Schmollers Jahrbuch 132 (2012), 297 – 321
Duncker & Humblot, Berlin

Earnings Inequality – Does the Accounting Period Matter?

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Abstract

Under mild assumptions, Shorrocks (1978) has proved that measured inequality must decrease when the period over which income is measured, the accounting period, increases. The present work seeks to shed light on the quantitative size of this effect using a huge representative German database for the period 1975 – 2004. Our results indicate that the choice of the accounting period not only seriously affects the level of inequality. We can also show that the size of the effect varies over time.

JEL Classification: D31, D63, O15

1. Introduction

Income inequality studies have become increasingly important over the past few years as discussions concerning distributive justice, fairness and equity within populations have intensified. When measuring inequality of flow variables, such as income, choosing the "appropriate" accounting period is one of the problems encountered (e.g., Böheim / Jenkins, 2006). For example, individuals at the lower end of the income distribution may have little possibility of evening out short-term fluctuations by spreading their income over "good" and "bad" periods. Then even short periods of low income may have significant consequences (e.g., Ruggles, 1990): Setting up a household requires a minimum housing rent, maintenance flows of a minimum stock of durables, nutrition and heating needs (e.g., Donaldson / Pendakur, 2004, 2005, and Koulovatianos et al., 2006). Financially weak households have particular bad access to the capital market, and intra-annual income fluctuations may cause substantial complications for them to meet their basic needs or to undertake efficient human capital investments in their children (Becker / Tomes, 1986). Moreover, as pointed out by Bradbury et al. (2001), many income-tested cash benefits in

* I would like to thank Carsten Schröder and two anonymous referees for most valuable advice. Furthermore, I thank the IAB-FDZ for helpful support and the participants of the FDZ-RV-Workshop 2011 for helpful and constructive suggestions.

industrialized countries are assessed on the basis of income over the course of a month or an even shorter period of time. Therefore, studies concerned with the effectiveness of these programs should be aware of the consequence of choosing a particular accounting period. An example for Germany are unemployment benefits, which are paid on a monthly basis. When analyzing the effectiveness of unemployment benefits one may focus on incomes on a monthly basis rather than an annual incomes. Otherwise, sub-annual fluctuations and sub-annual changes between years remain unconsidered.

Under mild assumptions, Shorrocks (1978) has shown that the level of inequality must decrease when the accounting period increases. Previous empirical literature on the size of this effect has focused on accounting periods of one year and longer. Early examples include Soltow (1965) or Shorrocks (1978). Some more recent studies focus on shorter accounting periods, i.e. a month, a quarter or a year (e.g., Böheim/Jenkins, 2006, Gibson et al., 2001, Wodon/Yitzhaki, 2003, Finkel at al., 2006, and Canto at al., 2006).

To the best of our knowledge, this is the first study on the role of the accounting period on measured inequality for Germany. As data set, we employ the IAB Employment sub-sample. This data set is used to construct monthly, quarterly, semi-annual and annual distributions of earnings. In contrast to previous literature, the database does not only allow the computation of inequality measures in a particular year, but also for a rather long observation period. Particularly, this paper provides inequality indices for the time horizon from 1975 till 2004 for three birth cohorts (1945–54, 1955–64 and 1965–74). For each cohort and each earnings accounting period the following four inequality indices are calculated and contrasted: the Gini index and three members of the General Entropy family.

Our results support the results found in previous literature, e.g., Canto et al. (2006), in that we find increasing differences between the results of the earnings accounting periods with an increasing sensitivity to earnings at the bottom of the earnings distribution. The differences for the Gini index, for example, are quite small (ca. 1% when changing from annual to monthly earnings) while the differences for the Theil index are higher (ca. 8%). We do not restrict our research to these findings, but expand to the dynamics of the differences over time, and we find changes in sub-annual trends and a higher variation of within annual inequality when looking at the Theil index instead of the Gini index.

The paper is structured as follows. Section 2 gives a brief overview over previous results in the literature concerning the impact of the income accounting period. Section 3 introduces the inequality indices underlying the empirical analysis. Section 4 provides an example to illustrate the impact of the accounting period on inequality. The data and its processing are described in Section 5. The empirical results are provided in Section 6 and discussed in Section 7. Section 8 concludes.

2. Previous Results in the Literature

The fact that inequality declines, when the period over which income is measured increases, is well known and well documented. Shorrocks (1978) proved for strictly convex, scale invariant inequality measures $I(.)$ the relationship $I(\sum_t Y_t) \leq \sum_t \omega_t I(Y_t)$ holds true with Y_t being a random variable representing the income distribution in period t and ω_t weighting the inequality indices of the periods. Hence, he showed formally that the average inequality of the given periods is higher than the inequality calculated for all periods together. By expanding the accounting period from e.g., one month to a year, variations in monthly income become subsumed within the annual figure. The magnitude of the decline, of course, is an empirical question.

Based on the British Household Panel Survey (BHPS), Böheim/Jenkins (2006) explored, whether estimates of Britain's income distribution and its trends are sensitive to the choice between current and annual income. They calculated the Gini index and the half squared coefficient of variation (GE(2)), a member of the Generalized Entropy family and found small differences for the inequality measured with current and annual incomes. Annual income refers to the total amount of income received over the year and current income is the total income received in the month before the interview takes place both expressed in pounds per week.

Gibson et al. (2001) examined income inequality in China and the fact that income inequality in China is comparatively low. In China income inequality is typically measured using annual income. However, Gibson et al. (2001) found an increase of measured inequality from 17% to 69%, depending on the inequality measure used, when using monthly incomes instead of annual incomes.

Another empirical study by Wodon/Yitzhaki (2003) is based on panel data of urban wages in Mexico (16 metropolitan areas). They calculated the Gini indices and correlations between periods. The lower the correlations the stronger the decrease of inequality over several periods of time compared to the average level of inequality for the various periods taken separately. They found a decrease of ca. 12% when expanding the income accounting period from one quarter to five quarters.

Based on the concepts of Wodon/Yitzhaki (2003), Finkel at al. (2006) used household income given by the Israeli Household Expenditure and Household Income Survey to analyze the magnitude of extending the income accounting period for several years (1979/1980 and 1999). They found an average decrease of 1.7% when changing the accounting period from month to quarter and a decrease from quarterly to annual inequality by about 1.7%–4.1%. These results were stable over both time horizons, but were sensitive to the definition of income (higher changes for net income per equivalent adult than for net household income).

Empirical results for Spain are provided in Canto at al. (2006), which is based on the Encuesta Continua de Presupuestos Familiares (ECPF), a Spanish sample similar to the US SIPP. They calculated General Entropy indices and the Gini index using quarterly and annual income. When using quarterly data instead of annual data they found a significant increase in measured inequality and the lower the parameter of inequality aversion was, the higher was the divergence they found between short-term measurement intervals and longer ones.

