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INCOME INEQUALITY IN GERMANY DURING THE 1980s AND 1990s

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This paper estimates a variety of inequality measures for three sub-samples of the German population using cross-sectional data on equivalent income from the German Socio-Economic Panel (GSOEP). The sub-populations under consideration are residents of West Germany including foreigners for the years 1984 to 1996, residents of East Germany for the years 1990 to 1996 and a comprehensive German population for the years 1990 to 1996. Bootstrap methods are applied to test whether changes in inequality are statistically significant. In order to account for panel attrition and over-sampling, sample weights are incorporated into the estimation procedure. The empirical results confirm the relative stability of the West German income distribution. While income inequality in West Germany has generally not altered in an economically relevant way over the period 1985 to 1996, inequality in East Germany has increased after reunification. Despite this increase, inequality remains substantially higher in the western part of the country. Convergence of eastern mean income to the western level generally overcompensated the rise in inequality in East Germany, so that the level of inequality in unified Germany is lower in 1996 than in 1990.

1. INTRODUCTION

Distributional issues have experienced a renaissance in recent years, especially as a consequence of the discussion on the increase of earnings inequality in the United States [for a survey, see Levy, Murnane (1992)]. While earnings inequality or wage inequality may be interesting for its own sake, e.g. when studying changing conditions on the labor market, it does not tell the whole story, if one is interested in the distribution of individual welfare in a population.

This is particularly true of European countries, where the income distribution is affected by state interventions to a much greater extent than in the United States. It is generally accepted that a good method to study the distribution of welfare across individuals is to consider the distribution of equivalent income. This approach can account for two important facts in the distribution of income, namely that income is shared in households and that this sharing of resources generates economies of scale.

In a recent study for the OECD, Atkinson, Rainwater, Smeeding (1995) take equivalent income as a basis to examine, among other aspects, the evolution of income inequality in OECD countries. Their results suggest that income inequality has considerably increased in some countries, especially in the United States and Great Britain, while it remained nearly constant in other countries, e.g. in Canada and France. For Germany, Atkinson, Rainwater, Smeeding (1995) only present an inequality estimate for the year 1984.

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The aim of this paper is to study in detail the evolution of inequality in three sub-populations of Germany, namely residents of West Germany including foreigners, residents of East Germany and a comprehensive German population, using cross-sectional data from the German Socio-Economic Panel (GSOEP). Moreover, the so-called immigrant sample of the GSOEP is used to investigate whether recent immigration has increased inequality or not.

Related studies are that of Burkhauser, Crews, Daly (1997), Schwarze (1996), Bedau, Frick, Krause, Wagner (1996) and Becker, Hauser (1997). Burkhauser, Crews, Daly (1997), examine how the income distribution of working-age households evolves over the business-cycle of the 1980s using 90/10-percentile ratios and kernel density estimates. Unfortunately, their comparisons only comprise the trough year 1984 and the peak year 1991 so that long-term conclusions on the trend of inequality might be affected by the state of the business-cycle.

Schwarze (1996) decomposes inequality levels and trends for the years 1990 to 1992 into eastern and western components in order to determine the effect of the massive public transfers from West to East in the post-reunification period. Bedau, Frick, Krause, Wagner (1996) relate inequality in the immigrant population to that of the German population as a whole. They conclude that income inequality is not substantially enhanced by immigration. The study that is most similar to the present one is that of Becker, Hauser (1997). Their book examines, among many other things, income inequality for various years from 1962 to 1995 using data from the Statistisches Bundesamt and the GSOEP.

From a statistical point of view, these studies suffer from two weaknesses. The first one is that they use unweighted data to compute inequality indices [an exception is Becker, Hauser (1997)]. In the following, sample weights will be incorporated into the estimation procedure of the different inequality measures. This also allows me to take account of the group of foreigners in an adequate way, a group which amounts to about ten percent of the West German population and the well-being of which might substantially influence the picture of inequality in Germany. Foreigners were grossly over-sampled in the GSOEP to ensure a sufficient sample size for a separate analysis.

This paper also considers another statistical aspect of the estimation of the different inequality indices, which seems to be particularly important when the dynamics of a notoriously stable income distribution like the German one is under consideration. To assess the variability of the inequality estimates, bootstrap confidence intervals and bootstrap standard errors are calculated. To the knowledge of the author, this paper is also the first one to present inequality estimates for a longer period—the first seven years—for reunified Germany.

The rest of the paper is organized as follows. Section 2 presents the data, while Section 3 introduces the employed inequality indices and the statistical methods. In Section 4, the empirical results for the respective sub-populations are discussed. Section 5 concludes. Some numerical results appear in the Appendix, all other numbers are available from the author on request.

2. The Data

This paper uses cross-sectional data from the GSOEP [for an introduction to the GSOEP, see Burkhauser, Kreyenfeld, Wagner (1997)]. Four kinds of

samples will be considered. The first sample with thirteen cross-sections ranging from 1984 to 1996 is that of the West German population. It includes foreigners living in West Germany who mainly represent the so-called guest-workers and their families.

In the GSOEP, foreigners have a sampling probability four times as high as that of non-foreigners in order to allow separate analyses of this socio-economic sub-population. This fact has to be taken into account by using the appropriate sample weights delivered with the GSOEP. These sample weights are estimates of the reciprocal inclusion probabilities. For details, see DIW (1997, Chap. 5).

Cross-sections of the East German population are not available until 1990, the year of reunification. For East Germany, seven cross-sections ranging from 1990 to 1996 will be examined. As a consequence of the longitudinal design of the GSOEP, its cross-sections may lose representativeness over time, due to the fact that persons immigrating into the population have zero sampling probability. In order to solve this problem, the so-called immigrant sample of the GSOEP was created in 1994/1995. This third sample consists of households with persons who have immigrated to West Germany after 1984. Two cross-sections of this sample are available for the years 1995 and 1996.

The fourth sample is that of a comprehensive German population including all individuals who belong to either of the first three samples. This last sample consists of seven cross-sections, ranging from 1990 to 1996. The only group of individuals that is not covered by these samples is the institutionalized residents.

Following a generally accepted methodology, the concept of equivalent income will serve as a substitute for personal income, which is unobservable. Equivalent income y is calculated as follows. In a first step, household income h is adjusted for by household type θ using an equivalence scale $e(\theta)$. This adjusted household income $y = h/e(\theta)$ is then attributed to every member of the given household, which implies that income is distributed equally within households.

In this paper, the monthly net household income variable in the GSOEP serves as the basis for all income calculations. The GSOEP net household income definition includes the income of all household members inclusive of transfers and exclusive of taxes and social security contributions. The choice of this variable—which is a direct answer to a survey question—has the disadvantage that respondents may be less precise when answering this question. However, a yearly income measure would be very tedious to construct and would lead to much more missing observations. Moreover, the choice of monthly income reduces the chance of household composition changes since the interview period. The remaining few observations with zero or negative net household income were deleted from the sample. Household income is reported in prices of the respective year, except for the comprehensive sample, where East German incomes were adjusted upward to account for the higher purchasing power of the West German currency in the East, especially in the first years following reunification. The choice of nominal income for individual sub-samples is unproblematic, since all of the employed inequality indices are invariant with respect to changes in the price level.

In order to see whether empirical results depend qualitatively on the specific choice of the equivalence scale, two alternative scales are employed. The first scale has been repeatedly used by the Federal Statistical Office of Germany [compare

for example Statistisches Bundesamt (1997)]. According to this scale, the household head gets a weight of 1, whereas any other member of the same household gets a weight of 0.7, if 15 years or older and a weight of 0.5 otherwise. As an alternative, the so-called OECD-scale is used, which deflates household income by the square root of household size. The economies of scale implied by this scale are very large. For this reason, the exposition will concentrate on the results implied by the scale of the Statistisches Bundesamt.

