THE OLDER, THE RICHER? -

A DECOMPOSITION OF WEALTH INEQUALITY BY AGE SUBGROUPS*

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ABSTRACT

Departing from the implication of the basic life cycle model that substantial wealth inequality may arise simply because of differences in age, at first, we investigate the quantitative importance of age as a source of wealth differences in Germany using individual wealth data from the German Socio-Economic Panel for the years 2002, 2007 and 2012. Employing the well-known Gini coefficient, we decompose wealth inequality by age subgroups and calculate within- and between-group inequalities. Results suggest that more than one third of overall wealth inequality can be explained by transitory lifetime wealth differences due to age. Secondly, unconditional quantile regression is used to examine the effects of age on different points of the wealth distribution. Results reveal that the age effect is heterogeneous across the distribution. We find that age has no effect on low quantiles and an almost linear effect for the higher ones. For the middle part of the distribution, results show a hump-shaped pattern as predicted by theory. A combination of these results provides tentative evidence that an aging of the German population is associated with a growing dispersion of wealth at the upper tail of the distribution.

JEL CLASSIFICATION: D30, D31, D63

KEYWORDS: AGE, WEALTH, INEQUALITY DECOMPOSITION, UNCONDITIONAL QUANTILE REGRESSION

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1 Introduction

In order to examine the quantitative importance of age as a source of individual wealth differences in Germany, we decompose wealth inequality by age subgroups and calculate within- and between-group inequalities. Then, unconditional quantile regression is used to analyze the effects of age on different points of the wealth distribution. The underlying research questions can be formulated as follows: How much of the wealth differences can simply be explained by differences in age, i.e. by the the fact that people are observed at different stages of their lifetime? What is the impact of a shift in the German population's age structure on the distribution of wealth? Investigating these questions allows us to uncover the "natural" or age-related amount of wealth differences in Germany that may lead to a different normative evaluation of overall observed inequality and to determine possible effects of the demographic aging with regard to the distribution of wealth.

The analysis is motivated by two observations. First, recent research documents a continuing rise of wealth inequality in Europe and the US in the last decades (Piketty and Saez, 2014). The Gini coefficient for OECD countries typically ranges between 0.6 and 0.8 (Cagetti and De Nardi, 2008; Cowell et al., 2013). With a Gini coefficient of 0.78 in 2012, Germany's wealth inequality is one of the highest (Grabka and Westermeier, 2014). The high wealth concentration in Germany is often seen as a source of socio-political problems (Piketty, 2014). However, a snapshot of the distribution of wealth in a cross-section does not take population heterogeneity into account (Davies, 2011) and hence, runs the risk of overestimating inequality. Theoretically, the analysis is motivated by the standard life cycle saving model (LCM) of Modigliani and Brumberg (1954) which models wealth accumulation for life cycle purposes. The model abstracts from inheritances and thus is purely intra-generational (Davies and Shorrocks, 2000). The LCM specifies a representative individual's consumption/saving planning problem over a lifetime (Jenkins, 1990) and aims at explaining current differences in self-accumulated wealth by the optimizing behavior of rational economic agents. According to the LCM, individuals aim to smooth consumption to equalize its discounted marginal utility over the lifetime, so that the model predicts that wealth holdings vary with age (Davies and Shorrocks, 2000). In the very basic model, the old-age provision motive, stating that individuals accumulate wealth to finance expenditures after retirement, is the main saving motive. Accordingly, wealth is accumulated during the earning span and dissaved during the time of retirement, so that the age-wealth relationship shows a hump-shaped pattern. This implies a "natural" large wealth concentration among the elderly, as older people had more time to accumulate wealth than younger people (Piketty et al., 2006). Thus, substantial wealth inequality may arise simply due to the fact that people are observed at different stages of their lifetime. These age-related wealth differences would not represent differences in lifetime opportunities, but a purely demographic phenomenon of much less concern for public policy (Davies and Shorrocks, 2000). Against this background, in a cross-section, it is important to distinguish wealth differences within age groups from those between age groups.

Second, relative population shares of age groups are likely to have a significant impact on the wealth distribution and its evolution over time (Davies, 2011). According to the most recent population projections of the German Federal Statistical Office, Germany is facing a significant demographic change. Germany's total population will drop from roughly 81 million at the end of 2013 to 68 million (73 million under the assumption of higher immigration) in 2060, mainly due to its relatively low fertility rate. Although international migration is growing, it cannot stop this development. At the same time, as a consequence of continuing increases in life expectancy, the share of elderly people will increase considerably. The aging process will be mainly reflected by a growing number of the oldest seniors. The percentage of the German population aged 80 or over is expected to rise from 5.4 percent in 2013 to around 13 percent in the next fifty years (Destatis, 2015). In the light of the aging of the German population, in our mind, it is worth investigating the distributional effects of an increase in age on wealth.

Our work is related to the literature on the relative importance of life cycle factors as a source of wealth inequality. There are several studies that test whether the LCM is a plausible approximation of the real world. Many of them are based on simulations of perfect egalitarian societies in which individuals only differ with respect to age (Davies and Shorrocks, 2000). Atkinson (1971) is one of the first who models such a society and calculates the shares of the top 1, 5, and 10 percent of wealth-holders. He compares the hypothetical wealth shares with those estimated for Britain and finds out that the latter shares are substantially larger and that wealth within age groups is still very unequally distributed. Oulton (1976) comes to a similar conclusion. He shows that age differences only account for 10 percent of the observed inequality in Britain. Simulations of egalitarian societies in which individuals differ in both age and income lead to a better approximation of actual wealth inequality (Flemming, 1976; Davies and Shorrocks, 1978). All in all, simulation studies show that although life cycle factors are important, they can only explain a small, or if allowing for income differences as well, at least not the major part of wealth inequality. Additionally, life cycle factors seem to play an even smaller role at the upper tail of the wealth distribution (Atkinson, 1971; Flemming, 1976).[2]

There are a number of studies that derive an age-adjusted Gini coefficient relying on a definition of equality such that differences of wealth due to age are allowed. Paglin (1975) is the first who addresses the idea of an age-adjusted Gini coefficient and defines the so called Paglin-Gini. In contrast to the "classical" simulation studies, the author finds that in 1962, age explains a large part of wealth inequality in the US. The traditional Gini coefficient, that does not adjust for age effects, overstates the degree of wealth inequality by about 52 percent. The author's proposal of an age-adjusted Gini coefficient in cross-sectional distributions has been commented on and has been further developed by many authors, e.g. Danziger et al. (1977), Johnson (1977), Kurien (1977), and Minarik (1977) (Deutsch and Silber, 1999). Pudney (1993) isolates the life cycle effects of age on income and wealth for Chinese households using non-parametric density and regression estimation techniques. He shows that only a small part of the observed wealth inequality in China can be explained by life cycle factors. Cowell et al. (2013) calculate the contribution of cross-country differences in the age structure to differences in levels of household wealth inequality for the UK, Italy, Finland, Sweden and the US. Applying a counter-factual decomposition analysis, they also find small explanatory power of age. Piketty et al. (2006) use a more descriptive approach and focus on the development of the age effect. They provide data about the development of the age-wealth profile from the 19th century until

[2] See Davies and Shorrocks (2000) for a more detailed review of the literature.

today. They find that it was hump-shaped at the beginning of the 19th century, while nowadays, it is relatively flat, indicating that the between-age-group inequality respectively the relative importance of age as a source of wealth inequality has decreased over the last century.

