Lifetime Inequality and Redistribution in Germany

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Abstract: We employ German social security records and a comprehensive microsimulation model to investigate lifetime income inequality and redistribution within cohorts, starting with those born in 1935. We document a secular rise of lifetime income inequality, both pre-fisc and post-fisc. Over entire life cycles, the German tax-transfer system is found to be progressive and generating substantial effects on the disposable incomes of the two extreme deciles of the lifetime income distribution. The overall lifetime tax-transfer-system is close to linear. Governmental lifetime income redistribution mechanically reduces lifetime inequality by more than a fifth; redistribution displays an inverted-U shape over cohorts. Differential mortality increases lifetime income inequality by just 4 %. We develop a money-metric welfare measure that takes the value of greater longevity into account. We find that differential mortality increases lifetime welfare inequality by a substantially larger amount.

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I. Introduction

Economists are interested in the inequality of people's opportunity sets and these are usually conceived of as long-run sets, covering the bulk of people's lives. Since the seminal contributions by Franco Modigliani and Milton Friedman, most economists believe that this type of inequality is best gauged by the notion of lifetime income or permanent income. Yearly incomes recorded at some point in the life cycle may namely fail to be representative of an individual's position in the long-term distribution, e.g. low incomes during college years and unemployment spells, or high incomes thanks to temporarily skyrocketing bonuses. Lifetime incomes are not subject to these biases and are therefore useful to assess people's long-run opportunities. Since disposable incomes at any point in time are significantly affected by taxes and transfers, and the latter significantly vary over the life cycle, also the picture of governmental redistribution of income that is delivered by a lifetime analysis can substantially differ from the one provided by an annual analysis.

This paper combines high-quality administrative data with a microsimulation model covering sixty-five years of legislation in order to study actual lifetime incomes and the extent of lifetime income redistribution in Germany for cohorts born after 1935. We adopt a cohort perspective and investigate the distributions of both market and disposable lifetime incomes of individuals who were born in the same year.

Our empirical investigation is devoted to the largest European economy, Germany. We exploit data on earnings biographies from social security records as well as the SOEP to shed light on the following issues: How have the levels of real lifetime income evolved across cohorts? What is the magnitude of lifetime incomes inequality and how does it compare to measures of inequality of annual incomes? Is the tax-transfer-system progressive over complete lifetimes and how much cohort-specific redistribution does it generate? How does differential mortality affect lifetime inequality and redistribution within cohorts?

In order to answer those questions we analyze the earnings histories of yearly birth cohorts in Germany, ranging from individuals who were born in 1935 to those born in 1975. We impute the family context during the entire life-cycle and apply a micro-simulation model to compute disposable incomes. The dataset we scrutinize is a highly representative sample of the employee population in West Germany. We study working-life incomes and complete lifetime incomes. Working-life incomes are defined as the present value of an individual's incomes until the individual reaches age sixty.

Findings

Relation to literature

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The next Section describes our dataset and defines the variables of interest. Section III quantifies working-life incomes, their inequality, and the mechanical distributive effect of the tax-transfer-system on cohort-specific inequality. Section IV is devoted to disentangling the effects of women labor market participation and fertility on the evolution of cohort-specific inequality. In Section V we extend the analysis to complete lifetimes, i.e. including retirement and incorporating differential mortality. Along with lifetime income we develop a quantitative analysis of lifetime welfare. Section VI concludes.

II. Data and Methodology

The core of our empirical investigation is based on administrative data of the German social security. Most employees in Germany mandatorily participate in its national pay-as-you-go pension system which, being of the Bismarckian variety, carefully records all contributors' earnings biographies. The dataset we analyze is based on the Insurance Account Sample

(*Versicherungskontenstichprobe*, VSKT for short) of the Federal Pension Register.[1] The VSKT is a stratified random sample of individuals who live in Germany, have at least one entry in their social security record and are aged between thirty and sixty-seven in the reference year of the sample. VSKT waves of reference years 2002 and 2004 to 2016 form the basis of our study.[2] Each sample contains the earnings biographies of the observed individuals up to the reference year. The data are collected following individuals over time so as to form a panel. For each individual, a monthly history of employment, unemployment, sickness, and contributions to the pension system is recorded. It starts when the individual reaches age fourteen and it ends when the individual turned sixty-seven in case of complete biographies. Information about the contributions made to the pension system allows one to recover the earnings received by that individual in each month.

The current investigation focuses on German citizens – including naturalized immigrants with complete earnings biographies in Germany and excluding ethnic Germans that immigrated to Germany after having worked in their country of origin. Because of insufficient comparability of earnings information and wage levels in the FRG and the GDR, we restrict the attention to individuals who have only been working in West Germany.[3] Furthermore, we exclude contributors for whom a consistent earnings biography cannot be reconstructed.[4] In this way we exclude contributors who worked also as self-employed or civil servants, or who emigrated abroad at some point in time, and who may thus have substantial earnings that are not recorded in the Federal Pension Register. After elimination of those observations, we are left with a

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[1] The final dataset we work with (*FDZ-RV − VSKT2002, 2004-2015_Bönke*) is provided to researchers by the Data Research Centre of the German Federal Pension Insurance and it is accessible through controlled remote computing.

[2] A detailed description of the data is given by Himmelreicher and Stegmann (2008). We use all seven samples in our analysis. Information on birth cohorts 1935 and 1936 is picked from the 2002 sample; cohort 1937 stems from the 2004 sample, cohort 1938 from the 2005 sample, cohort 1939 from the 2006 sample, cohort 1940 from the 2007 sample and cohort 1941 from the 2008 sample. Later birth cohorts are covered using the 2009 sample.

[3] West-East migration was almost inexistent before reunification; after reunification it affected a tiny share of the labor force from West Germany, see Fuchs-Schündeln and Schündeln (2009).

[4] More precisely, we only allow for an average of one month of missing information per year after the age of thirty. For further details see Bönke et al. (2015, online appendix I.4).

number of individuals for each cohort that oscillates between 1,000 and 1,600 - see Appendix B, Table B1.[5]

While the dataset we use is virtually free from measurement errors, three adjustments were necessary in order to prepare the earnings data for the analysis. The first one concerns the imputation of one-time payments. Those payments were not included in the social security data before 1984 while they are included from that year onwards. In order to obtain a time-invariant definition of earnings, we exploit the panel structure of our data and estimate each individual's earnings path so as to identify spurious growth between 1983 and 1984. Conditional on an individual's age and position in the earnings distribution we then adjust his earnings before 1984.[6]

Our second adjustment is the addition of the employers' social security contributions (to pension, unemployment, health, and nursing care public insurances) to the individuals' gross earnings. In first approximation, those contributions represent the value of insurance that the employees would have purchased if it had not been provided by the government. Adding those elements of pay is warranted in order to take into account the heterogeneity of insurance protection offered to the various subgroups of the working population - subgroups whose relative weights in the working population have substantially changed across cohorts.[7] Thus, the earnings measure we employ is a measure of the market value of labor. As a major robustness check, we have repeated the entire analysis when the employer contributions are excluded. As shown in Online Appendix III.2, all findings remain qualitatively unaltered - in particular the

[5] In Online Appendix I.5.we document how many individuals are originally included in the dataset and how many remain after eliminating individuals that do not satisfy our selection criteria.

[6] See Online Appendix I.3 for further details and a robustness check. Our method to correct for the 1984 break extends the one proposed by Fitzenberger (1999) and used by Dustmann et al. (2009) and Card et al. (2013) in a cross-sectional setting so as to make it suitable for a longitudinal analysis. While also those papers investigate social security records, their datasets stem from the Employment Register of the Federal Labor Office.

[7] Otherwise, it would be highly problematic to include in the analysis some categories of employees like miners, sailors and distinctive employees of the federal railways that have special social security arrangements.

rise of lifetime earnings inequality retains the same order of magnitude when employer contributions are excluded.

Third, we deal with the issue of top-coded earnings. In Germany, employees contribute a share of their gross wage to the mandatory pension system up to a wage ceiling. As a result, our social security data is right-censored as individuals whose wages exceed that ceiling are recorded as if their wages were equal to the ceiling. On average over all years and cohorts, censoring concerns about seven percent of the recorded earnings of men.[8] In order to better approximate the true distribution of top earnings, we impute them to the individuals affected by top coding. Our imputation method rests on the assumption that the upper tail of the earnings distribution behaves according to the Pareto law. We posit that the top ten percent of individual earnings below the contribution ceiling are Pareto-distributed. Then, we estimate the corresponding Pareto-coefficient by OLS. The estimation is conducted separately for all years and birth cohorts. The estimated Pareto-coefficients are then used to determine the distribution of the unobserved earnings above the contribution ceiling. The assignment of estimated earnings to individuals is done so as to preserve the individual rankings in the distribution of annual earnings. Thereby, the rank of an individual is based on the last observable rank in relation to all individuals at or above the contribution ceiling in the cohort-specific earnings distribution. We also explore the implications of two alternative imputation methods: an imputation of the estimated mean income above the ceiling to all individuals with top-coded earnings and a maximum mobility scenario where the ranking order is reversed every year. Results from those alternative imputations are reported in Online Appendix III.3. They do not differ much from those obtained under our preferred rank-preserving assumption.[9]

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[8] Further information about how censoring affects our sample is provided in Online Appendix I.2. There we also provide additional information on our imputation procedure.

[9] In Online Appendix III.7 we also present a robustness check concerning the bottom of the distribution. Legislated exemptions from social security contributions may lead to an underrepresentation of very low earnings in some years. As it turns out, simulating a constant exemption regime over time generates qualitatively the same results as the ones reported here.

