 1984, p. 764)

$$P_\alpha(y;z) = \sum_{k=1}^{K} v_k \cdot P_{\alpha,k}(y_k;z), \tag{9}$$

where v_k denotes the population share. Subgroup k's income vector is denoted by y_k and poverty measured within each group by $P_{\alpha,k}(y_k;z) = \sum_{i=1}^{q_k}(w_i/\sum_{i\in k} w_i) \cdot \left(\frac{g_i}{z}\right)^\alpha$ for $y_{i\in k} \leq z$, where q_k denotes the number of poor units within group k. Hence, total poverty can be expressed as a weighted sum of poverty in population subgroups with population share weights (Bourguignon and Ferreira, 2005, p. 26).

In order to assess how much of an observed change in total poverty can be attributed to demographic changes, it is necessary to decompose the change into components accordingly. One can show that (see Appendix)

$$\Delta P_\alpha = P_\alpha^{t+1} - P_\alpha^t = \underbrace{\sum_{k=1}^{K} \bar{v}_k \cdot \Delta P_{\alpha,k}}_{A} + \underbrace{\sum_{k=1}^{K} \bar{P}_{\alpha,k} \cdot \Delta v_k}_{B}, \tag{10}$$

where Δ again denotes the difference-operator. This decomposition of change also corresponds to the one that results from a Shapley value decomposition (Shorrocks, 1999). So, the change in total poverty (ΔP_α) can be decomposed into the change in levels of group poverty (labeled A) and changes in the composition of population (demographic change, labeled B).

2.3.3 Richness

Income richness is a less considered field than income poverty. However, there are measures that do not only account for the head count of rich, but are also decomposable by population subgroups, and allow for a consideration of the intensity and severity of affluence analogous to the FGT poverty measure. For a description of desirable properties and axioms that a measure of richness should satisfy see Peichl,

Schaefer, and Scheicher (2008). The richness measure that we employ is defined as

$$R_\beta(y;\rho) = \sum_{i=1}^{s} \frac{w_i}{\sum_{i=1}^{n} w_i} \cdot \left[1 - \left(\frac{\rho}{y_i}\right)^\beta\right] \text{ for } y_i \geq \rho. \tag{11}$$

Here, $\beta > 0$ is a parameter for the sensitivity to intensive richness. For greater values of β the richness measure puts more weight on the "very rich". The richness line is denoted by ρ. Individuals with an income above this line are defined as the rich in the society. As before individual incomes and population weights are denoted by y_i and w_i respectively. As in the cases of inequality and poverty it is possible to express richness as a weighted sum of richness within population subgroups $k \in \{1, \ldots, K\}$:

$$R_\beta(y;\rho) = \sum_{k=1}^{K} v_k \cdot R_{\beta,k}(y_k;\rho), \tag{12}$$

where richness within each group k is denoted with $R_{\beta,k}(y_k;\rho) = \sum_{i=1}^{s_k}(w_i/\sum_{i\in k} w_i) \cdot \left(1 - (\rho/y_i)^\beta\right)$ for $y_{i\in k} \geq \rho$ and s_k denotes the number of rich within each group. Analogous to the decomposition of poverty change over time it is straightforward to decompose the change in richness between periods t and $t+1$:

$$\Delta R_\beta = R_\beta^{t+1} - R_\beta^t = \underbrace{\sum_{k=1}^{K} \bar{v}_k \cdot \Delta R_{\beta,k}}_{A} + \underbrace{\sum_{k=1}^{K} \bar{R}_{\beta,k} \cdot \Delta v_k}_{B}. \tag{13}$$

The interpretation of this decomposition is the same as for poverty: summand B is the fraction of the over-all change in richness that is related to demographic change (see above).

3 Empirical Foundation

3.1 Data: The German Socio-Economic Panel Study

The German Socio-Economic Panel Study (GSOEP) is a panel survey of households and individuals in the Federal Republic of Germany that has been conducted annually since 1984. The study is maintained by the German Institute for Economic

Research (DIW) in Berlin. A weighting procedure allows to make respondents' data to be representative for the German population as a whole. A detailed overview of the GSOEP is provided by its Desktop-Companion (Haisken-DeNew and Frick, 2005) or by Wagner, Frick, and Schupp (2007). Issues concerning sampling and weighting methods or the imputation of information in case of item or unit non-response is well documented by the GSOEP Service Group.[13] We use waves from the GSOEP that contain income information on an annual basis for the longest possible period 1991–2007, in order to include East Germany after reunification. The data sets contain relevant information from 17,921 individual observations in 6,665 survey households for 1991. For 2007, the sample increased to 25,366 individuals and 11,072 households.

3.2 Income Concept

The decomposition of the change in measures of distribution from Equations (7), (10), and (13) can be computed for any concept of income. We compute it for equivalence-weighted pre fisc incomes and are also are interested in post fisc incomes. The progressive German tax-benefit system induces an inequality-reducing redistribution of incomes and by and large takes into account household structures of tax-payers and recipients of benefits respectively. Looking at pre- and post fisc incomes allows us to assess to what extent the German tax benefit system compensates for changes in household size.

Data sets from the GSOEP contain appropriate income variables that are defined as follows (Grabka, 2007, p. 41 f.): A household's pre fisc income consists of labor earnings, asset flows, private retirement income and private transfers from all household members.[14] A household's post fisc income encompasses pre fisc income, public transfers, and social security pensions from all household members minus total

[13] For a detailed overview of several data documentations see `http://www.diw.de/en/diw_02.c.299052.en/survey_methods.html`.

