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Income Mobility and Poverty

On Income Mobility in Germany

By Christian Schluter*

Summary

Using the GSOEP the paper analyzes income mobility and inequality dynamics in Germany from 1990 to 1992. The analysis includes a variety of cross-sectional and panel measures of inequality, including a bivariate kernel density estimator. The author finds that inequality did not change over the period and that individual income mobility has fallen.

1. Introduction

Income mobility in Germany is often thought to be low. Such a view rests on the assumption that the labor market is segmented, inflexible, and immobile; since earnings constitute the main source of income for the majority of the population, incomes should behave similarly. Moreover, the entire structure of the German welfare state is built on the premise of stability. But does such a view fit the facts? In this paper the German Socio-Economic Panel (GSOEP) is used to examine income mobility and other dynamic distributional issues. We look at a variety of standard approaches to the measurement of mobility and find that a consistent story emerges. In the process we also examine whether different socio-economic groups have been affected differently during the period of observation.

The analysis of income mobility is comprised of two complementary parts: an analysis of the changing shape of the income distribution and an examination of intradistributional mobility¹. The shape dynamics are analyzed in this paper by means of inequality indices on the moving cross sections. In order to analyze the issue of intradistributional mobility, two complementary methods are employed. Bivariate kernel density estimates map income transitions at the individual level. Although they are powerful descriptive devices, they do not permit a rigorous statistical analysis. To do this we aggregate individuals into groups,

construct transition matrices, and statistically test for changes over time and symmetry in upward and downward mobility.

The plan of the paper is as follows. The next section describes the data. The following section examines movements of the aggregate distribution and is thus confined to a cross-sectional view. The analysis then moves to the lowest micro level and directly examines the changes in the economic fortunes of individuals using kernel density estimation. This analysis is complemented by an examination of transition matrices, including a partitioning of the sample into occupation categories, and a conclusion.

2. The Data

Of course, a variety of income concepts could be employed. In this paper we focus on two that are particularly useful for interpreting the results in terms of their implications for social welfare². First, we construct annual pretax, prebenefit (or gross) income by combining gross earnings, bonuses, gross pensions, and maintenance payments. Our second measure adds social security payments and deducts social security contributions, taxes, and tax surcharges, yielding posttax, postbenefit (or net) income.

In order to take into account family size and composition, and economies of scale within families, the McClements' equivalence scales are applied to both income measures. Although the choice of any equivalence scale is arbitrary, the McClements' scale is widely used by researchers and

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¹ This point has been iterated by Quah in a series of papers. See for instance, Quah (1995).

² Schluter (1996) provides an extensive description of the raw data, the algorithms for the tax benefit simulation (see Schluter 1995), sample selection, and the derived data.

the United Kingdom Department of Social Security³. Incomes are evaluated at 1992 prices. In constructing the sample, all persons are dropped whose disposable income falls below the (arbitrary) cutoff point of 1,000 DM. The resulting samples always exceed 9,000 observations.

3. Cross-Sectional Dynamics: A Changing Profile of Inequality in the 1990s?

How did income inequality change in the early 1990s? The use of standard inequality indices confines one to a cross-sectional view, which is nevertheless interesting as a snapshot of the economy. Table 1 reports the various income statistics for the years 1990, 1991, and 1992⁴. GE_α refers to the generalized entropy index with sensitivity parameter α . The table shows that both mean and median income grew over the period. How did this income growth affect inequality? The differences in the inequality measures across the three years are small for both gross and net income. It appears that income was slightly more unequally distributed in 1992 compared to 1990: the Gini for net income increases from 0.287 to 0.296, and GE_1 increases from 0.148 to 0.157, for example. Are these changes in the inequality indices statistically significant? Since the indices are asymptotically normal, a (non-parametric) difference of means test can be applied to test this hypothesis. This test is valid if incomes in two periods can be assumed to be independent. Let $\hat{\mu}$ be an estimator of the population parameter μ , $\hat{\sigma}^2$ the estimator of its variance, and n the sample size. The test statistic s is of the form,

$$s = \frac{\hat{\mu}_1 - \hat{\mu}_2}{\left(\frac{\hat{\sigma}_1^2}{n_1} + \frac{\hat{\sigma}_2^2}{n_2} \right)^{0.5}},$$

which is, under the null hypothesis of identical inequalities, distributed as a standard normal. Pair-wise tests for the

years 1990 to 1992 reveal that most changes are not statistically significant or only marginally so at the 5 percent level.