3. Measuring Inequality

Inequality analysis describes the distribution of a particular measure, i.e. income, at a given point in time. Typically, the magnitude of income inequality is represented by a scalar measure, by an i.e. inequality index. In inequality literature a list of five key principles, that an inequality index should fulfill, has been suggested: weak/strong principle of transfer, income scale independence, population principle and decomposability.[1] Ad-hoc indices, such as the Gini index, are easy to interpret, but typically violate some of the afore-mentioned principles. The Gini index, for example, violates the principle of decomposability. Entropy-based indices on the other hand accommodate those principles, but lack a direct intuitive interpretation. Here we use four indices, defined and summarized below.

The *Gini coefficient*, G, is one of the most frequently used indices. The index is defined as twice the area between the line of perfect equality and the Lorenz curve. Cowell (1996, 23):

$$I_{Gini} = \frac{1}{2n^2\bar{y}} \sum_{i=1}^{n} \sum_{j=1}^{n} |y_i - y_j| \,. \tag{1}$$

In (1) $\bar{y}$ denotes mean income, y_i the income of person i and n the number of individuals in the society. The Gini index lies between zero and one and the index increases with the inequality in the society. An index of zero means perfectly equally distributed incomes and an index of one that one individual in the society captures all income.

A family of indices that satisfy all afore-mentioned principles simultaneously are the *Entropy-based inequality measures*. They rely on an analogy between inequality analysis and information theory. In information theory, one is concerned with the problem of valuing the information $h(p_i)$, that a certain event out of a large number of possibilities has occurred. Each event has a probability p_i (with $i = 1, \ldots, n$ denoting the events). The lower the probability of the event being observed, the higher the value that is assigned to this infor-

[1] For a detailed description see Cowell (1996, 54–65).

mation[2]. Based on this concept, Theil suggested to re-interpret the events as individuals in a society and the probabilities as the units equalized incomes shares in total equalized income. The indices introduced by Theil became special cases of the general class of entropy measures, which are given by Cowell (1996, 60)

$$I_c = \frac{1}{c(c-1)} \frac{1}{n} \sum_{i=1}^{n} \left[\left(\frac{y_i}{\bar{y}} \right)^c - 1 \right] \tag{2}$$

with parameter c representing the weight given to the distances between incomes at different parts of the income distribution. The smaller the value of c, the more sensitive the index is to income differences at the bottom of the distribution. The following analysis is based on three members of the General Entropy family, the Mean Log Deviation:

$$I_{Ge(0)} = \frac{1}{n} \sum_{i=1}^{n} \log \frac{\bar{y}}{y_i}, \quad c = 0 \tag{3}$$

the Theil index:

$$I_{GE(1)} = \frac{1}{n} \sum_{i=1}^{n} \frac{y_i}{\bar{y}} \log \frac{y_i}{ry}, \quad c = 1 \tag{4}$$

and the half coefficient of variation squared:

$$I_{GE(2)} = \frac{1}{2n} \sum_{i=1}^{n} \left[\left(\frac{y_i}{\bar{y}} \right)^2 - 1 \right] = \frac{\sigma^2}{2\bar{y}^2}, \quad c = 2. \tag{5}$$

The indices take their minimum values zero if the incomes are equally distributed and everybody receives the same (average) income. The indices increase with inequality in society.

4. Impact of the Accounting Period on Inequality

As mentioned in Section, 2 Shorrocks (1978) showed formally that inequality decreases when the accounting period is extended. He showed that inequality over T periods is less than the average of period inequalities weighted by their share in total income. The reason is that when inequality is measured over longer time horizons, the relative position of those individuals at the bottom of the distribution tends to improve, whereas the situation of those at the top

[2] For a detailed description of the Entropy concept and the analogy between inequality analysis and information theory see Cowell (1996, 47–49).

tends to deteriorate. The regularities are illustrated by means of an example illustrated in Table 1.

The example is based on a two person society with monthly incomes given over the course of a year. The Theil index is calculated for four different income accounting periods, monthly income y^M, quarterly income y^Q, semi-annual income y^S and annual income y^A. From these different income distributions, the Theil index, together with its average over all intra-yearly periods $S = (A, S, Q, M)$ with corresponding $T = (1, 2, 4, 12)$ are derived:

$$\bar{I}^S = \sum_{t=1}^{T} w_t^S \cdot I_t^S \tag{6}$$

$$w_t^S = \frac{Y_t^S}{\sum_{t=1}^{T} Y_t^S} \quad \text{with} \quad Y_t^S = y_{1,t}^S + y_{2,t}^S \,. \tag{7}$$

In this way it is possible to compare inequality in the distribution of monthly, quarterly, semi-annual and annual incomes. As shown by Shorrocks (1978) it is always the case, that $\bar{I}^M > \bar{I}^Q > \bar{I}^S > I^A$. In the empirical analysis, we will quantify how large these differences are and how they evolve over time.

Table 1

The impact of the income accounting periods on inequality

Month	y_1^M	y_2^M	yI^M	y_1^Q	y_2^Q	I^Q	y_1^S	y_2^S	I^S	y_1^A	y_2^A	I^A
1	2	1	0.566									
2	3	1	0.131	2.667	1.333	0.057						
3	3	2	0.02									
4	1	2	0.566				2	1.833	0.001			
5	1	2	0.566	1.333	2.333	0.377						
6	2	3	0.02									
7	1	3	0.131							2.25	2.08	0.00074
8	1	3	0.131	1.333	3.333	0.095						
9	2	4	0.057									
10	3	1	0.131				2.5	2.333	0.0006			
11	4	1	0.193	3.667	1.333	0.113						
12	4	2	0.057									
$\bar{I}$			0.086			0.079			0.00075			0.00074

5. Data

The analysis is based on the German IAB employment sub-sample Regional-file 1975 – 2004 (IABS R-04) provided by the Research Data Center (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) as a scientific use file. The sub-sample is a 2% random sample taken from the IAB employee histories with additional information on benefit recipients. The sample is stratified according to Germans and non-German employees as well as to individuals from East and West Germany, whose employment cases have been covered by social security at least once in the given period, including marginal employment since 1999 (the file contains the employment notifications of 1,360,949 insured persons, 1,183,108 cases for western Germany and 177,841 cases for eastern Germany). Self-employed persons, family workers and civil servants are not included. The sample contains dynamic variables such as the daily income, social security status and type of employment on a daily basis and static variables such as sex, age, education and region for the entire employment history.[3] The sample covers a period of 30 years for West Germany (1975 – 2004) and 13 years for East Germany (1992 – 2004). As the IAB employment subsample is a longitudinal data set containing exact daily flow information on the employment history of employees as recorded by the social insurance system and on periods of drawing benefits as well, it allows the reproduction of employment careers without typical problems of longitudinal surveys, that arise in social research (e.g., panel mortality, memory gaps).[4]

5.1 Earnings Variable in the IAB Employment Sub-Sample

The IAB employment sub-sample 1975 – 2004 contains a variable for the gross daily earnings of the employees. These are individual earnings covered by social security and therefore do not include income from other sources such as capital income. As earnings relate to the individual level, we do not adjust incomes by means of an equivalence scale. The earnings are calculated individually by using the information of earnings within the employment period provided by the employer together with the length of the employment period.

$$\text{Daily Earnings} = \frac{\text{Earnings of the whole employment}}{\text{calendar days elapsed}} . \tag{8}$$

The employment period is the period between two employment reports. Every person has at least one report (for employment, unemployment or marginal employment) every year ("Jahresmeldung" = annual report). A new report

[3] A detailed description can be found in Drews (2008).