3. Statistical Issues

As mentioned before, the cross-sections of a panel may lose representativeness with respect to the target population due to several reasons. That individuals immigrating into the population have no chance to get into the sample is only one reason. Other reasons are non-response, panel-attrition and deliberate over-sampling. (See DIW, 1997, Chap. 5.) While omitting immigrants and panel attrition only have a gradual effect, non-response and over-sampling directly influence the composition of the panel from the first wave on.

These systematic biases in the selection of the sample may lead to biased estimates of the distribution of population characteristics and result in misleading conclusions. Estimation and inference for inequality indices has therefore taken into consideration differences in sample selection probabilities.

The strategy used here is to estimate in a first step the population distribution of equivalent personal income F by $\hat{F}$ using the different inclusion probabilities. In a second step, this estimated distribution $\hat{F}$ is employed to calculate the respective inequality measures. For the following and for alternative modelling strategies in inequality measurement from sample surveys, see Nygård, Sandström (1989).

Let U denote the target population of size N and let $s \subset U$ be a random sample of size n. Then $P(i \in s)$ represents the inclusion probability of individual i in the sample. Estimates of inclusion probabilities are delivered with the GSOEP.

$$\hat{F}(y) = \hat{N}^{-1} \sum_{i \in s} 1\{y_i \leq y\} / P(i \in s) \tag{1}$$

with $\hat{N} = \sum_s 1/P(i \in s)$ and $1\{\cdot\}$ the indicator function.

In the following, a variety of inequality indices will be estimated. The reason for using many alternative measures is to ensure that observed trends in inequality do not depend on the inequality measure chosen. An inequality measure is a functional $\mathcal{I}(F)$ of the population distribution function F. [For a general discussion of inequality measures and their properties, see Cowell (1995, 1998).] The measures considered in this paper are the Gini coefficient, the Theil measure, the coefficient of variation, the Atkinson index for inequality aversion parameter $\varepsilon \in \{0.5, 2\}$, the logarithmic variance and the second Theil measure, the mean logarithmic deviation. They are defined as

$$Gini(F) = \frac{1}{2\mu(F)} \int \int |x - x'| \, dF(x) \, dF(x'), \tag{2}$$

$$Theil(F) = \int \frac{x}{\mu(F)} \log\left(\frac{x}{\mu(F)}\right) dF(x), \tag{3}$$

$$cv(F) = \sqrt{\int \left[\frac{x}{\mu(F)} - 1\right]^2 dF(x)}, \tag{4}$$

$$Atkinson0.5(F) = 1 - \frac{1}{\mu(F)}\left[\int x^{0.5}\, dF(x)\right]^2, \tag{5}$$

$$Atkinson2.0(F) = 1 - \frac{1}{\mu(F)}\left[\int x^{-1}\, dF(x)\right]^{-1}, \tag{6}$$

$$logvar(F) = \int \left[\log\left(\frac{x}{\mu(F)}\right)\right]^2 dF(x), \tag{7}$$

$$mld(F) = -\int \log\left(\frac{x}{\mu(F)}\right) dF(x), \tag{8}$$

where $\mu(F)$ denotes the mean of F

$$\mu(F) = \int x\, dF(x). \tag{9}$$

In some cases, the income shares

$$S(F; q) = \frac{1}{\mu(F)} \int_{Q(F;q-0.2)}^{Q(F;q)} x\, dF(x) \tag{10}$$

$q \in \{0.2, 0.4, 0.6, 0.8, 1\}$ of the quintiles

$$Q(F; q) = \inf\{x \mid F(x) \geq q\} \tag{11}$$

will also be considered. Note that $Q(F, 0.5) = median(F)$ is the median of the distribution.

The estimate $\hat{F}$ of F can then be used to calculate point estimates of the various inequality measures $\mathcal{I}(F)$ by replacing F by $\hat{F}$ in the above formulas. It is often overlooked in applied studies that calculating inequality measures $\mathcal{I}(\hat{F})$ for a sample population produces only a point estimate for inequality in the population distribution $\mathcal{I}(F)$. This point estimate does not take into account the sampling variability inherent in random sampling. A way to determine this sampling error is by the method of bootstrapping. For a discussion of the bootstrap approach, see Efron (1982) and Hall (1992).

In the context of inequality measurement, bootstrapping was applied by Mills, Zandvakili (1997). In the present study, percentile confidence intervals are calculated on the basis of the bootstrap [compare Hall (1994, p. 2,348)]. This kind of confidence interval $[\mathcal{I}(\hat{F}) - t, \mathcal{I}(\hat{F}) + t]$ satisfies the equation

$$P(\mathcal{I}(\hat{F}) - t \leq \mathcal{I}(F) \leq \mathcal{I}(\hat{F}) + t \mid F) = 0.95. \tag{12}$$

The bootstrap procedure is based on a so-called resample. For this purpose, an artificial sample of incomes $(y_1^*, y_2^*, \ldots, y_n^*)$ is drawn from the sample distribution function $\hat{F}$. This artificial sample has the empirical distribution function

$F^*(y) = n^{-1}\#\{i | y_i^* \leq y\}$ and can be used to calculate the different inequality measures $\mathcal{I}(F^*)$. The bootstrap approach estimates t in the population equation (12) by $\hat{t}$ which solves the sample equation

$$P(\mathcal{I}(F^*) - \hat{t} \leq \mathcal{I}(\hat{F}) \leq \mathcal{I}(F^*) + \hat{t} | \hat{F}) = 0.95. \tag{13}$$

The sample equation (13) is just the population equation with F and $\hat{F}$ replaced by $\hat{F}$ and F^*.

In the present context, (13) cannot be solved analytically, so that one has to resort to Monte-Carlo simulation. Since (13) is equivalent to

$$P(|\mathcal{I}(\hat{F}) - \mathcal{I}(F^*)| > \hat{t}) = 0.05 \tag{14}$$

given $\hat{F}$, repeated resamples F_b^*, $b = 1, \ldots, B$ are used to empirically determine the distribution of $|\mathcal{I}(\hat{F}) - \mathcal{I}(F^*)|$. Here, B denotes the number of Monte-Carlo repetitions. In Section 4, B was set to 1,000. The confidence interval is asymptotically valid, in the sense that

$$P(\mathcal{I}(\hat{F}) - \hat{t} \leq \mathcal{I}(F) \leq \mathcal{I}(\hat{F}) + \hat{t}) \rightarrow 0.95 \tag{15}$$

as $n \rightarrow \infty$ [see Hall (1994, p. 2,366)].

This confidence interval $[\mathcal{I}(\hat{F}) - \hat{t}; \mathcal{I}(\hat{F}) + \hat{t}]$ can then be used for hypothesis testing. Since (15) or

$$P(|\mathcal{I}(\hat{F}) - \mathcal{I}(F)| > \hat{t}) \approx 0.05 \tag{16}$$

is equivalent to

$$P(|\mathcal{I}(\hat{F}) - \mathcal{I}_0| > \hat{t}) \approx 0.05 \tag{17}$$

given that H_0: $\mathcal{I}(F) = \mathcal{I}_0$ is true, H_0 is rejected, if $\mathcal{I}_0$ is not contained in the confidence interval.

In Section 4 it will be necessary to test whether inequality in one period $\mathcal{I}(F_{t_1})$ differs from inequality in another period $\mathcal{I}(F_{t_2})$. To this end a bootstrap confidence interval (15) will be computed for the difference $\mathcal{D} = \mathcal{I}(\hat{F}_{t_1}) - \mathcal{I}(\hat{F}_{t_2})$. The change in inequality $\mathcal{D}$ will be said to be statistically significant if zero is not contained in this confidence interval. The distribution of $\mathcal{D}$ will be simulated as above, but now by drawing independently from $\hat{F}_{t_1}$ and $\hat{F}_{t_2}$.

