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Poverty and life cycle effects: A nonparametric analysis for Germany

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DISCUSSION PAPERS IN STATISTICS AND ECONOMETRICS

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No. 5/96

Poverty and life cycle effects. A nonparametric analysis for Germany

by

Andreas Stich*

September 1996

Abstract

Most empirical studies on poverty consider the extent of poverty either for the entire society or for separate groups like elderly people. However, these papers do not show what the situation looks like for persons of a certain age. In this paper poverty measures depending on age are derived using the joint density of income and age. The density is nonparametrically estimated by Gaussian kernel density estimation. Applying the conditional density of income to several poverty measures provides an insight into the extent of poverty changes over the life cycle. Furthermore confidence bands for the poverty age profiles were computed.

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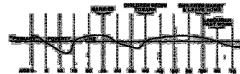
1 Introduction

One of the most important problems in the world today is poverty. Not only in the developing countries but also in industrial societies like the U.S.A. or Germany poverty endangers the well-being of people. It is an important duty of the government to fight against poverty. To examine the utility of actions against poverty, indices are needed which measure the extent of poverty.

In the recent literature many proposals for poverty measures can be found. For an overview see, e.g., Seidl (1988) or Scheurle (1991), but most of the papers only take into account the whole society or particular groups. An interesting point, often missing in empirical studies, is the dependence of poverty on age, i.e., the poverty in the life cycle.

Rowntree (1901) found that poverty fluctuates over the life course. He noticed that labourers are particularly prone to poverty during childhood, in the early middle life and in old age (see Rowntree (1901), p. 137) and illustrates his result with figure 1. About a century later Hedstrom and Ringen (1990) confirmed the results of Rowntree for seven countries and found two areas of poverty: childhood and old age. For their research they used seven age groups with bounds (0-24, 25-34, 35-44, 45-54, 55-65, 65-74, 75+). They found that in four out of the seven countries (including West Germany) poverty rates follow a Rowntree type of cycle, i.e., the risk of poverty is highest in the youngest and oldest age groups. The drawback of this classification is that changes in the bounds of the periods of poverty over time cannot be observed.

Figure 1: Poverty in the life cycle



Source: Rowntree, B.S. (1901): Poverty. A study of town life, p. 137

The change of the periods of poverty can only be observed if age dependent poverty measures are constructed. This will be done in this paper. It follows a line of research recently used in the measurement of inequality and mobility (Trede (1995), Gerfin (1994) and Pudney (1993)). The poverty age profiles of Germany for the years 1984-1994 are computed. The joint density of income and age is estimated via Gaussian kernel estimation and age dependent poverty measures are created using the conditional density function. This paper evaluates point estimators and confidence bands following a procedure introduced by Härdle (1991).

The next section derives the kernel estimator and presents the poverty measures. Section 3 describes the data and section 4 deals with the results. The last section concludes.

2 The Tools

In this paper two sections of statistics are needed. First the estimation of a bivariate density and, second, the measurement of poverty.

Before computing age-dependent poverty measures, the joint density of the variables age and income has to be estimated. Estimating the income distribution with parametric methods concerns many technical problems (see, e.g., Brachmann et al. (1996)) even in the one dimensional case. Besides, the recent literature claims that conventional parametric models of income earnings distributions fail to reproduce some important features of the true distribution (see, e.g., Cowell et al. (1994)). Therefore, a nonparametric method is needed: multidimensional kernel density estimation. Let $f_{X,A}$ be the joint density function of age and income. The Gaussian kernel estimator is (see Scott (1992))

$$\hat{f}(x, a) = \frac{1}{nh_X h_A} \sum_{i=1}^n \phi\left(\frac{x - x_i}{h_X}\right) \phi\left(\frac{a - a_i}{h_A}\right) \quad (2.1)$$

where $\phi(\cdot)$ is the pdf of the standard normal distribution, x_i is the income belonging to the i -th observation and a_i the respective age. h_X and h_A are the bandwidths. Scott (1992) gives the following rule of thumb for bandwidth choice in this case:

$$h_k = \sigma_k \cdot n^{-1/6} \quad k = A, X \quad (2.2)$$

where σ_k^2 is the variance of $k = A, X$.

Note that the kernel estimator for the marginal density of age is

$$\hat{f}(a) = \frac{1}{nh_A} \sum_{i=1}^n \phi\left(\frac{a - a_i}{h_A}\right). \quad (2.3)$$

So the estimator of the conditional density function of income is

$$\hat{f}(x|a) = \frac{\hat{f}(x, a)}{\hat{f}(a)} = \frac{\sum_{i=1}^n \phi\left(\frac{x - x_i}{h_X}\right) \phi\left(\frac{a - a_i}{h_A}\right)}{h_X \sum_{i=1}^n \phi\left(\frac{a - a_i}{h_A}\right)}. \quad (2.4)$$

Measuring poverty in a society can be divided into two steps. First it has to be decided whether a person is poor or not. A simple way to do this is fixing a threshold value, i.e., the poverty line (say p). Everyone with income lower than, or equal to, the poverty line is poor, otherwise he or she will be called rich. This threshold can be an absolute value, e.g., the minimum amount of money which someone needs for living, or a relative value, e.g., 40%, 50% or 60% of the mean. For an overview see Seidl (1988). In this paper 40% of the mean is used as poverty line.

Next an index has to be created which measures poverty. Since the seminal article of Sen (1976) three components of poverty are widely accepted (see Schaich (1995)):

- (i) the fraction of the poor
- (ii) the amount which is needed to lift the income of all poor to the poverty line, i.e., the income gap
- (iii) the disparity within the poor.

Furthermore, Sen (1976) demands the independence of the poverty indices from the income of the rich.

Schaich (1995) divides poverty measures into simple and complex poverty indices. Simple measures fulfills only one of the above mentioned properties. There are, among others, the Head Count Ratio, i.e., the share of the poor in the society

$$HCR = F(p) = \int_0^p f(x) dx \quad (2.5)$$

where $F(\cdot)$ is the distribution function and $f(\cdot)$ the density of income. The HCR only fulfills (i). An index fulfilling (ii) is the Income Gap Ratio. This function is defined as the amount of money which is needed to lift the income of all poor to the poverty line divided by the maximum income gap.

$$IGR = \int_0^p \frac{p-x}{p} dF^* = 1 - \frac{\int_0^p x dF^*}{p} = 1 - \frac{\mu^*}{p} \quad (2.6)$$

where F^* denotes the cumulative distribution function and μ^* denotes the mean of the income of the poor.

A complex index can be created as a function of the HCR , the IGR and a function measuring disparity, i.e., an inequality index, for the poor. A widely used function is

$$P_I(F) = HCR(IGR + (1 - IGR)I_{po}) \quad (2.7)$$

where I_{po} is an inequality measure for the poor. Sen (1976) used this function with the Gini-index. Other inequality indices could be the Atkinson measures

$$A^\varepsilon = 1 - \left[\int_0^\infty \left(\frac{x}{\mu} \right)^{1-\varepsilon} dF \right]^{\frac{1}{1-\varepsilon}} \quad \varepsilon > 1, \varepsilon \neq 1 \quad (2.8)$$

or the generalized Theil measures

$$T^\lambda = \frac{1}{\lambda(\lambda+1)} \left[\int_0^\infty \left(\frac{x}{\mu} \right)^{\lambda+1} dF - 1 \right] \quad \lambda \in \mathbb{R}, \lambda \neq -1, 0 \quad (2.9)$$

(see, e.g., Blackorby and Donaldson (1978, 1980, 1984)).

With

$$I_{po} = \frac{Var(F^*)}{\mu^{*2}} = CV_{po}^2, \quad (2.10)$$

the coefficient of variation, a slight variation of (2.7) is a member of the class of Foster et al. (1984)

$$P_{CV}(F) = HCR(IGR^2 + (1 - IGR)^2 CV_{po}^2). \quad (2.11)$$

Blackburn (1989) also uses the Theil measure. But he defines his poverty measure as

$$P_{BL}(F) = HCR(IGR - \ln(1 - T_{po}^\lambda)). \quad (2.12)$$

To obtain poverty measures conditioned on age the distribution functions in the definitions have to be replaced by the conditional distribution functions, i.e., one has to replace the pdf's by the conditional pdf's.

Estimators can be created by using the kernel estimator of the conditional pdf. Note that using the marginal density produces the usual, unconditional, poverty estimator.

The confidence bands are computed by a procedure which Trede (1995) used to evaluate confidence bands for mobility age profiles. It goes back to a procedure derived by Härdle (1991, ch. 7.2).

Let $y_i = (x_i, a_i)$, $i = 1, \dots, n$, be randomly drawn independent observations. Given the y_i one can estimate the poverty age profile for the different indices $\widehat{PI}(a)$ with $PI(a) = HCR(F(x|a))$, $IGR(F(x|a))$ or $P_I(F(x|a))$ respectively using (2.4) and evaluate it at a number of certain ages $a_0 = (a_{01}, \dots, a_{0m})$. Since $\widehat{PI}(a)$ is a random variable a confidence band of the entire function will give further information on the change of poverty during the life cycle. To achieve this bootstrap procedures rely on resampling. Let y_i^* , $i = 1, \dots, n$, be a random sample uniformly drawn from y_i , with replacement. Estimating the poverty age profile for the y_i^* yields $\widehat{PI}^*(a)$. This is repeated a large number of times, $B = 1000$, say, giving B poverty age profiles \widehat{PI}_b^* , $b = 1, \dots, B$, each evaluated at ages a_0 . Let $\widehat{PI}_{(1)}^*(a_{0j}) \leq \dots \leq \widehat{PI}_{(B)}^*(a_{0j})$, $j = 1, \dots, m$ be the order statistic of the resampled poverty age profiles at age a_{0j} .

The confidence bands of the entire profiles can be found by the following procedure (see also Trede (1995) and Härdle (1991), ch. 7.2). Define the lower boundary

$$\underline{PI}_k(a_0) = (\widehat{PI}_{(k)}^*(a_{01}), \dots, \widehat{PI}_{(k)}^*(a_{0m}))$$

and the upper boundary

$$\overline{PI}_k(a_0) = (\widehat{PI}_{(B-k+1)}^*(a_{01}), \dots, \widehat{PI}_{(B-k+1)}^*(a_{0m})).$$

Obviously, no resampled poverty age profile leaves the area enclosed by $\underline{PI}_1(a_0)$ and $\overline{PI}_1(a_0)$. Let k^* be the largest integer k such that the proportion of resampled poverty age profiles lying completely inside the boundaries is greater or equal to $(1 - \alpha)$. The lower and upper boundaries $\underline{PI}_{k^*}(a_0)$ and $\overline{PI}_{k^*}(a_0)$ constitute a $(1 - \alpha)$ confidence band.