In order to validate the earnings data we work with, we have compared it with the corresponding earnings data from the SOEP, i.e. earnings data that concern the same population in terms of gender, age, region, and employment status as the one we investigate. The SOEP is based on an annual survey of private households and is constructed so as to be highly representative of the total population in Germany. As shown in Appendix A, the cross-sectional earnings distributions obtained from the VSKT reproduce remarkably well those obtained from the SOEP for the same years and the two are statistically undistinguishable. Furthermore, the SOEP data reveal that the VSKT represents about 80% of the total male labor force in West Germany.

In order to determine the disposable income of individuals over their lifetime we have to take the composition of their households as well as the taxes paid and the transfers received by those households.

Since the information contained in the VSKT is not sufficient to determine the household composition of the recorded employees, we extrapolate the household composition by means of a statistical matching of the VSKT data with the SOEP. The adopted procedure entails

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A detailed account of the procedure can be found in the Appendix.

Finally, a detailed micro-simulation model was set up in order to determine the taxes and transfers that affected the households' disposable incomes. The model mirrors the corresponding legislation in the FRG since 1952; in forward-looking analyses we simulated future legislation as based on the one prevailing in the last year of our analysis that was actually observed.

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In the entire paper we employ two income concepts: pre-fisc income and post-fisc-income. A household's pre-fisc income in any given year is defined as the total gross market income generated by labor effort (and private transfers in form of alimonies); in line with the standard life-cycle model, capital incomes are neglected from the computation of lifetime incomes. In other words, we posit that household wealth at any given point in time entirely results from own saving rather than bequests.[10] Post-fisc incomes are defined as the incomes that result from pre-fisc income once the corresponding legislation on taxes and transfers is applied.

III. Working-Life Incomes

The aim of this section is to understand how the long-run disposable incomes of employees evolved in Germany and how such evolution was affected by governmental redistribution of income. Based on the matching procedure and the tax-transfer microsimulation model presented above, we compute the annual incomes of the households in which an individual has lived from age twenty to age sixty, or to the highest age the individual can be observed if this is less than sixty. We then apply the OECD equivalence scale to those yearly incomes and assign the resulting equivalized income to the individual. Based on these equivalized incomes, we then compute the accumulated incomes until some age X is reached, X = 40, …60. We call such incomes "up-to-age-X incomes" or UAX-incomes for short. If X = 60, we call the resulting income "working-life income".

When expressing UAX-incomes, we use year 2015 euros as a unit of measurement. When computing their absolute levels and growth rates, we express the results in real terms, using the consumer price index to homogenize across years. When computing cohort-specific inequality measures of UAX-incomes, we discount incomes using the average nominal returns on German government bonds, obtained from an official time series provided by the German central bank.[11]

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[10] Actually, Bönke et al. (2015) find that about one third of household wealth in Germany is inherited. However, the share of inherited wealth in total household wealth is quite stable across all deciles of the wealth distribution. This suggests that our simplifying assumption should not significantly bias our results.

[11] Details on the methodology used to compute the time series are available at http://www.bundesbank.de/statistik/statistik_zeitreihen.php?lang=de&open=zinsen&func=row&tr=WU0004.

We systematically conduct robustness checks in which nominal incomes are discounted using the inflation rate.[12]

Because of earnings mobility, inequality in lifetime earnings is smaller than inequality in annual earnings. The curve in the upper part of Figure 1 helps to compare yearly inequality with lifetime inequality. It depicts the average of the Gini coefficients of the distribution of yearly earnings for each cohort. That average Gini coefficient ranges from a minimum of X for the 1938 cohort to a maximum of Y for the 1949 cohort. Hence, Gini coefficients of lifetime earnings distributions are somewhat less than two-thirds of the corresponding average Gini coefficients of annual earnings distributions. Inequality measured from annual earnings substantially overestimates the inequality of lifetime earnings, but the latter is by no means negligible.

RESULTS:

Real medians of cohorts' pre- and post-fisc equivalized UAX

Gini coefficients of cohorts' pre- and post-fisc equivalized UAX

Annual Gini coefficients (pre- and post-fisc) of representative cohorts during the life-cycle

Cohorts' degrees of redistribution

Decomposition of total income in each quartile

Volatility of pre- and post-fisc incomes of the various cohorts.

IV. The Effects from Reduced Fertility and Increased Female Labor Force Participation

One of the major changes that occurred in the labour market during the period we investigate is the rise of the participation of women in it. A second major evolution was the

[12] The discounting method affects the level of lifetime inequality but not its evolution. A lower discount rate increases intra-generational inequality because of the steeper rising age-profile of earnings for better educated workers, who are also those with the higher lifetime earnings.

reduction of the number of children living in the households. In order to assess these effects we proceed as follows.

First, we compute the same statistics as above for a different income concept: instead of using equivalized income, we divide household income by the number of adults living in the household. The resulting per-capita UAX incorporate the assumption that in most cases the number of children is a matter of choice and hence a way in which a household allocates its long-run resources rather than a reduction of such resources.

The comparison with the results of the former section gives some hints about the role of fertility. We expect that the growth of per-capita UAX has been higher than for equivalized incomes; however, we do not expect big changes with respect to the evolution of cohort-specific inequality.

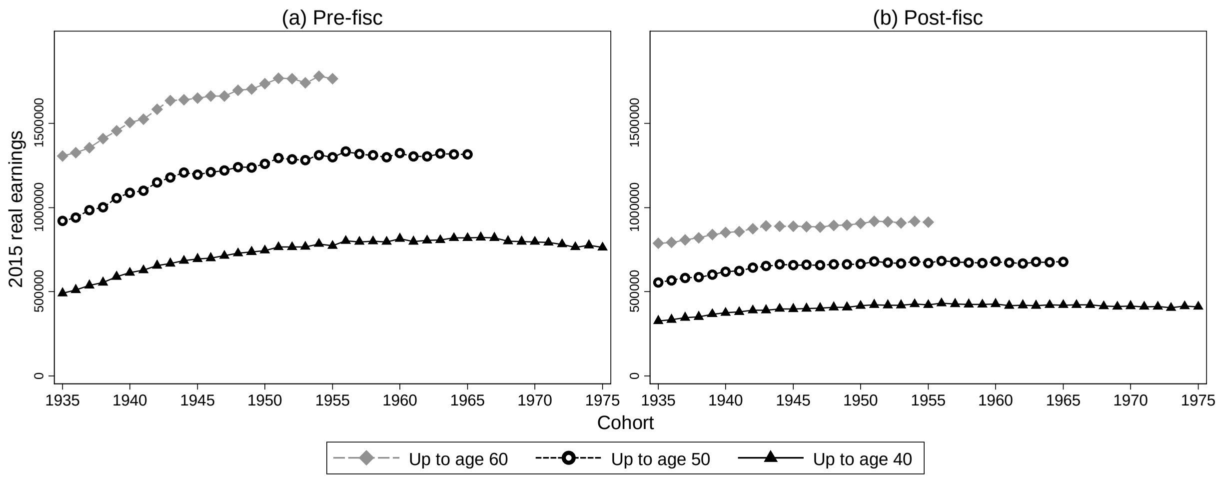
In a second step, we try to gauge the effect from the rise in the labour-market participation of women. We compare the statistics on the per-capita UAX with those that result under the hypothetical counterfactual that all men are single. This mirrors the fact that marriage is a voluntary act; with this “all-singles assumption” we thus capture the potential resources that the employees could have consumed if they had refrained from establishing a family.[13] In this exercise we do not use the SOEP and focus on wage income. This investigation thus avoids the uncertainties from simulating the household composition and it recognizes that marriage is a voluntary decision.

We expect significant effects, both on growth (increased by working wives) and inequality (reduced by working wives).

[13] We neglect the effects of marriage and child-rearing on the labor supply. In the case of men, the empirical literature suggests that these effects are small (Literature?). Furthermore, skill, as proxied by education level, is weakly correlated with marriage and number of children (Lit.?).

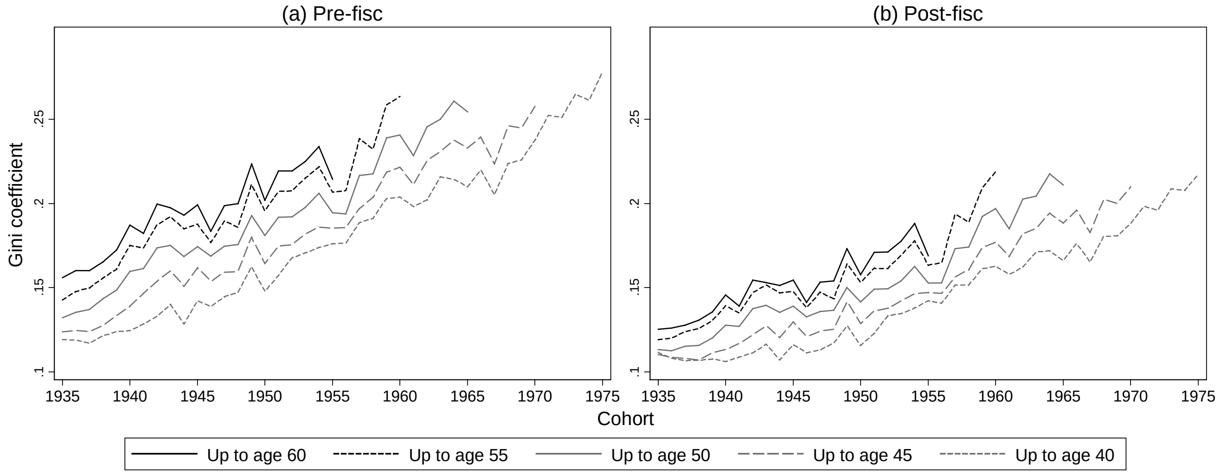
The Figures below show the medians of the UAX (X=40, 50, 60) for all cohorts of men as hypothetical singles; the first one depicts pre-fisc incomes, the second one post-fisc incomes. Real median working-life incomes increased over cohorts when measured before fiscal redistribution. But they almost stagnated in terms of post-fisc incomes: the cohort born in 1955 received only about 7 % more in real terms than the cohort born twenty years before. The evolution of the UA-40 allows one to examine also later cohorts. Both in terms of pre-fisc and post-fisc incomes an inverted-U shape obtains: while the cohort born in 1955 received after redistribution about 23 % more in real terms than the cohort born in 1935, the one born in 1975 only obtained 7 % more.