In the context of the longitudinal design of the GSOEP, this may seem problematic since the draws $\hat{F}_{t_1}$ and $\hat{F}_{t_2}$ from F_{t_1} and F_{t_2} are not really independent [compare the discussion in Mills, Zandvakili 1997)]. The problem does not arise, if measures are compared across independent subpopulations such as West Germany and East Germany.

Bootstrap standard errors

$$std_{boot}(\mathcal{I}(\hat{F}))^2 = var_{boot}(\mathcal{I}(\hat{F})) \tag{18}$$

$$= \frac{1}{B-1} \sum_{1 \leq b \leq B} \left(\mathcal{I}(F_b^*) - \frac{1}{B} \sum_{1 \leq b \leq B} \mathcal{I}(F_b^*) \right)^2$$

were also calculated, but will not be reported in detail.

In order to reduce computational costs, the bootstrap test was only used for long-term comparisons and comparisons of different subpopulations. An alternative test was applied for the year-to-year comparisons. This test makes use of asymptotic normality, which was proved for most of the distribution measures [compare Cowell (1989), Thistle (1990) and Nygård, Sandström (1989)]. The test statistic under H_0: $\mathcal{I}(F_{t_1}) = \mathcal{I}(F_{t_2})$ is

$$
\begin{aligned}
n &= \frac{\mathcal{D}}{\sqrt{var(\mathcal{D})}} \\
&= \frac{\mathcal{D}}{\sqrt{var(\mathcal{I}(\hat{F}_{t_1})) + var(\mathcal{I}(\hat{F}_{t_2})) - 2\,cov(\mathcal{I}(\hat{F}_{t_1}), \mathcal{I}(\hat{F}_{t_2}))}} \qquad (19) \\
&\overset{\text{approx}}{\sim} \mathcal{N}(0, 1),
\end{aligned}
$$

where $cov(\mathcal{I}(\hat{F}_{t_1}), \mathcal{I}(\hat{F}_{t_2}))$ is set to zero in analogy to the bootstrap test, where the resampling from different time periods was independent. The variances $var(\mathcal{I}(\hat{F}_{t_1}))$ and $var(\mathcal{I}(\hat{F}_{t_2}))$ are estimated by (18).

The test statistic (19) shows that statistical significance is understated in this test and the corresponding bootstrap procedure if $\mathcal{I}(\hat{F}_{t_1})$ and $\mathcal{I}(\hat{F}_{t_2})$ are positively correlated. This makes it necessary to modify the rejection rule. A rejection of the null hypothesis carries over, but a non-rejection is now uninformative [compare Schluter (1998) for a similar situation].

4. Empirical Results

This section presents empirical results for every sub-population as well as comparisons between the different sub-populations. More specifically, inequality will be examined to see whether it has significantly changed from one year to another and over the relevant period of the respective sample. For the latter question, it is important to take account of a possible dependence of inequality on the state of the business cycle. Figure 1 shows growth rates of GDP for West Germany from 1980 to 1996 and for East Germany from 1991 to 1996. (Exact numbers are given in the Appendix.)

With respect to West Germany, this figure suggests a comparison of the years 1985 and 1996, as both follow a recession with a lag of three years. Since it is rather difficult to identify any business cycle in the East German case, inequality in 1996 will be compared to that in 1990.

4.1. *West German Sample*

Figures 2 and 3 present the estimates $\mathcal{I}(\hat{F})$ of the diverse inequality measures for the West German sample. In most cases, the direction of change and its statistical significance is independent of the chosen index. All measures note a significant decrease in inequality from 1984 to 1985.

From 1984 to 1985, the Atkinson index with high inequality aversion parameter $\varepsilon = 2$, which puts more weight on individuals with low income shows a

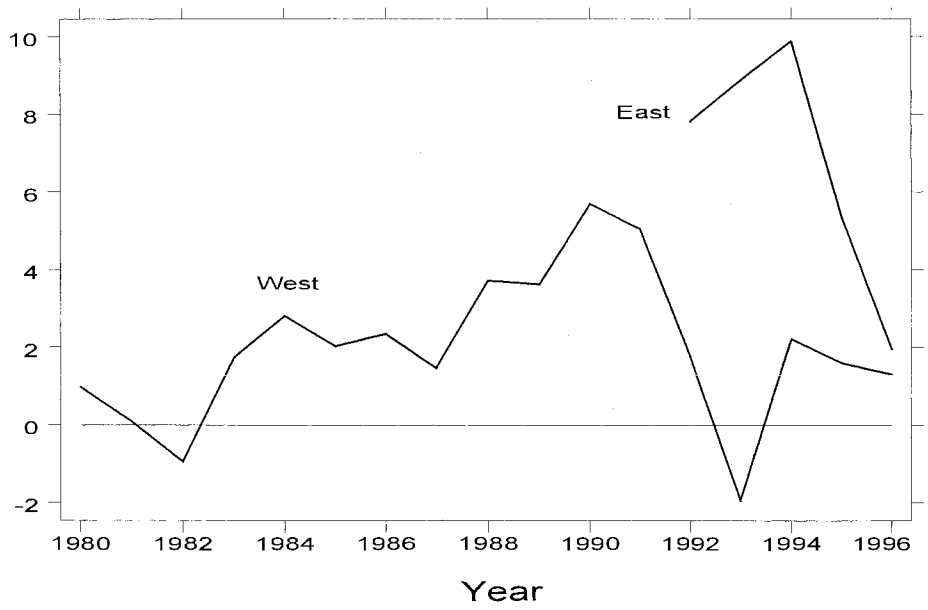

Figure 1. GDP Growth Rate Germany
(Source: Statistisches Bundesamt)

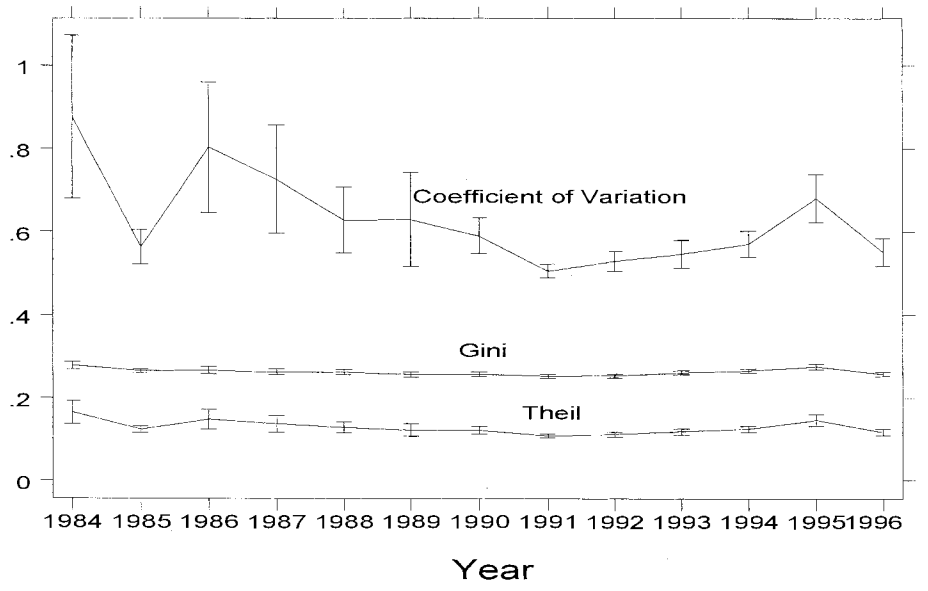

Figure 2. Inequality Indices for West Germany
(Source: GSOEP, own calculations)