To compute the confidence bands the WARP algorithm of Härdle (1991) is used. More details can be found in Trede (1995).

3 The Data

This paper examines the dependence of poverty on age in Germany in 1984 – 1994 using the German Socio-Economic Panel (SOEP) data. The panel participants are interviewed annually; the data are recorded on the household level as well as on the individual level.

The panel includes a large section on income and earnings in the preceding year. The main respondent of a household is asked in each wave of the SOEP: "If you add all: What is the total monthly amount of the household net income of all household members today? Please report the monthly net amount, i.e. the amount after tax and social insurance. Regular payments like aid for dwelling and children, student loans, alimony payments, etc. add to the amount! In the case of "I don't know", please estimate the amount".

There are of course several drawbacks in this information. First, about 50% underestimate their true net income. (see Rendtel et al. (1992)). Second, the values are rounded. While Rendtel et al. (1992) show that the first point is irrelevant when the poverty line depends on an income distribution parameter, for the second aspect there is no solution known. So it has to be taken into consideration when the results are interpreted.

The East German observations are not taken into account until 1991. Before this year only the sample containing the West German and the sample containing foreigners are used. All observations with income less than 0 or missing age data are deleted. The number of the remaining observations can be found in table 1.

Table 1: Number of valid observations

year	<i>n</i>
1984	15393
1985	13884
1986	13276
1987	13123
1988	12534
1989	12148
1990	11972
1991	17564
1992	17235
1993	16925
1994	16572

The aim of this article is estimating the dependence of poverty of the German society on age. For this purpose the welfare level of every person is needed. However, the variable used is the net income of the household. So the household net income has to be transformed to a personal income which contains the same level of welfare for every member of the household. The economies of scale inside the household should also be considered. To realize this conversion equivalence scales are developed. In this paper the scale of Buhmann et al. (1988) is used, which has a single parameter (θ), the elasticity of the scale rate with

respect to household size. This equivalence scale is characterized by the following equation:

$$X = \frac{HI}{S^\theta} \quad (3.1)$$

where equalized income (X) equals net household income (HI) divided by household size (S) raised to the power θ . Economies of scale can be thought of as a function of θ . At the one end, where $\theta = 0$, scale economies are perfect so that a family of any number of members can live exactly as well as a one person household with the same amount of disposable income. At the other end, where $\theta = 1$, no economies of scale exist and a household of two requires twice as much disposable income as a household of one to reach the same level of welfare. The equivalence income is the income which every person would have if he or she lived in a one person household with the same welfare level as his or her present family.

Burkhauser et al. (1994) computed θ for different equivalence scales used for Germany and the U.S.A. The "official" scale of Germany embedded in German public welfare law (BSHG) since 1991 implies $\theta = 0.81$. From the ELES scale for Germany, developed by Merz et al. (1993) follows $\theta = 0.38$. Between these bounds the value of the international experts scale can be found. This scale was developed by several analysts and used in various studies undertaken on behalf of the Office of Economic Cooperation and Development (Förster (1994), Atkinson et al. (1994)), as well as the Statistical Office of the European Community (Hagenaars et al. (1994)) and by Ruggles (1990). The elasticity of this scale is $\theta = 0.50$.

Although Burkhauser et al. (1994) found that overall inequality and poverty measures are not sensitive with respect to the equivalence scale used, the scales yield different results when subgroups of the population, e.g all people elder than 65 years, are considered. Therefore, this study computes the poverty indices for the three values of θ mentioned above.

4 The Results

Before the age dependent poverty measures can be computed, the joint densities and the poverty lines have to be calculated. The poverty line in this paper is 40% of the mean equivalence income. The values for the observed years and different θ are shown in figure 2. The densities are estimated with formula (2.1). In doing so (2.2) is used to calculate the bandwidths which can be found in table 2. Both the poverty lines and the bandwidths show a structural break in 1991; this is due to the inclusion of the East German sample which is taken into account since 1991.

Figure 2: Poverty lines for different equivalence scales 1984–1994

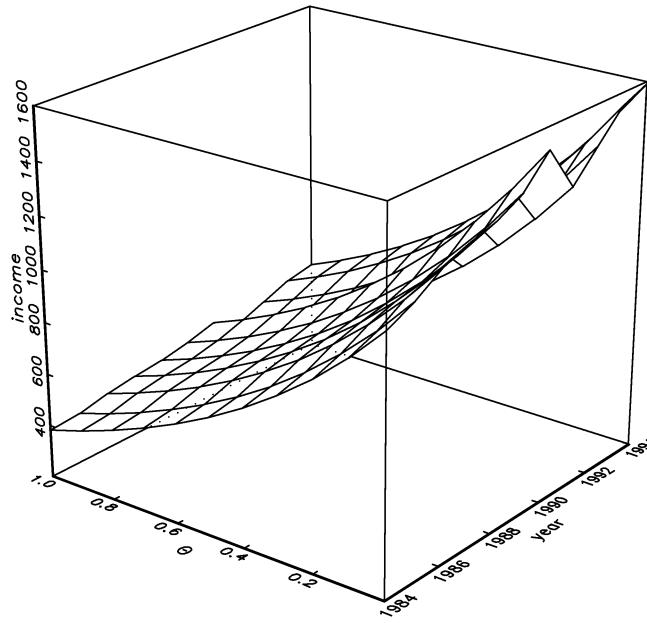
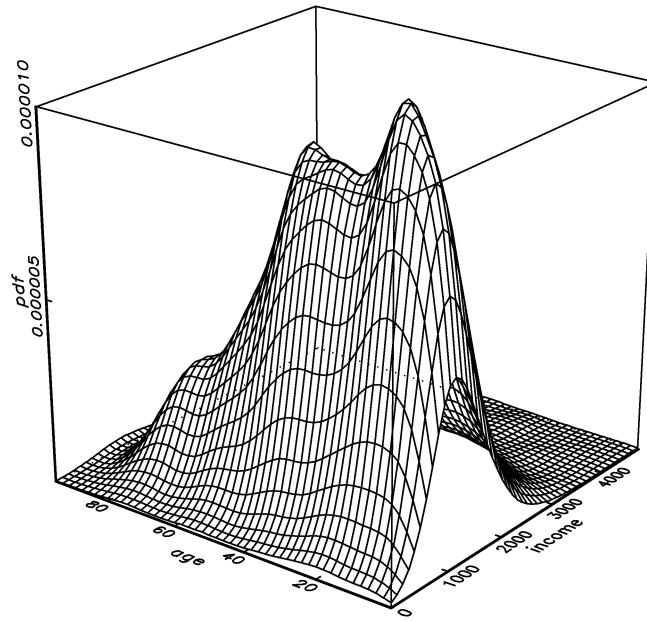


Table 2: Bandwidths for different equivalence incomes 1984 – 1994

year	θ					
	0.38		0.50		0.81	
	h_X	h_A	h_X	h_A	h_X	h_A
1984	280.28	4.21	251.60	4.21	198.07	4.21
1985	246.46	4.18	210.73	4.18	154.08	4.18
1986	334.30	4.21	292.06	4.21	213.62	4.21
1987	280.31	4.22	248.77	4.22	191.89	4.22
1988	286.08	4.28	250.28	4.28	187.25	4.28
1989	260.75	4.30	233.35	4.30	186.39	4.30
1990	314.88	4.34	269.40	4.34	194.80	4.34
1991	213.29	4.06	188.80	4.06	149.60	4.06
1992	216.81	4.09	192.59	4.09	155.06	4.09
1993	240.68	4.12	214.04	4.12	171.29	4.12
1994	241.99	4.15	215.18	4.15	172.58	4.15

The joint densities for 1984 and 1994 with $\theta = 0.50$ can be seen in figures 3 and 4. In figures 5 and 6 the influence of θ is plotted. Obviously the density with $\theta = 0.81$ is greater in the lower part of the distribution and lower in the higher part than the density with $\theta = 0.38$. This is not surprising because the economies of scale at $\theta = 0.81$ are lower than at $\theta = 0.38$. This means that the members of a household have a lower welfare level at $\theta = 0.81$. Expressing this in terms of income, they have less income than in the case of $\theta = 0.38$. So the density with $\theta = 0.81$ has a bigger tail at the lower end and a smaller one at the upper end.

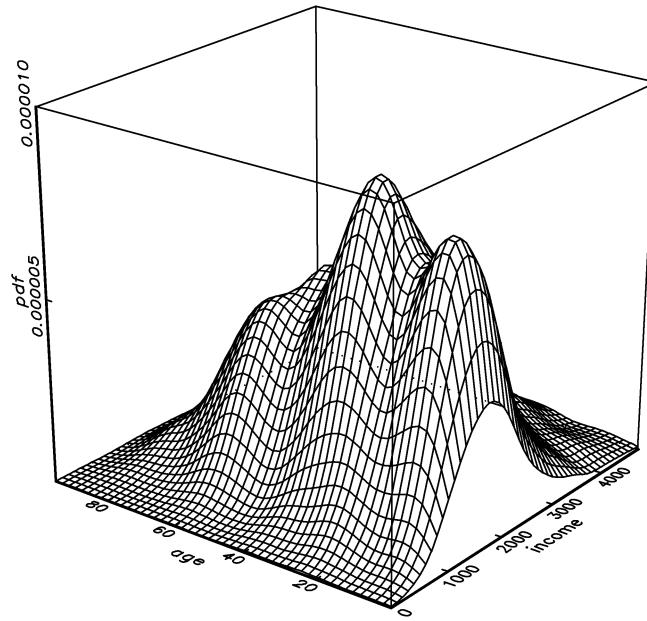
Figure 3: Joint density for income and age with $\theta = 0.50$ in 1984

With the estimated joint densities the age dependent poverty measures can be computed. But which measures should be calculated? Not only the simple measures HCR and IGR but also some complex measures should be computed. Taking the behaviour of the disparity measures into account there should be one with high sensitivity in the low income area and one with high sensitivity in the high income area.