Comparison with per-capita and equivalized incomes.



We now turn to the evolution of long-run inequality. The following two figures depict the evolution respectively for accumulated pre-fisc incomes (earnings) and for post-fisc incomes, both discounted using federal bonds.

Comparison with per-capita and equivalized incomes.



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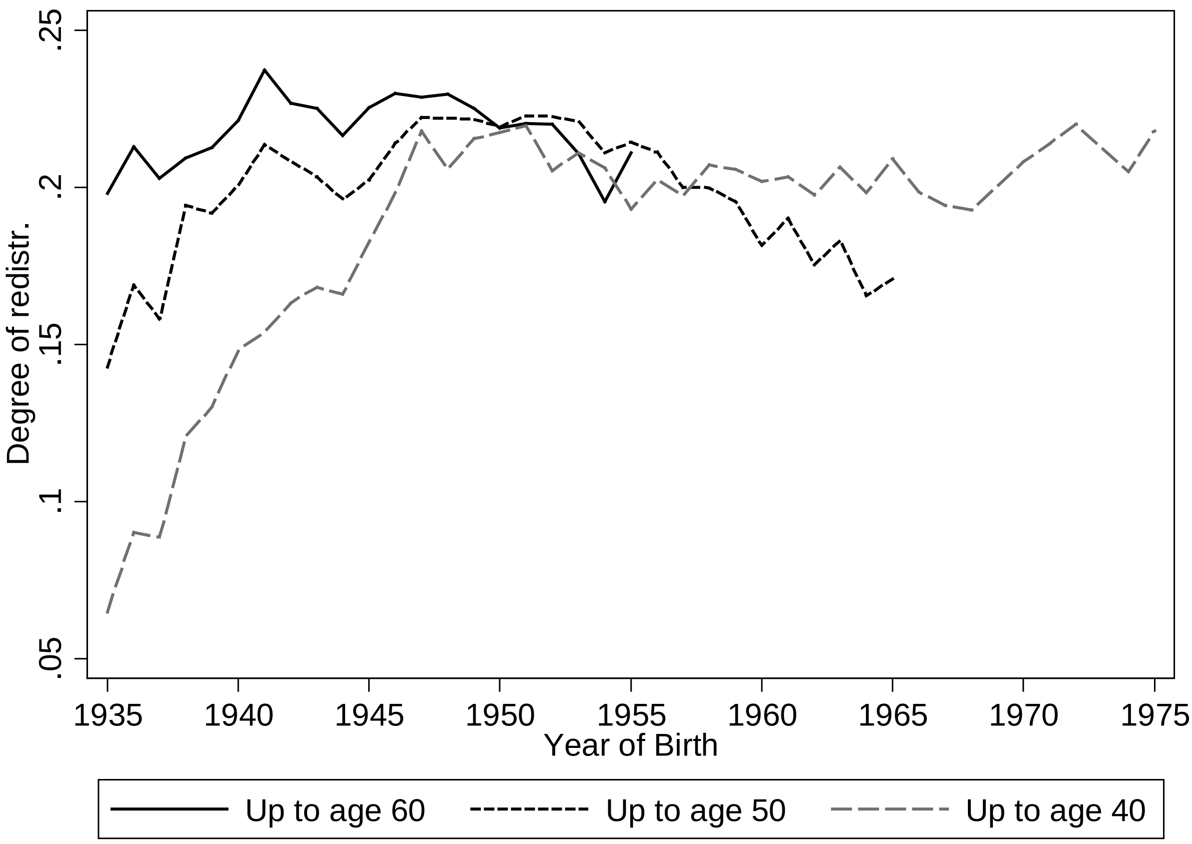
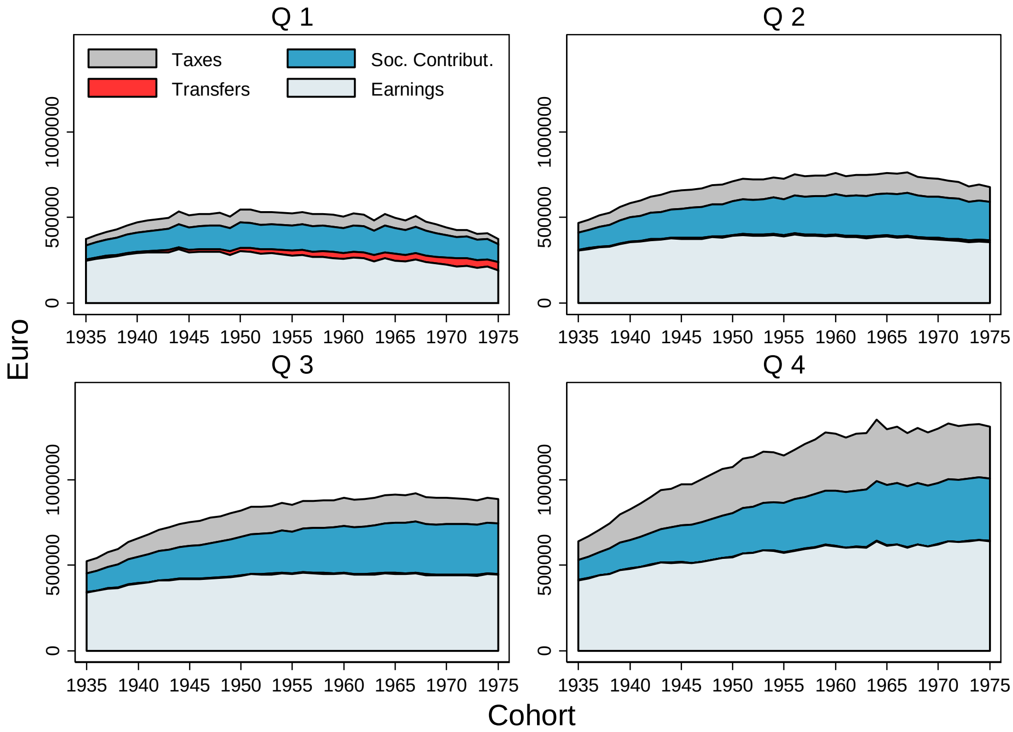
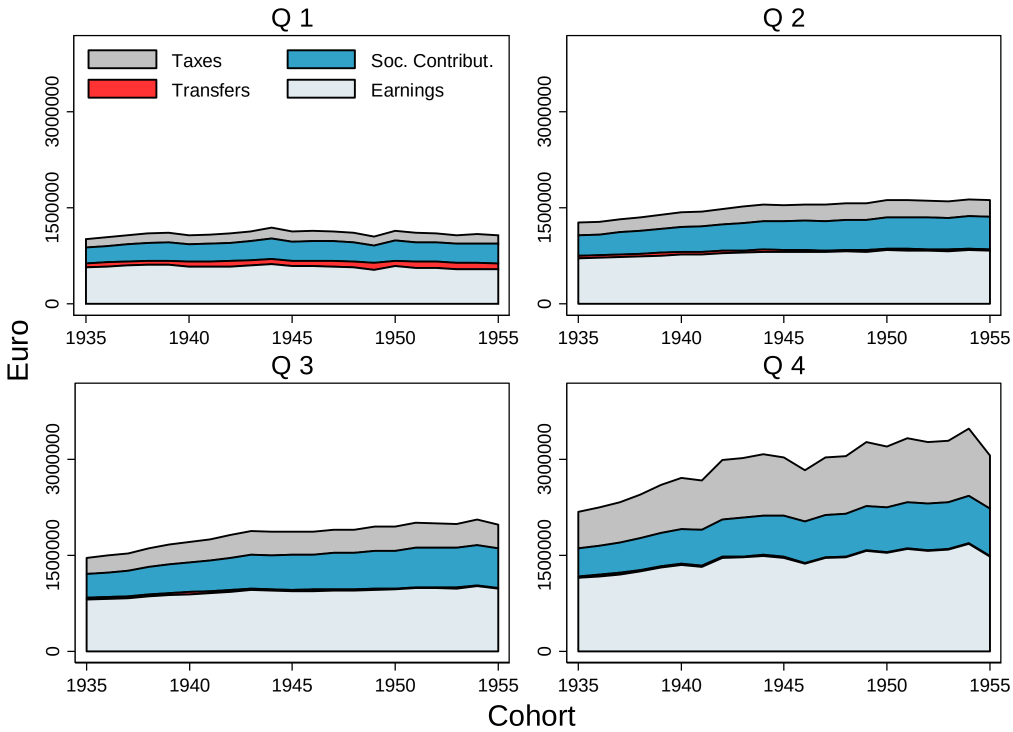
Degree of redistribution for every cohort: Gini net divided by Gini market for various UAX.



Decomposition of pre-fisc income into its components for each quartile. First UA-40, then working-life incomes.





