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Inequalities of income and inequalities of longevity: a cross-country study

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Inequalities of Income and Inequalities of Longevity: a Cross-Country Study

Objectives. We examined the effects of market income inequality (income inequality before taxes and transfers) and income redistribution via taxes and transfers on inequality in longevity.

Methods. Life tables were used to compute Gini coefficients of longevity inequality for all individuals and for individuals that survived at least to the age of ten. Longevity inequality was regressed on market income inequality and income redistribution controlling for a range of potential confounders in a cross-sectional time-series sample of up to 28 predominantly Western developed countries and up to 37 years.

Results. Income inequality before taxes and transfers is positively associated with inequality in the number of years lived, while income redistribution (the difference between market income inequality and income inequality after taxes and transfers have been accounted for) is negatively associated with longevity inequality in our sample.

Conclusions. To the extent that our estimated effects based on observational data are causal, governments can reduce inequality in the number of years lived not only via public health policies, but also via their influence on market income inequality and the redistribution of incomes from the relatively rich to the relatively poor.

Public policies not only affect health and mortality at the individual level, but also the inequality of longevity – inequality in the number of years lived. For example, higher tobacco[1] and alcohol[2] taxes reduce their consumption, as do non-fiscal regulatory measures such as restrictions to smoking in closed spaces. This reduces avoidable mortality from lung cancer and liver cirrhosis. More directly, governments implement different health and safety regulations, they influence total health spending and its allocation and regulate the coverage of health insurance across individuals. All factors that reduce premature deaths will also reduce longevity inequality.

While these pathways are generally well understood, we focus here on a mechanism for which surprisingly no cross-country evidence exists: the influence of income inequality and income redistribution on lifetime inequality. Low income has multiple direct and indirect negative consequences for individual health.[3,4,5] This does not necessarily imply that higher income inequality leads to higher inequality in health outcomes at the population level. However, higher income inequality is typically associated with a higher prevalence of poverty.

A higher prevalence of poverty in turn all other things equal increases the number of premature deaths and therefore leads to higher longevity inequality.[6] Poverty is, for example, linked to unhealthy diets and lack of physical activity, thus contributing to the emergence of diabetes and cardiovascular diseases such as coronary heart disease and strokes, as well as enhanced alcohol and tobacco consumption, thus contributing to lung cancer, diseases of the liver and many other diseases.[5] Poor people enjoy fewer opportunities for recreational activities and report higher levels of stress and higher levels of mental health problems, which reduce one's capacity to cope with life's adversities.[7] Poverty also diminishes individual investment in education, which has been shown to be an important predictor of subsequent mortality.[8]

Yet, one should keep in mind that higher income inequality need not represent a higher prevalence of poverty but could instead reflect a higher concentration of incomes at the top at the expense of the income share held by individuals in the middle of the income distribution. It is therefore important not to equate the effect of income inequality on longevity inequality with the effect of poverty on longevity inequality. Income inequality affects inequality in longevity through societal effects that go well beyond any potential direct impacts on individuals' behavior as a function of their low disposable personal income.[9]

In some countries, high income inequality tends to result in the spatial segregation of rich and poor. Poor communities and neighborhoods have lower levels of social cohesion, support and capital, receive lower quality public services and experience higher crime rates, social disorder and violence with potentially negative health implications.[10,11] Importantly, however, economic inequality also affects political decision-making. Poor people are less likely to vote and have little influence on political decisions, whereas the (very) rich can exercise a strong influence via lobbying and donations. More economically unequal societies will thus be characterized by more unequal access to political decision-making.[12,13] This in turn creates political incentives to skew policies toward benefiting the relatively rich at the expense of the relatively poor, for example by lower government investment in goods such as publicly funded education or recreational and health care facilities that benefit people independently of their personal income. In ongoing research, we model one specific pathway through which larger income inequality affects longevity inequality, namely via a lower share of public to total health expenditures at the country level. The poor are dependent on public health expenditures since they cannot afford substantial investments into private health care, while the rich can buy better health privately.

Though research has occasionally speculated that a relation between redistributive policies and longevity inequality exists at the country level,[14] we are the first to empirically study the relationship between market inequality and redistributive government policies on the one hand and inequality in longevity on the other hand in a pooled analysis of up to 22 Western developed countries plus the Czech Republic, Estonia, Israel, Poland, the Slovak Republic and Slovenia over up to 37 years (with considerably fewer years for some, particularly the non-Western, countries).