In this paper the Blackburn poverty measure with $\lambda = 1$ is calculated. The Theil measure is very sensitive in the upper area when its parameter is high (see Schmid (1991)). Calculating (2.7) with the Theil measure and $\lambda = 1$ permits to investigate the influence of the different functional forms of the poverty measures. To make available an inequality measure with high sensitivity in the lower area, the Atkinson measure with $\varepsilon = 2$ (see Schmid (1991)) is used in (2.7). Furthermore the poverty measure based on the coefficient of variation as a member of the class of Forster is calculated. Notice that the Coefficient of variation is highly sensitive in the upper tail (see Schmid (1991)).

With these indices the age dependent poverty levels as well as the overall poverty levels are calculated. The overall indices can be found in tables 3 – 8. They are computed by using the marginal density of income in the formulae of the poverty measures. The age dependent poverty levels can be found in figures 7 – 10 and 12 – 23 for the years 1984 and 1994 and for the remaining years in figures 24 – 29. They are computed up to an age of 80 years because above this age the number of observations is too small (between 164 and 289) to give exact estimates for the poverty measures.

The constant lines in the figures are the values of the overall indices. So it is possible to compare these indices with the age dependent values. In figures 7, 8 and 12 – 15 the solid lines mark the point estimates of the poverty indices and the dashed lines show the 95% confidence bands. In figures 9 – 11 and 16 – 29 the solid lines show the values for $\theta = 0.38$,

Figure 4: Joint density for income and age with $\theta = 0.50$ in 1994

the dashed lines identify the values for $\theta = 0.50$ and $\theta = 0.81$ is marked by the dotted lines.

Table 3: Head Count Ratios for different equivalence incomes 1984 – 1994

year	θ		
	0.38	0.50	0.81
1984	0.0597	0.0600	0.0932
1985	0.0564	0.0559	0.0702
1986	0.0683	0.0706	0.0912
1987	0.0515	0.0529	0.0727
1988	0.0556	0.0577	0.0635
1989	0.0446	0.0463	0.0698
1990	0.0536	0.0474	0.0710
1991	0.0648	0.0530	0.0631
1992	0.0466	0.0473	0.0513
1993	0.0509	0.0449	0.0527
1994	0.0447	0.0479	0.0614

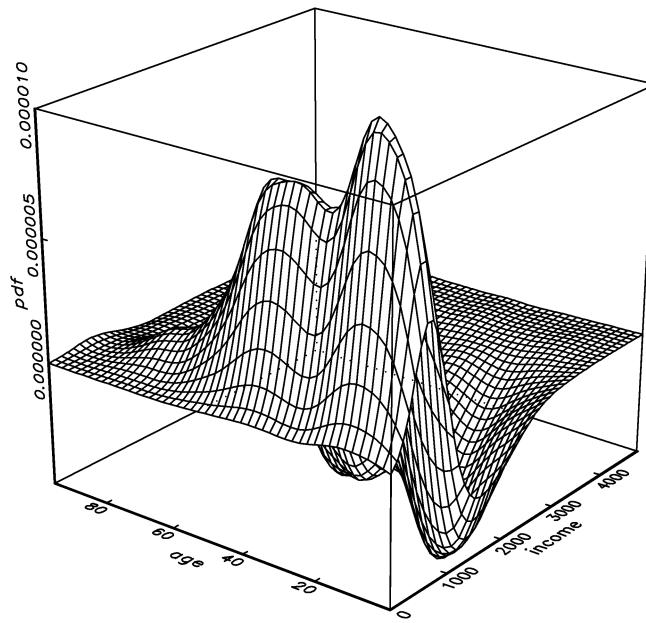
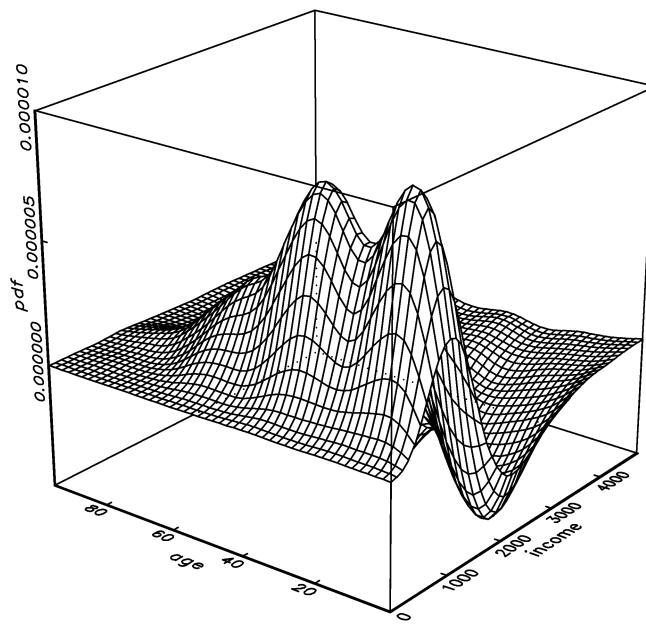
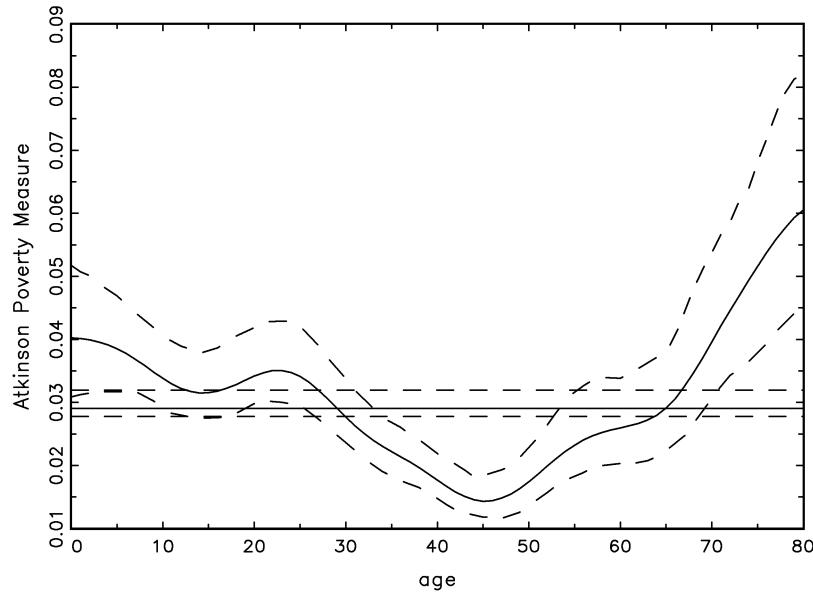
Figure 5: Difference of the joint densities with $\theta = 0.81$ and $\theta = 0.38$ for 1984

Table 4: Income Gap Ratios for different equivalence incomes 1984 – 1994

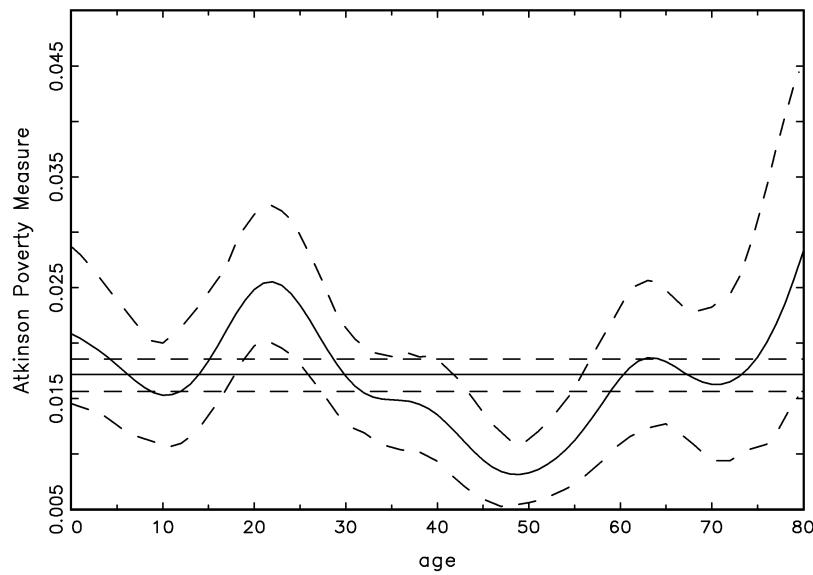
year	θ		
	0.38	0.50	0.81
1984	0.2839	0.2889	0.2471
1985	0.2401	0.2287	0.2249
1986	0.2619	0.2494	0.2361
1987	0.2668	0.2526	0.2387
1988	0.2365	0.2145	0.2480
1989	0.2703	0.2510	0.2141
1990	0.2504	0.2644	0.1993
1991	0.2178	0.2501	0.2334
1992	0.2263	0.2021	0.2195
1993	0.2264	0.2424	0.2409
1994	0.2417	0.2107	0.1984

Figure 6: Difference of the joint densities with $\theta = 0.81$ and $\theta = 0.38$ for 1994Table 5: Atkinson Poverty Measures with $\varepsilon = 2$ for different equivalence incomes 1984 – 1994

year	θ		
	0.38	0.50	0.81
1984	0.0290	0.0290	0.0425
1985	0.0240	0.0225	0.0261
1986	0.0330	0.0327	0.0404
1987	0.0233	0.0227	0.0294
1988	0.0235	0.0226	0.0252
1989	0.0198	0.0194	0.0266
1990	0.0246	0.0214	0.0265
1991	0.0233	0.0203	0.0235
1992	0.0160	0.0150	0.0170
1993	0.0198	0.0178	0.0208
1994	0.0172	0.0169	0.0207

Figure 7: Age-dependent Atkinson Poverty Measures for 1984 with $\theta = 0.38$ Table 6: Blackburn Poverty Measures with $\lambda = 1$ for different equivalence incomes 1984 – 1994

year	θ		
	0.38	0.50	0.81
1984	0.0230	0.0235	0.0316
1985	0.0180	0.0169	0.0206
1986	0.0244	0.0239	0.0294
1987	0.0183	0.0177	0.0229
1988	0.0175	0.0163	0.0206
1989	0.0160	0.0153	0.0197
1990	0.0181	0.0167	0.0187
1991	0.0183	0.0172	0.0190
1992	0.0135	0.0122	0.0143
1993	0.0152	0.0143	0.0166
1994	0.0141	0.0131	0.0158