V. Complete Lifetime Incomes

5.1. Income inequality

All results exhibited so far pertain to the incomes received when the individuals are in working age. In order to arrive at a more comprehensive assessment of the individuals' lifetime opportunity sets we now proceed to incorporate the incomes received during the retirement years in our analysis. There are two main reasons why valuable insights can be expected from this step. First, a large share of governmental transfers occurs through the old-age pension system and pension benefits constitute for a large share of single individuals in the upper half of the distribution the only monetary transfer that they receive from the government over their entire lifetime. Incorporating the retirement years can therefore significantly affect how both lifetime income inequality and redistribution are assessed. Second, lifetime opportunity sets depend on longevity and the latter is positively correlated with lifetime earnings. Hence, differential mortality can further change the appraisal of both lifetime income inequality and redistribution.

In this section, we provide an analysis of complete lifetime incomes for the cohorts born between 1935 and 1949. We do not consider younger cohorts in order to avoid the large margins of error to which are subject simulations of future labor incomes. The cohorts on which we focus are all retired by now, so that their complete lifetime earnings can be observed and we only need to simulate their future pension benefits – a much safer exercise. We concentrate on men under the assumption that they are single (see the interpretation given in the previous section and the advantage to avoid matching). We define a cohort as the set of all individuals born in the same year and who are still alive at age sixty.

Our simulation of retirees' future incomes grounds on the following assumptions. With respect to future pension and tax legislation, we assume that the status quo of current legislation is maintained until the end of the investigated time horizon. Based on current official predictions, we posit a constant pension growth rate of 1.5% per year in real terms.[14] The tax schedule is correspondingly shifted by the same annual rate (real indexing). We further assume that the real interest rate equals the growth rate and we conduct various robustness checks to assess the sensitivity of our results to alternative assumptions.

With respect to mortality rates, we follow a recent study by Haan et al. (2018) and make them contingent on both the year of birth and the decile of the cohort-specific distribution of total accumulated earnings points. Of course, for individuals with complete earnings biographies, the total number of earning points is strongly correlated with the rank in the lifetime earnings distribution. Haan et al. (2018) employ SK90 data that cover the universe of German male retirees starting with the cohort born in 1905. They estimate cut-off values for deciles by earnings points at age 65 and, for these deciles, predict age- and cohort-specific mortality rates for the retirees of the cohorts 1926-1949. As shown in their paper, mortality rates for the universe of retirees can be easily linked to the pension biography data that we use in our analysis.

For our cohorts born between 1935 and 1949, we use the estimation results in Haan et al. (2018) to recover their mortality rates from age sixty onwards. A cohort is defined as formed by the individuals born in the same year and who are alive when the cohort is sixty; because of paucity of data, cohorts from three consecutive birth years are grouped together when mortality rates are assigned to individuals.[15] The resulting life expectancies for the deciles of the various cohorts are displayed in the appendix. Longevity increases with both the year of birth and the relative income within the cohort. The expected additional years of life at age 60 vary from 17 for the bottom decile of the 1935 cohort to 24 for the top decile of the 1949 cohort.

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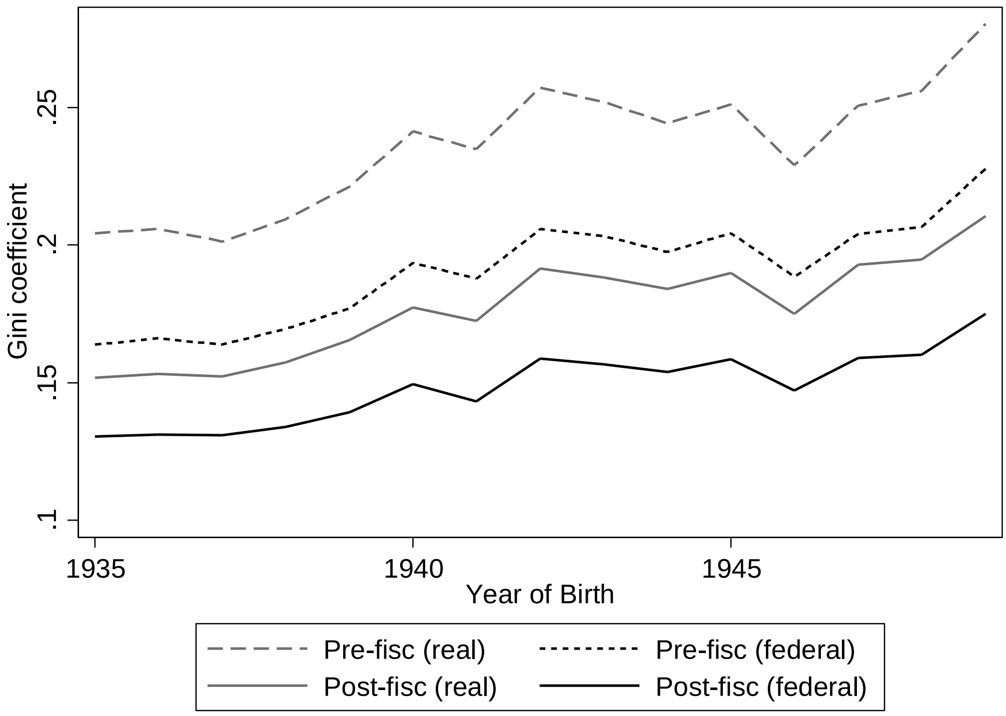
[14] We follow Lüthen (2016) and consider laws introducing a relative floor, which pensions cannot undercut, as well as expected real wage growth as part of the pension growth formula. For details and robustness see Lüthen (2016).

[15] We assign to each individual the mortality rates associated with the individual's earning points at age 65. In order to take into account the individuals who died between age 60 and age 65, we compute the differential mortality in that age class for every decile within each cohort. Then, we correspondingly re-weight the observations in our sample of 65-years old for the years where they are between 60 and 65.

For every individual in a given cohort/decile, we define his complete lifetime income as the expected lifetime income as of age 60. This equals the sum of the *observed* incomes until age 65 and the *expected* incomes after age 65. The latter obtain from multiplying the simulated income after age 65 with the statistical survival probability conditional on having reached each possible age until age 99, which is assumed to be the highest possible age.[16]

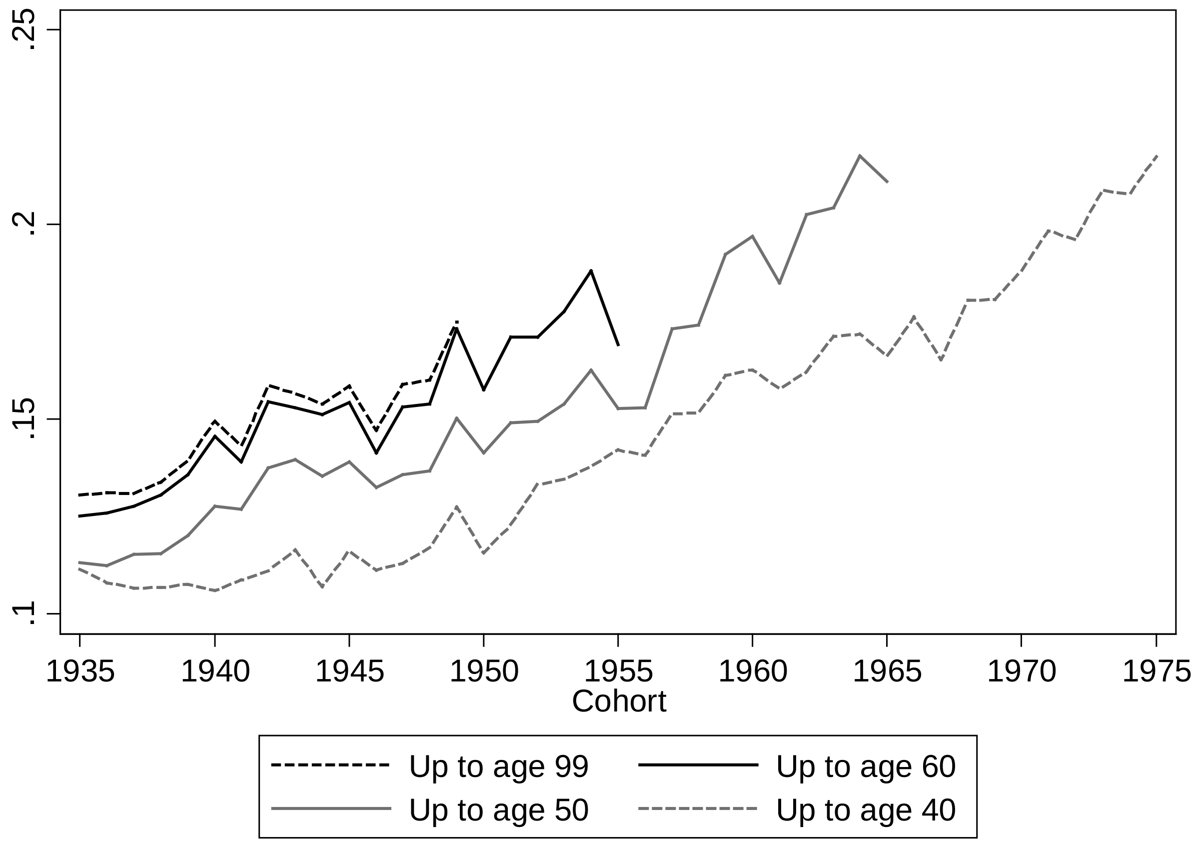
The following figure depicts the Gini coefficients for complete lifetime incomes, both pre-fisc and post-fisc, according to our two discounting methods.