We use the Gini coefficient as our preferred measure of inequality but different inequality measures that capture the entire distribution tend to produce similar results in the analysis of longevity.[15] The Gini coefficient is the most popular measure of inequality in the social sciences. It describes how far the Lorenz curve deviates from the line of perfect equality. The Lorenz-curve is a cumulative distribution function. It sorts all individuals according to the dimension in which inequality is measured, age at deaths in our case – see figure 1. Accordingly, the 100,000 individuals of death tables are sorted from those who died at birth on the left to those who lived to the age of 110 years on the right. The Lorenz curve depicts the proportion of the total time lived by the bottom x% of the entire cohort. Logically, all individuals together lived 100 percent of all the years. If, hypothetically, every individual reached exactly the same age, then the 'lowest' 10 percent of the population would live 10 percent of all years lived, 20 percent of the individuals would live 20 percent of all years lived and so on. The function of perfect equality is represented by the straight line from the origin to the upper right corner. If only one individual survived birth, then one would get total inequality. All individuals bar one would live 0 percent of the total time while the last individual would live 100 percent of the total time lived. Figure 1 plots an actual Lorenz curve based on actual US longevity data for 2010. The further away the Lorenz curve is from the diagonal, the larger the inequality in the data. The Gini coefficient measures the area between the Lorenz curve and the line of perfect equality (the light grey area) as a proportion of the total area below the line of equality in the quadrant. As figure 1 shows, longevity is relatively equally distributed. Not surprisingly, given natural constraints on the number of years anyone can live, longevity is more equally distributed than incomes are.

Since infant mortality has a relatively strong effect on longevity inequality, most demographers analyze not the entire range of life tables, but typically left-truncated ones of those who have survived beyond the age of 5, 10 or 15.[16,17] We report analyses of Gini coefficients over both the entire life tables (0-110 years) and for those who have survived to the age of 10 (10-110 years) to eliminate the potentially strong influence of child mortality, but our findings also hold for other thresholds.

Longevity inequality has declined in all countries included in our sample over the last two centuries. This development was paralleled by a large increase in life expectancy. Because of the strong association between both trends, some argue that one should only analyze inequality in longevity controlling for life expectancy.[15] However, rather than increases in life expectancy causing more equality in longevity, both trends are likely being determined by the same factors: the sharp decline in infant mortality and the somewhat less pronounced decline in premature mortality. [14,17]

Despite the dramatic decline in longevity inequality over the last two centuries, substantial differences in longevity inequality across countries exist and persist. Even for the seemingly similar countries included in our sample lifetime inequality varies moderately over the time period covered and across countries; it varies more strongly over longer time periods and larger sets of countries.[16,17] A good example is provided by comparing Sweden, one of the most equal, and the USA, one of the most unequal countries, in 1975 and in 2010. Figures A1 and A2 of the online appendix plot mortality rates by age for these two countries in these two years. Both countries experience significant increases in life expectancy and reductions in longevity inequality. However, there is considerable stability in the differences between both countries over 35 years. The USA lags behind the development in lifetime inequality in Sweden, reaching Sweden’s level of longevity inequality from 1975 only 35 years later in 2010.

METHODS

As our measure of longevity inequality, we compute Gini coefficients from internationally comparable life tables from the Human Mortality Database.[18] It provides age-specific mortality data for 37 countries and, depending on the country, in part with time series of up to 200 years. Note that our sample size is much smaller and entirely determined by the availability of data for our explanatory variables. We use annual data but our results do not change substantively if we employ 3- or 5-year averaged data instead. We include average life expectancy as a control variable in our estimation models, but all results hold regardless of whether we include life expectancy or not.