Table 2 presents another cross-sectional inequality measure, the Lorenz curve, for each of the three years. The respective Lorenz curves do not intersect, but the ordinates are very close together for successive years. In fact, they lie so close together as to be indistinguishable, for which reason they are not depicted here. Furthermore, statistical tests fail to detect differences across the three years⁵.

In summary, the inequality in the cross sections, whether measured by standard inequality indices or by Lorenz curves, did not change in a statistically significant fashion. Although the shape of the distribution did not change greatly, it is quite possible that mobility within the distribution has. To investigate this possibility, the panel aspect of the data must be exploited.

4. Intradistributional Mobility

We use a variety of techniques to investigate the income mobility patterns over the three year period. We begin at the individual level by simply showing the scatterplot of 1990 and 1991 income. This is followed by bivariate kernel density estimates and contour plots. The kernel density

³ See DSS (1993), "Households Below Average Income," for instance. Banks and Johnson (1994) provide a recent appraisal of the McClements scale. Jenkins (1994) also uses this scale. In addition, Burkhauser, Smeeding, and Merz (forthcoming) argue that the German social assistance scale implies scale economies that are too low.

⁴ Frick et al. (1995) produce Gini coefficients for this period (0.267, 0.263, 0.264) using a different income concept and equivalence scales based on the German social assistance program.

⁵ The test statistic s_i is defined as above. Since there is one test statistic for each Lorenz ordinate, they can be summed, resulting in the test statistic $c = \sum s_i$, which is distributed as a chi-squared, the degrees of freedom equaling the number of population shares. See Schluter (1996c) or Beach and Davidson (1983) for a fuller description of the test.

Table 1

Cross-Sectional Summary Statistics and Inequality Measures

	Net Equivalized Income			Gross Equivalized Income		
	1990	1991	1992	1990	1991	1992
Gini	0.287	0.286	0.296	0.329	0.334	0.341
GE_{-1}	0.282	0.287	0.317	0.662	0.533	0.411
GE_0	0.164	0.168	0.174	0.191	0.188	0.187
GE_1	0.148	0.146	0.157	0.194	0.202	0.207
Standard Deviation	18,865 DM	19,007 DM	22,002 DM	32,776 DM	33,928 DM	38,212 DM
Mean	30,947 DM	31,950 DM	33,953 DM	48,393 DM	50,267 DM	54,433 DM
Median	28,125 DM	29,042 DM	30,650 DM	42,883 DM	44,800 DM	47,913 DM

Source: Author's calculations from GSOEP data.

Table 2

Lorenz Curve Estimates for Net Equivalent Income, 1990 to 1992
standard error in parentheses

Decile by Population Share	1990		1991		1992	
	Lorenz Ordinate Φ	Income Share Ψ	Lorenz Ordinate Φ	Income Share Ψ	Lorenz Ordinate Φ	Income Share Ψ
.1	0.031 (0.0006)	0.031 (0.0006)	0.029 (0.0006)	0.029 (0.0006)	0.024 (0.0007)	0.024 (0.0007)
.2	0.085 (0.0009)	0.054 (0.0004)	0.082 (0.0009)	0.053 (0.0005)	0.076 (0.001)	0.051 (0.0005)
.3	0.152 (0.0012)	0.067 (0.0004)	0.149 (0.0012)	0.066 (0.0004)	0.140 (0.0013)	0.064 (0.0005)
.4	0.229 (0.0015)	0.077 (0.0004)	0.225 (0.0015)	0.077 (0.0004)	0.216 (0.0016)	0.075 (0.0004)
.5	0.316 (0.0017)	0.086 (0.0004)	0.312 (0.0018)	0.087 (0.0004)	0.301 (0.0019)	0.058 (0.0005)
.6	0.412 (0.0019)	0.097 (0.0005)	0.408 (0.0020)	0.097 (0.0005)	0.396 (0.0021)	0.097 (0.0005)
.7	0.522 (0.0022)	0.109 (0.0005)	0.517 (0.0023)	0.108 (0.0005)	0.506 (0.0024)	0.109 (0.0005)
.8	0.646 (0.0024)	0.124 (0.0005)	0.641 (0.0025)	0.125 (0.0006)	0.632 (0.0027)	0.125 (0.0006)
.9	0.789 (0.0026)	0.144 (0.0007)	0.787 (0.0027)	0.460 (0.0007)	0.780 (0.0029)	0.148 (0.0008)