In a complete lifetime perspective, inequality is slightly larger than from the perspective of working lifetimes and follows a similar pattern over cohorts, as shown by the next figure for the case of post-fisc incomes discounted using the interest rates on government bonds. This

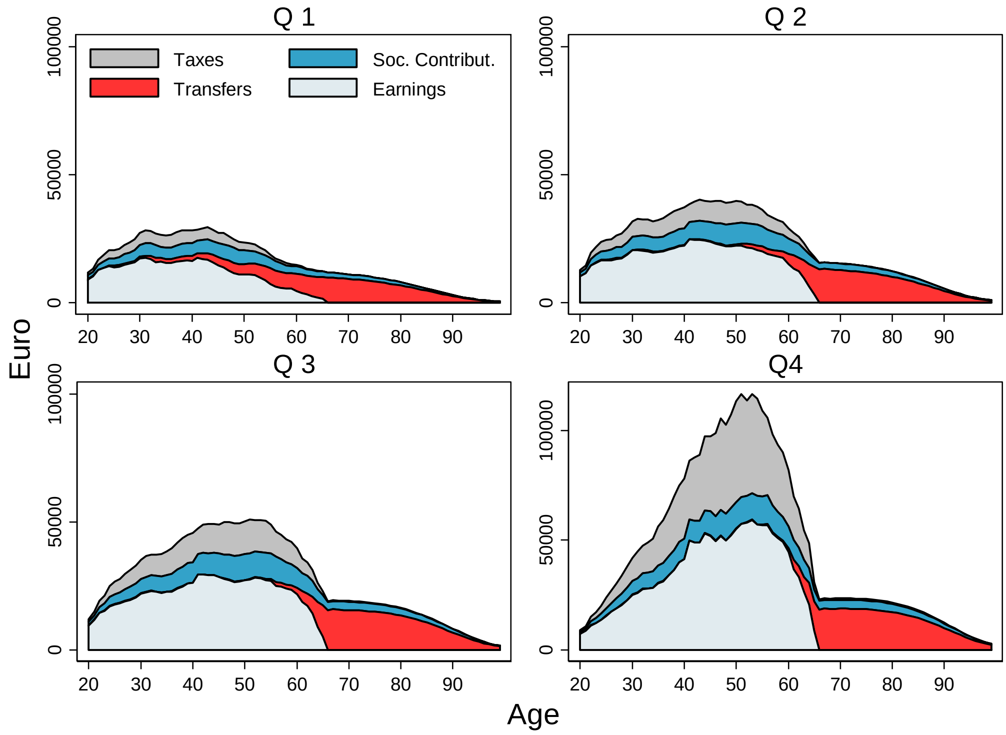
[16] These disposable incomes will effectively be consumed if the individuals have a deterministic lifespan or purchase fair annuities.

evidence suggests a secular increase of cohort-specific inequality also in terms of complete lifetime incomes.

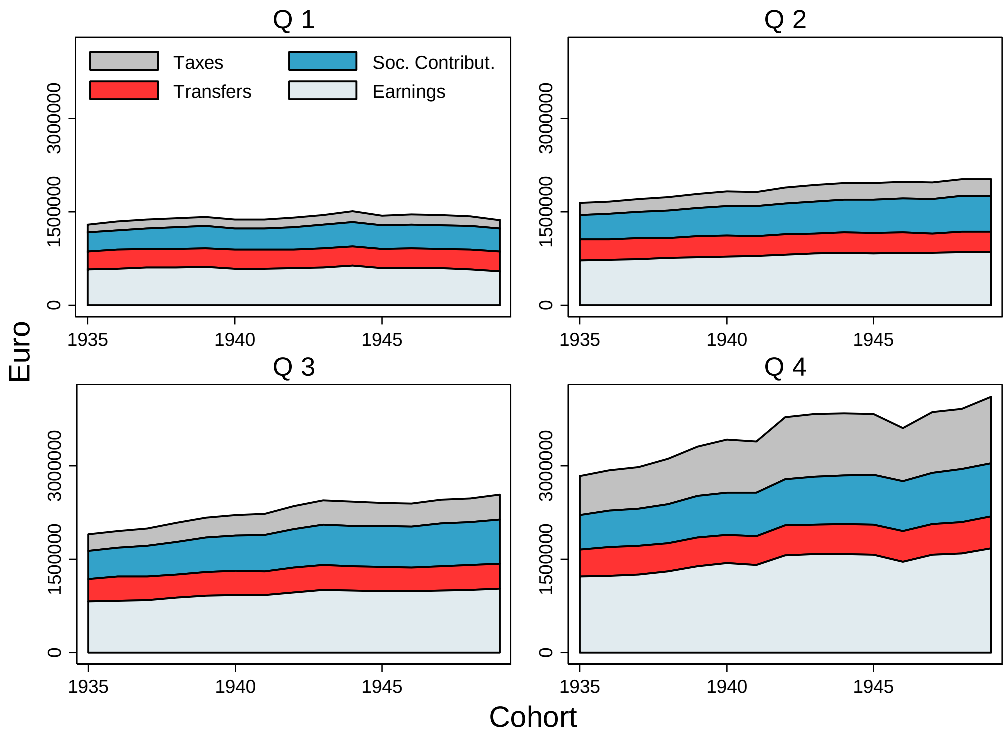


In order to understand this finding, it is instructive to assess the role played by taxes and transfers.

Age-income profile with decomposition until age 99 for the 1949 cohort



Decomposition of real complete lifetime incomes by quartile (1935-49).

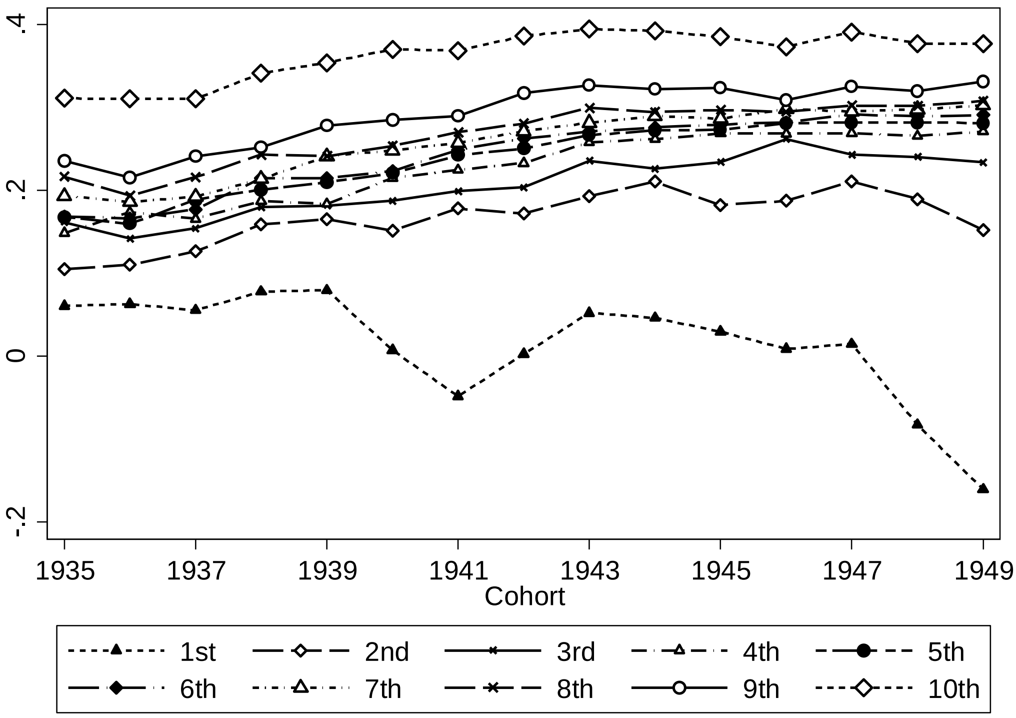


The main difference with respect to the corresponding decomposition until age 60 concerns the role of transfers. During the working lifetime, the bottom quartile receives by far the largest share of governmental transfers. During the entire lifetime, the higher the quartile, the larger the share of total transfers received.

Is the tax-transfer system progressive, judged from the viewpoint of the entire life-cycle?

We deal with this issue separately for each birth cohort. For any given cohort, we compute for every decile of the distribution of pre-fisc lifetime income its lifetime effective tax rate (LETR). This is given by (y-x)/y, where y denotes pre-fisc lifetime income and x is post-fisc lifetime income, both computed for the same decile. The tax-transfer system is progressive over the entire life-cycle if the average LETR strictly increases with the decile.

We conduct this exercise in two versions: using discounted incomes and using real incomes.



As shown by the figures, the overall tax-transfer system is progressive over lifetimes. The lowest decile heavily benefits from it. Notice that as compared with LETR for U-60, the top decile is quite apart from the deciles below it. The reason is as follows: because of the wage ceiling in the pension system, the top decile receives pensions that are lower, proportionally to its lifetime earnings, than those of the other deciles – for which that ceiling is irrelevant. This means that the transfers received by the top decile after age sixty are, relative to its lifetime earnings, lower than those received by the deciles below it. Furthermore, only the highest pensions are subject to the income tax. These effects more than compensate the one on received pensions that stems from the higher life expectancy of the top decile.

Progressivity of the overall tax-transfer-system does not require that effective marginal tax rates be increasing with income, as progressivity can also result from a linear system with a demogrant and a constant marginal tax rate. The optimal pattern of marginal tax rates is a long-standing issue in the literature on optimal taxation, with Mirrlees (1971) stressing the closeness to linearity of the optimal tax schedules that he numerically simulated and various counterexamples being offered by the literature in the aftermath. What is the shape of lifetime marginal tax rates in reality?

The next figure exhibits a scatter plot of all pairs of pre-fisc lifetime income and post-fisc lifetime income for the oldest cohort in our sample. The figure strongly suggests the existence of a linear relationship between those two variables. An OLS regression yields an R^2 equal to 0.96 and thus confirms the visual impression. Repeating the same regression exercise for every cohort in our sample reveals a stable pattern, with R^2 lying always between 0.95 and 0.97. Although we doubt that Mirrlees' simulations had any influence on the German legislator, we do find that in a lifetime perspective the German tax-transfer-system is very close to linear.[17]

HIER: Scatter Plot for Cohort 1935

[17] This result holds independently of the discounting method we employ.