Explanatory Variables

As our measures of market income inequality and income redistribution we use, firstly, the Gini coefficient of incomes before taxes and transfers, which for simplicity we call market or pre-tax income inequality, and, secondly, the absolute difference between the Gini coefficient of incomes *before* taxes and transfers and the Gini coefficient of incomes *after* taxes and transfers. Note that a higher absolute difference does not necessarily imply that more income in absolute amounts is redistributed. Rather, it implies that income was redistributed in a way that resulted in a larger reduction in income inequality. For example, redistributing income from upper middle income brackets to lower middle income brackets has a smaller influence on our measure of income redistribution than the redistribution of an equally sized sum from high income to low income brackets. This feature makes this operationalization so attractive for our research. We source data from the OECD.[19]

As control variables, we include life expectancy at birth, computed from the life tables. Further, we source data on GDP per capita in thousand constant purchasing power parity

Dollars and total health expenditures per GDP from the OECD and the WHO's European Health for All database.[19,20] We take the logarithm of both variables and include their second-degree polynomial terms to account for potential non-linear effects. Lastly, we account for cross-country differences in lifestyle and health and safety regulations that impact on longevity inequality. We thus include the logarithm of average alcohol per capita consumption in liters of pure alcohol. Since we have no data with comprehensive coverage on tobacco consumption and on lifestyle choices and health and safety regulations that result in death due to external causes, we account instead for the mortality consequences of these by including mortality rates from lung cancer and from external causes per 1,000 inhabitants (all data sourced from the OECD and WHO). Countries with large population sizes could be inherently more heterogeneous, but population size did not contribute significantly to our estimation model and was therefore not included as a control variable. We linearly interpolate (but not extrapolate) missing observations on the explanatory variables. Table 1 provides summary descriptive variable information.

Estimation

Our data have some properties that require attention. The data are temporally dependent and would exhibit serially correlated errors, as evidenced by a Cumby-Huizinga test for auto-correlation, if we did not control for temporal dependency. We therefore include the lagged dependent variable, after which the same test fails to reject the hypothesis of no auto-correlation. Note that with the lagged dependent variable included, the coefficients of explanatory variables b represent their short-run marginal effects, whereas their long-run marginal effects are $b/(1-p)$, with p the estimated coefficient of the lagged dependent variable.

In addition to being temporally dependent, the data also exhibit strong trends over time. Medical and other progress that reduces infant mortality and premature deaths over time will exert a strong influence on longevity inequality, but this progress is impossible to observe and measure. However, this progress should lead to an upward trend in life expectancy and a downward trend in longevity inequality which is common to all countries included in our sample. We deal with this complication by adding year-specific fixed effects to the lagged dependent variable in our model specification and by controlling for life expectancy.

Finally, we account for remaining cross-sectional heterogeneity by including healthcare system fixed effects. We rely on Böhm et al.'s classification,[21] which groups countries into types of healthcare systems according to the private, societal or state organization of the regulation, financing and provision of health care. Countries can be grouped into those adopting systems of national health service (Denmark, Finland, Iceland, Norway, Portugal, Spain, Sweden, and the UK), national health insurance (Australia, Canada, Ireland, New Zealand, Italy), social health insurance (Austria, Germany, Luxembourg, and Switzerland), social-based mixed-type (Slovenia), etatist social health insurance, which we subdivide into Western (Belgium, France, Netherlands, Israel, and Japan) and Eastern (Czech Republic, Estonia, Poland and Slovakia), and private health (USA). Our estimator is ordinary least squares with standard errors clustered on countries.

RESULTS

Table 2 presents estimation results covering the entire sample with interpolated data, once for the Gini coefficient of longevity over the entire life tables and once for the Gini coefficient calculated conditional on survival to the age of 10 as dependent variables. Results are very similar for the two measures of longevity inequality. The Online Appendix provides further estimation results, always for both dependent variables. One set of estimations restrict the sample to available data without missing values in between available data points linearly interpolated, in order to check that results are not driven by the data interpolation. Another set of estimations restrict the sample to the more homogeneous 22 Western developed countries to check whether the results are driven by the presence of Eastern European countries and Israel in the sample. Among the developed countries, the USA is the most unequal in terms of longevity with relatively high market inequality and relatively low income redistribution. A final set of estimation models therefore further drop the USA from the sample to check whether this country alone determines the results. Results on our variables of principal interest are very robust across these different samples.