Our study is closest to the one by Azpitarte (2010) who decomposes the Gini coefficient for Spain by age subgroups among others. The aim of his study is to investigate the role of age differences in explaining why wealth is much more unequally distributed than income. He finds a clear hump-shaped age-wealth profile and the between-age-group inequality to contribute 29 percent to total wealth inequality. Given that the between-age-group inequality accounts for a higher share of income inequality (32 percent), the author concludes that differences between age groups play an important role in the explanation of wealth inequality, but that they cannot explain why wealth is much more unevenly distributed than income. However, the study relies on household wealth data and age is defined as the age of the household head. As the author himself points out, a lot of young Spanish adults live in households together with their parents, where the father or the mother is the household head. This may reduce the importance of age in explaining household wealth inequality in this study.

Summarizing, the empirical evidence with regard to the contribution of life cycle factors, and age in particular, as a source of wealth inequality is highly controversial, depending on the country that is focused on and especially on the methodology that is employed. Studies about the decomposition of wealth inequality are still rare, probably due to data unavailability or limitations in the application of decomposition techniques to variables with negative values. Empirical economic research has largely focused on the decomposition and development of income inequality so far. Most of these studies aim to capture the part of the trend in income inequality that is due to changes in the population age structure (e.g. Mookherjee and Shorrocks, 1982; Jäntti, 1997; Jenkins, 1995; Johnson and Wilkins, 2004)[3] and the part that is due to other demographic characteristics (e.g. Soltow, 1960; Fishlow, 1972; Cowell, 1984).[4]

To the best of our knowledge, there is no study that analyzes the quantitative importance of age-related wealth differences and the effects of age on different points of the wealth distribution for Germany. Therefore, employing the Gini coefficient, we first decompose wealth inequality by age subgroups. The use of the Gini coefficient allows us to include negative wealth values, which are often neglected in other studies, and to derive additional useful information about the degree of overlap between the age subgroups' wealth distributions. Second, we employ unconditional quantile regression to analyze the effect of age on different points of the wealth distribution. Thus, we add to the literature by applying this relatively new method, which has mainly been used in the analysis of wage differences so far, in the context of wealth.

Our analysis relies on survey data from the German Socio-Economic Panel (GSOEP) that, as one of a few datasets, contains information on individual wealth for people aged 17 years and older. Data from the GSOEP is especially suitable for the analysis as it accounts for the usual problems arising in sample surveys on wealth issues, i.e. sampling and non-sampling errors. Moreover, we are able to connect the wealth information with a variety of

[3]See Burtless (2011) for a review of the literature.
[4]See Deutsch and Silber (1999) for a review of the literature.

socio-demographic and -economic variables. In 2002, the wealth questionnaire is launched for the first time and is repeated every 5 years, so that we use data of the years 2002, 2007 and 2012.

Our results show that inequality between age groups accounts for around one third of overall wealth inequality, indicating that age is important for explaining wealth differences in Germany. However, unconditional quantile regression results suggest that the relative importance of age as a source of wealth inequality differs across the distribution. We find that age has no effect on low quantiles and an almost linear effect for the higher ones. For the middle part of the distribution, results show the expected hump-shaped age-wealth relationship. A combination of these results provides tentative evidence that a rise in mean age of the German population may lead to a growing dispersion of wealth at the upper tail of the distribution - given all other parameters stay constant.

The rest of the paper is structured as follows. Section 2 gives a detailed overview of the survey data used in the analysis. Research methodology and empirical results of the inequality decomposition and unconditional quantile regression analyses are presented in sections 3 and 4, respectively. Finally, in section 5, we discuss the findings and point to issues left for further research.

2 Data

The empirical analysis relies on data taken from the GSOEP which has been conducted annually since 1984 and contains a variety of socio-economic characteristics both at the household as well as at the individual level.[5] In 2002, for the first time, the panel survey additionally provides information on individual wealth holdings of persons aged 17 years and older. Since then, it is collected every 5 years, so that we use wealth data on the individual level for the years 2002, 2007 and 2012. Analyses of wealth holdings often are problematic due to data limitations. The main difficulty with population sample surveys is to ensure an adequate response rate. Given that information on wealth is highly sensitive, item non-responses occur quite often. Especially high wealth is underrepresented, since rich people avoid reporting on their wealth, so that there is selection in the data and representativeness of the sample is not given. The GSOEP accounts for this problem by multiple imputation of missing data values.[6] Moreover, it allows investigating wealth issues on the individual level and provides information over a large range of distinct wealth components. However, the GSOEP also has some shortages. It does not provide information on wealth components like cars or furniture, nor on pension entitlements. Given that especially in Germany, public pension entitlements play an important role for the majority of the working population, wealth in the GSOEP is likely to be underestimated.[7]

The GSOEP wealth questionnaires survey eight components of wealth: owner-occupied property, other property (both including mortgage debt), financial assets, business assets, tangible assets, building loan contracts, private insurances, and consumer debts. Hereby, other property comprises all forms of housing equity apart from the own-

[5] For an overview of the SOEP see Wagner et al. (2007).
[6] For a detailed description of the imputation process see Grabka and Westermeier (2015).
[7] There is a large debate about whether a complete recording of wealth must take pension entitlements into account. On the one hand, they do not fulfill most of the standard wealth functions (Frick and Grabka, 2010), on the other hand, they play an important role for financial security and well-being (Bönke et al., 2016).

occupied property, in particular, apartment buildings, vacation homes and undeveloped land. Financial assets are reported as the net value of saving accounts, bonds, shares and investments. Business assets contain all forms of commercial enterprises, i.e. companies, shops, offices, practices and farms, while tangible assets consist of gold, jewelry, coins and valuable collections. Finally, private insurances comprise life insurance policies and private retirement plans including Riester and Rürup pensions.

Our wealth measure of interest is total net wealth of an individual. Net wealth is defined as the sum of total gross assets minus total liabilities that are surveyed in the GSOEP. Liabilities are the sum of mortgage debts collaterized with own-occupied property, mortgage debts collaterized with other property and non-mortgage debts in form of consumer credits. If there are joint wealth holdings among couples or families, e.g. joint own-occupied housing equity, every person is asked to report its individual share of the respective wealth component. To get the value of individual wealth holdings, we multiply the distinct joint wealth components with the respective percentage the individual owns thereto. Finally, the resulting values are summed up.