The constancy of the lifetime marginal tax rate is a striking result. In Germany, the (annual) personal income tax has always been characterized by direct progression, i.e. strictly increasing marginal tax rates up to a threshold. It is its combination with the marginal taxation implicit in the social security contributions and in social transfers that generates the linearity of the overall tax-transfer-system. Individuals with very low earnings fall below the basic allowance and therefore pay no personal income tax; however, at the margin those individuals pay social security contributions that do not increase their future pensions and unemployment benefits – i.e. disposable income - because they will receive guaranteed social minima. Hence, the total rate of social contributions (approximately 40 %, half of which is formally paid by employers) is equivalent to a marginal tax rate for those individuals. Furthermore, during the periods in which they receive means-tested benefits, those individuals' earnings are subject to a high withdrawal rate that adds to the marginal taxation stemming from the payment of social contributions.[18] Individuals with somewhat higher earnings do pay personal income tax, at relatively low marginal tax rates; at the same time, the entirety of their social contributions is not equivalent to a tax because to some extent those contributions increase those individuals' future pensions and unemployment benefits. The higher the earnings level, the higher is the marginal tax rate on the personal income tax and the lower the implicit tax component in social contributions. As shown by the Figure above, the two effects offset each other, so as to result in a virtually constant marginal tax rate. This is close to the top marginal tax rate of the personal income tax, which is paid by individuals with an income beyond the thresholds for social security and who therefore pay no social contributions on their marginal income.

From a lifetime perspective, the overall tax-transfer-system in Germany can thus be summarized by just two numbers: its constant marginal tax rate and its demogrant. For the

[18] In an annual perspective, there typically is a significant fraction of individuals who earn very little and receive means-tested benefits that are subject to withdrawal rates much in excess of 50 %. Hence, in an annual perspective, marginal tax rates are declining at low levels of earnings. In a lifetime perspective, the fraction of individuals who receive means-tested benefits in all or most years of their life-cycle is virtually nil. Hence, marginal tax rates close to the withdrawal rates of means-tested benefits do not arise in a lifetime perspective.

cohort born in 1935, the estimated coefficients of the OLS regression imply that the marginal tax rate is 0.49 and the demogrant equals 27 percent of the median post-fisc lifetime income of the same cohort.[19] Similar results hold for the remaining cohorts.

These relatively large numbers hint at a remarkable redistribution of income during complete lifetimes. The next figure shows the mechanical reduction of income inequality over entire lifetimes that is produced by the tax-transfer system. It amounts to about 20 % - 23% and is therefore similar to the result for the UA-60. Because of differential mortality, one could have expected less redistribution than for the UA-60. Since the Gini coefficient is not very sensitive to changes in the tails of the distribution, the wage ceiling effect is unlikely to play an important role here. We believe that the regressive effect from differential mortality is mainly offset by the labor-market behaviour of the various deciles between age 60 and age 65. The data show that lower deciles leave the labor market earlier and this does not cause a mathematically fair reduction of their pensions.

Abb.5: Degree of redistribution = (Gini pre – Gini post) / Gini pre, federal.

[19] If we discount using the inflation rate, the marginal tax rate is 0.48 and the demogrant equals 36 percent of the median post-fisc lifetime income of the cohort. The demogrant appears to be larger than in the case of discounting using the nominal interest rate because the bulk of transfers is received during the late part of the life cycle as pensions.

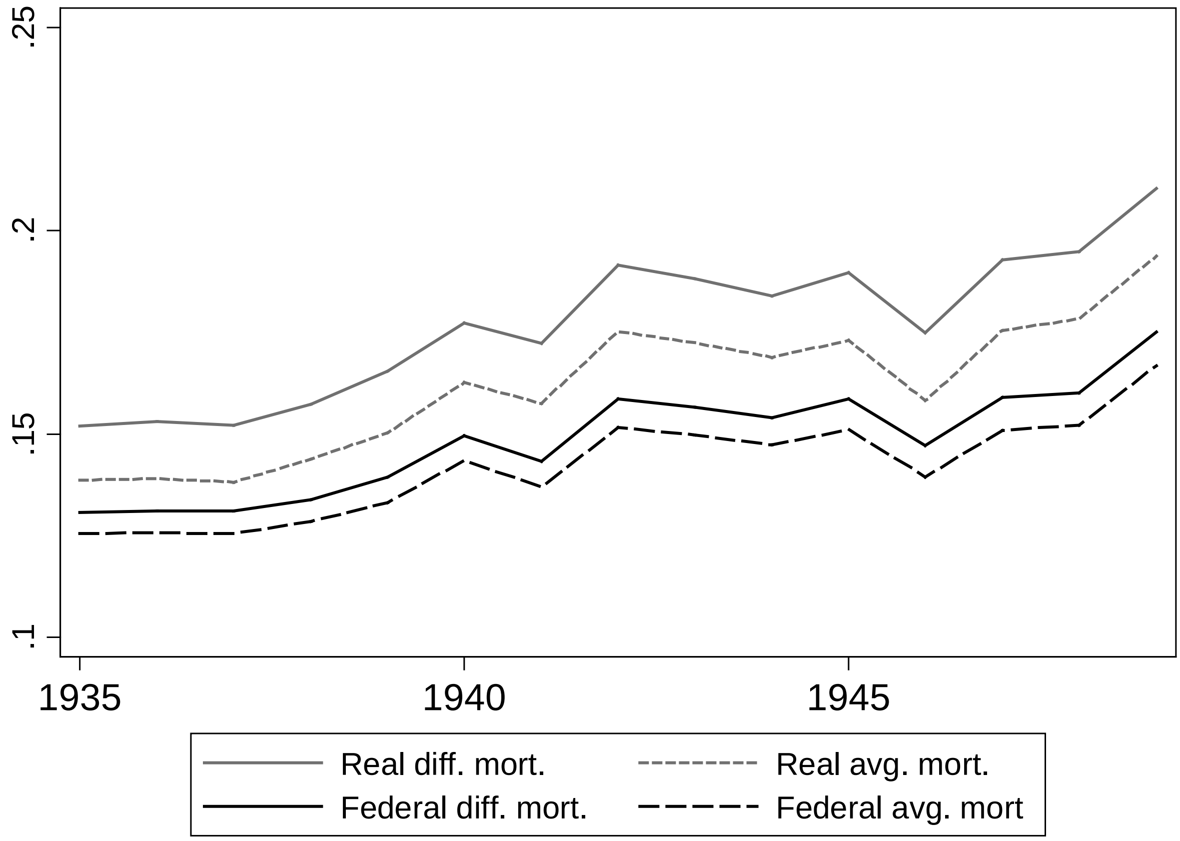
We briefly present two additional measures of governmental income redistribution. For each cohort, we compute the Reynolds-Smolensky index: pre-fisc Gini minus concentration coefficient of the post-fisc incomes. Then, we compute the Kakwani index: concentration coefficient of net taxes (hoping that they are all positive!) minus pre-fisc Gini.

The pattern closely mirrors the one in the previous figure (they could be put in one figure!).

Reynolds-Smolensky :

Effect from differential mortality: counterfactual under the assumption that every decile has the same mortality rate as the average one of the corresponding cohort.

Impact of diff. Mort. On lifetime inequality



It appears that differential mortality increases lifetime inequality by about 4 % (8 % if one does not discount real incomes).

5.2. The value of longevity and welfare inequality

Hitherto we have assessed the inequality of access to economic resources over lifetimes. In such a perspective, no difference is made between equal lifetime incomes stemming from lives of different lengths. This is justified if one is interested in the way in which society distributes its aggregate income among its members. However, if one is interested in the distribution of well-being, focusing on lifetime incomes is not appropriate for a society whose members have different lifespans. Because in that case, individuals who live longer can distribute a given lifetime income across more periods, i.e. they have access to a greater variety of goods. If the instantaneous utility of consumption is strictly concave, this will allow those individuals to translate a longer lifetime into a higher well-being. Furthermore, there may be an independent effect on welfare due to being alive rather than dead.

The monetary value of additional longevity can be computed by comparison to a reference individual. For a given cohort, we take its reference member to be the individual with the lowest expected longevity. Denote by Y his net lifetime income and by S his survival function. Denote his expected lifetime indirect utility by V(Y,S).

We assume that all individuals have the same preferences and the same access to capital markets, so that they all can described by the same function V(.,.). Let us consider another individual in the same cohort who achieves utility V(Y',S'). The equivalent income that would allow the individual with the shortest lifespan to achieve the same well-being is implicitly defined by

$$V(Y',S') = V(Y+X+W',S)$$

where X = Y'-Y is the difference in lifetime incomes and W' is the value expressed in income units of an infra-marginal change of the survival function from S to S', i.e. the monetary value of the corresponding additional longevity. A money-metric well-being comparison assigns to the worst-off individual the lifetime welfare indicator Y and to the other individual the indicator Y' + W'. We call this indicator "lifetime welfare".

In order to compute the cohort-specific distributions of lifetime welfare we build on the theoretical framework developed by Becker et al. (2005) and extend it. We retain their functional form for the common utility function and adopt its parameter values from their calibration, but generalize their approach in two respects. First, we relax their assumption that the interest rate is time-invariant and equal to the pure time preference. Allowing for variable interest rates during the life-cycle makes this theoretical framework suitable for the analysis of historical situations, like the one considered here, that display substantial variations of the interest rate over time. Second, we compute lifetime welfare levels under two polar scenarios: with and without access to capital markets. The first scenario is the one envisaged by Becker et al. (2005); it assumes that capital markets are perfect and that individuals optimally purchase mathematically fair annuities. The second, opposite scenario assumes that the individuals have no access to capital markets whatsoever and thus consume in each period their disposable income. Since capital markets in the period under investigation were imperfect and annuities uncommon, computing the distribution of lifetime welfare under the assumption of hand-to-mouth agents delivers an instructive robustness check.