[4] For further information see Bender et al. (2000).

is made in presence of a notifiable reason.[5] Changes into and out of unemployment, into and out of marginal employment and into and out of employment are documented immediately as well as changes of jobs (given a change of firm or notice of departure and a new enrollment). Hence, with these reports, an adjustment of earnings takes place. Changes in earnings within a given contract are no reason for a new report, and are, therefore, not documented within the year, but within the yearly report.

Earnings are the individual gross daily earnings subject to social security averaged over the time interval of the employment period. Special payments, such as Christmas bonuses, and increases in earnings during a year with the same employer are averaged over the employment period. In cases of, for example, two reports for a year (1: Jan. 1 till Aug. 31; 2: Sept. 1 till Dec. 31), Christmas bonuses are averaged over the period of the last / second report.

The earnings are right- and left-censored and are rounded up to whole numbers (see Drews, 2008, 22). Earnings are only measured up to the social security contribution assessment ceiling starting from the marginal earnings threshold[6]. Hence, for my studies, all earnings from minor employment are set on the value of the marginal earnings threshold and all earnings above the social security contribution assessment ceiling on the value of the contribution assessment ceiling. Individuals also might have overlapping employment cases or cases that change within a month. Therefore, the social security status "being in an employment case covered by social security" is handled as superior. The same process takes place for daily earnings, where the higher earnings are handled as being superior.

The daily earnings are adjusted to inflation using the price indices of the Federal Statistical Office[7] and to the Euro (1 Euro = 0.511292 * 1 Deutsche Mark), since earnings had been reported in DM until the end of 1998. Monthly earnings are calculated by using daily earnings. The daily earnings are multiplied by 30 for each month, otherwise, there would be differences induced by the difference of days per month.

$$\text{Monthly earnings} = \text{Calender days} \cdot \max\left[\text{real daily earnings in Euro}\right]. \tag{9}$$

Monthly earnings are the basis for deriving the earnings for all accounting periods. The mean annual, mean semi-annual and mean quarterly earnings are calculated using the formula introduced in the example in the previous Section.

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5 These reasons are documented in the variable "grund". For a detailed description of the variable see Drews (2008).

6 The social security assessment ceilings and the marginal earnings threshold are given on daily basis, detailed tables can be found in Drews (2008).

7 For a detailed table of the price indices see Deutsche Bundesbank (a).

5.2 Sample Selection

The sample is reduced by concentrating on West Germany and on three cohorts (1945 – 1954), (1955 – 1964) and (1965 – 1974),[8] which are analyzed over the whole time horizon from 1975 to 2004.[9] Only individuals with full employment histories are considered, people who have a record for every month, either an income record or a social security record.[10] For the cohort 1945 – 1954 we concentrate on those working in 1975 and still working in 2004. For the second cohort and third cohort, we focus only on those individuals working in 1985 or 1995 respectively, and still working in 2004. Table 2 illustrates the number of observations in the final sample as well as the percentage of men and women in every cohort and the percentage of foreign people. The percentage of women increases from the first to the third cohort (from 29.1% to 37.3%), whereas the percentage of foreigners to the whole population varies only slightly. Zero incomes are set to one, so that the inequality indices using log incomes can be calculated and for all other indices there are no significant differences in the results.

Table 2

Number and relative frequencies of observations

	Total	Men	Women	German	Foreign
Cohort 1945 – 1954	22423	0.71	0.291	0.92	0.077
Cohort 1955 – 1964	33047	0.698	0.302	0.95	0.05
Cohort 1965 – 1974	44833	0.627	0.373	0.916	0.084

Source: IABS-R04, own calculations.

5.3 Differences in Earnings Variables

Based on the afore-mentioned definitions of earnings, the differences between annual and sub-annual earnings are income differences based on the afore-noted reporting reasons. Therefore, sub-annual earnings are equal to average annual earnings for people with no employment / contract change within the year (no sub-annual employment report). Only in cases of new sub-annual reports (reasons were afore-mentioned), the average annual earnings and the

[8] We start with the first cohort in 1945, as their working biography captures the entire time horizon under consideration from 1975 to 2004.

[9] People in the German Miners Pension remain unconsidered as well as people from East Germany. For East Germany we only have earnings given after 1992, therefore it is not possible to construct equivalent cohorts as for West Germany and it is not possible to regard the whole time horizon from 1975 until 2004.

[10] Otherwise we would have changing groups in every month and hence, annual groups would differ from sub-annual groups.

sub-annual earnings diverge. Table 3, 4 and 5 illustrate the number of earnings changes per person per year for the first, second and third cohort respectively. In each Table, the first column, for example, contains the number of individuals per year with no changes, the second column the number of individuals per year with one change and so on.

Across all cohorts most people have no change in earnings in a given year. Over the years the number of income changes increases (for cohort 1945 – 54: 1.583 % have more than one change in earnings in 1975, compared to 11.048 % in 2004, for cohort 1955 – 64: % have more than one income change in 1985, compared to 11.048 % in 2004 and for cohort 1965 – 74: 3.863 % have more than one income change in 1995, compared to 14.382 % in 2004). Especially the percentage of one and two changes in earnings increases for all three cohorts.