As we want to investigate the role of age as a source of wealth inequality, we divide the total population into seven age groups. In line with Grabka and Westermeier (2014) among others, the age subgroups are classified as follows: 17-25, 26-35, 36-45, 46-55, 56-65, 66-75 and >75 years. Table 1 presents the most important distributional statistics by the distinct age subgroups and reveals substantial differences in their wealth distributions.[8] As predicted by the life cycle model, for all years under consideration, we observe a hump-shaped pattern of the cross-sectional age-wealth profile. Indeed, average wealth first increases with age and reaches its peak in the 56-65 age group in 2002 and 2007, respectively in the 66-75 age group in 2012. Afterwards, average wealth is decreasing, reflecting the theoretical concept of dissaving in retirement.

Table 1: Distributional statistics by age subgroups

	2002			2007			2012		
	Mean	Median	Gini	Mean	Median	Gini	Mean	Median	Gini
17-25	4,380	0	0.96	4,938	100	1.19	6,630	0	0.95
26-35	30,977	5,000	0.90	27,317	4,860	0.96	20,988	3,765	0.92
36-45	73,063	27,000	0.73	70,079	20,300	0.78	66,124	21,029	0.76
46-55	108,523	48,100	0.70	100,214	35,528	0.74	105,516	40,000	0.73
56-65	122,552	55,000	0.68	128,541	58,000	0.69	118,406	64,990	0.67
66-75	109,139	47,688	0.68	108,841	40,859	0.70	131,437	67,500	0.66
>75	92,627	19,400	0.72	109,391	25,000	0.73	109,012	39,000	0.70

Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

This relationship between age and wealth is also shown by the age composition of wealth quintiles, which is displayed in table 2 (columns 2 to 7). For comparison purposes, column 9 shows the population shares in each age group. While in the lower part of the distribution, younger individuals are overrepresented, in the top 30 percent of wealth holders, middle-aged subgroups are overrepresented and the age composition shows a hump-shaped pattern. Older individuals are mainly present in the middle-upper part of the distribution. All in all, these figures suggest that there is a clear age-wealth profile in Germany that may contribute to explain differences in wealth.

[8]See table A1 in the appendix for summary statistics and inequality measures for individual net wealth holdings of the

Table 2: Age composition of wealth percentiles

	Bottom 10%	Next 20%	Next 20%	Next 20%	Next 20%	Top 10%	Obs.	Pop. shares
				2002				
17-25	8.3	47.3	19.8	3.1	0.3	0.3	3,094	12.9
26-35	32.4	22.1	21.6	17.6	6.9	3.9	3,612	15.1
36-45	31.0	15.3	19.4	29.1	25.7	18.2	5,220	21.8
46-55	17.5	7.9	12.6	19.3	26.8	27.3	4,350	18.2
56-65	7.5	5.1	11.3	16.5	21.9	29.4	3,888	16.2
66-75	2.8	2.0	9.4	10.3	12.9	14.0	2,450	10.3
>75	0.6	0.3	5.9	4.2	5.5	6.9	1,278	5.3
All	100	100	100	100	100	100	23,892	100
				2007				
17-25	8.5	42.0	20.3	4.0	0.5	0.1	2,305	11.0
26-35	27.5	27.6	20.4	14.7	4.6	2.4	2,721	13.0
36-45	31.2	9.3	17.5	26.5	20.7	15.1	4,149	19.9
46-55	18.5	8.8	12.4	20.2	25.3	24.8	3,910	18.7
56-65	9.3	3.8	9.3	13.9	22.7	28.4	3,280	15.7
66-75	4.3	6.8	12.5	14.0	18.8	19.9	3,007	14.4
>75	0.7	1.8	7.6	6.8	7.4	9.3	1,497	7.2
All	100	100	100	100	100	100	20,869	100
				2012				
17-25	19.6	35.2	17.7	2.4	0.2	0.3	1,730	9.4
26-35	16.4	20.8	19.9	12.4	3.1	1.2	2,132	11.6
36-45	15.1	11.1	14.9	19.7	13.8	9.2	2,742	15.0
46-55	16.1	12.6	14.7	23.4	24.6	24.1	3,678	20.1
56-65	13.9	8.0	10.3	17.7	25.9	28.0	3,328	18.2
66-75	10.9	7.2	12.0	15.8	22.0	25.3	2,969	16.2
>75	8.0	5.1	10.4	8.7	10.4	11.8	1,749	9.5
All	100	100	100	100	100	100	18,328	100

Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

It is also interesting to consider wealth inequality within the distinct age subgroups (table 1). As can be observed, in 2002, 2007 and 2012, the degree of wealth concentration varies between the subgroups. With a Gini coefficient of over 0.9[9], it is largest for the two youngest age groups and with Gini coefficients ranging from 0.66 to 0.7, it is smallest within the two age groups of 56-65 and 66-75. However, in every subgroup, wealth is relatively unequally distributed. The median is much smaller than the mean, so that the wealth distribution of every subgroup is right skewed with a long upper tail.

3 Decomposition Analysis - Methodology and Results

Descriptive statistics have shown that there is a clear age-wealth profile in Germany. In order to investigate the quantitative importance of age-related wealth differences, we decompose overall wealth inequality in Germany by age subgroups.

There are several methodological challenges with regard to inequality decomposition that have been discussed in a variety of studies - mostly in terms of income. There evolved two important strands of the literature. Triggered by the influential paper by Theil (1967), the first group of researchers focuses on the class of additively decomposable inequality measures. In the context of inequality decomposition, the advantages of attractive decomposition properties, in particular additive decomposability, are often mentioned. Substantial research effort has been devoted to axiomatically derive inequality indexes which could be decomposed into the sum of between- and within-group components (Bourguignon 1979; Shorrocks (1980; 1984)).[10] The second group of researchers in the field of inequality decomposition concentrates on the decomposition of the Gini coefficient (Bhattacharya and Mahalanobis, 1967; Rao, 1969; Pyatt, 1976; Mookherjee and Shorrocks, 1982; Silber, 1989; Yitzhaki and Lerman, 1991; Lambert and Aronson, 1993; Yitzhaki, 1994; Dagum, 1997).[11] They show that the overall Gini coefficient can be decomposed into three contributions: a within-group component, a between-group component and a residual. Lambert and Aronson (1993) among others have argued that the residual must not be considered as a shortcoming as it was the case for a long time. On the contrary, by interpreting it directly and explicitly in terms of an area on the Lorenz diagram, they illustrate that it provides useful information on the degree of overlap between the subgroups' distributions.

Due to the presence of negative values in the case of wealth, the class of additive decomposable measures, at least its members with the most satisfying properties, i.e. Mean Logarithmic Deviation and Theil coefficient,[12] cannot be used in the analysis, since they are defined for positive values only. Therefore, we employ the Gini coefficient which allows for negative values. Besides, it is the most popular and most widely used inequality measure in economic research and has an appealing intuitive interpretation. We decompose the Gini coefficient

whole population.

[9] Note that in the presence of negative values, the Gini coefficient can exceed the value of one.

[10] The class of additive decomposable inequality indexes contains the Generalized Entropy family and monotonic transformations of its members. For a detailed description of these measures see Shorrocks (1980).

[11] See Deutsch and Silber (1999) for details.