Figure 8: Age-dependent Atkinson Poverty Measures for 1994 with $\theta = 0.38$ Table 7: Theil Poverty Measures with $\lambda = 1$ for different equivalence incomes 1984 – 1994

year	θ		
	0.38	0.50	0.81
1984	0.0191	0.0195	0.0269
1985	0.0155	0.0146	0.0179
1986	0.0206	0.0203	0.0252
1987	0.0154	0.0150	0.0197
1988	0.0150	0.0143	0.0176
1989	0.0135	0.0131	0.0172
1990	0.0154	0.0141	0.0165
1991	0.0160	0.0147	0.0165
1992	0.0117	0.0108	0.0125
1993	0.0131	0.0123	0.0143
1994	0.0121	0.0115	0.0139

Figure 9: Age-dependent Income Gap Ratios for 1984

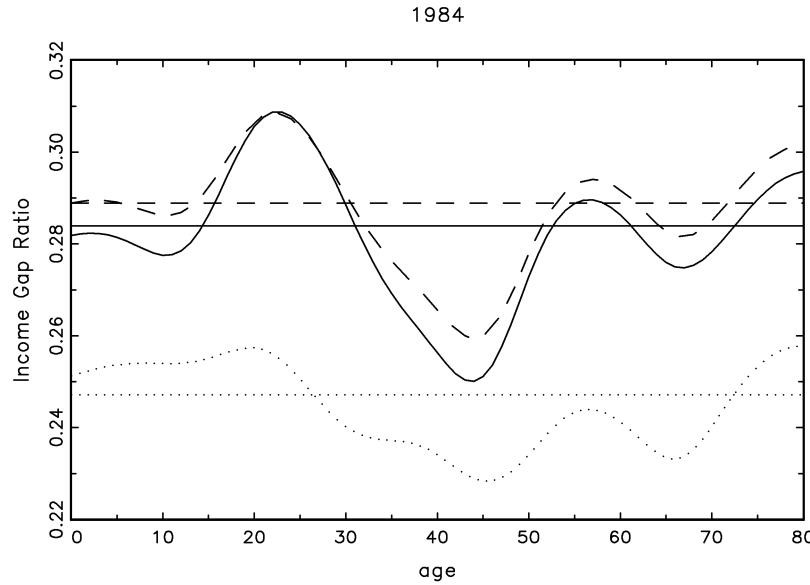
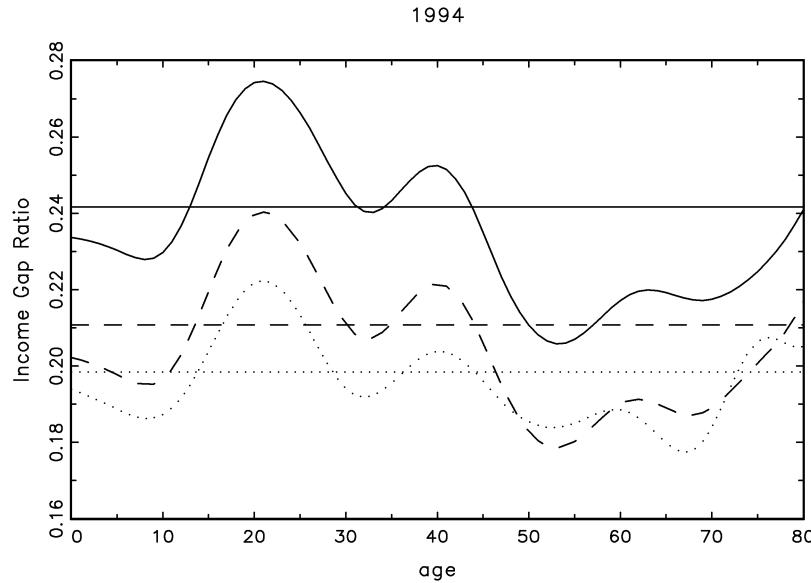


Table 8: Coefficient of Variation Poverty Measures for different equivalence incomes 1984 – 1994

year	θ		
	0.38	0.50	0.81
1984	0.0079	0.0081	0.0115
1985	0.0062	0.0057	0.0068
1986	0.0087	0.0085	0.0107
1987	0.0062	0.0059	0.0077
1988	0.0060	0.0056	0.0067
1989	0.0053	0.0051	0.0067
1990	0.0063	0.0056	0.0065
1991	0.0060	0.0055	0.0061
1992	0.0042	0.0038	0.0044
1993	0.0051	0.0047	0.0055
1994	0.0046	0.0043	0.0052

Looking at figures 7 – 11 and 26 – 29 it is obvious that *all* age dependent poverty measures show the same reaction when the age is changed, see, e.g., figure 11. Just the level of poverty indicated by the single measures is different. But here a definite ordering can be found. The values of the Atkinson poverty measure are always the highest followed by the Blackburn, the Theil and the Coefficient of variation poverty measures. For the different θ the curves of the different poverty measures never cross. This can be seen, e.g., in figure 11 and, for the Atkinson poverty measure, in table 9. In this table the minimum and maximum differences between the single poverty measures of all years are given. From this result it can be seen that there exists no influence on the measurement

Figure 10: Age-dependent Income Gap Ratios for 1994



of poverty through the different functional forms in the Blackburn and Theil measure or the sensitivity of the different measures in this research.

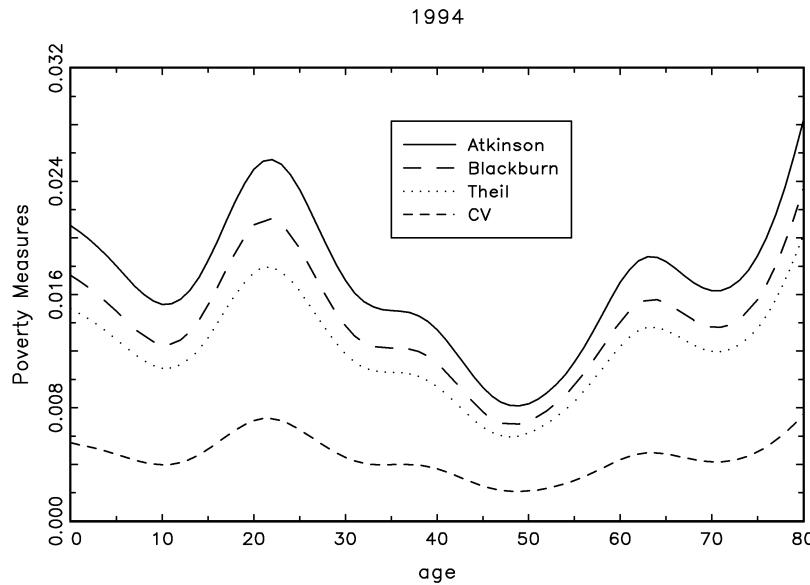
Table 9: The minimum and maximum differences of all years between the Atkinson poverty measure and the other complex measures

θ	Blackburn		Theil		CV	
	min	max	min	max	min	max
0.38	0.0012	0.0172	0.0020	0.0259	0.0060	0.0492
0.50	0.0015	0.0145	0.0022	0.0209	0.0060	0.0388
0.81	0.0009	0.0192	0.0014	0.0279	0.0040	0.5581

Furthermore, the functional form of the age dependent Head Count Ratios is very similar to the complex poverty measures (see figures 16, 17 and 24). Because of this similarity of the complex poverty measures only the Atkinson measure is taken into account in the sequel. Only the Income Gap Ratios show a slightly different behaviour. They have two significant peaks, one at the age of 25 and the other at the age of 60 in 1984 and at the age of 40 in 1994. These peaks can also be found in the complex measures but they are much smoother than in the ICR's.

One of the interesting points is whether the curve of the age dependent poverty measures lies beneath the overall index or not. This question can be answered for the HCR and the complex poverty measures in the same way because the points of intersection have almost the same age coordinates. These only differ with the change of θ and a little bit over time. For $\theta = 0.38$ the age dependent poverty measures are lower than the overall index from an age around 30 years until an age of about 65 in the years 1984 to 1987. Then the upper

Figure 11: All complex Poverty Measures for 1994



point is located at an age of about 55 years. With $\theta = 0.50$ this area has a range of 30 to 70 years until 1991. In recent years the upper bound decreases to 60 years. Only in 1994 it changes to about 78 years. The widest range can be found with $\theta = 0.81$; here the lower point is at 25 years and the upper at 80 years. This is true until 1988. Then the lower bound changes to 30 years. The age dependent ICR's show a range of 30 to 50 years. Only in 1994 a slight movement to the younger people can be found.

Looking at the confidence bands a similar picture can be found. The bands of the complex measures and of the *HCR* behave in the same manner. Therefore, only the confidence bands for the Atkinson Poverty Measures in the years 1984 and 1994 are plotted (see figures 12 – 15). From this figures it can be seen that people in middle life are significantly richer than the rest of the society and that people in young age (in 1984 with $\theta = 0.50, 0.81$ and in 1994 with $\theta = 0.81$) or old age (in 1984 with $\theta = 0.38, 0.50$ and in 1994 with $\theta = 0.38$) are significantly poorer.

All figures support the thesis that middle aged people are relatively well off. This result is not very surprising. In this age class are those people who are well-off due to their long time in job. Furthermore, the people who had studied are working now and so earning more money. The class ends at an age of about 65 years. At this age in Germany many people retire. From now on they only get pension which is less than their last income. If they do not have some private old-age pension they become much poorer in the following years. Furthermore with $\theta = 0.38, 0.50$, all complex measures show the Rowntree type of cycle, i.e., higher risk of poverty in childhood, early middle life and old age. This conclusion cannot be drawn with $\theta = 0.81$ where the risk of poverty is very high in young age while it is low in old age. This effect can be explained by the low economies of scale. Older people live usually in small families, i.e. one or two persons in a household. Here the absence of economies of scale decreases the welfare level not so much as in bigger

households in which younger people commonly live.

Table 10: The minimal and maximal deviation of the age dependent Atkinson measures of all years

θ	minimum	maximum
0.38	-0.0147 (-0.5263)	0.0352 (1.5159)
0.50	-0.0135 (-0.5307)	0.0204 (0.8802)
0.81	-0.0248 (-0.7504)	0.0344 (1.0309)

The values in brackets are the relative minima and maxima, i.e., the minima and maxima of the differences divided by the overall index.