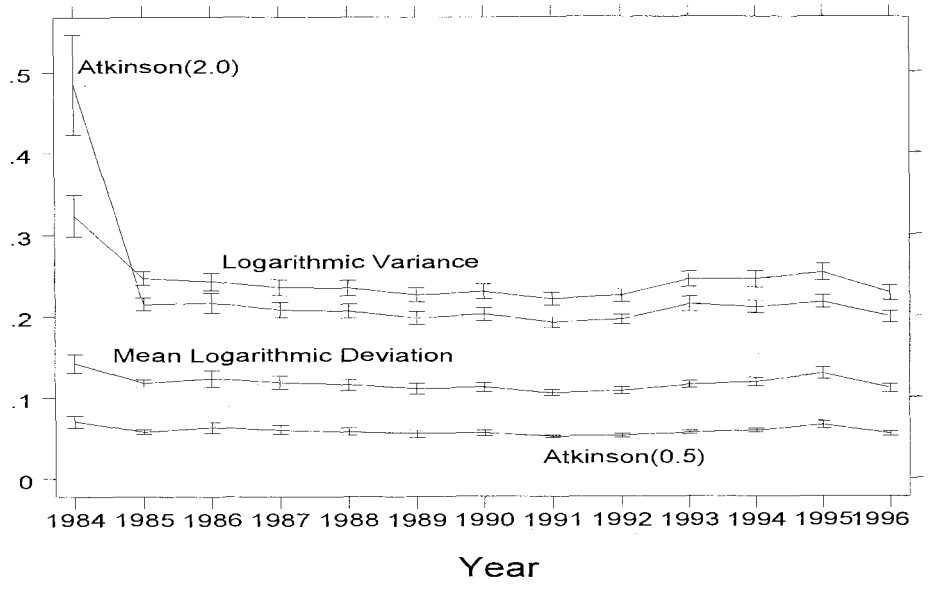

Figure 3. Inequality Indices for West Germany
(Source: GSOEP, own calculations)

particularly sharp drop in inequality. This suggests that the overall drop in inequality was caused by an improving relative welfare position of poor individuals. However, in view of the results in Pannenberg, Rendtel (1996), this might be due to measurement error since 1984 was the only year where attrition was significantly biased towards very low income receivers.

From 1990 to 1991, inequality once again dropped significantly for all measures except the Gini coefficient and the logarithmic variance. Between 1992 and 1993 however, the Gini coefficient, the Atkinson index with $\varepsilon = 2$, the logarithmic variance and the mean logarithmic deviation increased significantly. The same is true between 1994 and 1995 for the Gini coefficient, the Theil measure, the coefficient of variation and the Atkinson index with low inequality aversion parameter $\varepsilon = 0.5$. This development is reversed by a significant decrease of all measures from 1995 to 1996.

To sum up the year-to-year changes, one can say that the development of inequality in the period under consideration was characterized by a slight drop in the mid 1980s and a kind of hump in the period 1991 to 1996, but generally remained very stable over the whole period. While this evidence does not directly correspond to any development of the business cycle, the latter hump might have something to do with the so-called reunification boom, in which the West German economy was confronted with considerable extra demand from the eastern part of Germany.

The year-to-year development is confirmed by the direct comparison between 1985 and 1996. All measures show a decrease, which is statistically significant only for the logarithmic variance, the mean logarithmic deviation and the Atkinson index with high inequality aversion parameter $\varepsilon = 2$.

It is very difficult to assess whether this long-term drop has any political or economic relevance [compare the discussion in Cowell (1995, p. 132)]. A convincing method to assess the economic significance of a change in inequality is only available for the Gini coefficient. The method was proposed by Blackburn, 1989, and makes use of the relation $Gini(F^+) - Gini(F) = k/2\mu(F)$, where F^+ is the distribution that results if a lump sum tax of k is imposed on the poorest 50 percent of the population in order to finance a transfer of the same amount to every individual belonging to the richest 50 percent.

With respect to the comparison between 1996 and 1985, this means that 1.3 percent of the mean income in 1996, i.e. 27 deutschmarks, would have to be redistributed from every person with income lower than the $median(\hat{F}_{1996})$ to every individual with income higher than the median in order to reach the higher level of inequality in 1985 $Gini(\hat{F}_{1985})$. This, of course, does not amount to a major redistribution.

In comparison to this long-term development, the drop in inequality from 1995 to 1996 would correspond to a redistribution of 3.6 percent of the mean income in 1996, i.e. 75 deutschmarks, from every individual above the median to every individual below the median. This might already be considered as a perceptible change in inequality.

In order to get an impression of the shape of the distribution, weighted kernel density estimates of the distribution of normalized income—i.e. equivalent income normalized by mean income – for both 1985 and 1996 are given in Figure 4. One can see that the shape of the distribution has not altered dramatically, but that its mode at about three-quarters of mean income has become more marked resulting in a slightly lower level of inequality.

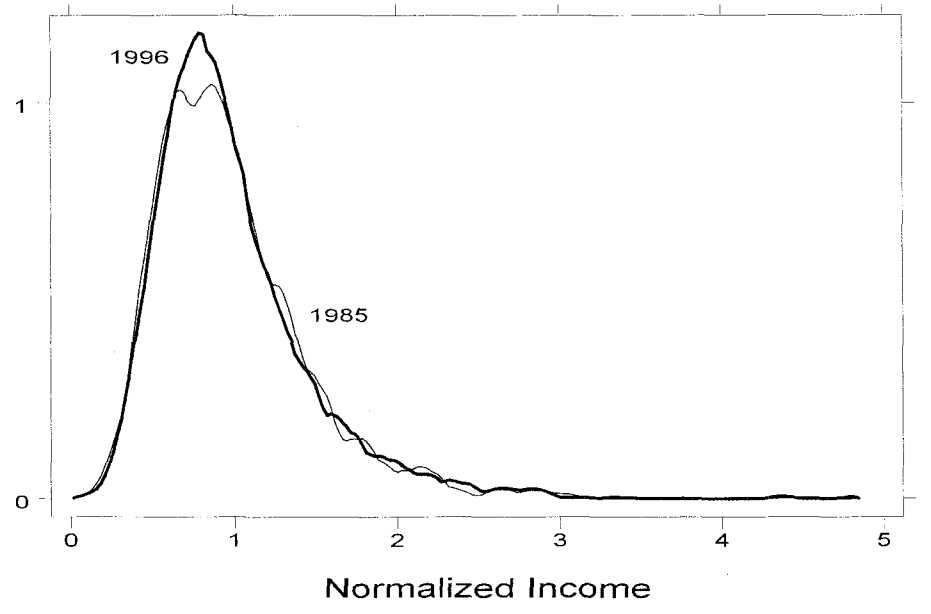

Figure 4. Density of Income Normalized by Mean, West Germany
(Source: GSOEP, own calculations)

4.2. *East German Sample*

Figures 5 and 6 present the evolution of inequality indices over the period 1990 to 1996. All indices note significant increases from 1990 to 1991 and from 1992 to 1993. However, the peak of this development seems to be passed in 1995, where inequality falls significantly for all measures.