Table 3

Relative frequencies of income changes per person per year for the cohort 1945 – 1954 when incomes are not price-adjusted

Year	Relative frequency of income changes per year												
	0	1	2	3	4	5	6	7	8	9	10	11	12
1975	0.926	0.058	0.014	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1976	0.909	0.069	0.021	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1977	0.908	0.068	0.021	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1978	0.916	0.066	0.017	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1979	0.909	0.072	0.018	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1980	0.914	0.069	0.016	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1981	0.926	0.057	0.015	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.936	0.048	0.015	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.942	0.042	0.014	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1984	0.941	0.045	0.013	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.939	0.045	0.015	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.938	0.046	0.014	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1987	0.940	0.046	0.012	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1988	0.944	0.044	0.011	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1989	0.942	0.045	.011	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1990	0.938	0.047	0.013	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.945	0.042	0.011	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.949	0.039	0.011	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.949	0.038	0.012	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.951	0.035	0.013	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

1995	0.943	0.045	0.011	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1996	0.946	0.040	0.013	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.930	0.054	0.014	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	0.930	0.054	0.014	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.913	0.069	0.016	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.924	0.060	0.014	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.865	0.114	0.019	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.887	0.087	0.021	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.844	0.127	0.024	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.849	0.122	0.023	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Source: IABS-R04, own calculations.

Table 4

Relative frequencies of income changes per person per year for the cohort 1955–1964 when incomes are not price adjusted

Year	Relative frequency of income changes per year												
	0	1	2	3	4	5	6	7	8	9	10	11	12
1985	0.866	0.092	0.035	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.876	0.091	0.028	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1987	0.886	0.087	0.023	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1988	0.892	0.084	0.020	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1989	0.894	0.084	0.019	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1990	0.889	0.091	0.018	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.910	0.072	0.015	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.917	0.066	0.015	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1993	0.925	0.057	0.015	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.932	0.052	0.014	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.919	0.064	0.014	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1996	0.928	0.055	0.015	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.912	0.071	0.015	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	0.922	0.064	0.012	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.898	0.082	0.017	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.912	0.072	0.014	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.861	0.119	0.017	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.894	0.086	0.017	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.861	0.114	0.021	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.882	0.092	0.020	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Source: IABS-R04, own calculations.

Table 5

Relative frequencies of income changes per person per year for the cohort 1965–1974 when incomes are not price-adjusted

Year	Relative frequency of income changes per year												
	0	1	2	3	4	5	6	7	8	9	10	11	12
1995	0.832	0.130	0.032	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1996	0.864	0.103	0.029	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.862	0.107	0.025	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	0.875	0.098	0.023	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.852	0.116	0.026	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.863	0.110	0.022	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.818	0.150	0.026	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.829	0.137	0.026	0.006	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2003	0.808	0.154	0.030	0.006	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.840	0.119	0.028	0.009	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Source: IABS-R04, own calculations.

6. Empirical Results

6.1 Snapshot 2004

We begin our empirical analysis by first looking at the year 2004. Table 6 contains the annual results and annual means of the Gini index and the three entropy-based inequality indices (GE(2), GE(1) and GE(0)) for the three cohorts, using annual and monthly earnings (I^A and $\bar{I}^M$). Additionally, the percentage (ratios) of the differences between the annual results using annual earnings and the annual mean results using monthly earnings are displayed ($\%^A_M$). It is apparent from our results that the quantity of the impact varies according to the index chosen and the cohort under consideration.

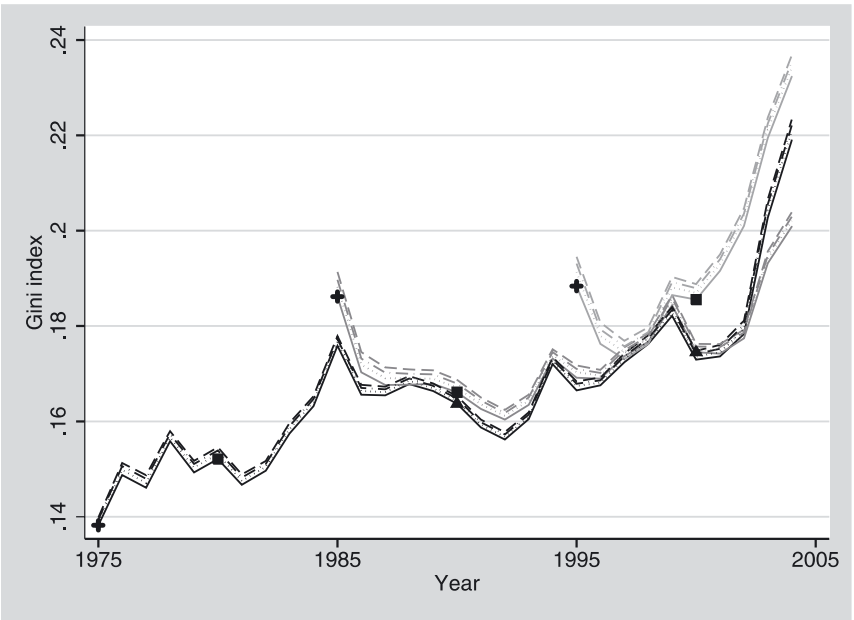
Table 6

Snapshot 2004: Differences between the annual inequality results using monthly earnings and annual inequality results using annual earnings in 2004 for all three cohorts

Cohort	Gini Index			GE(2) Index			GE(1) Index			GE(0) Index		
	I^A_{Gini}	$\bar{I}^M_{Gini}$	$\%^A_M$	$I^A_{GE(2)}$	$\bar{I}^M_{GE(2)}$	$\%^A_M$	$I^A_{GE(1)}$	$\bar{I}^M_{GE(1)}$	$\%^A_M$	$I^A_{GE(0)}$	$\bar{I}^M_{GE(0)}$	$\%^A_M$
1945–1954	0.219	0.223	101.986	0.076	0.080	105.206	0.090	0.099	110.230	0.175	0.245	140.414
1955–1964	0.201	0.204	101.499	0.064	0.066	104.174	0.070	0.076	109.131	0.105	0.154	146.369
1965–1974	0.232	0.237	101.923	0.087	0.092	105.036	0.103	0.114	110.479	0.247	0.348	140.928

Source: IABS-R04, own calculations.

When studying the impact of the inequality index on the differences between the accounting periods, we find that the impact is the largest for the GE(0) index. We find an increase of more than 40 % when changing from annual to monthly earnings. This change shows its lowest impact on the Gini index, with an increase of just about 2 %. The indices can be ordered by the impact of the accounting period in the following way: Gini < GE(2) < GE(1) < GE(0), valid over all three cohorts. The quantitative impact of the entropy-based indices increases with the sensitivity to earnings differences at the lower tail of the earnings distribution, though varying over the time horizon and the observed cohort.



Note: Database is IABS-R04; own calculations. + = average cohort age of 25, ■ = average cohort age of 30, ▲ = average cohort age of 40, black line = cohort 1945 – 1954, grey line = cohort 1955 – 1964, light grey line = cohort 1965 – 1974.