Looking at tables 3 – 8 it can be seen that poverty is falling from 1984 to 1994. Like the age dependent indices the complex overall indices show a similar behaviour over the years. Between 1984 and 1994 poverty fluctuates a little bit so that no straight decrease of poverty can be found. Obviously the degree of poverty increases with increasing θ because the economies of scale decrease and so more people, especially in big families are poor. The same conclusion is valid for the overall Head Count Ratios.

5 Conclusion

Calculating age dependent poverty measures for Germany reveals that poverty decreases with increasing age until an age of around 50 years and then increases. This is in coincidence with a priori knowledge about the development of poverty over the life cycle. The different poverty measures behave *all* in the same way. Their poverty age profiles lie in the same ranges above or below the overall measures. Only the degree of poverty is different. This can be seen for all years from 1984 to 1994. This conclusion cannot be drawn for the different equivalence scales. Although all measures react equally for a fixed θ the single measures show different behaviour for different θ . Because of this the equivalence scale should be chosen carefully, whereas the computation of one complex poverty measure is sufficient to estimate the life cycle effect of poverty.

Astonishingly, about a century after the research of Rowntree (1901) the same cycle of poverty can be found. This means that the industrialization, development and social policy which took place during the last 90 years did not essentially change the age profile of poverty.

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Appendix

Figure 1: Age-dependent Atkinson Poverty Measures for 1984 with $\theta = 0.50$

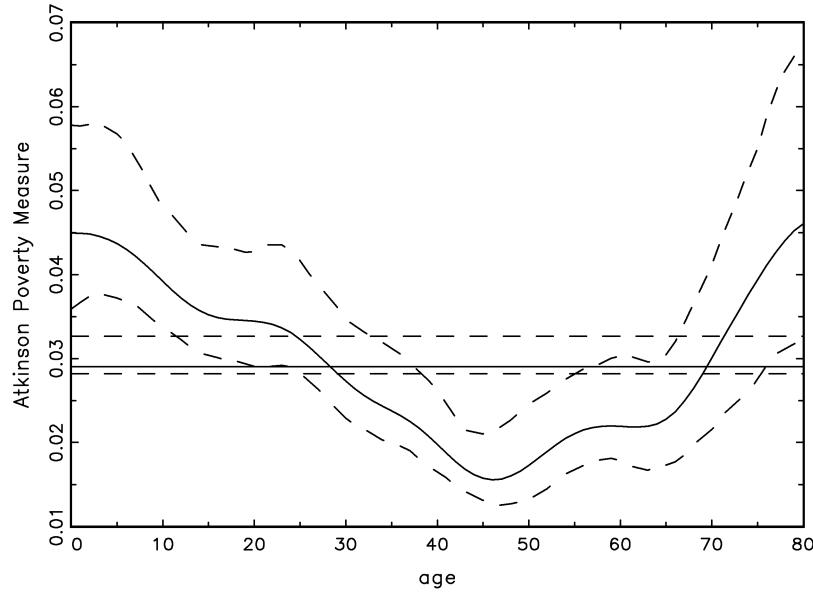


Figure 2: Age-dependent Atkinson Poverty Measures for 1984 with $\theta = 0.81$

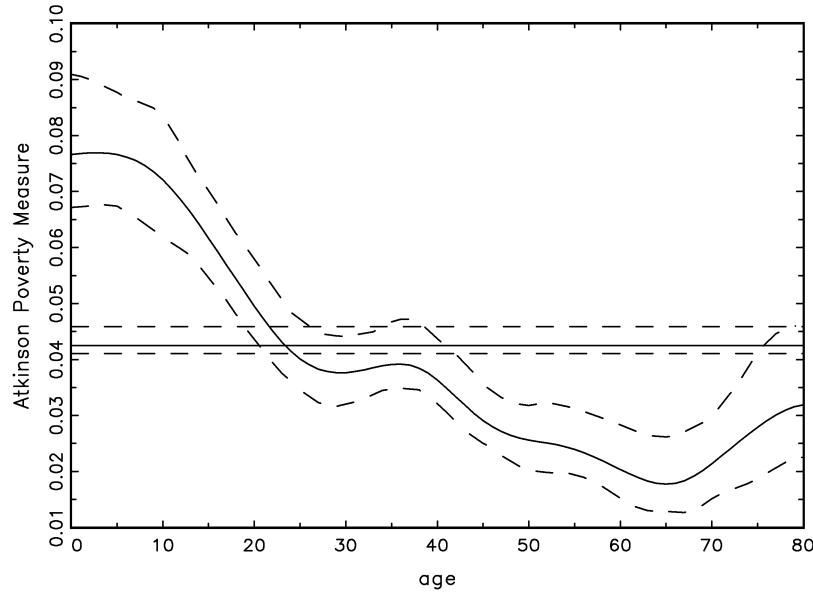


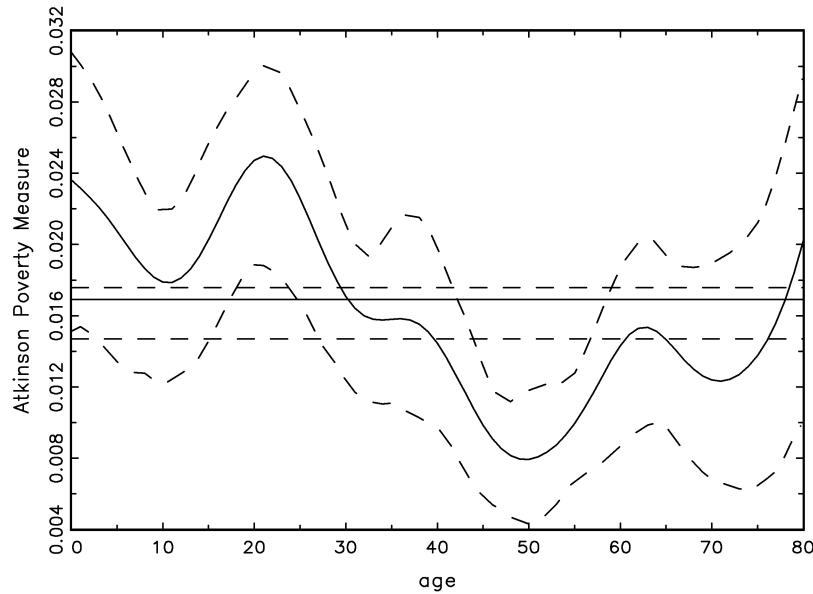
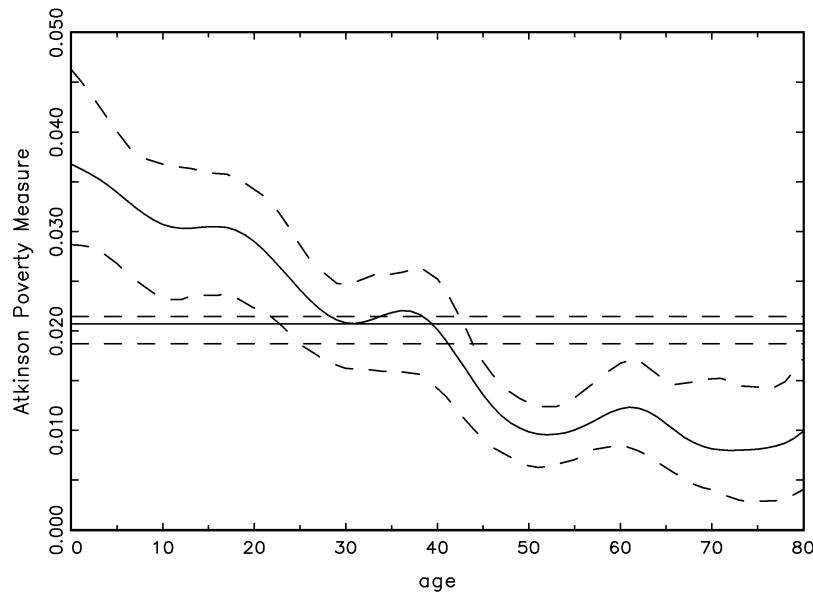
Figure 3: Age-dependent Atkinson Poverty Measures for 1994 with $\theta = 0.50$ Figure 4: Age-dependent Atkinson Poverty Measures for 1994 with $\theta = 0.81$ 