For any given cohort, the formula of an individual's lifetime welfare can be derived as follows. Let us express time t in discrete units, each unit representing one year. The time horizon goes from t=1 to t=T. Individuals receive their yearly incomes and consume at the end of each year. Interest maturated from one unit of savings in year t and received in year t+1 is denoted by r_{t+1}. Individuals differ by their streams of yearly net incomes and their survival functions. An individual's expected lifetime utility reads

$$E[U] = \sum_{t=1}^{T} \beta^{t-1} S(t) u(c(t))$$

Where β is the inverse of one plus the rate of time preference, *S* is the survival function, and the instantaneous utility function reads

$$u = \frac{c^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}} + \alpha$$

where c denotes yearly consumption and γ is the intertemporal elasticity of substitution. Implicitly, the utility of being dead is normalized to zero and α determines the level of annual consumption at which the individual would be indifferent between being alive or dead.

In the scenario with *perfect capital markets*, each individual optimally selects a consumption path from those that are allowed by the individual's intertemporal budget constraint:

$$Y \equiv S(1)y(1) + \sum_{t=2}^{T} S(t)y(t) \prod_{j=2}^{t} (1+r_j)^{-1} = S(1)c(1) + \sum_{t=2}^{T} S(t)c(t) \prod_{j=2}^{t} (1+r_j)^{-1}$$

Setting up the Lagrangean and computing the first-order-conditions yields:

$$\beta^{\tau-1}S(\tau)u'\big(c(\tau)\big) = \lambda S(\tau)\prod_{j=2}^{\tau}(1+r_j)^{-1} \qquad \forall\tau \geq 2$$

$$S(1)u'\big(c(1)\big) = \lambda S(1) \qquad \tau = 1$$

Dividing each side of the first equation by the corresponding side of the second equation yields:

$$\frac{\beta^{\tau-1}u'(c(\tau))}{u'(c(1))} = \prod_{j=2}^{\tau}(1+r_j)^{-1} \quad \rightarrow \quad \frac{u'(c(\tau))}{u'(c(1))} = \beta^{1-\tau}\prod_{j=2}^{\tau}(1+r_j)^{-1}$$

Using the definition of *u* gives

$$\left(\frac{c(\tau)}{c(1)}\right)^{-\frac{1}{\gamma}} = \beta^{1-\tau}\prod_{j=2}^{\tau}(1+r_j)^{-1}$$

which can also be written as

$$c(\tau) = G_\tau c(1)$$

where

$$G_\tau \equiv \left[\beta^{1-\tau}\prod_{j=2}^{\tau}\big(1+r_j\big)^{-1}\right]^{-\gamma} \qquad ,\tau \geq 2$$

Insert this expression in the intertemporal budget constraint to get

$$Y = c(1)\left[S(1) + \sum_{t=2}^{T} S(t)G_t\prod_{j=2}^{t}(1+r_j)^{-1}\right]$$

Solving this equation und using the optimal consumption growth derived above yields the complete solution for the optimal consumption path over the entire life-cycle, which can be written as:

$$\begin{cases} c_1 = Y\left[S(1) + \sum_{t=2}^{T} S(t)G_t\prod_{j=2}^{t}(1+r_j)^{-1}\right]^{-1} \\ c_t = G_t c_1 \qquad\qquad t = 2, \ldots T \end{cases}$$

Define now *y*, the corresponding annuity income, as

$$y \equiv \frac{Y}{S(1) + \sum_{t=2}^{T} S(t) \prod_{j=2}^{t} (1 + r_j)^{-1}}$$

The optimal level of consumption at t=1 can then be expressed as

$$c_1 = \kappa * y$$

where

$$\kappa \equiv \frac{S(1) + \sum_{t=2}^{T} S(t) \prod_{j=2}^{t} (1 + r_j)^{-1}}{S(1) + \sum_{t=2}^{T} S(t) G_t \prod_{j=2}^{t} (1 + r_j)^{-1}}$$

Lifetime indirect utility is therefore given by

$$V = \sum_{t=1}^{T} \beta^{t-1} S(t) \left[\frac{c_t^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}} + \alpha \right]$$

or

$$V = \sum_{t=1}^{T} \beta^{t-1} S(t) \left[\frac{(G_t * \kappa * y)^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}} + \alpha \right]$$

where

$$G_1 \equiv 1$$

Equivalently,

$$V = \sum_{t=1}^{T} \beta^{t-1} S(t) (G_t \kappa)^{1-\frac{1}{\gamma}} u(y) + \alpha \left[\sum_{t=1}^{T} \beta^{t-1} S(t) - \sum_{t=1}^{T} \beta^{t-1} S(t) (G_t \kappa)^{1-\frac{1}{\gamma}} \right]$$

In concise notation, lifetime welfare can thus be expressed as

$$V = Au(y) + B$$

where

$$A = \sum_{t=1}^{T} \beta^{t-1} S(t) (G_t \kappa)^{1-\frac{1}{\gamma}}$$

$$B = \alpha \left[\sum_{t=1}^{T} \beta^{t-1} S(t) - A \right]$$

In order to arrive at a money-metric representation, choose the following monotone increasing transformation of lifetime utility:

$$M = \Omega * u^{-1}\left(\frac{V-B}{A}\right)$$

where

$$\Omega = S(1) + \sum_{t=2}^{T} S(t) \prod_{j=2}^{t} (1+r_j)^{-1}$$

and the values of Ω, B and A are those associated with the reference individual, i.e. the one with the shortest lifetime expectancy in the cohort. For such an individual,

$$M = \Omega * u^{-1}\big(u(y)\big) = \Omega * y = Y$$

so that M is indeed a money-metric utility representation. For any other member of the same cohort with annuity income y' and corresponding values Ω', B' and A', we have

$$M' = \Omega * u^{-1}\left(\frac{A'u(y') + B' - B}{A}\right)$$

where

$$u^{-1} = \left[\left(1-\frac{1}{\gamma}\right)(u-\alpha)\right]^{\frac{\gamma}{\gamma-1}}$$

In order to compute the individual's lifetime welfare M', notice that

$$u^{-1}\left(\frac{A'u(y') + B' - B}{A}\right) = \left\{\left(1-\frac{1}{\gamma}\right) * \left[\frac{A'u(y') + B' - B}{A} - \alpha\right]\right\}^{\frac{\gamma}{\gamma-1}}$$

$$= \left\{\left(1-\frac{1}{\gamma}\right)\left[\frac{A'\left(\frac{y'^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}} + \alpha\right) + B' - B - \alpha A}{A}\right]\right\}^{\frac{\gamma}{\gamma-1}}$$

$$= \left\{\frac{A'}{A} y'^{1-\frac{1}{\gamma}} + \alpha\left(1-\frac{1}{\gamma}\right)\left(\frac{A'-A}{A}\right) + \left(\frac{B'-B}{A}\right)\left(1-\frac{1}{\gamma}\right)\right\}^{\frac{\gamma}{\gamma-1}} \equiv z'$$

So, $M' = \Omega * z'$ and the value of the additional longevity enjoyed by this individual is $W' = \Omega * (z' - y')$.

Consider now the second scenario, in which all individuals are *hand-to-mouth agents*. Since consumption equals net income in every period, their expected lifetime utility is now given by

$$\hat{V}_i = \sum_{t=1}^{T} \beta^{t-1} \cdot S_i(t) \cdot \left[\frac{y_i(t)^{1-1/\gamma}}{1 - 1/\gamma} + \alpha \right]$$

We now ask about the level of the equivalent annuity income that the individual would have needed in the presence of perfect capital markets in order to obtain the same lifetime utility level if he had optimized. From the analysis of the first scenario, such an equivalent annuity income – denoted by $\hat{y}$ - is implicitly defined by

$$A_i \cdot u(\hat{y}_i) + B_i = \hat{V}_i$$

Which can be solved to yield

$$\hat{y}_i = u^{-1}\left(\frac{\hat{V}_i - B_i}{A_i}\right) = \left[\left(1 - \frac{1}{\gamma}\right) \cdot \left(\frac{\hat{V}_i - B_i}{A_i} - \alpha\right)\right]^{\frac{\gamma}{\gamma-1}}$$

As in the first scenario, we obtain a money-metric representation of lifetime welfare by transforming utilities through

$$\widehat{M}(x) = \Omega_0 \cdot u^{-1}\left(\frac{x - B_0}{A_0}\right)$$

Or

$$\widehat{M}(\hat{V}_i) = \Omega_0 \cdot u^{-1}\left(\frac{A_i u(\hat{y}_i) + B_i - B_0}{A_0}\right)$$

Notice that for the reference individual with the shortest lifespan we have

$$\widehat{M}(\hat{V}_0) = \Omega_0 \cdot \hat{y}_0 \equiv \hat{y}$$

By similar steps as in the case of the first scenario, the welfare level in money units can be written for any individual i as

$$\widehat{M}_i = \Omega_0 \cdot \hat{z}_i$$

Where

$$\hat{z}_i = \left\{\hat{y}_i^{1-1/\gamma} \cdot \frac{A_i}{A_0} + \alpha\left(1-\frac{1}{\gamma}\right)\left(\frac{A_i - A_0}{A_0}\right) + \left(\frac{B_i - B_0}{A_0}\right)\left(1-\frac{1}{\gamma}\right)\right\}^{\frac{\gamma}{\gamma-1}}$$