[12] Apart from these two measures, the weighting coefficients are not independent from the between-group contribution (Shorrocks, 1980).

using the method proposed by Mookherjee and Shorrocks (1982) which builds on Bhattacharya and Mahalanobis (1967), Rao (1969), and Pyatt (1976). Following this method, the Gini coefficient can be written as

$$G = \sum_k v_k^2 \lambda_k G^k + G_B + R, \tag{3.1}$$

where G^k is the Gini coefficient for age group k, G_B is the Gini coefficient that is obtained when every individual wealth is replaced by the average wealth of the subgroup the individual belongs to and R is the residual. The variable v_k is the population share of group k and the variable λ_k is the average wealth of group k relative to that of the whole population. The first term in equation 3.1 corresponds to the within-group inequality and represents a weighted average of the Gini coefficients for every subgroup. The second term corresponds to the between-group inequality. By definition, it is associated with inequality due solely to age-related differences in mean wealth, so that it is referred to as the "age effect". The third term is usually called the "interaction effect" (interaction term) among subgroups. It depends upon the frequency and magnitude of overlaps between the wealth holdings of individuals of different subgroups, so that it is positive if the wealth ranges of subgroups overlap and zero if there is full stratification by age groups (Mookherjee and Shorrocks, 1982).

The results of the Gini decomposition by age subgroups are displayed in table 3. We present the relative contributions of the within-group component, the between-group component and the interaction term. For all years under consideration, the figures suggest that the between-group component is quantitatively important for explaining wealth inequality in Germany. Age-related wealth differences are found to account for 35 to 37 percent of actual wealth inequality as measured by the Gini coefficient. Hence, more than one third of wealth inequality can simply be explained by the fact that people are observed at different points of their lifetime. Given that age-related wealth differences do not represent differences in lifetime opportunities, inequality in opportunities is substantially lower than suggested by cross-section wealth figures. From a political point of view, this finding is quite interesting since inequality resulting from differences in lifetime opportunities is certainly of more concern than differences in age, which simply reflect a demographic phenomenon.

Table 3: Inequality decomposition by age subgroups

	2002	2007	2012
Within-group	0.15	0.15	0.14
Between-group	0.36	0.35	0.37
Interaction	0.49	0.50	0.49
Overall	1	1	1

Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

The relative contribution of the within-age-group component to the overall Gini coefficient of net wealth is smaller than that of the between-age-group component. It amounts to 14 to 15 percent, but is far from being negligible. The within-group inequality can further be split off into the relative contributions of the respective age-group's inequality to total within-group inequality. Table 4 shows that the greatest part of the within-group inequality (80 percent in 2002 and 2012, 73 percent in 2007) results from inequality within the middle-aged groups (36-45, 46-55, 56-65), whereas the relative contributions of the two youngest (17-25, 26-35) and those of the two oldest age groups (66-75, >75) play only a minor role. This is likely due to the larger population shares of middle-aged subgroups (see section 2) which overcompensate their lower Gini coefficients.

Table 4: Relative contributions of within-age-group inequalities

	2002	2007	2012
17-25	0.01	0.01	0.01
26-35	0.07	0.05	0.05
36-45	0.28	0.23	0.27
46-55	0.28	0.27	0.29
56-65	0.24	0.23	0.24
66-75	0.09	0.17	0.11
>75	0.02	0.04	0.03
Total	1	1	1

Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

In all three years under consideration, the largest share of wealth inequality, more precisely 49 to 50 percent, is explained by the interaction term, so that its relative contribution to total wealth inequality is as large as that of the within-group and the between-group components together (see table 3). This result provides evidence of a high degree of overlap of the age subgroups' wealth distributions, indicating that there are many individuals of older age groups that have less wealth than those of younger age groups and vice versa. Accordingly, there are young individuals who are relatively rich and older individuals who have comparatively low wealth holdings, thus providing tentative evidence that there are a number of individuals whose life cycle wealth accumulation deviates from the standard hump-shaped pattern predicted by the LCM.

Concluding, one can say that age is important as a source of wealth differences in Germany, so that part of the observed cross-section wealth inequality is spurious from an equity perspective. However, there is also a substantial part that is attributable to other factors.[13]

4 Unconditional Quantile Regression - Methodology and Results

As we have seen in the previous section, although between-age-group differences are high, they do not account for the major part of overall inequality. To examine the effects of age and additional factors on different points of the wealth distribution, we use the unconditional quantile regression (UQR) approach developed by Firpo et al. (2009). The UQR is based on influence functions that give the influence of a single observation on a distributional statistic, like for example the median. The recentered influence function (RIF) is calculated by adding the distributional

[13] Results of the decomposition of the HSCV (Half the Squared Coefficient of Variation), which is a member of the Generalized Entropy family of indexes and allows for negative values, are available upon request from the authors. They suggest that the within-group inequality explains almost all inequality. This is certainly the result of the high sensitivity of the index to the presence of extremely large values of the variable under consideration (see also Azpitarte, 2010). However, the results are robust with regard to the use of other Gini decomposition methods, as for example to the use of Silber (1989)'s decomposition method based on matrix algebra.

statistic to the influence function. For quantiles, the RIF is defined as

$$RIF(Y; q_\tau, F_y) = q_\tau + \frac{\tau - 1\{Y \leq q_\tau\}}{f_Y(q_\tau)}, \tag{4.2}$$

where q_τ is the estimated sample quantile at τ, $f_Y(q_\tau)$ is the density at the quantile (usually estimated by kernel) and $1\{Y \leq q_\tau\}$ is a variable indicating whether the observation value lies under or above the quantile. We replace the individual wealth observations by the RIF values and use these RIF values as the dependent variable in our regression. Firpo et al. (2009) show that the estimated coefficients of a RIF regression reflect the marginal effects of the covariates on the unconditional quantiles. We estimate the following model by a simple OLS regression method for a wide range of quantiles[14]:

$$RIF_i^q = \beta_0 + \beta_1 Age_i + \beta_2 Age_i^2 + \beta_3 X_i + \epsilon. \tag{4.3}$$

In our analysis, we include age as a quadratic effect since we expect an inverse u-shaped relationship between age and wealth as predicted by theory. Further explanatory variables, which are summarized in X, are gender, region, family status and education.[15] While gender and region are dummy variables, family status and education are categorical variables. The gender dummy is one if the individual is female and zero if the individual is male. The region dummy is one if the individual lives in West Germany and zero if the individual lives in East Germany. Family status is divided into three categories: "married" (reference group), "unmarried" and "divorced or widowed". Education is measured as the highest degree obtained, with "general elementary" as the reference group. The other education classes are summarized in "vocational and middle vocational" and "higher vocational and higher education". Summary statistics of the covariates are reported in table A2 in the appendix.

UQR is a useful tool if one is interested in the effect of a marginal change in the age structure on the (unconditional) wealth distribution. In contrast, parameter estimates of conditional quantile regression (CQR) solely reflect the wealth effect within groups of covariates. For comparison purposes, we show the CQR results in the appendix. Besides quantiles, the RIF regression can also be estimated for several other distributional statistics. We do this additionally for the Gini coefficient. As our main goal is to calculate between- and within-group-inequalities, we are not interested in causality. Probably, our results do not show any causal relationship between age and wealth. If wealth for example has a positive influence on life expectancy, our sample would reflect a positive selection in higher age groups. Wealth in these age groups would be overestimated.