Figure 5: Age-dependent Head Count Ratios for 1984

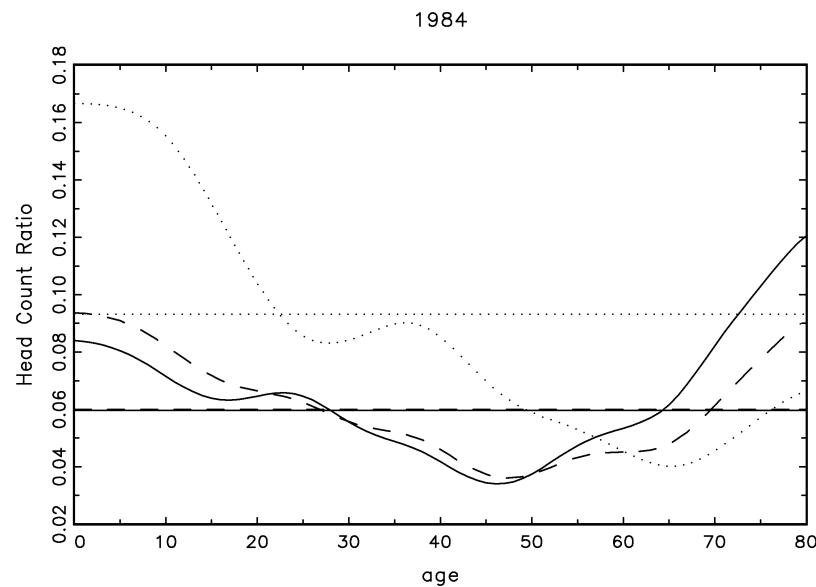


Figure 6: Age-dependent Head Count Ratios for 1994

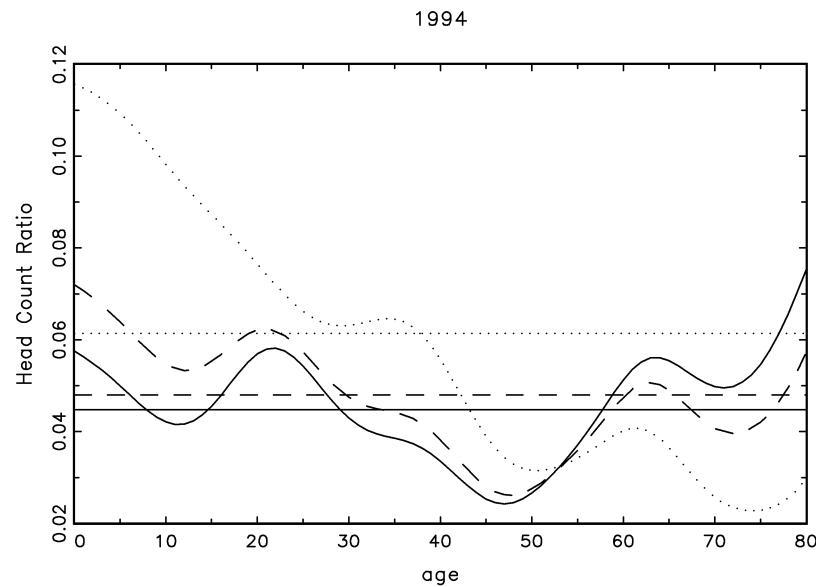


Figure 7: Age-dependent Blackburn Poverty Measures for 1984

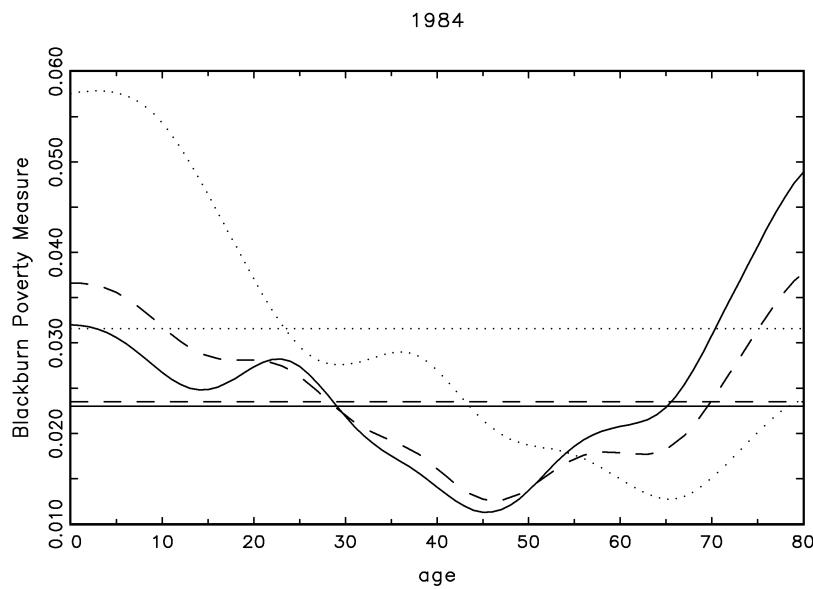


Figure 8: Age-dependent Blackburn Poverty Measures for 1994

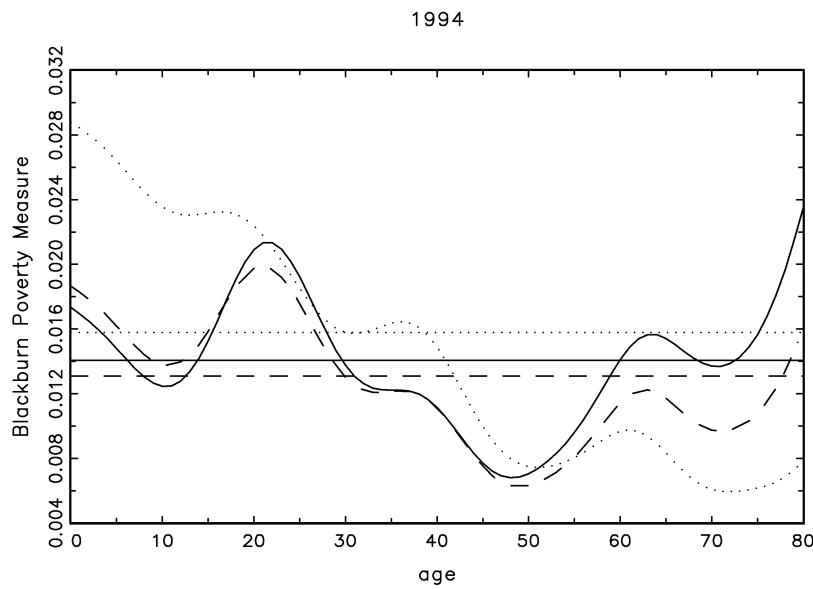


Figure 9: Age-dependent Theil Poverty Measures for 1984

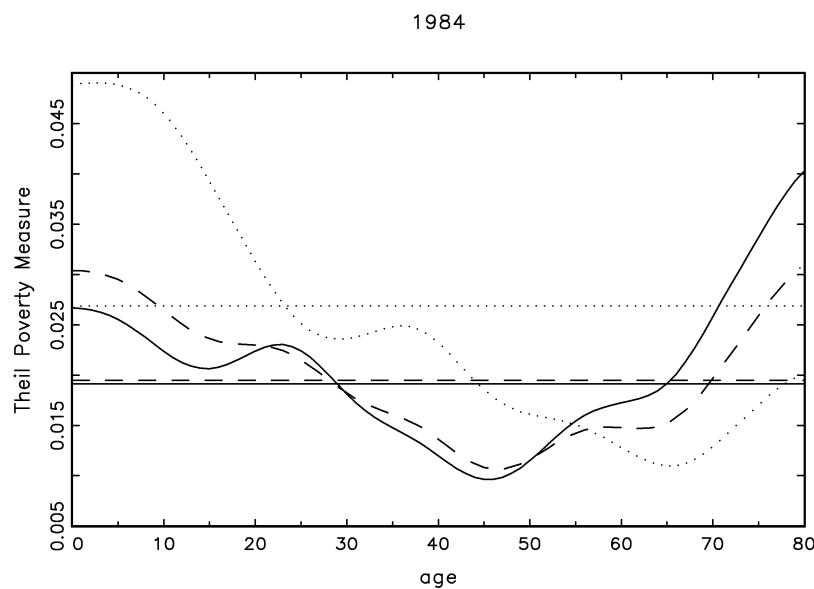