Figure 1: Annual Gini inequality results of the four income accounting periods between 1975 and 2004 for the three cohorts from western Germany

If one takes a look at the calculated indices and analyzes the results with respect to cohorts, we find that, for the Gini index and the GE(2) index changing the accounting period has the largest impact for the first cohort (Gini: 101.986 % and GE(2): 105.206 %) followed by the third cohort with nearly the same value. For the GE(1) index the largest impact can be observed for the third cohort, followed by the first cohort and once again the second cohort has the lowest value with more than 1 % less than the other two. This order changes

for the GE(0) index, in this case the second cohort has by far the highest value (146.369%) compared to the other two cohorts.

Concluding one can say that, as the GE(2) is most sensitive to earnings differences at the upper tail of the earnings distribution, the first and third cohort reveal higher differences at the upper tail of the distribution within the year than the second cohort compared to the annual differences. The second cohort, on the other hand, has higher earnings differences at the lower end of the earnings distribution within the year as the other two cohorts compared to the annual differences, as the GE(0) index, as afore-mentioned, is most sensitive to earnings differences at the lower end of the earnings distribution.

6.2 Inter-Temporal Perspective

While the results of the last chapter have solely been concerned with the year 2004, the following analysis takes the longer development of the earnings accounting periods into consideration. The index, the cohort and the chosen point in time are expected to have a quantitative impact on the results of the accounting periods, as seen by the results for 2004. Our observations over a longer time horizon give support to afore-assumed determinants.

Figure 1 illustrates the annual inequality results calculated using the Gini index for the three cohorts (1945 – 54, 1955 – 64 and 1965 – 74). The Gini is plotted against time beginning with 1975 up to 2005. It is calculated for the four different earning periods – annual, semi-annual, quarterly and monthly – as explained in Section 4.

The inequality measured by the Gini index develops analogically for all accounting periods and all cohorts: it increases over time with peaks in 1985, 1994 and 1999. The increase between 1975 and 2005 is supported by papers of Becker / Hauser (1995) and Birkel (2004), who summarize the empirical evidence from several studies. The peaks result from particularly high unemployment rates in these years[11].

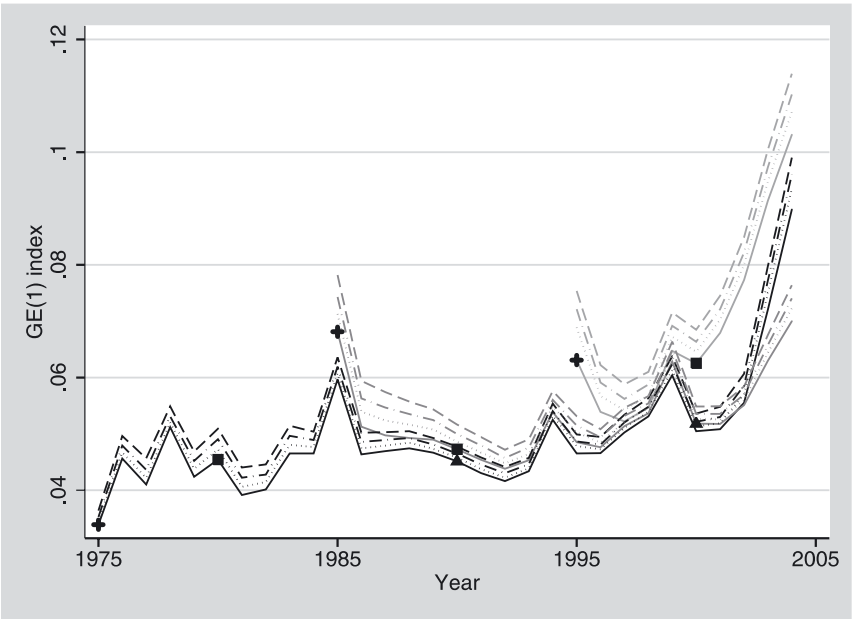
In Figure 1 the points in time, in which the individuals in the cohorts are in average 25, 30 or 40 years old, are marked. By this we can see, that the inequality calculated with the Gini index increased from the first to the second cohort at the age of 25 while it decreased from the second to the third cohort. For the individuals at age 30 and 40 the inequality increased over time.

We find the same development for the Theil index[12] illustrated in Figure 2, where the annual inequality results calculated using the Theil index for the

[11] For further information see Deutsche Bundesbank (b).

[12] For the GE(0) index this development is different. For 30 year-old individuals inequality decreased from the first to the second cohort to increase again to the third cohort, but the decrease for the 25 year-old people from the second to the third cohort is also higher.

three cohorts are plotted against time beginning in 1975 up to 2005. The increase found for the Theil index is equivalent to the one found by the Gini index, but with a higher increase from 1975 to 2004. E.g. for the first cohort the Theil index increased by 165% compared to the rise in the Gini index by 58%. The Theil index has peaks in 1985, 1994 and 1999 as well. These peaks and the general increase are both higher than for the Gini index which means, that the inequality peaks are mostly based on earnings differences at the lower tail of the earnings distribution as the Theil index is more sensitive to earnings differences at the bottom of the earnings distribution.[13]



Note: Database is IABS-R04; own calculations. + = average cohort age of 25, ■ = average cohort age of 30, ▲ = average cohort age of 40, black line = cohort 1945–1954, grey line = cohort 1955–1964, light grey line = cohort 1965–1974.

Figure 2: Annual GE(1) inequality results of the four income accounting periods between 1975 and 2004 for the three cohorts from western Germany

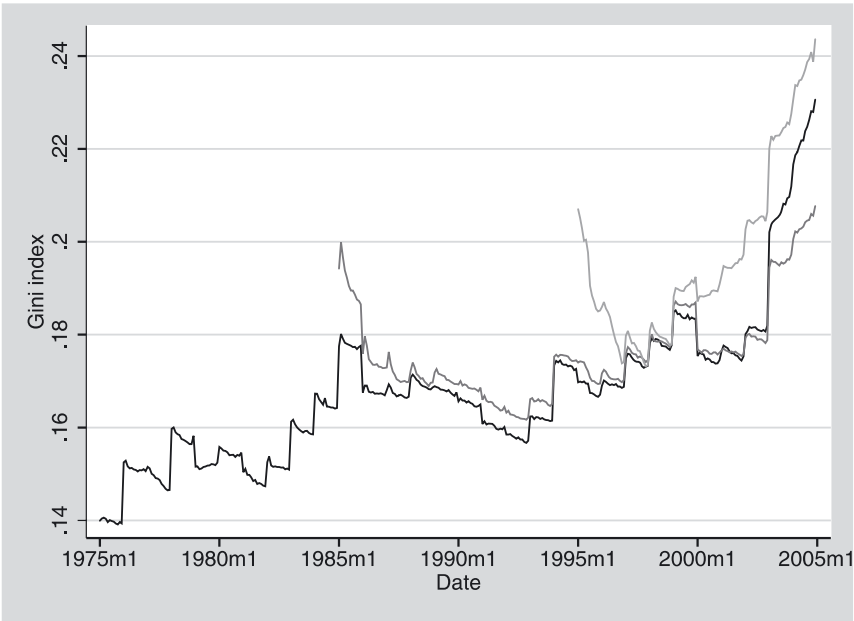
[13] These results are further supported by the results for the GE(2) index which is most sensitive to earnings differences at the upper tail of the earnings distribution and has a lower increase than the Theil or the Gini index. The results of the GE(0) index which is most sensitive to earnings differences at the lower tail of the earnings distribution and has an even higher increase of inequality over time than the Theil index. Both results are illustrated in the Appendix.