The results of the RIF regression for age and age squared for a set of quantiles for 2012 are shown in figure 1

[14] Firpo et al. (2009) show that results are similar if the equation is estimated by a logit regression or a non-parametric method.

[15] The life cycle model suggests that the accumulation of wealth is determined by permanent rather than current income (Sinning, 2010). Unfortunately, a measure of permanent income is not available in the GSOEP. Anyway, permanent income is likely to be highly correlated with age, so that its inclusion in the regression would produce problems of multicollinearity.

and 2, respectively. The black lines represent the quantile effects and the blue lines reflect the OLS results. The dashed lines are the corresponding 95 percent confidence intervals.

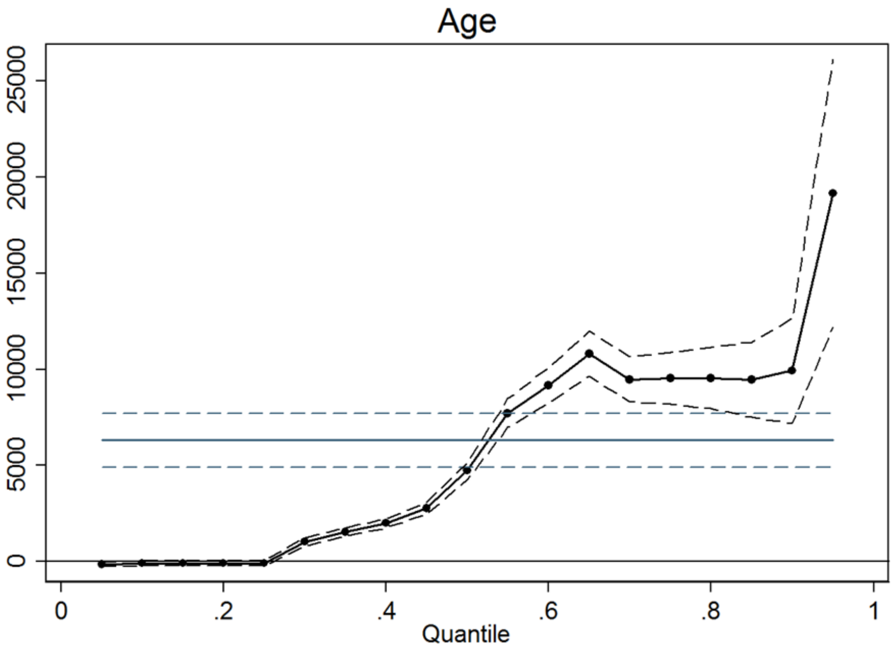

Figure 1: Unconditional quantile regression results - the effects of age. The black line shows the age effect at different quantiles and the blue line shows its effect at the mean. The dashed lines are the corresponding 95 percent confidence intervals. Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

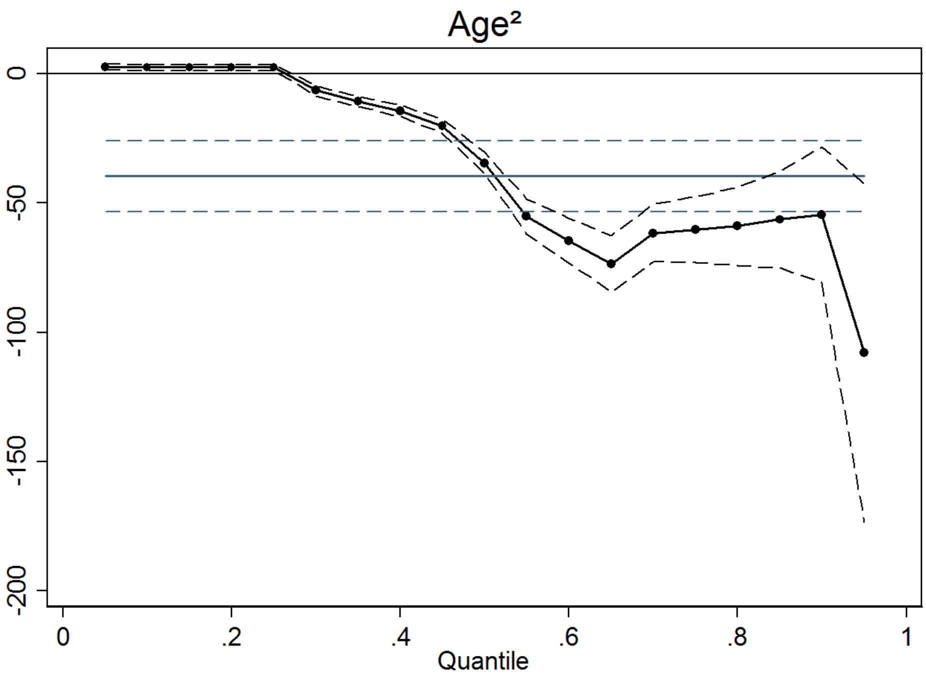

Figure 2: Unconditional quantile regression results - the effects of age squared. The black line shows the effect of age squared at different quantiles and the blue line shows its effect at the mean. The dashed lines are the corresponding 95 percent confidence intervals. Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

Results reveal substantial heterogeneity in the effect of age across the wealth distribution. We find that age has no effect on the wealth dispersion for quantiles below the 25th quantile. For the lower-middle part of the distribution, results show the well-known inverse u-shaped relationship between age and wealth that is predicted by theory. Results suggest further that the effect of age is almost constant for quantiles between the 60th and 90th and monotonically increasing for the highest ones (90th and 95th). This pattern is similar for all years under consideration.[16] For illustration purposes, we give a numerical example in table 5, which presents the calculated effects of age for the 10th, 50th, 65th and 90th wealth quantile for 2012 (columns 2 to 5).[17] As age enters the regression as "age" and "age squared", the effects depend on the current level of age. Thus, we show the effects at different ages, in particular, at the age of 30, 60 and 90 years. In columns 6 to 8, table 5 reports calculations of the effects of age on wealth inequality as measured by the 50-10, 90-50 and 90-65 gap, respectively. The 50-10 gap for example is the difference between the effect on the 50th and the effect on the 10th quantile. The other gaps are defined accordingly. First, results suggest that there is a positive relationship between age and wealth inequality at almost all ages. Second, the inequality increasing effect of age is found to be larger at the higher than at the lower end of the wealth distribution. At an age of 30 for example, one additional year increases the 90-50 gap by about 4,000 euro, while it increases the 50-10 gap only by about 2,600 euro. However, we find that the positive link between age and wealth inequality at the lower part of the wealth distribution is only true until a "turning-point" age. For the median, it lies at 68 years for example. Accordingly, in retirement ages, there seems to be an alignment at the lower end of the wealth distribution. At an age of 90 years, results suggest that an increase in age by one year decreases the 50-10 gap by 356 euro. Results of the Gini regression show that age has a small but negative effect on overall wealth inequality in all years under consideration (see table A3 in the appendix). Based on our UQR results, we are tempted to conclude that this is likely due to the alignment of lower and middle wealth quantiles in older ages.