Figure 10: Age-dependent Theil Poverty Measures for 1994

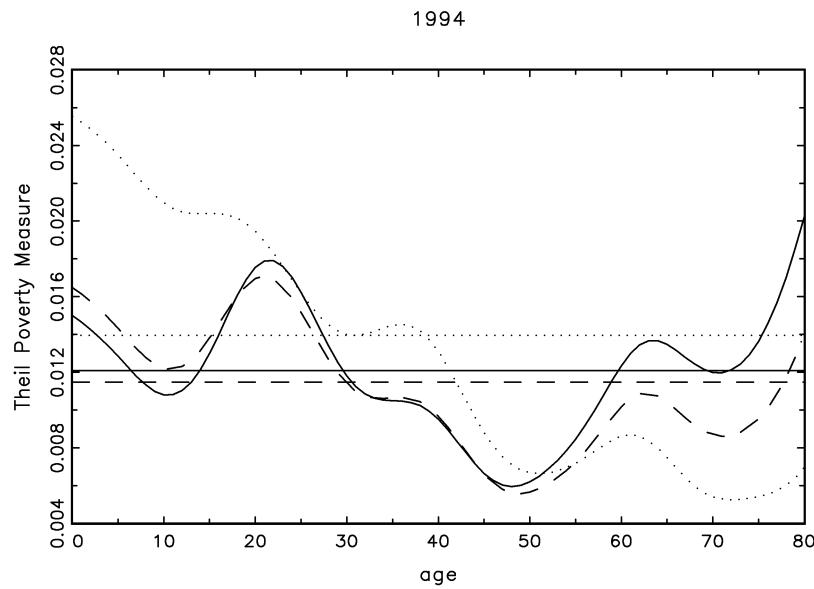


Figure 11: Age-dependent Coefficient of Variation Poverty Measures for 1984

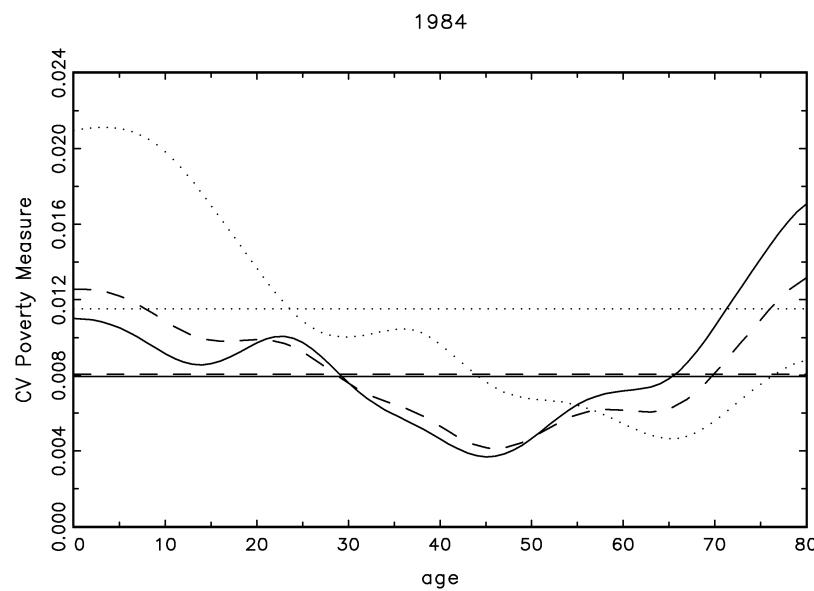


Figure 12: Age-dependent Coefficient of Variation Poverty Measures for 1994

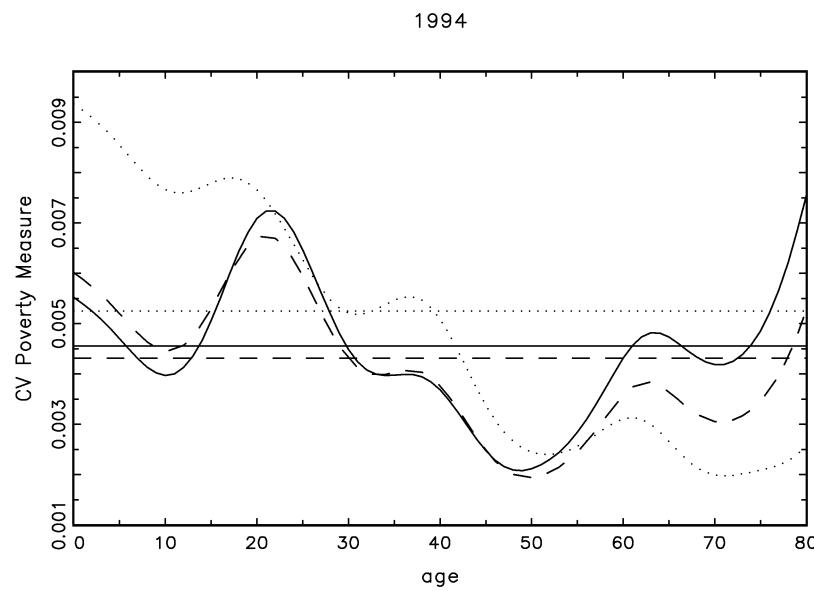


Figure 1: Age dependent Head Count Ratios for 1985–1993

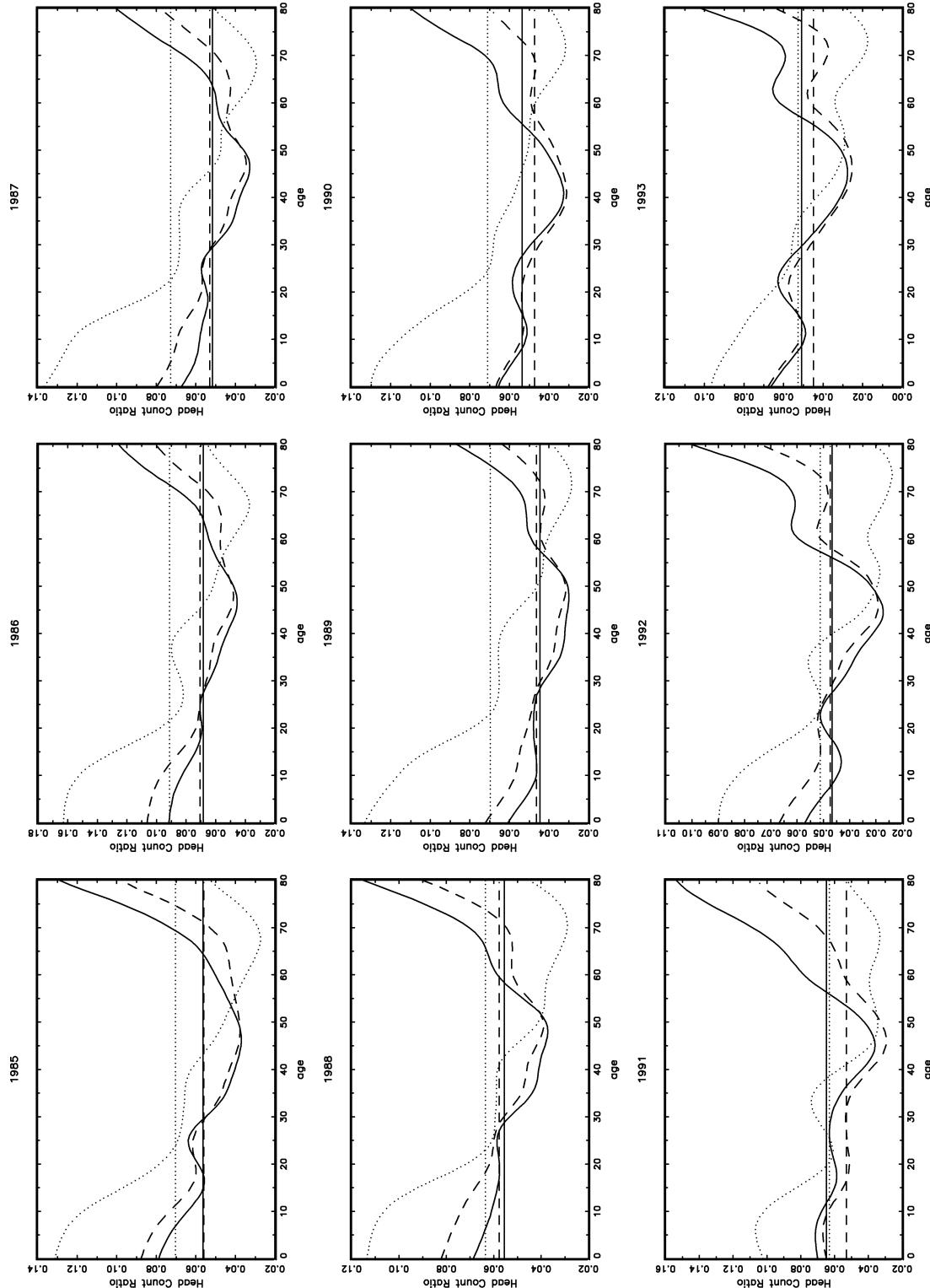