Looking at the differences between the results, the impact of the accounting period, using the four earnings accounting periods – annual, semi-annual, quarterly and monthly – the differences are larger for the Theil index than for the Gini index. This relation holds for the entire time interval. While this relation holds, the individual differences between the results of the indices vary according to the point in time and according to the chosen cohort and hence, a further look into detail is necessary. Calculating the differences between the results using the Gini index, the differences for the first cohort decrease up to 1994 and increase after 1999 and are so "U-shaped" over the time interval. The differences using the Gini index for the second and third cohort decrease up to 1999 and increase after 2002. Every new cohort enters at a higher level of calculated differences. These differences diverge until 1999, when the first cohort surpasses the second cohort and in 2003 also the third cohort. Calculating the differences between the results using the Theil index, the differences for the first cohort now vary stronger over time and have peaks of high differences in 1977 and 1980. After 1980 the differences decrease until 1999 and increase again up to 2004. For the second and third cohort the differences have the same trend as for the Gini index. Equally to the Gini index every new cohort enters with higher calculated differences in the Theil index and these differences diverge until 1999, when the differences in the indices for the first cohort surpass the ones for the second and in 2001 the ones for the third cohort. The last relation is reversed for the year 2004.

6.3 Sub-Annual Fluctuations

To take a further look into detail, we additionally examine the development of the sub-annual results. Figure 3 displays the monthly inequality results calculated using the Gini index of the three cohorts. The indices are plotted against time starting in January 1975 and ending in December 2004. The first dynamics that are apparent are the large increases in inequality between December and January, which raises the inequality on a new level for the following year. We found these jumps mostly in years of increasing inequality, in which the inequality within the year remains nearly constant in contrast. In periods of decreasing inequality this trend is less marked. For the third cohort the within year dynamic changes after 2000 from decreasing or constant into an increasing tendency within the year. For the first cohort and second cohort, these trends start in 2002 and 2004 respectively.

Figure 4 illustrates the monthly inequality results calculated using the Theil index for the three cohorts plotted against time. The general trends are similar to those found for the Gini index – high jumps of increasing inequality between December and January in periods of increasing inequality. However, in comparison to the Gini index, the sub-annual results vary more within the year.

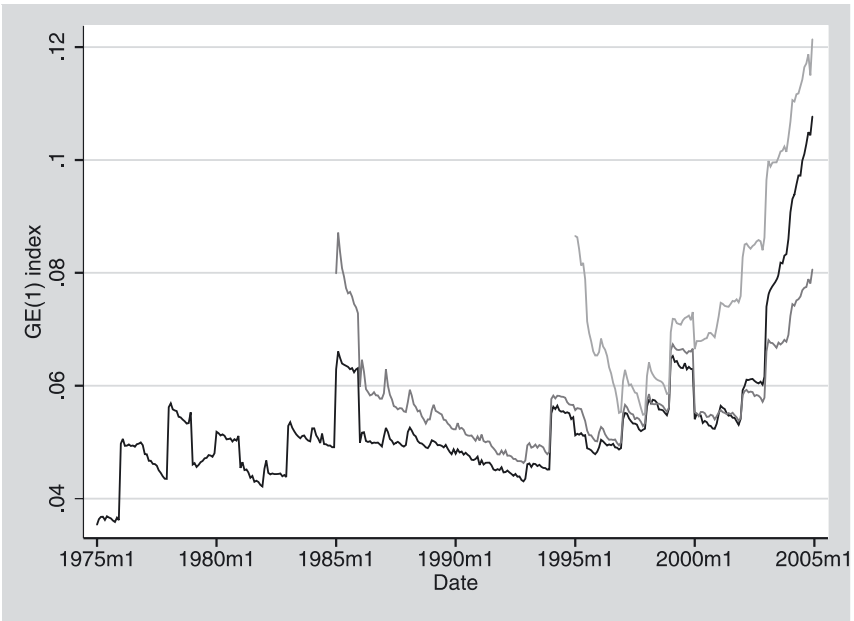


Note: Database is IABS-R04; own calculations. Black line = cohort 1945 – 1954, grey line = cohort 1955 – 1964, light grey line = cohort 1965 – 1974.

Figure 3: Sub-annual Gini inequality results using monthly earnings for the period from 1975 to 2004 for all three cohorts from western Germany

There is not only a constant development within the year but also a variation from month to month, which confirms the results of the previous section as the differences for the Theil index vary more than for the Gini index. This dynamic is also supported by the GE(0) index, for which the results can be found in the Appendix. The more sensitive an index is to earnings differences at the bottom of the earnings distribution the more it varies within the year. So for low earning groups the variations are most markable and most important, as those individuals have less opportunities to spread their earnings over bad and good periods as afore-mentioned.

When looking at the three cohorts, we found increasing variation from one cohort to the next. The youngest cohort faces more variation in inequality than the oldest cohort and this also mostly for the low earnings. In general the second and third cohort enter with high inequality which is then decreasing also within the year. For all three cohorts the inequality is increasing after 2000, as afore-noted, and so is the inequality within the year for the third cohort. For the first cohort the increasing inequality within the year starts in 2002 and for the second in 2003.



Note: Database is IABS-R04; own calculations. Black line = cohort 1945 – 1954, grey line = cohort 1955 – 1964, light grey line = cohort 1965 – 1974.

Figure 4: Sub-annual GE(1) inequality results using monthly earnings of the period from 1975 to 2004 for all three cohorts from western Germany

7. Discussion

Comparing our results to previous studies we first need to stress that the present paper concentrates on individuals gross earnings subject to social security and not on household income as the household context is not known. Therefore, measuring the impact of the accounting period on poverty is not meaningful with the given data.

Böheim / Jenkins (2006) analyzed the influence of the accounting period on inequality measurement based on the BHPS, which contains variables for the annual and current income. They found very similar results for both accounting periods, which they trace to the construction of the incomes, as the current income refers stronger to the usual income than to the effective income during the previous month. They also have problems with high income outliers which lead to high increases for the GE(2) index and for which they have to control. In comparison to Böheim/Jenkins (2006), we have no problems with high income outliers as earnings are censored by the social security assessment ceiling. As a result our resulting differences for the GE(2) index are quite small

and stay at the level of ca. 2%, while Böheim/Jenkins (2006) found an increase of ca. 1% to 14% when changing from annual income to current income. For the Gini index our results range in the same region, around one percentage point.