Table 5: Estimated effects of age on wealth quantiles and wealth inequality

		Quantiles				Inequality	
Age	10th	50th***	65th***	90th***	50-10 gap	90-50 gap	90-65 gap
30	61	2,654	6,397	6,645	2,593	3,991	248
60	199	580	1,983	3,374	381	2,794	1,391
90	244	-112	511	2,283	-356	2,395	1,772

Calculations from UQR results for *age* and age^2. ***Significance at the 99 percent confidence interval. Source: GSOEP 2012 with 0.1 percent Top-Coding, author's own calculations.

We can summarize that, if all other structural parameters stay constant, an aging of the population will lead to an increase in the dispersion of wealth if the population is currently relatively young. The older the population already is, the lower is this effect. If the share of retired people increases, wealth inequality is likely to decrease at the lower and middle end of the distribution, while the wealth gap between the majority of the population and the very rich people even will increase. Hence, at least part of the increase in the gap between the people of middle wealth classes and the richest ones, which has been observed over the last years, can likely be explained by the

[16] UQR results for 2002 and 2007 are shown in figure 3 and 4, respectively. For comparison purposes, CQR results are displayed in figures 6, 7, 8.

[17] Results for 2002 and 2007 are available upon request from the authors.

demographic change.

The effects of the other covariates on the wealth distribution are presented in figures 3, 4 and 5 in the appendix. Results indicate that an increase in the share of highly educated people would increase the level of wealth as well as overall wealth inequality. Results further suggest that West German people are wealthier, but that wealth in West German counties is less equally distributed than in East German counties. Moreover, we find that average wealth holdings of women are lower than those of men, but that wealth among women is more evenly distributed. While at the lower end of the distribution, we can observe the same picture for singles compared to married individuals, at higher quantiles, singles are still poorer than married individuals, but inequality among singles is higher.

5 Discussion and Conclusion

Recent studies indicate that wealth inequality in Germany is quite high, yielding to a lively discussion about its economic, political and social consequences as well as to the development of policy instruments to reduce it. The paper's contribution in this debate is to examine the importance of life cycle factors, in particular age, as a source of wealth inequality in Germany, which is especially worth investigating in times of significant demographic aging of the German population. The analysis is motivated by the implication of the LCM that substantial wealth inequality may arise simply due to differences in age. Using cross-section data from the GSOEP for 2002, 2007 and 2012, we decompose the Gini coefficient by age subgroups in order to quantify the relative contribution of age to overall wealth inequality and employ unconditional quantile regression to analyze the effects of age on different points of the wealth distribution.

Inequality decomposition results suggest that the between-age-group inequality accounts for more than one third of overall wealth inequality, implying that there is a significant "natural" wealth gap between younger and older Germans. Thus, a substantial part of wealth differences in cross-sectional analyses can simply be explained by the fact that people are observed at different stages of their lifetime and thus simply reflects a demographic phenomenon. Hence, inequality of opportunity, which is a major concern for public policy, is significantly lower than actual wealth inequality figures suggest. Unconditional quantile regression results show that the effect of age on wealth is heterogeneous across the distribution. We can largely distinguish three effects: First, age has no effect on low quantiles, indicating that in each age group, there are individuals with very low or even zero wealth, resulting in a significant overlap of low wealth values across age groups. This finding is supported by the quantitative importance of the interaction term, which is found to account for nearly 50 percent of total wealth inequality. Second, we find that age has an almost constant effect on middle-upper wealth quantiles and a monotonically increasing effect on the highest ones. Third, for the middle part of the distribution, we find the hump-shaped age-wealth profile that is predicted by theory, indicating that for the middle class, life cycle factors play an important role in the wealth accumulation process. Summarizing, age is important as a source of wealth inequality in the middle and upper part of the distribution, but is of less importance in the lower part. Based on a combination of our results, we are tempted to conclude that a rise in the mean age of the German population is likely to lead to a growing dispersion of wealth at the upper tail of the distribution - given that all other parameters stay constant. Consequently, the aging of the German population may lead to an increase in overall wealth inequality.

Our conclusions about the effect of age on wealth and its distribution are based on the analysis of cross-sectional data. However, in a cross-section, the effect of age may not only capture differences in wealth holdings due to the fact that individuals are at different stages of their life cycle, but also due to cohort differences. The effect of age in a cross-sectional analysis tests the life cycle hypothesis only, if one assumes identical age-wealth profiles for all cohorts. If however, we would expect younger generations to have flatter age-wealth profiles than older ones for example, the effect of age would be overestimated and would partly reflect a cohort effect. To distinguish life cycle effects from cohort effects, an analysis based on longitudinal data is necessary. Therefore, the estimation of a cohort model based on panel data could be an interesting approach for future research on this topic.

Results have shown that current wealth differences cannot completely be explained by differences in age. Other factors that were not considered in the analysis are likely to contribute to actual wealth inequality in Germany as well. Against this background, inequality decomposition by other socio-demographic variables can be valuable to gain a more comprehensive and complete picture of the driving forces of wealth inequality in Germany. According to the literature, inheritances play an important role as a source of wealth inequality, especially at the upper end of the distribution (Davies, 2011). Based on the finding that wealth inequality is mainly driven by the older age groups' extremely high wealth holdings, it would be particularly interesting to analyze the effects of inheritances on wealth inequality in more detail. So far, existing studies on the effects of inheritances across the wealth distribution focus on the Anglo-American regions, so that there is a need for future research on this topic for Germany.

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6 Appendix

6.1 Tables

Table A1: Distributional statistics for the whole population

	2002	2007	2012
Percentiles (in euro)			
p99	755,200	778,500	806,000
p95	319,212	317,467	320,000
p90	210,000	205,000	216,600
p75	97,476	91,050	100,000
p50	15,450	15,000	17,212
p25	0	0	0
p10	0	0	0
p5	-1,010	-3,500	-3,000
p1	-18,600	-27,012	-22,060
Observations	23,158	20,965	18,356
Mean (in euro)	78,995	79,010	82,337
Gini coefficient	0.763	0.788	0.767
p90/p50	13.6	13.7	12.6
p75/p50	6.3	6.1	5.8

Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

Table A2: Summary statistics of regression variables

	2002			2007			2012		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Net wealth	82,718	-252,000	5,711,280	84,147	-518,490	5,360,000	86,851	-256,000	5,370,000
Age	49.31	16.17	98.92	50.15	17.25	97.67	51.04	17.17	101.25
Age^2	2744.94	261.37	9784.34	2827.78	297.60	9539.45	2923.06	294.78	10251.80
Women	0.52	0	1	0.52	0	1	0.52	0	1
West	0.81	0	1	0.79	0	1	0.79	0	1
Fam. status									
Married	60.43			57.58			56.79		
Single	22.54			24.54			26.04		
Wid/Div	17.03			17.88			17.16		
Education									
Low	18.95			16.09			14.26		
Middle	57.92			58.03			57.70		
High	23.13			25.88			28.04		
Obs.	21,587			19,433			17,261		

Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

Table A3: RIF regression of the Gini coefficient

	2002		2007		2012	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	-0.0180***	0.0012	-0.0185***	0.0014	-0.0163***	0.0013
Age^2	0.0001***	0.0000	0.0001***	0.0000	0.0001***	0.0000
Women	-0.0108*	0.0064	-0.0100	0.0074	-0.0100	0.0072
West	-0.0740***	0.0079	-0.0787***	0.0090	-0.0715***	0.0088
Fam. status						
Married			Reference group			
Single	0.0606 ***	0.0096	0.0185*	0.0110	0.0568***	0.0105
Div/wid	0.1125***	0.0091	0.1177***	0.0104	0.1252***	0.0101
Education						
Low			Reference group			
Middle	-0.0391 ***	0.0084	-0.0307***	0.0105	-0.0181*	0.0106
High	-0.0646***	0.0101	-0.0863***	0.0121	-0.0913***	0.0119
Constant	1.3449***	0.0314	1.4260***	0.0372	1.3353***	0.0360
R^2	0.0578		0.0505		0.0650	
Observations	21,587		19,433		17,261	

The dependent variable is the RIF of the Gini coefficient. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

6.2 Figures

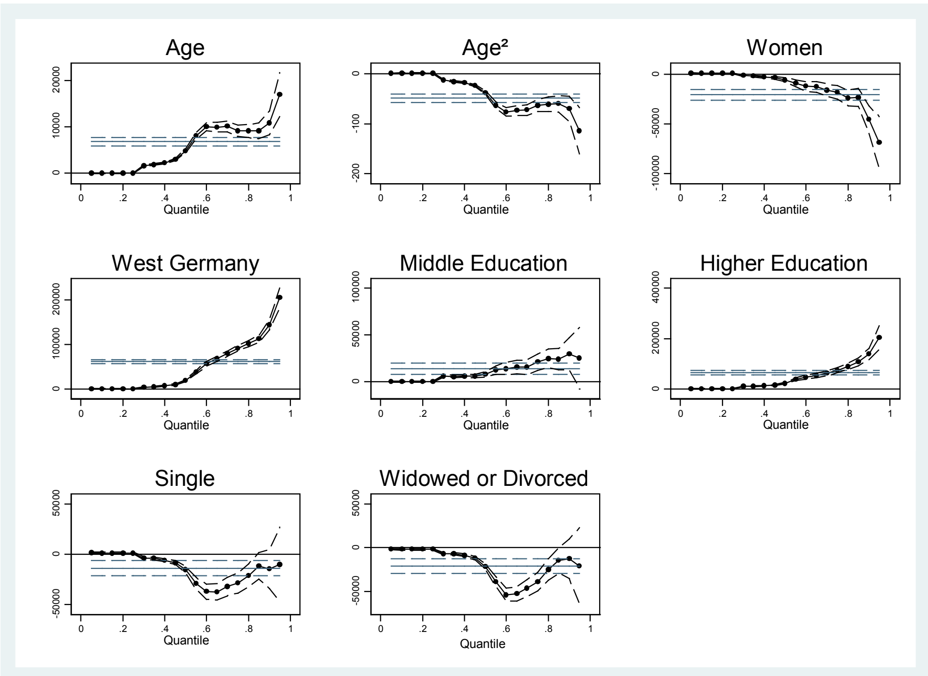

Figure 3: Unconditional quantile regression results for 2002. Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

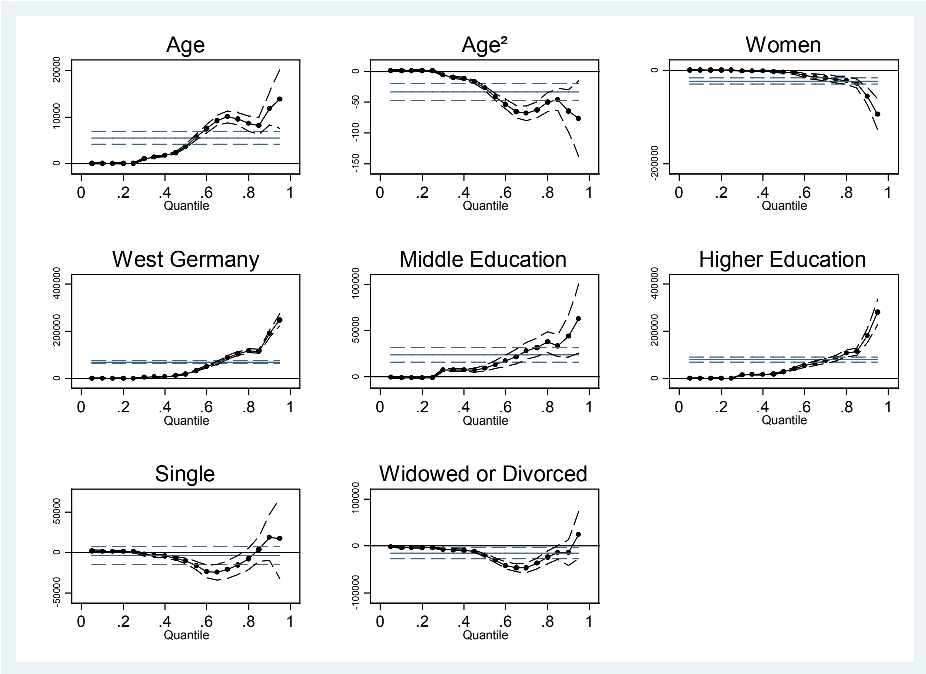

Figure 4: Unconditional quantile regression results for 2007. Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

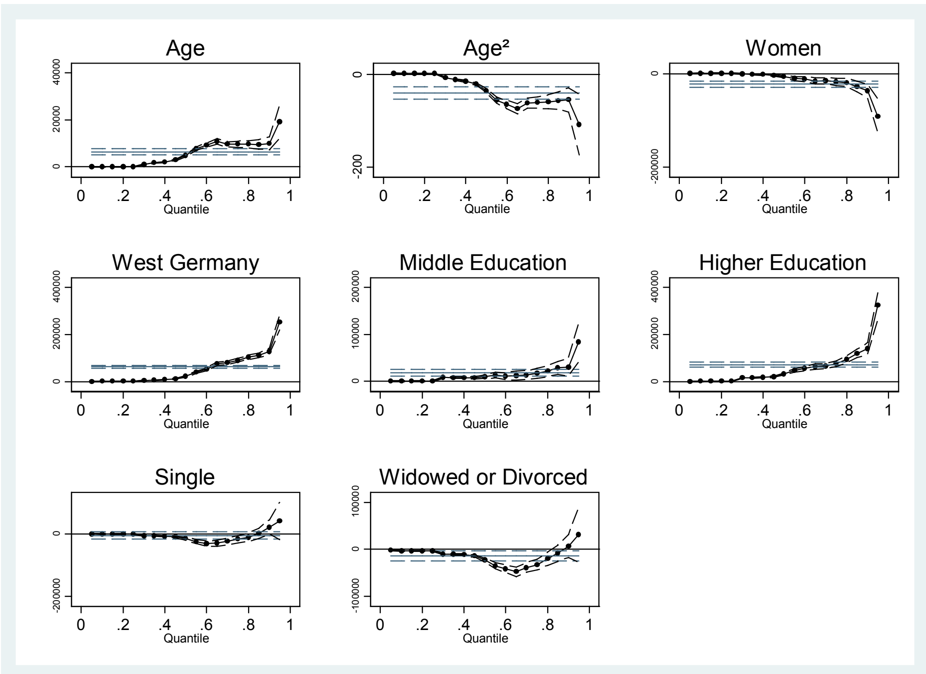

Figure 5: Unconditional quantile regression results for 2012. Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