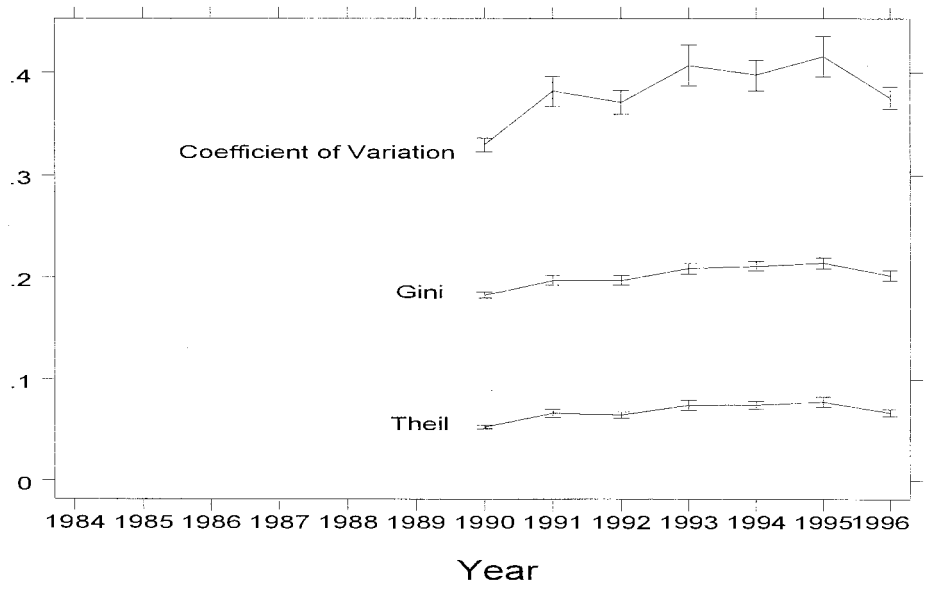

Figure 5. Inequality Indices for East Germany
(Source: GSOEP, own calculations)

While the overall development with a kind of hump in the first half of the 1990s is very similar to that in the West German data, the hump in the Eastern part seems to be considerably more marked. This could be explained by the aforementioned reunification boom. This boom brought extra profits for West German entrepreneurs entering the East German market as well as quick income increases for the few East Germans who could cope with the conditions of a market economy.

The results in Burda, Schmidt (1997) show that the observed patterns of inequality are unlikely to be explained by the development of wages alone, as the period of rapid wage growth ended in 1992. Other explanations should identify developments affecting both parts of Germany, but with stronger effects on the economy in transition.

The long-term comparison 1990 to 1996 shows, that this still amounts to a significant increase in inequality for all measures. This is consistent with the evolution of the income shares in Figure 7. For the long term, this figure shows a significant increase of the top share $S(\hat{F}; 1)$ at the expense of $S(\hat{F}; 0.8)$ and the lowest share $S(\hat{F}; 0.2)$. Most of the redistribution seems to have happened in the upper part of the distribution.

Judged by the Gini coefficient, the increase from 1990 to 1996 would correspond to a redistribution of 3.8 percent of the mean income in 1996, i.e. 63

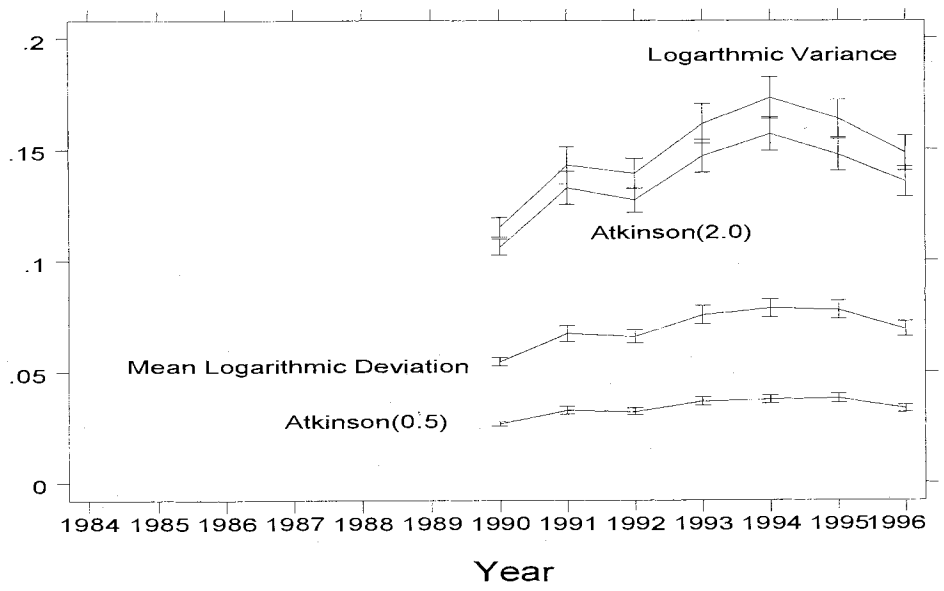

Figure 6. Inequality Indices for East Germany
(Source: GSOEP, own calculations)

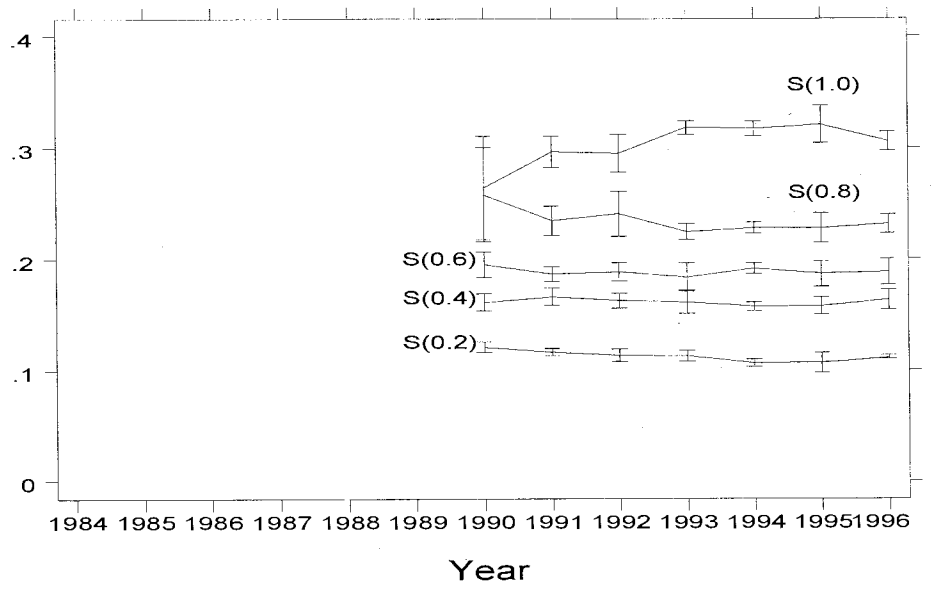

Figure 7. Income Shares of Quintiles for East Germany
(Source: GSOEP, own calculations)

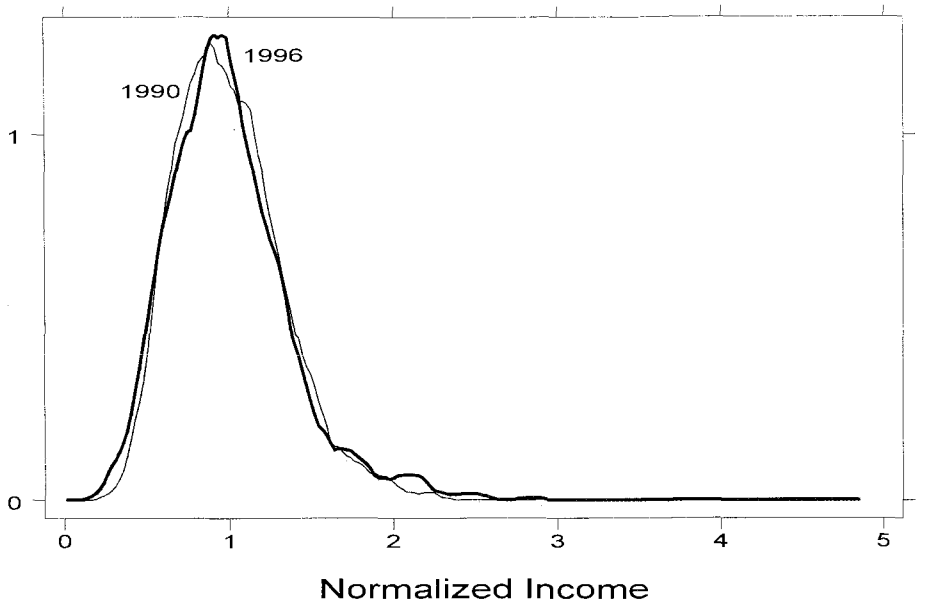

Figure 8. Density of Income Normalized by Mean, East Germany
(Source: GSOEP, own calculations)

deutschmarks from each individual of the poorer 50 percent to each individual of the richer 50 percent of the East German population. This change can be considered as economically quite significant.