[14] Labor earnings include wages and salary from all employment including training, self-employment income, and bonuses, overtime, and profit-sharing. Asset flows include income from interest, dividends, and rent. Private transfers include payments from individuals outside of the household including alimony and child support payments (Grabka, 2007, p. 41).

tax-payments of all household members.[15] Both concepts of income are deflated in order to compute real incomes. Moreover, we add household imputed rental values.[16]

Computations are hence conducted as follows: individual incomes y_i are equivalent pre and post fisc incomes respectively. That means household incomes are divided by the sum of equivalence weights according to the OECD-modified equivalence scale (OECD, 2005). For population weights w_i we use the according weights from the GSOEP (Grabka, 2007, pp. 181 ff.). In the following analysis, we define the poverty line z to be 60 per cent and the richness line ρ is defined as 200 per cent of the median of equivalent pre- and post government incomes respectively.

3.3 Definition of Population Subgroups

Like the definition of an income concept, a definition of how to divide population into disjoint and exhaustive subgroups is of great importance for the following analysis. Since, according to our research question, household composition with respect to number and age of household members is of relevance, the assignment of an individual to a group is based on this information: the first criterion is the number of adult household members, the second one is the number of children living in the household. According to the definition of the modified OECD equivalence scale, we define a person to be an adult at the age of 15 years or older. Analogously, a person is defined to be a child if its age does not exceed 14 years.[17] We distinguish 14 population subgroups according to household composition (see Table 1). Tables 7 and 8 in the Appendix show in detail how different types of households are captured by our 14 subgroup in the years 1991 and 2007 respectively.

[15] Public transfers include housing allowances, child benefits, subsistence assistance, government student assistance, maternity benefits, unemployment benefits, unemployment assistance, and unemployment subsistence allowance. Social security pensions include payments from old age, disability, and widowhood pension schemes. The tax burden includes income taxes and payroll taxes: health, unemployment, retirement insurance and nursing home insurance taxes (Grabka, 2007, p. 42).

[16] Taking into account an estimated income advantage for owner-occupiers is common in empirical research (Eurostat, 2006; Grabka, 2007).

[17] The choice of equivalence scale is not completely irrelevant, since inequality rankings in cross-country comparison are sensitive to different values of the equivalence-scale elasticity (Ebert and Moyes, 2003; Bönke and Schröder, 2008). However, we find that with respect to our research question the choice of different equivalence scales does not alter our results substantially (results for different scales are available upon request from the authors).

Place Table 1 here.

Group 1 covers single-households and groups 2, 3, and 4 almost solely cover individuals living in single-parent households. The vast majority of group 5 covers childless couples and only a minority consists of single parents and their adult child. Groups 6 to 10 are mainly covering couples with children. Groups 11 to 14 in addition are covering households consisting of multiple generations.[18]

Table 1 shows that between 1991 and 2007 population shares increased considerably only for two groups, namely singles (Group 1, +4.2 percentage points) and couples without children (Group 5, +5.4 percentage points). Note that these two groups do not only exhibit the strongest growth, but also make up for a large part of the population. In 2007 more than half the population either belong to a single- or a two-adult household without children.

4 Estimation Results

4.1 Re-weighting

Since we are interested in the effect of changing household structure on income distribution over time, we want to compare the actual change in values of distributional measures to the change that would have occurred when household structure would have remained unchanged between the base period of our analysis (the year 1991) and the most recent period available (2007), everything else equal. To do so, one has to assign counterfactual population weights to the sample population of 2007 in order to arrive at a marginal distribution of household structure identical to the one in 1991.

As it is pointed out in subsection 2.2 this is done by re-defining population weights by multiplying the actual population weights with a re-weighting factor that

[18] However, this form of cohabitation obviously is on the retreat in Germany: The proportion of individuals living in multiple generation-households decreased from 2.4 to 1.3 per cent between 1991 and 2007 and hence can be seen as a marginal phenomenon. The only household types whose proportions remarkably increased are one-person households (+4.2 percentage points) and couples without children (+5.7 percentage points), while the proportion of couples with children decreased (by 6.4 and 2.8 percentage points respectively) or remained nearly unchanged.

is equal to the ratio of the population shares in the base and final period. Formally, one can write the counterfactual population weights as

$$\widetilde{w}_i^{2007} = w_i^{2007} \cdot \frac{v_{k,i}^{1991}}{v_{k,i}^{2007}} = w_i^{2007} \cdot \psi_x(x), \tag{14}$$

where w_i^{2007} denotes the actual population weight of individual i in 2007 and $v_{k,i}$ denotes the population share of subgroup k to which individual i belongs. The re-weighting function $\psi_x(x)$ reduces to the fraction of population shares in case of not controlling for further characteristics. Hence, if individual i belongs to a group whose share increased between 1991 and 2007, the re-weighting factor is smaller than one and its weight is downsized. It is enlarged if the re-weighting factor is greater than one, i.e. the respective subgroup's population share has decreased. This way of re-weighting has been applied in the OECD report (OECD, 2008, p. 66) in order to calculate counterfactual changes in income inequality assuming a constant population structure with respect to household and age structure respectively.[19]

We apply this type of re-weighting for Germany and report calculations for different GE inequality measures (I_0, I_1, and I_2) as well as for the Gini coefficient (I_{Gini}) and the measures for poverty and richness that were already introduced in the previous sections. We compute how large the change in measures of distribution would have been if the marginal distribution of household structure would not have changed between 1991 and 2007. Table 2 reports several measures of inequality, poverty, and richness and distinguished between pre and post fisc incomes. We denote this counterfactual change

$$\Delta^{rew} = \frac{M^{rew,07} - M^{rew,91}}{M^{rew,91}}, \tag{15}$$

where rew stands for re-weighted, and the actual observed change is denoted by

$$\Delta^{act} = \frac{M^{act,07} - M^{act,91}}{M^{act,91}}. \tag{16}$$

[19] The OECD defines six population subgroups with respect to household structure are defined by the age of the household head (working or retirement age), the number of adults in the household (one or at least two), and the presence of children. In addition, the study refers to the 20-year-period from 1985 to 2005 and only to the distribution of disposable incomes for West Germany (OECD, 2008, p. 66).