Canto et al. (2006) analyzed the impact of the income accounting period for Spain using the ECPF. The data contains a variable for annual and for quarterly income. They found increases of 36.6% when changing from annual to quarterly income for the GE(0) index, increases of 14.9% for the GE(1) index, increases of 24.8% for the GE(2) index and increases of 5.3% for the Gini index. In general these differences are higher than those we found and although they state that the differences between the accounting periods increase with the level of inequality aversion (higher sensitivity to the situation at the bottom of the distribution) these results are not as apparent as in our results. Our results support the relation for all entropy-based indices calculated.

Another study concerning inequality and the impact of the accounting period is the study of Finkel et al. (2006) using data from Israel. For the years 1979/80 and 1999 they found an average increases of 1.7% when changing from quarterly to monthly net income per household and increases of 3.9% to 4.1% when changing from quarter to year. These results were stable over time but sensitive to the definition of income (higher changes for net income per equivalent adult than for net household income). Our results are lower in contrast. For the Gini index, we found an increase of less than 1% when changing from quarterly to monthly income and an increase of ca. 1% when changing from annual to quarterly income.

Overall, one can say, that the differences for the Gini index and the GE(2) index in our study between the earnings accounting period are not large, also in comparison to the afore-mentioned studies. This can be based on the fact that the IAB data set captures only a small amount of income variations in comparison to the afore-mentioned studies, see Section 5.3 for details. On the other hand, we were able to look at the development of the differences, which only has been done only by Finkel et al. (2006) so far and only for two periods. Our study shows that the differences change over time, but that the relation between the indices remains the same whereas the relation between the cohorts changes.

8. Conclusion

The question considered in this paper was, whether the accounting period in which income is measured has an influence on inequality. Shorrocks (1978) showed formally, that inequality declines when extending the income accounting period and empirical studies (e.g., Canto et al., 2006, or Finkel et al., 2006) offered primary results about the magnitude of the differences. This paper examines the quantity of the differences between four different accounting periods and how these differences evolve over time for West Germany.

We find that inequality declines for all inequality indices when extending the accounting period of earnings. The quantity to which they differ depends on the index, the given cohort and the given point in time. The GE(1) shows higher differences than the Gini index and with increasing sensitivity to earnings differences at the bottom of the earnings distribution, the impact of the accounting periods increases for the three entropy-based indices. Also the cohort chosen influences the size of the accounting period's impact. Every new cohort enters at a higher level of differences and these differences converge towards 2004. As the Snapshot of 2004 illustrates, the relation between the cohorts changed as the first cohort has the highest differences compared to the other two cohorts for the Gini index and the GE(2) index, although they started at a higher level.

Looking at the dynamics of inequality within the year, the inequality of the Gini index decreases or is constant within the year and only increases in January of the following year. These increases vary in the intensity over the given time horizon and are most markable in periods of increasing inequality. The more sensitive an index is to earnings differences at the lower tail of the earnings distribution the more the variation within the year increases. This trend appears also for the cohorts, the younger the cohort, the more variation within the year is found.

The afore-noted results are important for inequality measurement. According to our results, there are substantial differences in inequality depending on the accounting period's length. For the entropy-based inequality indices with a low parameter of inequality aversion, e.g. GE(0), these differences are larger than 40 % and the inequality varies from month to month. As these indices are most sensitive to income differences at the bottom of the distribution, these differences between measurement with different earnings accounting periods and the variations within the year are even more important for people at the lower end of the earnings distribution. Particularly these people have bad access to the capital market and only little possibility of evening out earnings fluctuations. These results could be a valuable guide. However, it is still necessary to look further into detail to find reasons for the developments and the changes over time.

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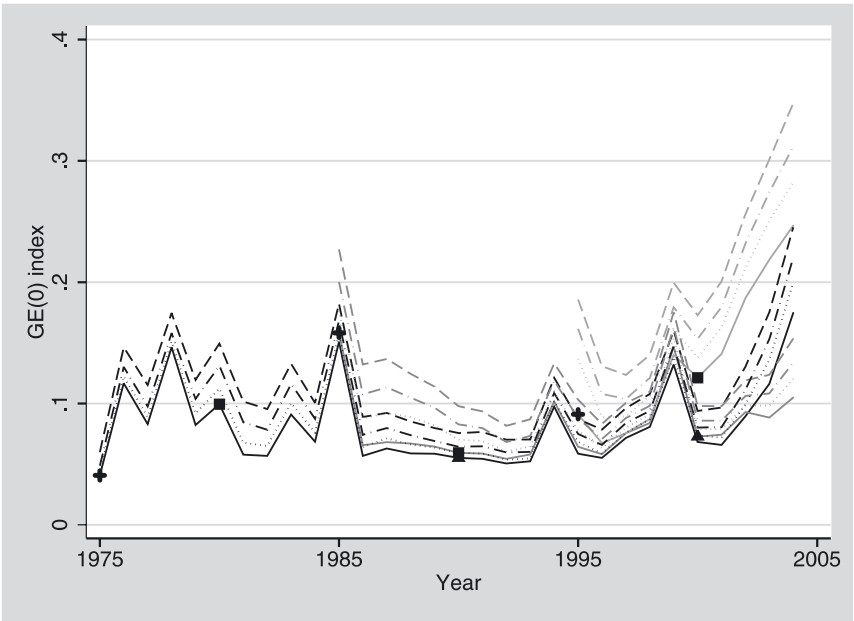
Annex

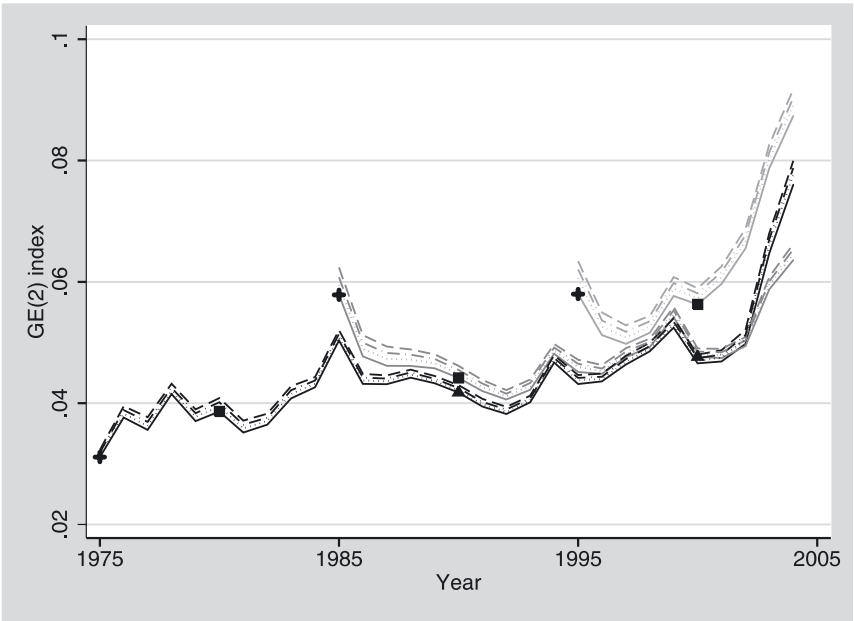
Inter-Temporal Perspective and Sub-Annual fFuctuations of the GE(0) and GE(2) Inequality Indices