Source: Author's calculations from GSOEP data.

estimates and the associated contour plots offer information on two aspects of income dynamics. Not only does it give a graphical representation of intradistributional mobility, by means of the location of the contours relative to the 45 degree line, but the profile of the density mountains also give an indication of the shape of the distribution. Then we aggregate individuals into income classes and derive transition matrices, which we test statistically for significant changes.

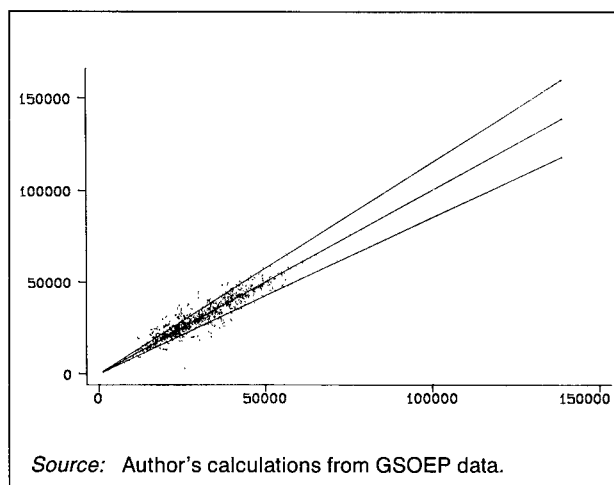
Figure 1 maps the evolution of equivalized disposable income from the 1991 wave to the 1992 wave (at 1991 prices) as a scatter plot. To facilitate the inspection of the diagram, a 45 degree line has been superimposed. In Figure 1, the second band represents a ± 15 percent change in income, which captures 55.4 percent of the sample. Bands of ± 10 percent and ± 5 percent capture only 42.8 percent and 25.0 percent of the sample, respectively.

Two results emerge. First, the majority of incomes are persistent, falling into the range of the superimposed band. This impression is corroborated by the bivariate kernel density estimate and its associated contour plot in Figure 2 and Figure 3, respectively⁶. The contour plot of Figure 3 concentrates most mass along the 45 degree line.

Second, a large group of individuals also experience significant changes in their income position from one year to the next. These changes appear to be symmetric relative to the 45 degree line. The bivariate kernel density estimates and the associated contour plot shown in Figures 4 and 5 show income transitions for the two-year period from 1990 to 1992. Not surprisingly, the dispersion about the 45 degree line increases; however, it remains symmetric.

Figure 1

Scatter diagram of equivalized disposable household income for 1990 and 1991 and a band of relative deviations (+ -15 %)



Source: Author's calculations from GSOEP data.

The contour plot has been supplemented by more conventional transition matrices, estimated by maximizing the relevant likelihoods, in order to make some statistical inferences. The results are reported in Tables 3 and 4. Income

⁶ The bivariate kernel density estimate has been implemented by the author following suggestions in Silverman (1986, p. 89).