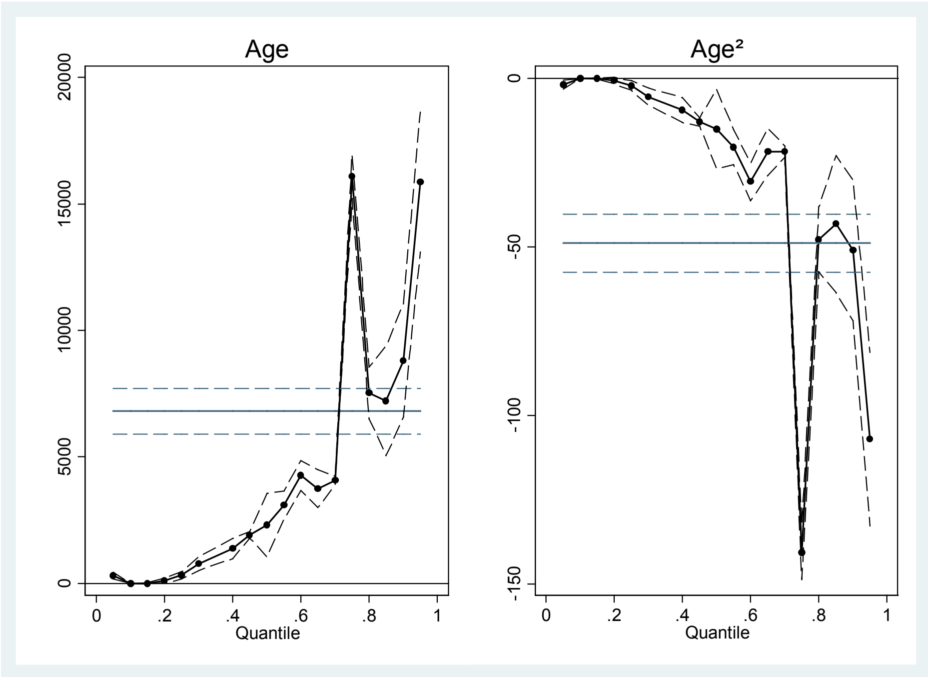

Figure 6: Conditional quantile regression results for 2002 - the effects of age. Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

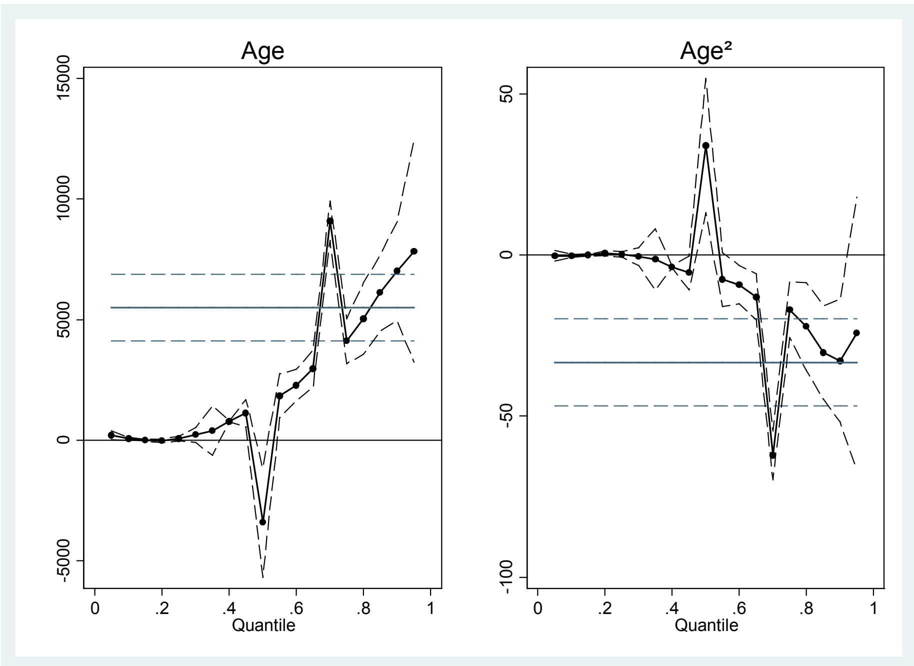

Figure 7: Conditional quantile regression results for 2007 - the effects of age. Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.

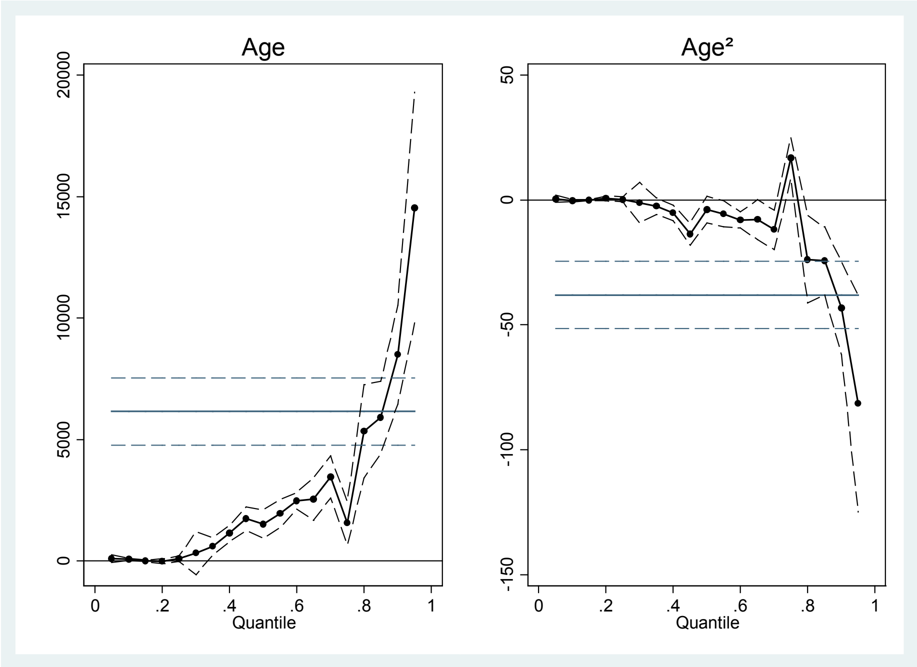

Figure 8: Conditional quantile regression results for 2012 - the effects of age. Source: GSOEP with 0.1 percent Top-Coding, author's own calculations.