One can easily show that the following holds

$$\frac{\Delta^{act} - \Delta^{rew}}{\Delta^{act}} = \frac{M^{act,07} - M^{rew,07}}{M^{act,07} - M^{act,91}}. \tag{17}$$

This term denotes the share of the changing household structure in the total change of the respective measure M.[20] Note that it would equal zero if the re-weighted counterfactual value in 2007 would resemble the actual one ($M^{act,07} = M^{rew,07}$). In this case, the changing household structure would not affect the change at all. In the other extreme case the term would equal 100 per cent if the re-weighted value of the measure under consideration in 2007 would be equal to the actual value of the base year 1991 ($M^{rew,07} = M^{act,91}$). Then the household structure would be related to the total change of the measure. The results are displayed in Table 2, which reveals that the share of changing household structure varies between measures for poverty (highest), inequality (medium), and richness (lowest) and between pre and post fisc incomes respectively. However, our results contradict the results of the OECD (2008) who find that 88.2 per cent of the actual change in the Gini coefficient of disposable income are due to changing household structure (p. 66), while we only find 12.8 per cent.[21]

Place Table 2 here.

For the re-weighting procedure, one can summarize that actual growth rates of the measures of distribution – without exception – are larger than the counterfactual re-weighted growth rates for pre fisc as well as for post fisc incomes. In other words, the results of our re-weighting procedures state that inequality, poverty, and richness would not have increased as much as they actually did if there would have been no trend towards smaller households. The fact that the share of the effect of household structure is especially large for the GE inequality measure I_2 (which is more sensitive to the upper tail of the distribution) and for the poverty measures P_2 (which is more sensitive to the "very poor") indicates that changes in household structure might

[20] Here, the character M is a placeholder for I (inequality), P (poverty), and R (richness) respectively.

[21] In the meantime, the authors of the OECD study upon request confirmed that the result of 88 per cent we refer to is *not* correct and a misprint.

be more related to the tails of the respective income distributions.

In order to check the sensitivity of the results with respect to the method chosen, we provide evidence from an alternative way of quantifying the effect of changing household structure on income distribution in the next subsection.

4.2 Decomposition Results

In this subsection we present the decomposition results for the different measures, income concepts, and – for inequality – regions.[22] In the case of Germany it makes sense to further differentiate between East and West Germany for the time after reunification in 1990.[23]

4.2.1 Inequality

The results for the decomposition of income inequality change according to Equation (7) are displayed in Table 3. For pre fisc incomes over-all inequality in reunified Germany has increased by about 36.5 per cent between 1991 and 2007. About 15.7 percentage points of this change can be attributed to changes in household structures (summands B and C). Consequently, one can note that more than 43 per cent of the increase in pre fisc income inequality is related to the demographic trend towards smaller household sizes.[24] Noticeably, by attributing 15.5 percentage

[22] Note that the decomposition results according to Equations (7), (10), and (13) are presented as percentages and percentage points respectively. For example, ΔI_0 and the summands A to D are divided by I_0^t and multiplied by 100 each. The fraction $\frac{B+C}{\Delta I_0}$ is multiplied by 100. The same holds analogously for the decompositions of poverty and richness.

[23] This appears to be appropriate since it seems that there are still significant income differentials between the "old" and "new" states of the Federal Republic. The non-convergence of income inequality is indirectly explained by much higher rates of unemployment in East Germany which causes a high level of inequality in labor income, which is of greater importance relative to capital income in East Germany (Frick and Goebel, 2008, p. 571).

[24] Executing the decomposition alternatively by defining population subgroups according to family types (see Section 3.3 and Tables 7 and 8 in the Appendix) yields slightly different results. The proportions of summands B and C are even of greater magnitude. Nevertheless, we find it more appropriate to use population subgroups according to Table 1, since these are exactly based on individual equivalence weights. Moreover, these results obviously are more conservative and certainly do not overstate the effect of changing household structure. The same holds similarly for poverty and richness. However, the proportions vary in magnitude for different time periods (see Tables 9–11 in the Appendix). E.g., for inequality of pre-fisc incomes vary between 28 and 35.8 per cent for different alternative periods with base years 1991 or 1992 and final years 2006 and 2007 respectively. For post-fisc incomes the results vary between 13.8 and 16.2 per cent.

points to over-all change, summand B makes up most of this proportion.[25]

Place Table 3 here.

In West Germany, pre fisc income inequality has increased by 26.3 per cent between 1991 and 2007, less than in the whole of Germany. The proportion of summands B and C (43.4 per cent) is more or less identical. This suggests that the rise in income inequality must have been much stronger in East Germany. Indeed, it has nearly doubled since reunification in 1991 (increase of 88.6 per cent). Shrinking household sizes make up for 44.5 per cent of the over-all increase in Germany's "new states".

Our results for post fisc income inequality decomposition show that the effect of changing household structures is significantly lower than for pre fisc income inequality. The proportion of summands B and C amounts to 14.9 per cent between 1991 and 2007. The German tax-benefit system obviously takes into account household structure and compensates for most (not all) of inequality increases that can be related to demographic changes. Altogether, post fisc income inequality has increased by 40.3 per cent. This increase is larger than the increase for pre fisc income. This result implies that the redistributive impact of the German tax-benefit system slightly declined over time.

Looking at West Germany separately reveals that the proportion of summands B and C between 1991 and 2007 (25.2 per cent) is higher than for the whole of Germany. In East Germany, income inequality has grown by 46 per cent between 1991 and 2007. Summands B and C account for about ten per cent.[26]

Table 4 displays the contributions of each single population subgroup to the components of inequality change for pre- and post fisc incomes respectively.[27] It

[25] Summand B from equation (7) describes the effect of the change in population structure on within-group inequality. Obviously, population subgroups that are characterized by smaller household size exhibit greater within-group inequality than others. Thus, the increase in relative size of these groups has significantly contributed to the over-all increase in income inequality.