Figure 2

Kernal Density estimates of disposable income transitions from 1990 to 1991

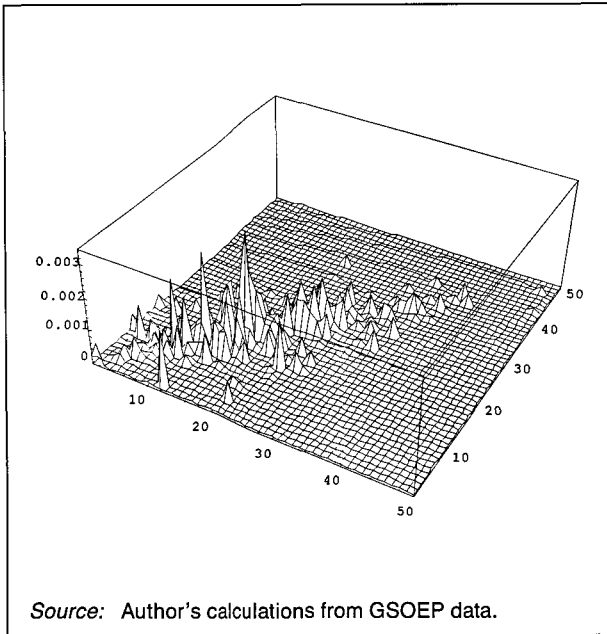
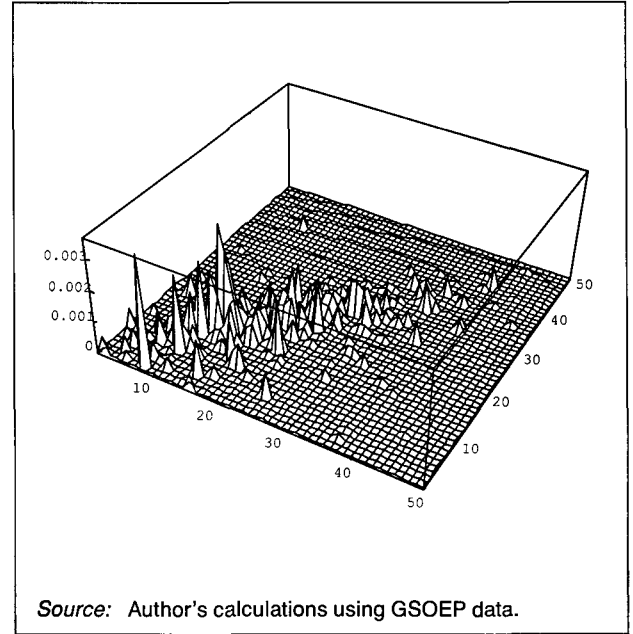


Figure 4

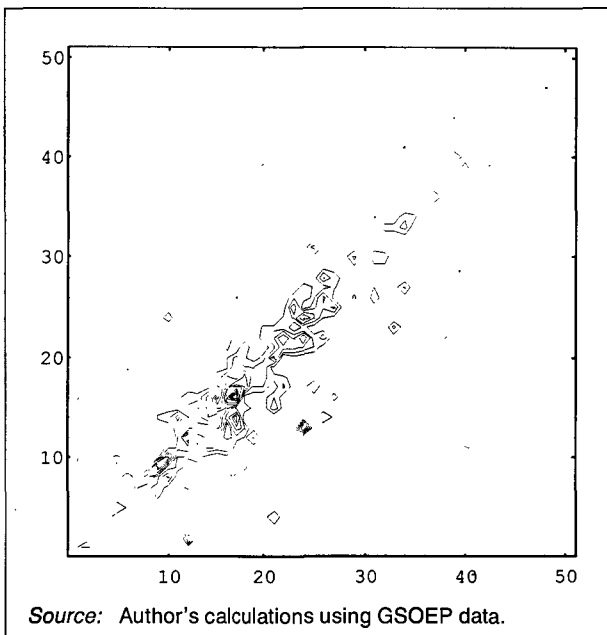
Kernal Density estimates of disposable income transitions from 1990 to 1992



has been grouped into four classes, the boundaries of which are defined in relative terms as 0.5, 1.0, and 1.5 times the contemporaneous median income. This partition is useful since the poverty line is often defined in the applied literature in relative terms as 0.5 of median income. Moreover, the median is robust against outliers in the data⁷.

Figure 3

Contours of the density estimate in Figure 2



The diagonal elements of the transition matrices affirm the results of the contour plot: the underlying stochastic process shows both the strong persistence, but also the significant risk of a change in one's income position. Persons in the lowest income group have a greater chance of escaping poverty, with a conditional probability of about $(1 - p_{11}) = 0.45$. The other elements on the main diagonal exhibit strong persistence with a conditional probability of remaining in one's income group of about 0.7. These observations can be formalized by means of a mobility index. A proviso is in order, however, since, as with inequality indices, no single index need be completely satisfactory. Let $P = [p_{ij}]$ denote the $n \times n$ transition matrix, λ_j its j th ordered eigenvalue, and $\text{tr}(P)$ the trace of P . Shorrocks' (1978) index is defined