This Section contains the results of the GE(0) and GE(2) index. Both are additionally given to support the results given in the empirical part of the paper. Figure 5 illustrates the inter-temporal perspective of the GE(0) index and Figure 5 the inter-temporal perspective of the GE(2) index. Both indices are plotted against time over the interval of 1975 to 2004 for all three cohorts. These indices help to support the result, that the differences of inequality measured with the four earnings accounting periods increases with an increasing sensitivity to earnings differences at the bottom of the earnings distribution.



Note: Database is IABS-R04; own calculations. + = average cohort age of 25, ■ = average cohort age of 30, ▲ = average cohort age of 40, black line = cohort 1945 – 1954, grey line = cohort 1955 – 1964, light grey line = cohort 1965 – 1974.

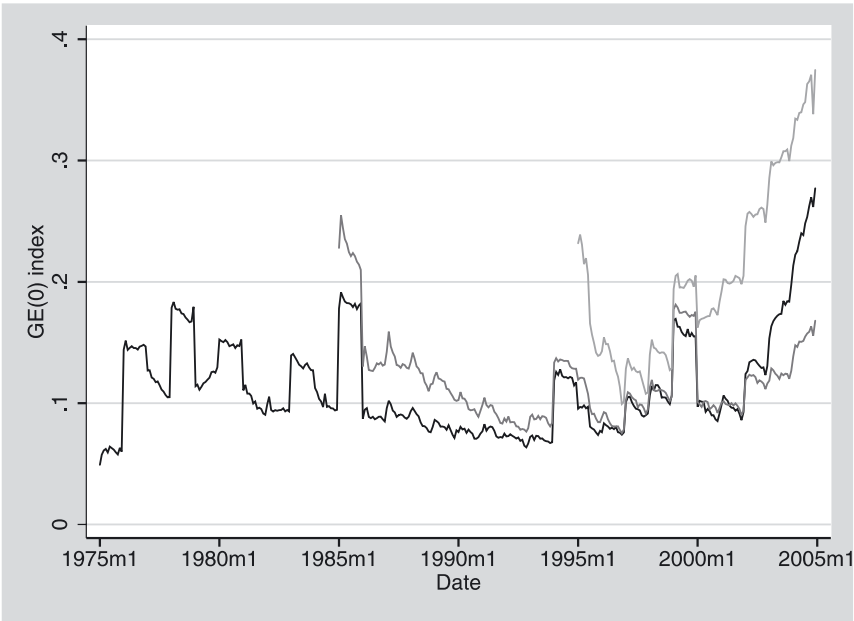
Figure 5: Annual GE(0) inequality results of the four income accounting periods between 1975 and 2004 for the three cohorts from western Germany



Note: Database is IABS-R04; own calculations. + = average cohort age of 25, ■ = average cohort age of 30, ▲ = average cohort age of 40, black line = cohort 1945 – 1954, grey line = cohort 1955 – 1964, light grey line = cohort 1965 – 1974.

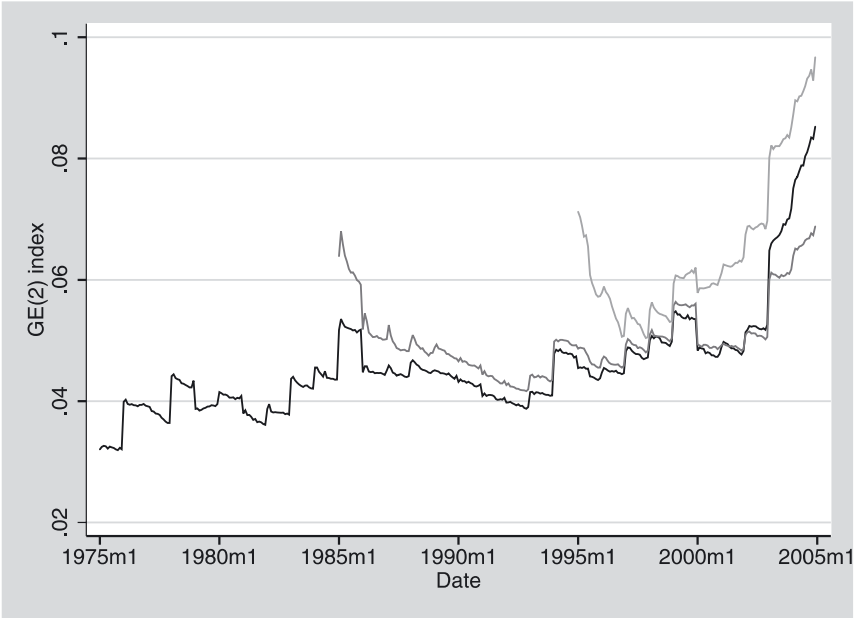
Figure 6: Annual GE(2) inequality results of the four income accounting periods between 1975 and 2004 for the cohorts from western Germany

Figure 7 illustrates the results of the sub-annual fluctuations of the GE(0) index and Figure 8 the sub-annual fluctuations of the GE(2) index, both illustrated by using the inequality results calculated with monthly earnings. The indices are plotted against time starting in January 1975 and ending in December 2004. These Figures support the results, that the within year variation of inequality increases with an increasing sensitivity to earnings differences at the bottom of the earnings distribution.



Note: Database is IABS-R04; own calculations. Black line = cohort 1945 – 1954, grey line = cohort 1955 – 1964, light grey line = cohort 1965 – 1974.

Figure 7: Sub-annual GE(0) inequality results using monthly earnings of the period from 1975 to 2004 for all three cohorts from western Germany



Note: Database is IABS-R04; own calculations. Black line = cohort 1945 – 1954, grey line = cohort 1955 – 1964, light grey line = cohort 1965 – 1974.

Figure 8: Sub-annual GE(2) inequality results using monthly earnings of the period from 1975 to 2004 for all three cohorts from western Germany