[26] Note that the results for $\frac{B+C}{\Delta I_0}$ for Germany are not be interpreted as a weighted average of the results for West and East. That is why it is possible to find a higher value for Germany while finding lower values for West and East both.

[27] Note that according to Equation (7) it holds that $A_k = \bar{v}_k \cdot \Delta I_{0k}$, $B_k = \bar{I}_{0k} \cdot \Delta v_k$, $C_k = \left[\bar{\lambda}_k - \overline{ln\left(\lambda_k\right)}\right] \cdot \Delta v_k$, and $D_k = \left(\bar{\theta}_k - \bar{v}_k\right) \cdot \Delta ln\left(\bar{y}_k\right)$.

becomes apparent that the results presented in Table 3 were mainly driven by certain subgroups, but not in a uniform way. Not surprisingly, especially groups 1 and 5 (single- and two-adult-households) positively contributed to overall inequality change. Another group with a smaller but still noticeable positive contribution is group 3 (one adult with two children not older than 14).

Place Table 4 here.

Contributions with a counteracting negative sign – i.e. a decrease in group-specific inequality – are groups that represent certain multi-person-households with children (Groups 6–10). For pre fisc incomes these groups remarkably reduce the proportion of summands B and C. The net-effect of 43 per cent, however, is still noteworthy. For post fisc incomes, the opposing effects we described at the beginning become even more evident. The positive and negative contributions of the groups that appear to be the "main drivers" of the over-all effect are quite substantial in both directions. However, the bottom line is the fact that the opposing gross-effects per group nearly outweigh each other, such that the over-all proportion of summands B and C (only) adds up to a mere 14.9 per cent.

4.2.2 Poverty

The results for the decomposition of poverty according to Equation (10) change are presented in Table 5. For pre fisc incomes, poverty measures increased by 21.3 to 24.7 per cent between 1991 and 2007, depending on the value for α. Note that for $\alpha = 0$ the FGT poverty measure equals the head count ratio (HC). More than half of the change in total pre fisc poverty can be attributed to demographic changes (varying between 52.4 and 73.1 per cent for different values of α). Hence, for $\alpha = 2$ the proportion of summand B is nearly three quarters.

Place Table 5 here.

For post fisc incomes, the demographic effect on poverty change sums to almost one quarter of total change. Just as in the case of pre fisc incomes, the highest value is reported for $\alpha = 2$, which is a measure that emphasizes severe poverty. It should

be noted that, similar to the observation for inequality, relative poverty growth was greater for post fisc incomes, although its level is lower than for pre fisc incomes. This means, governmental re-distribution of incomes became less effective during this period.

4.2.3 Richness

The results for the decomposition of the change in richness (see Equation (13)) are presented in Table 6. The richness measures for pre fisc incomes increased quite considerably between 1991 and 2007 by more than 81 per cent for $\beta = 1$ and by two thirds for $\beta = 3$. The head count ratio for richness (HC) increased by more than 41 per cent. Note that the richness measure R_β resembles the head count ratio for $\beta \to \infty$. The fraction of over-all pre fisc richness change that can be attributed to demographic changes amounts to quite considerable values between 42.3 and 52.2 per cent for different values of β respectively.

Place Table 6 here.

The overall growth rates of richness for post fisc incomes do not differ very much from those reported for pre fisc incomes (between 46.6 and 76.1 per cent). However, the proportions of summand B are much lower for incomes after tax and transfer payments. They vary between 8.0 and 9.4 per cent depending on the value for β. For richness, the difference between the shares of summands B and C for pre (beyond 40 per cent) and post fisc incomes (below 10 per cent) respectively is considerably large in comparison to the beforehand reported differences for inequality and poverty.

4.3 Potential fiscal costs

In addition we are interested in the potentially implicated fiscal costs the German state would be confronted with if the government would aim at undoing the increase in inequality that is associated with the change in household structure.

More precisely, we we want to know which amount of lump sum transfer pay-

ment[28] would be necessary in order to reduce the level of post fisc income inequality in 2007 for the actually observed distribution of household structure to the level that would have been reached in case of a counterfactual distribution of household structure identical to the one in 1991.

Thus, we iteratively increased post fisc equivalence-weighted income for every individual in the sample population (of 2007) by the same lump sum amount until the level of inequality, measured by I_0 as a benchmark, equalled the level attained when computed with counterfactual population weights (as described above).

The result is that it would require the state to distribute a lump sum transfer of about 263.0 equivalent money units to every individual in order to reduce the inequality measure I_0 accordingly, i.e. undoing the difference between actual and re-weighted growth. Taking into account different household sizes – and hence different equivalence weights – for every individual fiscal costs sum up to about 15.5 billion Euros. This is equivalent to 5.8 per cent of the federal government budget or 0.65 per cent of German GDP in 2007.[29]

5 Conclusions

The aim of this paper was to quantify the effect of continuously decreasing average household size on measures of income distribution in Germany. By means of a re-weighting procedure and decompositions of changes in measures of income distribution (inequality, poverty, and richness) and based on income data from the German Socio-Economic Panel, we computed to what extent the over-all changes in income distribution result from changes in population structure with respect to household composition.

Irrespective of the choice of methodology, it appears that the changing struc-

[28] Lump sum payment is the most efficient way to redistribute incomes from an optimal tax point of view. Moreover, this procedure reduces inequality since lower incomes gain more in relative terms. Hence, this makes the distribution more equal.

[29] The sums are expressed in prices of 2006 according to the Consumer Price Index (CPI) published by the Federal Statistical Office. Deflated by the CPI Germany's GDP amounted 2,390.0 billion Euros (Statistisches Bundesamt, 2009) and the federal budget 266.1 billion Euros (Bundesministerium der Finanzen, 2009).

ture of German population with respect to household composition during the period between 1991 and 2007 is associated with increasing values for all indices of inequality, poverty, and richness under consideration.[30] Without the demographic trend towards smaller households inequality, poverty, and richness would also have increased. But the levels would be lower than they actually are. However, our result that household structure accounts for about 15 per cent of the change in (post fisc) income inequality, which is much lower than it was reported by the OECD, suggests that there are other important driving forces underlying the growing income gap. Among else, these could be changes in the distribution of human capital or decreasing bargaining power of trade unions. Investigating these factors is left to future research.