$$(1) \quad \mu_1(P) = \frac{n - \text{tr}(P)}{n-1} = \frac{n}{n-1} \left\{ \frac{1}{n} \sum_i (1 - p_{ii}) \right\} = \frac{n - \sum_i \lambda_i}{n-1},$$

as being the inverse of the harmonic mean of the expected durations of remaining in a given income group. An alternative index is given

$$(2) \quad \mu_2(P) = \frac{n - \sum_i |\lambda_i|}{n-1},$$

⁷ The useful complementarity between the analysis of transition matrices and kernel density estimates is fully brought out here. Transition matrices group data, thus wasting information, but permit a statistical analysis. On the other hand, the contour plot permits an examination of the extent to which people in the same income group are heterogeneous. For instance, Figure 3 shows that a big cluster occurs near the poverty line, which is defined as 0.5 of median income.

Table 3

Transition Matrix: Joint Net Income Distribution, 1990 and 1991

1990	1991				
	Low Income	Modest Income	Middle Income	High Income	Marginals
Low Income	0.548	0.329	0.099	0.023	0.100
Modest Income	0.107	0.724	0.154	0.014	0.390
Middle Income	0.043	0.246	0.606	0.011	0.320
High Income	0.021	0.035	0.217	0.728	0.180

Note: The four income groups are defined with respect to the contemporaneous median as follows: low income (equivalized incomes below 0.5 times median income); modest income (equivalized incomes between 0.5 and 1.0 times median income); middle income (equivalized incomes between 1.0 and 1.5 times median income); high income (equivalized incomes above 1.5 times median income). Weighted data.

Source: Author's calculations from GSOEP data.

by which equals μ_1 if P 's eigenvalues are all real and non-negative. This index captures the speed of convergence of the underlying Markov process. This approach can be simplified by concentrating on the dominant convergence term, the second largest eigenvalue, λ_2 , of $\mu_3(P) = 1 - \lambda_2$.

Evaluating these indices yields $\lambda_1 = (T_{90,91}) = 0.43$, and $\mu_1(T_{91,92}) = 0.41$, so mobility fell slightly. The eigenvalues are, respectively, $\lambda_{90,91} = (1.00; 0.75; 0.53; 0.42)$ and $\lambda_{91,91} = (1.00; 0.76; 0.54; 0.48)$. Since all elements are real and nonnegative, μ_1 and μ_2 are identical. The use of μ_3 results in the same ranking of the transition matrices.

Are these changes of the mobility index statistically significant? Bootstrapping the Shorrocks' index, μ_1 , using

Efron's (1987) bias-corrected and accelerated BC_α method, resulted in 90 percent confidence intervals for $\mu_1(90, 91) = [0.41; 0.45]$ and $\mu_1(91, 92) = [0.39; 0.42]$, which overlap. On the other hand, since the Shorrocks' index can be shown to be asymptotically normally distributed, the difference of means test can be applied. The result of this test suggests that the estimates of the index are, in fact, statistically significantly different.

This brief discussion leads naturally to the next issue of characterizing the transition matrices. In particular, the two transition matrices appear to be similar. However, a multinomial test does not support this claim. Moreover, a likelihood ratio test rejects the hypothesis of symmetric matrices, which is not surprising, since there is evidence of a dominant upward mobility for the first two income groups.

How can these results be explained? The statistical results suggest that income transitions are not stationary. As a first ad hoc analysis, Table 5 disaggregates the data on income jumps from 1990 to 1991 according to occupational status. This procedure permits an examination of the extent to which the probability of an income change depends upon its size, its direction, and the occupational status of the person. Recall that the German labor market is highly segmented, the occupational status reflecting, in general, the socio-economic background of the person. The table differs from a transition matrix in that probabilities are not conditional on the previous income position.

Upward mobility dominates downward mobility. However, some tentative conclusions can be drawn. The conditional probabilities confirm prior expectations: the self-employed face the highest chances of large fluctuations. Civil servants enjoy favorable odds of upward mobility, which reflects both their job security and tenure-related pay. All probabilities fall with increases in the distance of the jump. Note, however, that these mobility results are not necessarily always due to fluctuations in the personal earnings of the individual in question, but may reflect other events experienced by the household.