Figure 8 presents the density estimates for years 1990 and 1996. Note that the tails of the distribution have become fatter. This apparent widening of the distribution is consistent with the noted increase in inequality.

4.3. *Comprehensive Sample*

The comprehensive sample for Germany consists of seven cross-sections ranging from 1990 to 1996. It comprises individuals from West and East Germany and—from 1995 on—recent immigrants. The inclusion of the latter leads to a slight structural break in 1995, which is acceptable in view of the higher representativeness of the sample. Another important point is that prices in East and West differed substantially in the first years after reunification [compare Hauser (1992)]. To account for this difference in purchasing power, East German incomes were adjusted upward by using the estimates in Krause (1994), for 1990 to 1994. According to these estimates, nominal income is multiplied by 1.433 in 1990, 1.286 in 1991, 1.178 in 1992, 1.127 in 1993 and 1.124 in 1994. These factors were extrapolated for 1995 and 1996 assuming that their difference to one declines exponentially. The resulting numbers are 1.075 for 1995 and 1.054 for 1996.

Figures 9 and 10 show the development of inequality indices for this comprehensive sample. From 1990 to 1991 all measures except the Gini coefficient, the Atkinson index with $\varepsilon = 2$ and the logarithmic variance decreased significantly. In the following years, inequality gradually rises again, but these changes do not

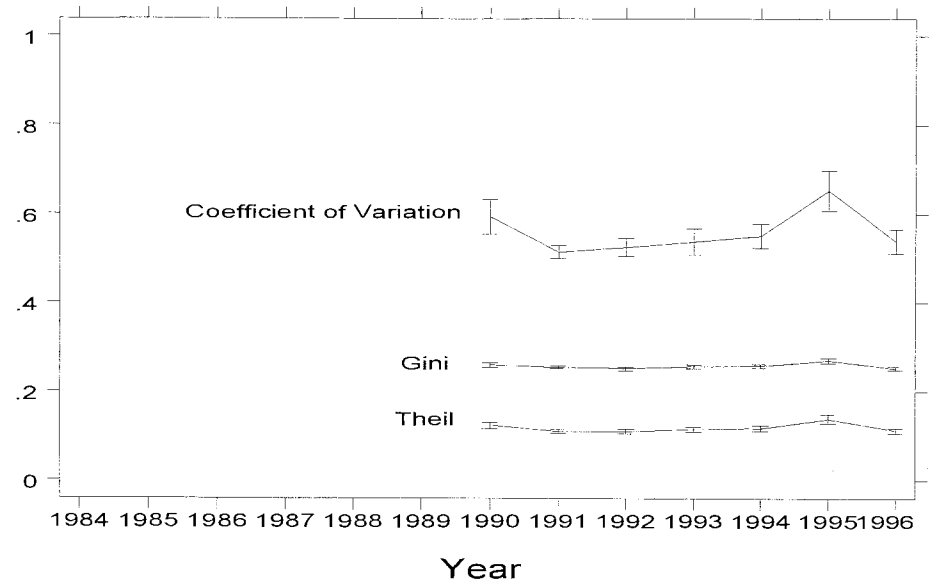

Figure 9. Inequality Indices for unified Germany
(Source: GSOEP, own calculations)

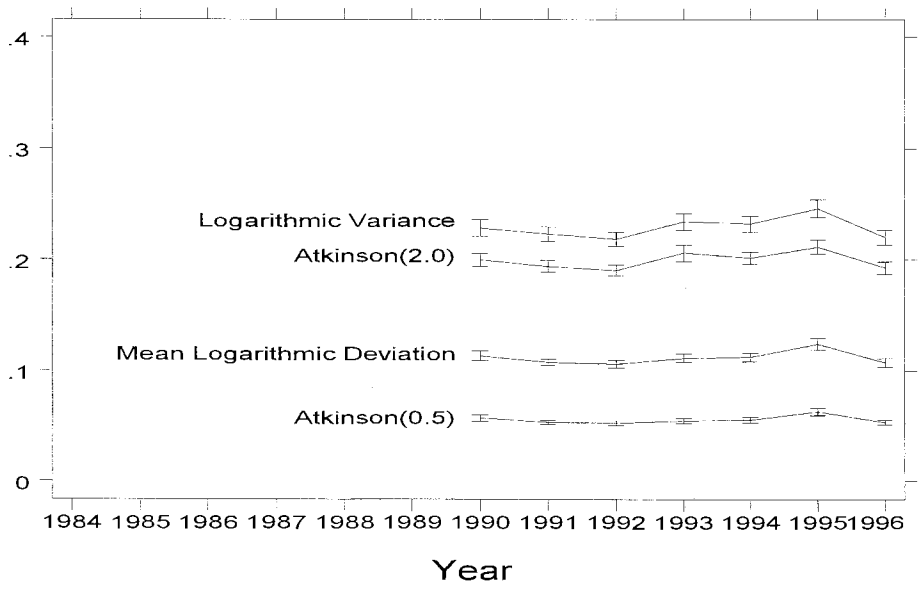

Figure 10. Inequality Indices for Unified Germany
(Source: GSOEP, own calculations)

seem to be statistically significant until 1995. From 1994 to 1995 all indices increased significantly. Part of this increase can be explained by the inclusion of recent immigrants from 1995, but there remains a weaker but significant increase if immigrants are excluded. However, from 1995 to 1996, the development is more than reversed by a statistically significant drop. In sum, inequality in reunified Germany first fell in the first two years after reunification, gradually increased afterwards, and decreased again in 1996.

This seems to be the result of two countervailing tendencies. On the one hand, the rise in inequality in East Germany *ceteris paribus* increases overall inequality. On the other hand, the convergence of eastern mean income to its western counterpart reduces inequality *between* the two parts thus also reducing overall inequality. In the long term 1990 to 1996, there remains a slight but statistically significant drop, which is comparable to a redistribution of 1.4 percent of 1996 mean income (in the comprehensive population) from the richer half to the poorer one. The comparison of the two distributions in Figure 11 reveals that the new density of 1996 is more centered, i.e. less unequal.