It turns out that the re-weighting approach and the decomposition reveal similar results for inequality, while the results for poverty and richness partly differ substantially. Hence, when looking at the whole income distribution the choice of methodology does not matter, while it does so at the tails of the distribution. In addition, we state that the effect of demographic change on income distribution is lower for post fisc than for pre fisc incomes, since we find much greater proportions of the demographic effect in cases of the latter. This means, the tax benefit system in Germany provides – at least implicitly – some form of compensation for changing household structure.[31]

Note that there are limitations to both approaches we apply here. First, they remain descriptive, i.e. based on these results one cannot state that there is a *causal* relationship between household structure and income inequality. Second, the decomposition approach that we employed is focused on distinct indices rather than taking into account the whole distribution. But it can be seen as a "first step" in explaining distributional changes (Bourguignon and Ferreira, 2005, p. 18).

[30] Note that increasing poverty and richness is implicitly equivalent to increasing polarization of the income distribution, since measures for polarization can be defined as weighted sums of poverty and richness for a given distribution (Scheicher, 2008).

[31] However, one could also argue that the fact that the German tax-benefit system compensated for most demographic change based increase in inequality, poverty, and richness itself has an effect on the demographic trend. So, as far as one can think of a causal relationship anyway, this could be reverse. For instance, the reform measures concerning German labor market policy in 2005 (the so-called "Hartz" reforms) generated incentives for young unemployed adults to leave their parents' house earlier in order to receive a certain social benefit (or at least a higher amount).

In summary, we conclude that statements on income distribution must be differentiated. If public policy aims at reducing the income gap, measures taken should depend on its causes. Hence, it is important to disentangle potential drivers of a growing income gap.

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A Appendix

A.1 Tables

Table 1: Population subgroups: definition, numbers, population shares, and mean incomes 1991–2007

k	adults	children	number 1991	Δ number	$v_{k,1991}$	Δv_k	$\bar{y}_{k,1991}$	$\Delta\bar{y}_k$
1	1	0	12.64	3.73	15.76	4.23	17,329.85	1,351.29
2	1	1	1.19	0.01	1.49	-0.02	11,446.88	668.90
3	1	2	0.32	0.43	0.41	0.52	11,722.34	1.69
4	1	$\geq$3	0.23	0.01	0.29	0.01	14,215.58	-3,852.96
5	2	0	20.92	4.86	26.09	5.39	20,852.58	2,463.13
6	2	1	8.11	-1.05	10.11	-1.49	18,626.29	2,382.14
7	2	2	9.35	-1.90	11.66	-2.56	17,262.37	2,649.78
8	2	$\geq$3	4.03	-1.58	5.03	-2.04	15,114.36	4,163.70
9	3	0	9.25	-1.58	11.54	-2.17	21,062.84	197.27
10	$\geq$3	1	5.54	-0.73	6.91	-1.03	18,537.21	-276.01
11	$\geq$3	2	1.66	0.00	2.07	-0.04	15,011.32	690.35
12	$\geq$3	$\geq$3	0.84	-0.44	1.05	-0.56	15,014.65	-1,334.53
13	4	0	4.88	0.04	6.08	-0.08	20,613.69	1,134.02
14	$\geq$5	0	1.21	-0.11	1.51	-0.16	19,466.01	-1,510.14
Total	–	–	80.17	1.70	100.00	0.00	18,815.36	1,775.49

Note: Own calculations based on GSOEP. Number of individuals in million. The population share of group k is denoted with v_k (in per cent). The symbol Δ denotes the difference-operator. Hence, Δv_k and $\Delta\bar{y}_k$ denote the change of population shares and group mean income between 1991 and 2007 respectively. Group mean incomes ($\bar{y}_k$) are annual equivalence weighted post fisc incomes (Euro, in prices of 2006).

Table 2: Actual and re-weighted changes of inequality, poverty, and richness measures 1991–2007

	pre fisc			post fisc		
measure	Δ^{act}	Δ^{rew}	$\frac{\Delta^{act}-\Delta^{rew}}{\Delta^{act}}$	Δ^{act}	Δ^{rew}	$\frac{\Delta^{act}-\Delta^{rew}}{\Delta^{act}}$
I_{Gini}	18.39	13.03	29.17	16.14	14.08	12.76
I_0	36.46	22.09	39.42	40.27	34.25	14.96
I_1	42.13	29.54	29.88	54.51	47.49	12.87
I_2	107.12	81.76	23.67	187.16	159.75	14.65
P_{HC}	21.32	13.38	37.26	22.60	18.74	17.09
P_1	24.69	13.28	46.22	36.35	27.97	23.06
P_2	22.66	10.34	54.39	47.24	34.68	26.59
R_1	81.11	59.03	27.23	76.06	69.78	8.26
R_3	66.12	46.45	29.76	65.75	60.17	8.48
R_{HC}	41.14	25.58	37.82	46.62	41.81	10.33

Note: Own calculations based on GSOEP. Note that the results for actual (Δ^{act}) and re-weighted changes (Δ^{rew}) as well as the term $\frac{\Delta^{act}-\Delta^{rew}}{\Delta^{act}}$ are displayed as percentages, i.e. they were multiplied by 100.