Figure 2: Age dependent Income Gap Ratios for 1985–1993

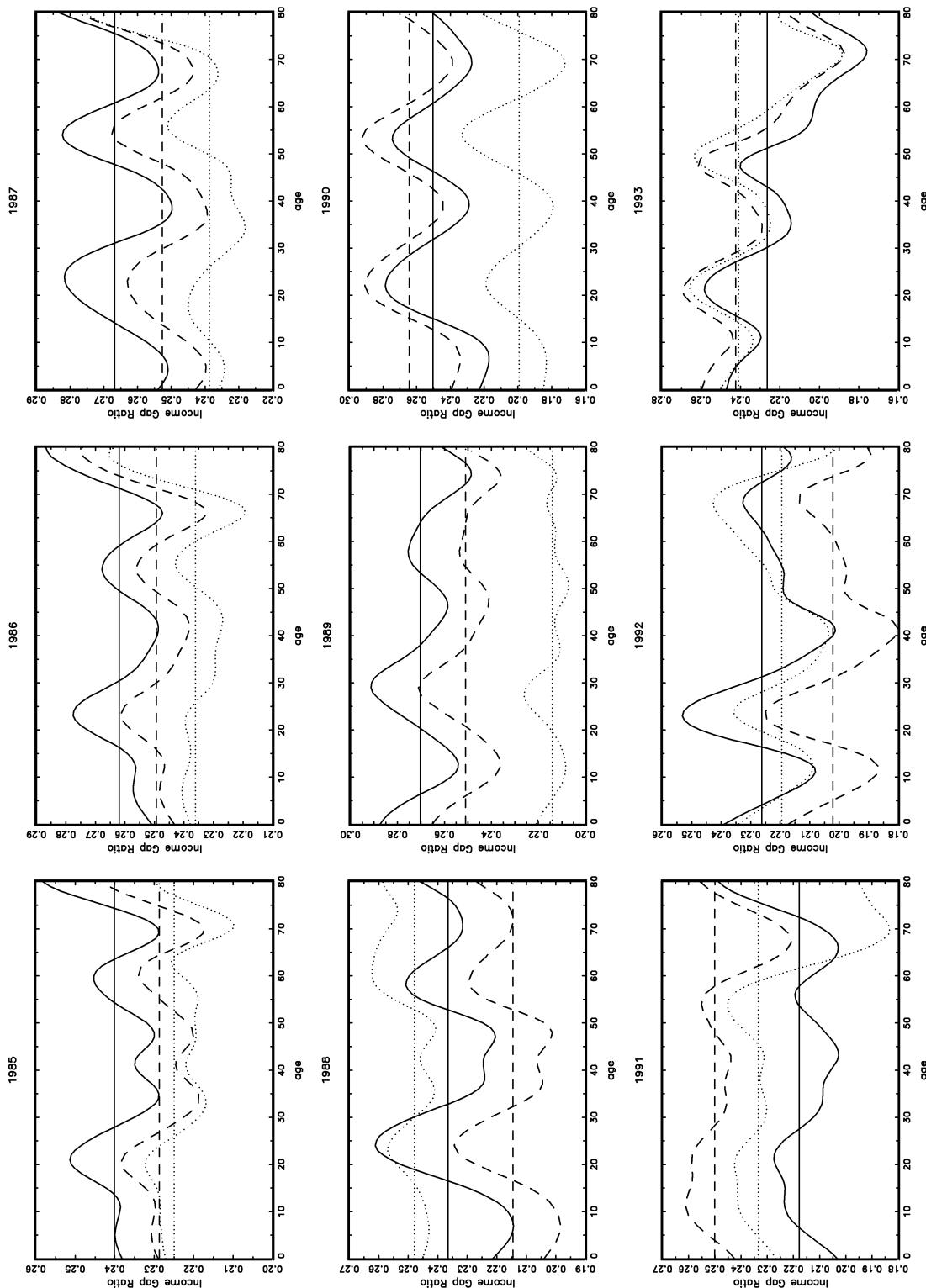


Figure 3: Age dependent Atkinson Poverty Measures for 1985–1993

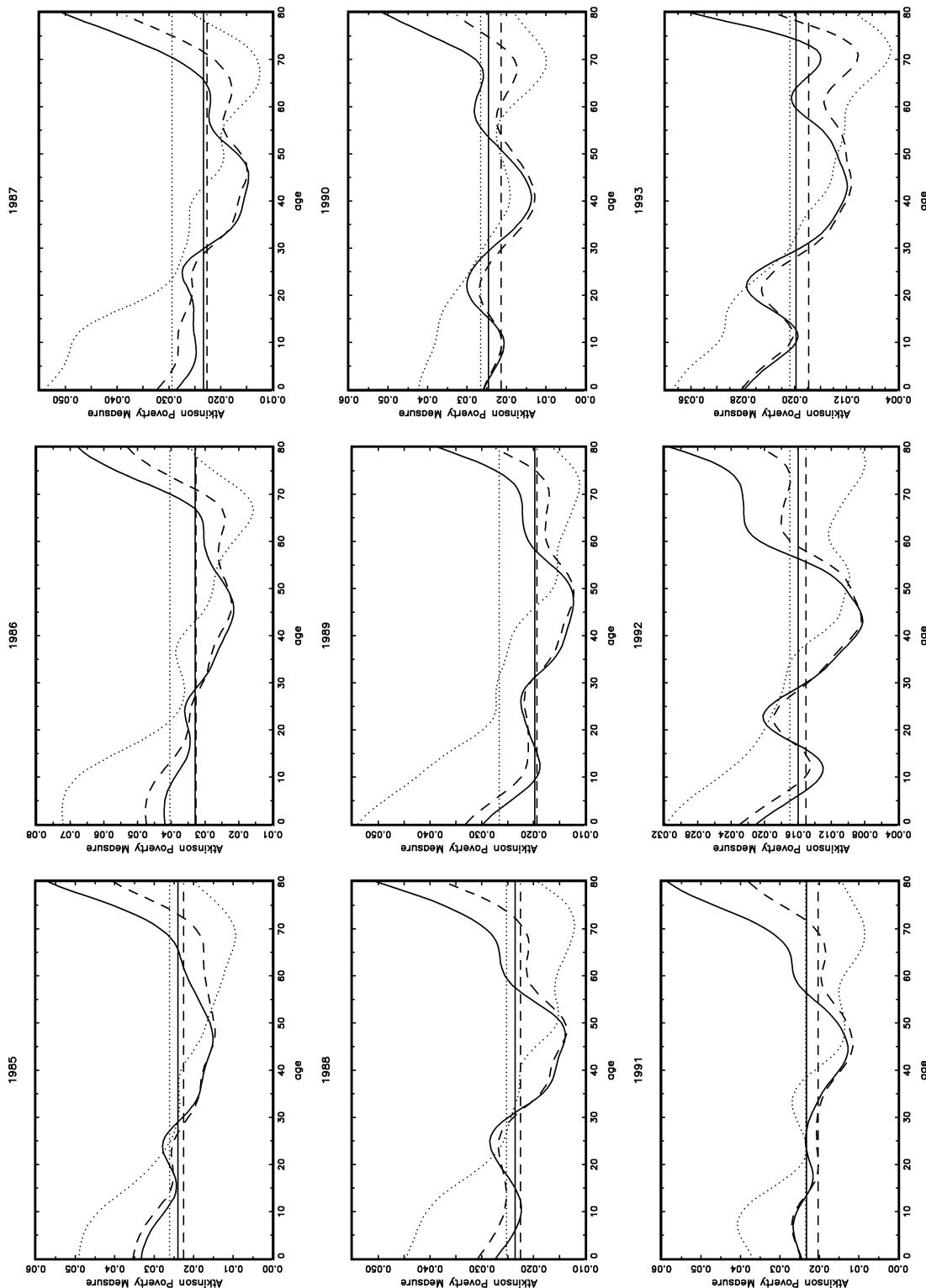


Figure 4: Age dependent Blackburn Poverty Measures for 1985–1993

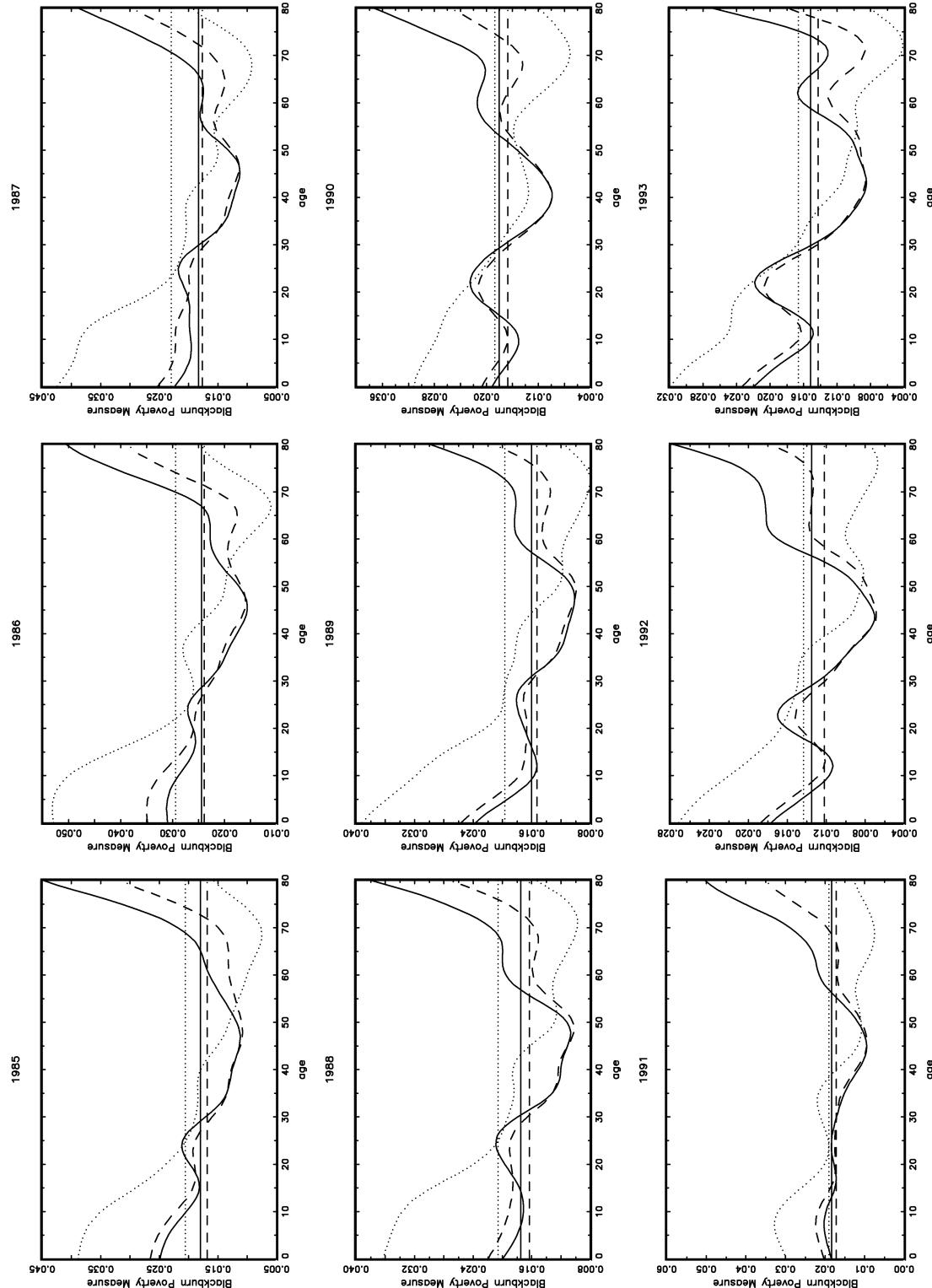


Figure 5: Age dependent Theil Poverty Measures for 1985–1993

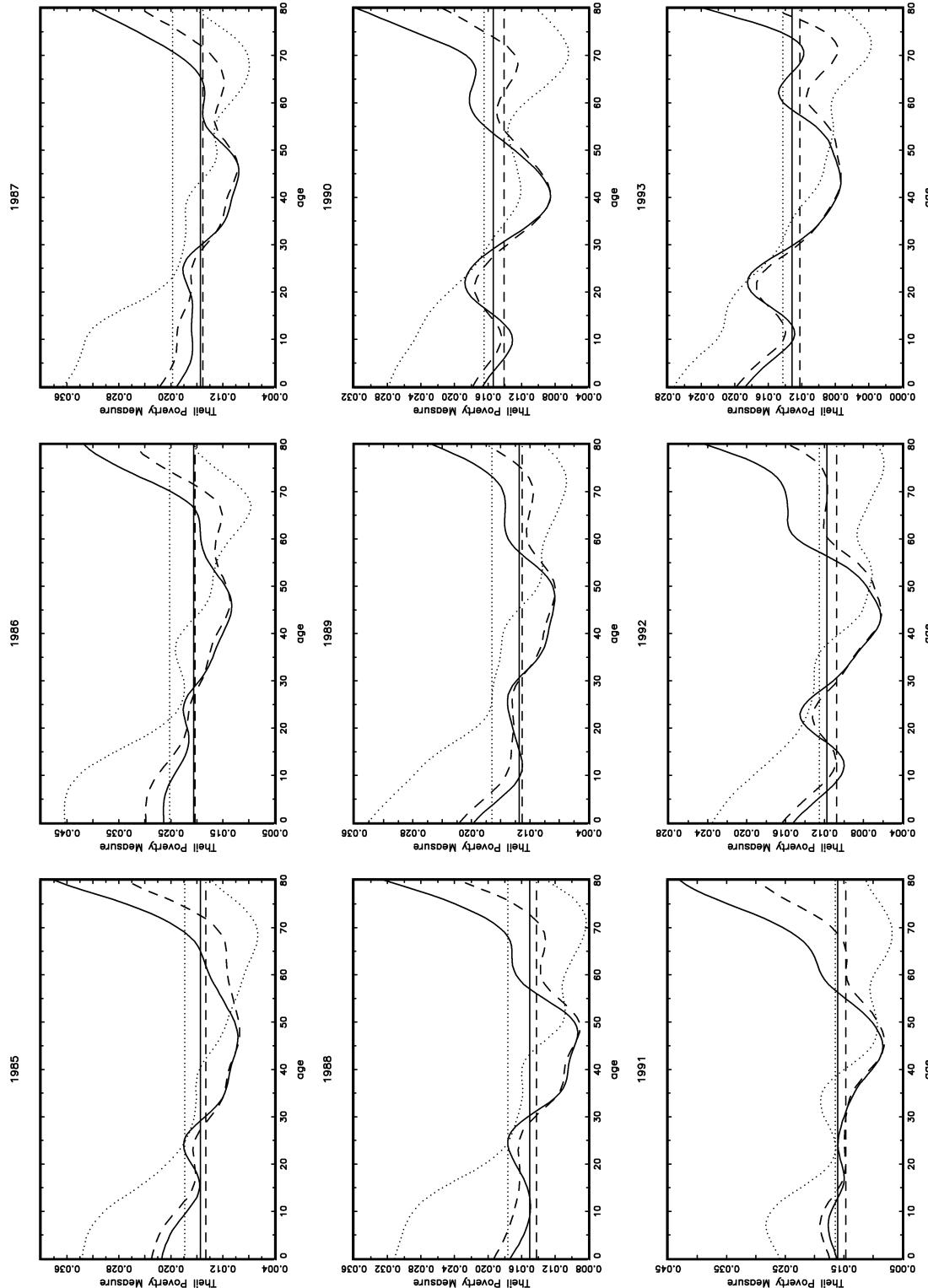


Figure 6: Age dependent Coefficient of Variation Poverty Measures for 1985–1993