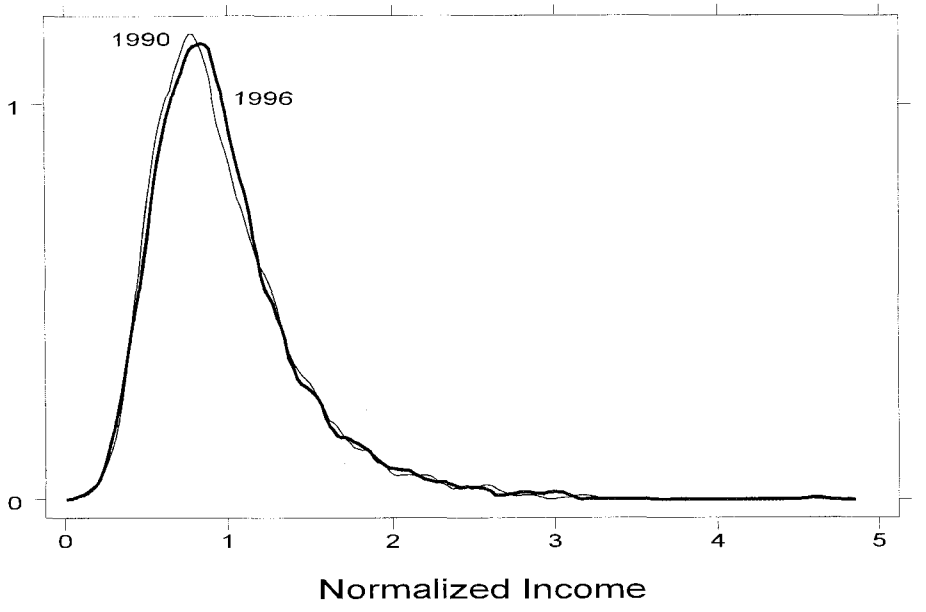

Figure 11. Density of Income Normalized by Mean, Unified Germany
(Source: GSOEP, own calculations)

4.4. *Comparison of Sub-Populations*

The next step is to compare the measures of certain sub-populations. With respect to inequality, all measures are significantly lower in East Germany than in West Germany. To assess what this means economically, the Gini criterion can be used. According to that calculation, 11.1 percent of western mean income, i.e. 231 deutschmarks, would have to be taken from every individual belonging to the western population with income higher than the median in order to give the

same amount to every individual in the same population with income below the median to reach the same level of inequality as in East Germany. This is a perceptible difference indeed.

Figure 12 sums up the differences between the three samples using weighted kernel density estimates. The distribution of the West German and the comprehensive sample are considerably more skewed than that of the East German sample, resulting in less inequality for the latter. Density and inequality of the West German sample differ only slightly from those of the comprehensive sample. The inclusion of the sample of recent immigrants into the West German or the comprehensive sample of 1996 increases inequality only very slightly, which can be interpreted as evidence for the hypothesis that immigration does not enhance inequality substantially [compare Bedau, Frick, Krause (1996) for a similar comparison for 1995].

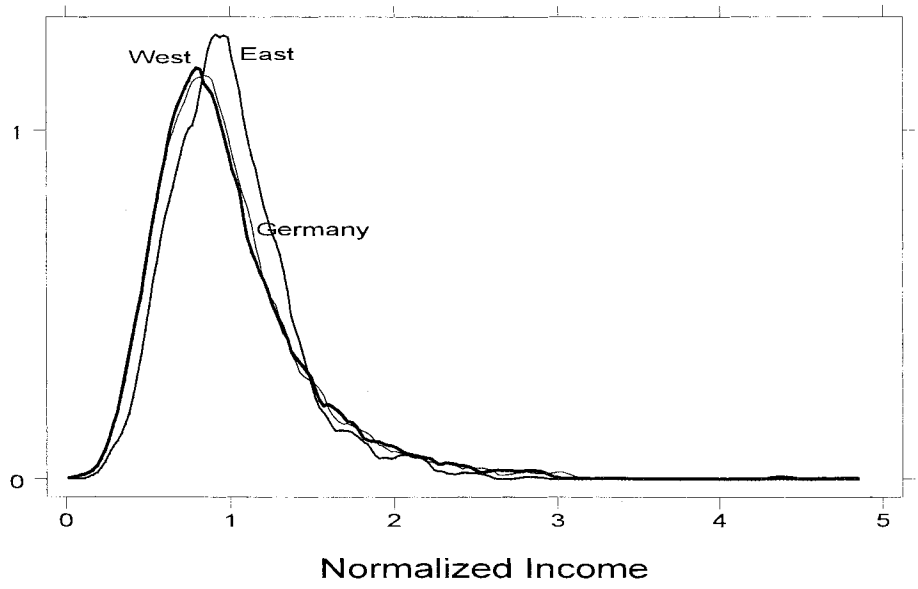

Figure 12. Densities of Normalized Income for 1996
(Source: GSOEP, own calculations)

5. Conclusion

The main results of this paper are the following. Inequality in the distribution of equivalent income in West Germany slightly fell over the period 1985 to 1996, but was generally very stable. The long-term decrease in inequality was not economically or statistically significant, however. In East Germany, inequality has significantly increased over the period 1990 to 1996. This rise in inequality can be compared to a redistribution of about 4 percent of mean income from every individual below the median to every individual above the median. Despite this increase, inequality still remains substantially lower in the eastern part of the

country. It has to be noted that the higher level of inequality in West Germany is accompanied by a still considerably higher average income. The development of income inequality in unified Germany is the result of two countervailing tendencies. On the one hand, the noted increase in inequality in the East also increased *ceteris paribus* inequality in the overall population. On the other hand, convergence of eastern mean incomes to the western level, led to a reduction in overall inequality. This tendency seems to be stronger in the long term 1990 to 1996. The induced drop in inequality is statistically significant but seems to be rather negligible from an economic standpoint.

Finally, all findings are generally independent of the employed equivalence scale. However, the slight fall in inequality in West Germany becomes more marked when the OECD-scale instead of the scale of the Statistisches Bundesamt is used, whereas the rise in inequality in the Eastern part loses statistical significance when the first of the two scales is used.

Appendix

TABLE 1

West Germany, Equivalence Scale of the Statistisches Bundesamt

Year	Mean	Gini	Theil	CV	Atkinson (0.5)
1984	1,312.52	0.277371	0.165265	0.874916	0.070709
1985	1,338.52	0.264199	0.123281	0.562876	0.058130
1986	1,416.81	0.266691	0.148174	0.802505	0.063693
1987	1,468.47	0.262469	0.137622	0.725479	0.060547
1988	1,502.24	0.261722	0.128468	0.628679	0.058513
1989	1,567.16	0.257122	0.122239	0.630018	0.055899
1990	1,686.60	0.257247	0.122554	0.590103	0.056469
1991	1,743.70	0.252270	0.108122	0.505750	0.051867
1992	1,836.03	0.253823	0.112502	0.529032	0.053397
1993	1,926.52	0.261308	0.118885	0.546626	0.056532
1994	1,959.49	0.266350	0.125333	0.571033	0.058773
1995	2,071.53	0.276193	0.147081	0.680632	0.065734
1996	2,082.70	0.257702	0.117666	0.551708	0.055244

Year	Atkinson (2.0)	Log. Variance	MLD	Observations	Growth GDP
1984	0.484736	0.323939	0.142572	15,392	2.81
1985	0.214928	0.247087	0.118119	13,878	2.03
1986	0.216600	0.242808	0.123801	13,268	2.34
1987	0.207969	0.235256	0.118718	13,113	1.47
1988	0.206632	0.234776	0.116355	12,531	3.72
1989	0.198117	0.226683	0.111589	12,142	3.62
1990	0.202757	0.230109	0.112909	11,964	5.70
1991	0.192398	0.221058	0.105721	11,909	5.04
1992	0.195894	0.225313	0.108358	11,814	1.76
1993	0.214918	0.244887	0.115602	11,696	−1.94
1994	0.210434	0.244681	0.118689	11,447	2.22
1995	0.216957	0.253212	0.129067	10,988	1.59
1996	0.198910	0.228511	0.111307	10,727	1.30

Source: GSOEP, Statistisches Bundesamt, own calculations.