Table 3: Inequality decomposition 1991–2007

income	region	I_0^{1991}	I_0^{2007}	ΔI_0	A	B	C	D	$\frac{B+C}{\Delta I_0}$
pre fisc	Germany	0.69	0.94	36.46	20.60	15.45	0.24	0.15	43.03
	West	0.68	0.86	26.29	14.97	11.28	0.12	-0.09	43.37
	East	0.66	1.24	88.62	49.05	38.11	1.36	0.18	44.54
post fisc	Germany	0.11	0.15	40.27	33.22	5.63	0.38	0.82	14.94
	West	0.11	0.15	46.02	40.30	4.48	0.22	0.83	10.22
	East	0.07	0.10	38.80	33.85	6.52	3.27	-4.98	25.24

Note: Own calculations based on GSOEP. Results for ΔI_0 and $\frac{B+C}{\Delta I_0}$ are displayed as percentages. Results for A–D are displayed as percentage points. See Footnote 22.

Table 4: Inequality decomposition 1991–2007: results per group

income	k	adults	children	A_k	B_k	C_k	D_k	$\frac{B_k+C_k}{\Delta I_0}$
pre fisc	1	1	0	-5.84	11.35	6.38	-0.98	48.63
	2	1	1	1.64	-0.04	-0.04	0.21	-0.23
	3	1	2	0.53	0.45	0.95	0.33	3.84
	4	1	≥3	-1.38	0.06	0.03	0.24	0.23
	5	2	0	9.55	7.96	7.81	0.05	43.25
	6	2	1	4.08	-0.77	-2.19	0.29	-8.13
	7	2	2	3.19	-0.91	-3.73	0.12	-12.71
	8	2	≥3	1.52	-0.89	-2.98	-0.16	-10.61
	9	3	0	3.16	-1.03	-3.19	-0.06	-11.58
	10	≥3	1	0.88	-0.27	-1.50	-0.04	-4.87
	11	≥3	2	1.55	-0.02	-0.06	0.05	-0.22
	12	≥3	≥3	0.49	-0.34	-0.88	0.09	-3.32
	13	4	0	0.37	-0.02	-0.12	0.03	-0.39
	14	≥5	0	0.86	-0.07	-0.24	-0.01	-0.85
	Total	–	–	20.60	15.45	0.24	0.15	43.03
post fisc	1	1	0	5.98	6.86	40.36	-1.10	117.24
	2	1	1	-0.00	-0.02	-0.24	-0.32	-0.66
	3	1	2	-0.70	0.49	5.51	-0.00	14.88
	4	1	≥3	-0.84	0.02	0.12	0.33	0.34
	5	2	0	10.99	7.04	51.52	3.71	145.40
	6	2	1	5.23	-1.47	-14.16	0.04	-38.83
	7	2	2	2.07	-2.02	-24.39	-0.86	-65.57
	8	2	≥3	2.14	-1.85	-19.58	-1.36	-53.22
	9	3	0	4.28	-1.98	-20.63	0.07	-56.15
	10	≥3	1	0.58	-0.78	-9.85	0.05	-26.41
	11	≥3	2	0.79	-0.03	-0.39	-0.19	-1.04
	12	≥3	≥3	0.02	-0.42	-5.53	0.17	-14.79
	13	4	0	2.09	-0.07	-0.79	0.23	-2.12
	14	≥5	0	0.56	-0.12	-1.54	0.05	-4.14
	Total	–	–	33.22	5.63	0.38	0.82	14.94

Note: Own calculations based on GSOEP. Results for $\frac{B_k+C_k}{\Delta I_0}$ are displayed as percentages. Results for A_k–D_k are displayed as percentage points. See Footnote 22.

Table 5: Poverty decomposition 1991–2007

income	α	P_α^{1991}	P_α^{2007}	ΔP_α	A	B	$B/\Delta P_\alpha$
pre fisc	HC	0.29	0.35	21.32	10.14	11.18	52.43
	1	0.18	0.23	24.69	9.39	15.31	61.98
	2	0.15	0.18	22.66	6.09	16.57	73.14
post fisc	HC	0.12	0.14	22.60	16.97	5.63	24.93
	1	0.02	0.03	36.35	27.06	9.30	25.58
	2	0.01	0.01	47.24	34.73	12.51	26.48

Note: Own calculations based on GSOEP. Results for ΔP_α and $B/\Delta P_\alpha$ are displayed as percentages. Results for A and B are displayed as percentage points. See Footnote 22.

Table 6: Richness decomposition 1991–2007

income	β	R_β^{1991}	R_β^{2007}	ΔR_β	A	B	$B/\Delta R_\beta$
pre fisc	1	0.03	0.05	81.11	50.25	42.34	52.20
	3	0.06	0.09	66.12	50.24	31.96	48.34
	HC	0.12	0.18	41.14	29.62	17.42	42.34
post fisc	1	0.01	0.02	76.06	57.37	6.06	7.96
	3	0.02	0.04	65.75	50.97	5.37	8.17
	HC	0.06	0.08	46.62	34.91	4.39	9.43

Note: Own calculations based on GSOEP. Results for ΔR_β and $B/\Delta R_\beta$ are displayed as percentages. Results for A and B are displayed as percentage points. See Footnote 22.

Table 7: Cross-tabulation: population group vs. household typology (1991, in per cent)

	Population subgroup k														
Household typology (GSOEP)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
adults (> 14)	1	1	1	1	2	2	2	2	3	≥ 3	≥ 3	≥ 3	4	≥ 5	–
children (≤ 14)	0	1	2	≥ 3	0	1	2	≥ 3	0	1	2	≥ 3	0	0	–
one-person-household	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.8
couple without children	0.0	0.0	0.0	0.0	88.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.0
single parent	0.0	94.6	100.0	100.0	9.2	4.7	1.0	1.4	4.4	2.2	0.9	0.0	1.3	0.0	5.9
couple with children ≤ 16	0.0	0.0	0.0	0.0	0.0	88.9	97.7	96.5	8.5	29.7	32.8	38.0	0.6	1.4	29.4
couple with children > 16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78.9	0.2	0.0	1.9	76.3	60.0	14.7
couple with children $\leq$ and > 16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.2	41.6	26.6	15.3	17.0	6.0
multiple generation-household	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.0	12.5	23.2	33.5	4.4	20.6	2.4
other combination	0.0	5.4	0.0	0.0	2.8	5.7	0.7	2.1	8.2	2.1	1.5	0.0	2.1	1.0	2.8
Total	15.8	1.5	0.4	0.3	26.1	10.1	11.7	5.0	11.5	6.9	2.1	1.1	6.1	1.5	100.0