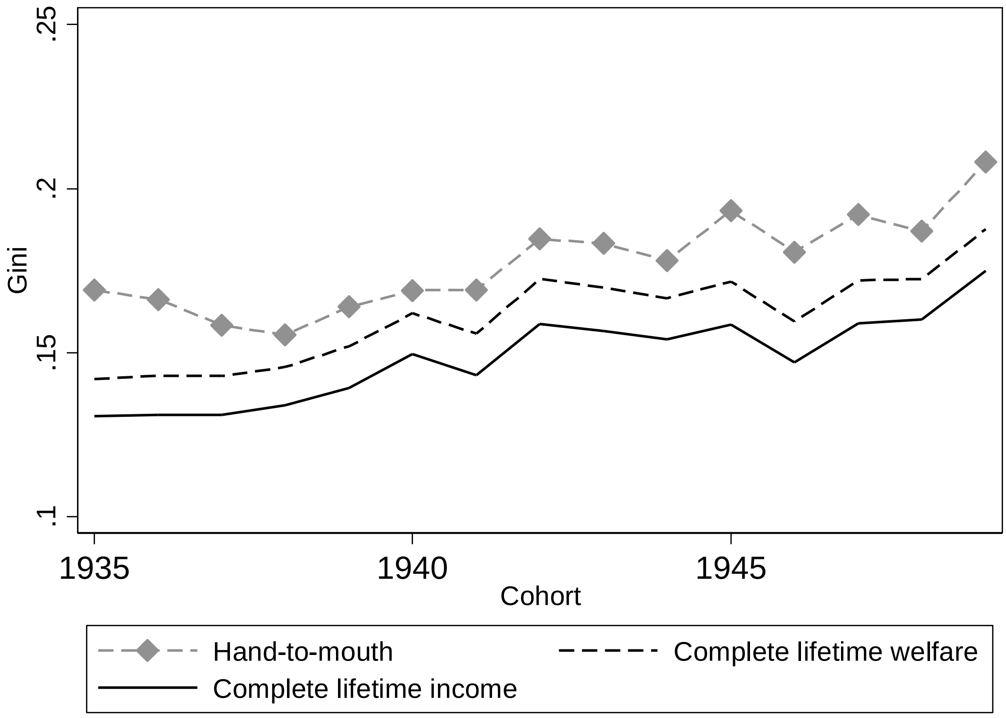
We now proceed to compute the lifetime welfare levels of all individuals using the formulas derived above. This computation employs our data in order to compute the yearly incomes, interest rates, and mortality rates. The numerical values of the parameters in the utility function are those used by Becker et al. (2005).[20]

As shown by the following Figure, taking the value of longevity into account substantially increases the measured inequality level. The Gini coefficient of the distribution of lifetime welfare is about 15 % higher than the Gini of the distribution of lifetime income. Differential mortality matters more for welfare inequality than for income inequality.

As a robustness check, we perform the same type of computations using the numerical values of the utility function proposed by Hall and Jones (2007). In this case, the Gini coefficient of the distribution of lifetime welfare is about 50 % higher than the Gini of the distribution of lifetime income.

FIGURE

[20] In particular, γ=1.25 and $\beta = 0.971$. In the case of α, this entails an adjustment so as to express it in euros 2015 rather than USD 1990. We thus have to divide the value used by Becker et al. (2005) by x to the power of 1 – 1/ γ, where x is the value of one USD 1990 expressed in euros 2015. We get ?



Notice that from a welfare point of view it could in principle be desirable to redistribute from a lifetime poor to a lifetime rich if the latter has a shorter lifespan. Case of a Rawlsian planner: the lifetime utility of the rich can be smaller than that of the poor if the latter lives longer and the value of longevity is large enough. Case of a Utilitarian planner: the marginal utility of consumption can be higher for the rich if he has less years over which he allocates his higher lifetime income. (Notice the conflict of redistributive preferences between the two planners in the case of two individuals who have the same lifetime income but different longevities).

In reality, the rich have longer lives than the poor. This should increase the optimal amount of redistribution relative to the case of uniform longevity.

Since both average lifetime incomes and longevity increase over cohorts, this can justify some intergenerational redistribution from young to old.

VI. Conclusion

[to be written]

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Appendix

	r_imp_4med_40		r_imp_4med_50		r_imp_4med_60	
1935	491366.9	1	920933.3	1	1307899	1
1936	510765.8	1.03947946	941060.5	1.02185522	1326795	1.0144476
1937	538152.4	1.095215	986000.1	1.07065311	1356491	1.03715272
1938	555414.1	1.13034496	1002757	1.08884867	1409002	1.07730184
1939	589926.8	1.20058311	1056799	1.14753045	1456426	1.11356152
1940	613218.1	1.24798414	1088589	1.18204977	1506675	1.15198115
1941	627641.1	1.27733696	1099977	1.19441549	1525840	1.16663443
1942	656108.1	1.33527126	1150175	1.24892324	1584893	1.21178547
1943	667714	1.35889088	1179269	1.2805151	1637483	1.25199499
1944	684135.5	1.39231092	1209172	1.31298542	1641864	1.25534464
1945	694633.1	1.413675	1197128	1.29990739	1650347	1.26183062
1946	700135.1	1.42487233	1210553	1.31448499	1663428	1.27183215
1947	714275.4	1.45364981	1219769	1.32449223	1662750	1.27131376
1948	728789.6	1.48318822	1241662	1.34826485	1698412	1.29858039
1949	736566.7	1.4990157	1238535	1.34486938	1703961	1.30282308
1950	745051.6	1.51628366	1260316	1.36852039	1736465	1.32767515
1951	765426.6	1.55774962	1293657	1.40472388	1768285	1.35200424
1952	765676.3	1.55825779	1288193	1.39879077	1766970	1.35099882
1953	766980.9	1.56091283	1282974	1.39312369	1740890	1.33105844
1954	784392.4	1.59634766	1312142	1.42479591	1780979	1.36170989
1955	773276.6	1.57372546	1299647	1.41122815	1767383	1.35131459
1956	802725.5	1.63365807	1333879	1.44839914		
1957	796343.9	1.62067062	1318116	1.43128281		
1958	799981.3	1.62807324	1310904	1.42345162		
1959	796691.1	1.62137722	1298797	1.41030518		
1960	816041.7	1.66075839	1323650	1.43729193		
1961	798432	1.6249202	1304072	1.41603306		
1962	804893	1.63806923	1304038	1.41599614		
1963	807497.7	1.64337016	1320578	1.43395618		
1964	819819.4	1.66844653	1317262	1.43035549		
1965	819261.8	1.66731174	1317351	1.43045213		
1966	822458.8	1.67381808				
1967	820831.5	1.6705063				
1968	800720	1.6295766				
1969	798346.5	1.62474619				
1970	796719.3	1.62143461				
1971	792167.3	1.61217066				
1972	781996.1	1.59147085				
1973	764938.2	1.55675565				
1974	776270.1	1.57981765				
1975	763326.8	1.55347623				

	r_netmed_40		r_netmed_50		r_netmed_60	
1935	326131.4	1	555870.9	1	788830.7	1
1936	334255.2	1.0249	567498.4	1.0209	792922.6	1.0052
1937	345861.4	1.0605	582596.8	1.0481	807671.3	1.0239
1938	350782.9	1.0756	585590.1	1.0535	820593.8	1.0403
1939	366483.4	1.1237	602591.6	1.0840	839575.2	1.0643
1940	374419.1	1.1481	619661.6	1.1148	851339.7	1.0792
1941	379793.2	1.1645	624327.4	1.1232	857284.8	1.0868
1942	389613.9	1.1947	642807.9	1.1564	875506.1	1.1099
1943	390714.6	1.1980	652301	1.1735	890964.6	1.1295
1944	398319.7	1.2213	661950.8	1.1908	889021.2	1.1270
1945	398124.4	1.2207	657220.8	1.1823	888168.1	1.1259
1946	400734.2	1.2288	660332	1.1879	887829.6	1.1255
1947	402270.5	1.2335	657372.1	1.1826	884534.4	1.1213
1948	407039	1.2481	663024.8	1.1928	895230.6	1.1349
1949	407606.8	1.2498	662925.3	1.1926	896076.2	1.1360
1950	416659.2	1.2776	664569	1.1955	905193.9	1.1475
1951	422017.6	1.2940	678971.4	1.2215	919282.6	1.1654
1952	420351.5	1.2889	673608.4	1.2118	916775	1.1622
1953	419861.5	1.2874	669008.2	1.2035	909158.8	1.1525
1954	426580.2	1.3080	681154.8	1.2254	917666.6	1.1633
1955	421109.2	1.2912	671295.4	1.2076	912866.2	1.1572
1956	431622.8	1.3235	683560.7	1.2297		
1957	426874.4	1.3089	678123.8	1.2199		
1958	424613.8	1.3020	672605.3	1.2100		
1959	423790.3	1.2994	670515.6	1.2062		
1960	427305.1	1.3102	678995.6	1.2215		
1961	417710.9	1.2808	672424.9	1.2097		
1962	419673.4	1.2868	668645	1.2029		
1963	417823.3	1.2812	676452.9	1.2169		
1964	421204.2	1.2915	675259.3	1.2148		
1965	420645.8	1.2898	678583.6	1.2208		
1966	421507.6	1.2924				
1967	421866.3	1.2935				
1968	414356.8	1.2705				
1969	411828.1	1.2628				
1970	415513	1.2741				
1971	410551.8	1.2589				
1972	411359.1	1.2613				
1973	403795.9	1.2381				
1974	413821.5	1.2689				
1975	410831.4	1.2597				

Grafik A.1: Lifetime tax rates, calculated as sums by deciles, federal (a) and real (b)