TABLE 2

EAST GERMANY, EQUIVALENCE SCALE OF THE STATISTISCHES BUNDESAMT

Year	Mean	$S(0.2)$	$S(0.4)$	$S(0.6)$	$S(0.8)$
1990	782.05	0.120799	0.161282	0.195292	0.264426
1991	949.88	0.116370	0.166078	0.186309	0.234540
1992	1,167.42	0.113324	0.162565	0.188192	0.240777
1993	1,360.02	0.112648	0.161243	0.183537	0.224549
1994	1,498.15	0.106349	0.157339	0.191322	0.227976
1995	1,594.22	0.106766	0.157653	0.186652	0.228039
1996	1,659.61	0.110973	0.163274	0.188310	0.231691

Year	$S(1.0)$	Gini	Theil	CV	Atkinson (0.5)
1990	0.258202	0.182794	0.053060	0.330174	0.026529
1991	0.296702	0.197052	0.066571	0.382777	0.032723
1992	0.295142	0.197398	0.064742	0.371839	0.032035
1993	0.318022	0.208808	0.074549	0.407543	0.036630
1994	0.317015	0.211175	0.074733	0.398396	0.037391
1995	0.320890	0.214631	0.077604	0.416360	0.037963
1996	0.305751	0.201984	0.067035	0.376019	0.033366

Year	Atkinson (2.0)	Log Variance	MLD	Observations	Growth GDP
1990	0.106091	0.115032	0.054517	6,045	—
1991	0.132794	0.142943	0.067180	5,655	—
1992	0.127140	0.139091	0.065776	5,420	7.81
1993	0.147076	0.161560	0.075480	5,228	8.87
1994	0.156892	0.173267	0.078408	5,125	9.88
1995	0.147566	0.163799	0.077732	4,954	5.34
1996	0.135313	0.148192	0.069029	4,910	1.96

Source: GSOEP, Statistisches Bundesamt, own calculations.

TABLE 3

UNIFIED GERMANY, EQUIVALENCE SCALE OF THE STATISTISCHES BUNDESAMT

Year	Mean	Gini	Theil	CV	Atkinson (0.5)
1990	1,564.47	0.259714	0.123785	0.592949	0.056935
1991	1,633.03	0.254895	0.110682	0.514071	0.052873
1992	1,739.64	0.251805	0.110745	0.525565	0.052440
1993	1,844.41	0.256677	0.115136	0.528014	0.054667
1994	1,902.59	0.258043	0.117856	0.550968	0.055486
1995	1,950.95	0.270638	0.139053	0.653079	0.062793
1996	1,974.22	0.252737	0.113041	0.539204	0.053210

Year	Atkinson (2.0)	Log Variance	MLD	Observations
1990	0.199633	0.228263	0.113358	18,009
1991	0.193934	0.223096	0.107411	17,564
1992	0.190282	0.218361	0.105973	17,234
1993	0.205952	0.234013	0.111359	16,924
1994	0.201615	0.232104	0.112197	16,572
1995	0.211658	0.246213	0.124048	17,492
1996	0.192561	0.220335	0.107257	17,093

Source: GSOEP, Statistisches Bundesamt, own calculations.

References

Atkinson, A. B., L. Rainwater, and T. M. Smeeding, *Income Distribution in OECD-Countries*, Organisation for Economic Cooperation and Development, Social Policy Studies No. 18, 1995.

Bedau, K.-D., J. Frick, P. Krause, and G. Wagner, Zuwanderung vergrößert Einkommensungleichheit und Einkommensarmut in Deutschland geringfügig, *DIW-Wochenbericht 50/96*, 1996.

Blackburn, McK. L., Interpreting the Magnitude of Changes in Measures of Income Inequality, *Journal of Econometrics* 42, 21–5, 1989.

Burda, M. and C. M. Schmidt, Getting behind the East–West Wage Differential: Theory and Evidence, in: R. Pohl, (ed.), *Wandeln oder Weichen-Herausfor derungen der wirtschaftlichen Integration für Deutschland, Wirtschaft im Wandel-3/97*, Sonderheft, 1997.

Burkhauser, R. V., A. D. Crews, and M. C. Daly, How the Fruits of Growth Were Distributed among Working-Age Families in the United States and Germany in the 1980s, *Paper presented at the 3rd Public German–American Academic Foundation Symposium, Bonn, June 10–11*, 1997.

Burkhauser, R. V., M. Kreyenfeld, and G. G. Wagner, The German Socio-Economic Panel: A Representative Sample of Reunited Germany and its Parts, *DIW Vierteljahreshefte zur Wirtschaftsforschung 1/97*, 7–15, 1997.

Cowell, F., Sampling Variance and Decomposable Inequality Measures, *Journal of Econometrics*, 42, 27–41, 1989.

———, *Measuring Inequality*, 2nd ed., Prentice Hall, London, 1995.

———, Measurement of Inequality, in A. B. Atkinson, and F. Bourguignon (eds.), *Handbook of the Income Distribution*, Elsevier, Amsterdam, 1998.

DIW (German Institute for Economic Research), *Desktop Companion to the German Socio-Economic Panel Study (GSOEP)*, Berlin, 1997.

Efron, B., *The Jackknife, the Bootstrap and Other Resampling Plans*, SIAM, Philadelphia, 1982.

Hall, P., *The Bootstrap and Edgeworth Expansion*, Springer, New York, 1992.

———, Methodology and Theory for the Bootstrap, in R. F. Engle, and D. L. McFadden, (eds.), *Handbook of Econometrics Vol. IV*, Ch. 39, Elsevier, Amsterdam, 1994.

Hauser, R., Die personelle Eikommensverteilung in den alten und den neuen Bundesländern vor der Vereinigung, in G. Kleinhenz, (ed.), *Sozialpolitik im vereinten Deutschland II*, Schriften des Vereins für Socialpolitik, Vol 208/II, 37–72, Berlin, 1992.

Krause, P., Armut im Wohlstand—Betroffenheit und Folgen, *DIW-Discussion Paper No. 88*, Deutsches Institut für Wirtschaftsforschung, Berlin, 1994.

Levy, F. and R. J. Murnane, U.S. Earnings Levels and Earnings Inequality: A Review of Recent Trends and Proposed Explanations, *Journal of Economic Literature*, Vol. XXX, 1333–81, 1992.

Mills, A. M. and S. Zandvakili, S., Statistical Inference Via Bootstrapping for Measures of Inequality, *Journal of Applied Econometrics*, 12, 133–50, 1997.

Nygård, F. and A. Sandström, Income Inequality Measures Based on Sample Surveys, *Journal of Econometrics*, 42, 81–95, 1989.

Pannenberg, M. and U. Rendtel, Documentation of Sample Sizes and Panel Attrition in the German Socio-Economic Panel (GSOEP) (1984 until 1995), *Discussion Paper No. 137*, Deutsches Institut für Wirtschaftsforschung (DIW), Berlin, 1996.

Schluter, Chr., Income Dynamics in Germany, the USA and the UK: Evidence from Panel Data, *CASE-Paper 8*, London School of Economics, London, 1998.

Sen, A., *Economic Inequality*, enlarged ed., Clarendon Press, Oxford, 1997.

Statistisches Bundesamt, *Wirtschaftsrechnungen, Einkommens- und Verbrauchsstichprobe 1993, Fachserie 15, Heft 4, Einnahmen und Ausgaben privater Haushalte*, Metzler-Poeschler, Stuttgart-Mainz, 1997.

Thistle, P. D., Large Sample Properties of Two Inequality Indices, *Econometrica*, 58, 725–28, 1990.