Table 8: Cross-tabulation: population group vs. household typology (2007, in per cent)

	Population subgroup k														
Household typology (GSOEP)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
adults (> 14)	1	1	1	1	2	2	2	2	3	≥ 3	≥ 3	≥ 3	4	≥ 5	–
children (≤ 14)	0	1	2	≥ 3	0	1	2	≥ 3	0	1	2	≥ 3	0	0	–
one-person-household	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0
couple without children	0.0	0.0	0.0	0.0	91.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.7
single parent	0.0	98.5	100.0	97.9	7.8	6.8	2.1	2.5	12.1	3.3	2.1	3.1	4.2	8.4	7.7
couple with children ≤ 16	0.0	0.0	0.0	0.0	0.0	92.6	97.6	97.5	7.3	28.1	35.8	22.0	0.7	0.0	23.0
couple with children > 16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	76.6	0.0	0.0	0.0	64.3	62.5	11.9
couple with children $\leq$ and > 16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.5	48.7	54.9	26.4	20.9	6.7
multiple generation-household	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	1.4	7.0	13.3	15.3	4.4	5.5	1.3
other combination	0.0	1.5	0.0	2.1	1.1	0.1	0.2	0.0	2.6	0.1	0.0	4.6	0.0	2.7	0.7
Total	20.0	1.5	0.9	0.3	31.5	8.6	9.1	3.0	9.4	5.9	2.0	0.5	6.0	1.4	100.0

Table 9: Inequality decomposition 1991–2006

income	region	I_0^{1991}	I_0^{2006}	ΔI_0	A	B	C	D	$\frac{B+C}{\Delta I_0}$
pre fisc	Germany	0.69	0.97	41.06	27.36	13.25	0.25	0.18	32.90
	West	0.68	0.88	29.35	19.96	9.11	0.20	0.09	31.71
	East	0.66	1.31	99.55	64.06	34.73	1.03	-0.28	35.92
post fisc	Germany	0.11	0.14	36.27	30.79	4.54	0.46	0.30	13.76
	West	0.11	0.15	41.73	36.98	3.45	0.48	0.65	9.43
	East	0.07	0.10	36.99	37.33	5.57	2.41	-7.93	21.57

Note: Own calculations based on GSOEP. Results for ΔI_0 and $\frac{B+C}{\Delta I_0}$ are displayed as percentages. Results for A–D are displayed as percentage points. See Footnote 22.

Table 10: Inequality decomposition 1992–2006

income	region	I_0^{1992}	I_0^{2006}	ΔI_0	A	B	C	D	$\frac{B+C}{\Delta I_0}$
pre fisc	Germany	0.68	0.97	43.77	31.46	11.90	0.34	0.06	27.97
	West	0.65	0.88	35.06	26.65	8.08	0.33	-0.01	23.99
	East	0.71	1.31	85.34	53.97	31.85	1.18	-1.46	38.71
post fisc	Germany	0.11	0.14	29.23	24.68	3.83	0.69	-0.08	15.46
	West	0.11	0.15	31.33	27.71	2.63	0.78	0.10	10.88
	East	0.07	0.10	35.04	33.23	5.97	2.18	-6.02	23.26

Note: Own calculations based on GSOEP. Results for ΔI_0 and $\frac{B+C}{\Delta I_0}$ are displayed as percentages. Results for A–D are displayed as percentage points. See Footnote 22.

Table 11: Inequality decomposition 1992–2007

income	region	I_0^{1992}	I_0^{2007}	ΔI_0	A	B	C	D	$\frac{B+C}{\Delta I_0}$
pre fisc	Germany	0.68	0.94	39.09	25.01	13.68	0.30	0.07	35.77
	West	0.65	0.86	31.86	22.12	9.66	0.19	-0.13	30.92
	East	0.71	1.24	75.18	39.83	35.18	1.43	-1.02	48.69
post fisc	Germany	0.11	0.15	33.03	27.06	4.79	0.56	0.48	16.21
	West	0.11	0.15	35.30	30.84	3.53	0.43	0.37	11.20
	East	0.07	0.10	36.82	29.95	6.76	2.60	-2.66	25.41

Note: Own calculations based on GSOEP. Results for ΔI_0 and $\frac{B+C}{\Delta I_0}$ are displayed as percentages. Results for A–D are displayed as percentage points. See Footnote 22.

Table 12: Poverty decomposition 1991–2006

income	α	P_α^{1991}	P_α^{2006}	ΔP_α	A	B	$B/\Delta P_\alpha$
pre fisc	HC	0.29	0.35	23.88	13.44	10.45	43.74
	1	0.18	0.24	30.03	16.24	13.79	45.92
	2	0.15	0.19	29.30	14.57	14.73	50.27
post fisc	HC	0.12	0.14	17.85	11.95	5.90	33.07
	1	0.02	0.03	38.28	30.46	7.81	20.41
	2	0.01	0.01	51.80	41.42	10.38	20.04

Note: Own calculations based on GSOEP. Results for ΔP_α and $B/\Delta P_\alpha$ are displayed as percentages. Results for A and B are displayed as percentage points. See Footnote 22.