Figure 5
Contours of the density estimate in Figure 4

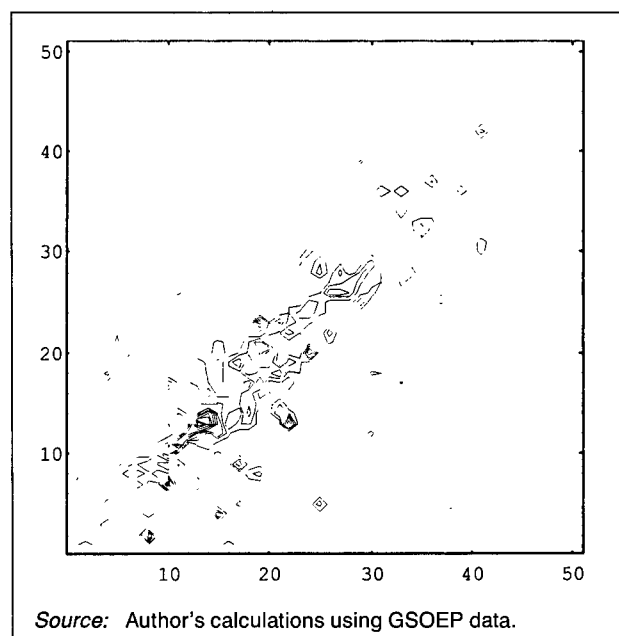


Table 4

Transition Matrix: Joint Net Income Distribution, 1991 and 1992

1991	1992				
	Low Income	Modest Income	Middle Income	High Income	Marginals
Low Income	0.549	0.310	0.110	0.030	0.120
Modest Income	0.103	0.790	0.163	0.016	0.380
Middle Income	0.044	0.168	0.667	0.121	0.310
High Income	0.031	0.040	0.174	0.754	0.190

Note: The four income groups are defined with respect to the contemporaneous median as follows: low income (equivalized incomes below 0.5 times median income); modest income (equivalized incomes between 0.5 and 1.0 times median income); middle income (equivalized incomes between 1.0 and 1.5 times median income); high income (equivalized incomes above 1.5 times median income). Weighted data.

Source: Author's calculations from GSOEP data.

5. Conclusions

This paper has analyzed income dynamics at various levels of aggregation. The analysis of the moving cross section reveals that income inequality did not change significantly from 1990 to 1992. Intradistributional mobility was then examined using bivariate kernel density estimates and more conventional transition matrices.

Contrary to current international trends, we show that inequality has increased only slightly over this time period. The inequality indices produce an unambiguous ranking, since the respective Lorenz curves do not intersect. However, differences in Lorenz curve ordinates and most

other inequality indices are found not to be statistically different. As regards income (im)mobility, we find that a person's income position is strongly persistent over one- and two-year periods. Both contour plots of bivariate kernel density estimates and transition matrices concentrate most mass along the 45 degree line (or main diagonal). Although the probabilities decrease away from the main diagonal, the transition matrices fail a test for symmetry. There is no evidence of a universal dominant upward mobility for all income groups, except for the poorest. Three popular mobility indices suggests that mobility has fallen from 1990 to 1992. Characteristics such as occupational status determine mean income jumps in an expected fashion.

Table 5

Income Jumps and Occupational Status, Transitions from 1990 to 1991

Jump: + DM -DM	+ 5,000 (-5,000)	+ 10,000 (-10,000)	+ 15,000 (-15,000)	+ 20,000 (-20,000)	+ 25,000 (-25,000)
Blue Collar (percent)	25.43 (18.73)	10.90 (9.16)	4.96 (4.73)	2.45 (2.47)	1.25 (0.68)
Self-Employed (percent)	32.26 (24.16)	18.36 (15.48)	13.09 (9.74)	9.70 (8.85)	6.70 (8.06)
White Collar (percent)	26.34 (16.86)	13.91 (9.01)	7.40 (6.20)	4.26 (4.65)	2.80 (2.57)
Civil Servants (percent)	22.94 (12.58)	11.40 (6.14)	6.08 (1.63)	4.19 (1.18)	1.84 (1.10)

Source: Author's calculations from GSOEP data.

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