Table 13: Poverty decomposition 1992–2006

income	α	P_α^{1992}	P_α^{2006}	ΔP_α	A	B	$B/\Delta P_\alpha$
pre fisc	HC	0.30	0.35	18.63	9.29	9.34	50.13
	1	0.19	0.24	25.73	13.37	12.35	48.02
	2	0.15	0.19	26.11	12.90	13.21	50.58
post fisc	HC	0.12	0.14	13.80	9.39	4.42	32.01
	1	0.03	0.03	31.79	24.67	7.11	22.37
	2	0.01	0.01	34.22	24.62	9.60	28.06

Note: Own calculations based on GSOEP. Results for ΔP_α and $B/\Delta P_\alpha$ are displayed as percentages. Results for A and B are displayed as percentage points. See Footnote 22.

Table 14: Poverty decomposition 1992–2007

income	α	P_α^{1992}	P_α^{2007}	ΔP_α	A	B	$B/\Delta P_\alpha$
pre fisc	HC	0.30	0.35	16.18	6.16	10.02	61.93
	1	0.19	0.23	20.57	6.93	13.64	66.33
	2	0.15	0.18	19.63	4.85	14.78	75.28
post fisc	HC	0.12	0.14	18.39	14.17	4.22	22.97
	1	0.03	0.03	29.95	21.83	8.12	27.11
	2	0.01	0.01	30.19	19.19	11.00	36.45

Note: Own calculations based on GSOEP. Results for ΔP_α and $B/\Delta P_\alpha$ are displayed as percentages. Results for A and B are displayed as percentage points. See Footnote 22.

Table 15: Richness decomposition 1991–2006

income	β	R_β^{1991}	R_β^{2006}	ΔR_β	A	B	$B/\Delta R_\beta$
pre fisc	1	0.03	0.05	82.31	65.80	39.20	47.63
	3	0.06	0.09	68.06	61.68	29.70	43.64
	HC	0.12	0.18	40.49	34.01	16.32	40.31
post fisc	1	0.01	0.02	73.39	51.72	4.04	5.51
	3	0.02	0.04	63.71	44.04	3.71	5.82
	HC	0.06	0.08	43.61	29.76	3.60	8.26

Note: Own calculations based on GSOEP. Results for ΔR_β and $B/\Delta R_\beta$ are displayed as percentages. Results for A and B are displayed as percentage points. See Footnote 22.

Table 16: Richness decomposition 1992–2006

income	β	R_β^{1992}	R_β^{2006}	ΔR_β	A	B	$B/\Delta R_\beta$
pre fisc	1	0.03	0.05	69.75	48.91	33.16	47.54
	3	0.06	0.09	58.95	49.94	25.74	43.67
	HC	0.13	0.18	39.93	31.10	15.51	38.85
post fisc	1	0.01	0.02	57.71	34.27	3.05	5.28
	3	0.03	0.04	50.70	28.52	3.14	6.19
	HC	0.06	0.08	30.47	20.28	3.02	9.93

Note: Own calculations based on GSOEP. Results for ΔR_β and $B/\Delta R_\beta$ are displayed as percentages. Results for A and B are displayed as percentage points. See Footnote 22.

Table 17: Richness decomposition 1992–2007

income	β	R_β^{1992}	R_β^{2007}	ΔR_β	A	B	$B/\Delta R_\beta$
pre fisc	1	0.03	0.05	68.64	34.08	36.43	53.08
	3	0.06	0.09	57.11	38.90	28.10	49.20
	HC	0.13	0.18	40.58	26.49	16.84	41.51
post fisc	1	0.01	0.02	60.13	39.22	5.06	8.41
	3	0.03	0.04	52.58	34.74	4.82	9.16
	HC	0.06	0.08	33.21	24.93	3.77	11.34

Note: Own calculations based on GSOEP. Results for ΔR_β and $B/\Delta R_\beta$ are displayed as percentages. Results for A and B are displayed as percentage points. See Footnote 22.

A.2 Decomposition of Poverty Change

$$\Delta P_\alpha = P_\alpha^{t+1} - P_\alpha^t \tag{18a}$$

$$= \sum_{k=1}^{K} v_k^{t+1} \cdot P_{\alpha,k}^{t+1}(y_k; z) - \sum_{k=1}^{K} v_k^t \cdot P_{\alpha,k}^t(y_k; z) \tag{18b}$$

$$= \sum_{k=1}^{K} v_k^{t+1} \cdot P_{\alpha,k}^{t+1} - v_k^t \cdot P_{\alpha,k}^t \tag{18c}$$

$$= \sum_{k=1}^{K} v_k^{t+1} \cdot P_{\alpha,k}^{t+1} - v_k^t \cdot P_{\alpha,k}^t + 0.5 \cdot v_k^t \cdot P_{\alpha,k}^{t+1} - 0.5 \cdot v_k^t \cdot P_{\alpha,k}^{t+1} \tag{18d}$$

$$+ 0.5 \cdot v_k^{t+1} \cdot P_{\alpha,k}^t - 0.5 \cdot v_k^{t+1} \cdot P_{\alpha,k}^t \tag{18e}$$

$$= \sum_{k=1}^{K} 0.5 \cdot \left[2 \cdot v_k^{t+1} \cdot P_{\alpha,k}^{t+1} - 2 \cdot v_k^t \cdot P_{\alpha,k}^t + v_k^t \cdot P_{\alpha,k}^{t+1} - v_k^t \cdot P_{\alpha,k}^{t+1} + v_k^{t+1} \cdot P_{\alpha,k}^t - v_k^{t+1} \cdot P_{\alpha,k}^t\right] \tag{18f}$$

$$= \sum_{k=1}^{K} 0.5 \cdot \left[(v_k^{t+1} + v_k^t) \cdot (P_{\alpha,k}^{t+1} - P_{\alpha,k}^t) + (P_{\alpha,k}^{t+1} + P_{\alpha,k}^t) \cdot (v_k^{t+1} - v_k^t)\right] \tag{18g}$$

$$= \sum_{k=1}^{K} \bar{v}_k \cdot \Delta P_{\alpha,k} + \sum_{k=1}^{K} \bar{P}_{\alpha,k} \cdot \Delta v_k \tag{18h}$$