The estimated coefficients of the lagged dependent variables of between 0.78 and 0.85 are safely below the unit root threshold of one. Life expectancy has the expected negative effect on inequality. GDP per capita has a non-linear effect. The two polynomial terms are jointly significant, with the estimated marginal effect being positive but statistically insignificant at low levels of GDP per capita, turning negative and statistically significant just beyond mean per capita income levels, thus in part suggesting a Kuznets-curve type relationship between per capita income and inequality in longevity, similar to the inverted U-shape relationship between per capita income and income inequality famously suggested by Nobel Prize winner Simon Kuznets in the 1950s.[22] Total health expenditures have no statistically significant effect on longevity inequality, except in one model reported in the Online Appendix where the two polynomials are jointly statistically significant suggesting a significantly negative marginal effect at lower expenditure levels that becomes positive but statistically insignificant at higher expenditure levels. It might be surprising that for the most part we do not find total health spending to have a statistically significant effect, when higher total health spending will reduce longevity inequality if it is focused on reducing premature mortality. However, in relatively developed countries additional resources for health care often go into cutting-edge medical treatment, which prolongs the lives of some, often the already elderly, but it does not systematically prevent premature deaths. In other words, moving from high to even higher spending on health care does not necessarily reduce inequality in longevity. Even the contrary is possible: if additional health care spending benefits mainly those who would otherwise not receive it because they are considered to be too old for some treatments, then additional health spending may actually increase longevity inequality. Neither average alcohol consumption nor the lung cancer mortality rate have a statistically significant impact on longevity inequality, whereas a higher mortality rate from external causes is predicted to increase longevity inequality, as expected.

Higher pre-tax income inequality is statistically significantly related to higher longevity inequality, whereas the opposite holds for higher income redistribution. The estimated substantive effects are similar, but in the opposite direction. Across all estimated models, including those reported in the Online Appendix, an additional percentage point in the Gini coefficient of pre-tax income inequality is predicted to increase the Gini coefficient of longevity by between 0.0069 and 0.0129 percentage points in the short run and, correspondingly, by between 0.046 and 0.058 in the long run. A percentage point reduction from the Gini coefficient of pre-tax income inequality to the Gini coefficient of post-tax income inequality is predicted to decrease the Gini coefficient of longevity by between 0.0064 and 0.0102 percentage points in the short run and by between 0.043 and 0.051 in the long run. These effects are substantively important given that the standard deviations in both market income inequality and income redistribution are about 4.4 and 5.6 times larger than the standard deviations in, respectively, longevity inequality over the entire life tables and longevity inequality conditional on survival to the age of 10. For the Gini coefficient of longevity based on the entire life tables, varying pre-tax income inequality or income redistribution by one standard deviation would result in a long run change in longevity inequality by, respectively, 19 and 18 per cent of its standard deviation. For the Gini coefficient of longevity conditional on survival to the age of 10, the respective figures are 25 and 23 per cent, respectively.

Figures 2 and 3 illustrate the long-term effects of our two main explanatory variables graphically. These figures plot the conditional longevity inequality – that is, longevity inequality minus of the predicted effects of the control variables – against income inequality and income redistribution, respectively, together with the corresponding regression lines. The figures refer to longevity inequality using the entire life tables but they would look very similar for longevity inequality conditional on survival to the age of 10.

DISCUSSION

Health inequalities, of which inequality in the number of years lived forms a very important component, matter. Many argue that society should be more averse to, or less tolerant of, health inequalities than income inequalities.[23] Contrary to income, which is instrumental only, health is regarded as a special good, providing both instrumental and intrinsic value to human beings.[24] Health inequality is regarded as undesirable because inequalities in health represent inequalities in people's functional capabilities.[23] This is clearest and most extreme for inequality in longevity: the prematurely dead have been deprived of everything. Yet, income inequality and income redistribution can have important effects on inequality in longevity, as our analysis based on observational cross-national time-series data has shown.

Previous studies have focused on analyzing the effect of income inequality on health outcomes in single countries, predominantly in the USA,[25,26,27,28,29] but also in Brazil,[30] Canada,[31] Italy,[32] Norway,[33] and a few others. Whilst results have been somewhat mixed, a meta-analysis found income inequality to be associated with a modest excess risk of premature mortality.[34] Cross-country studies have typically focused on the effect of income inequality on aggregate population health rather than on measures of inequality in health or mortality.[35] Our analysis differs from these existing studies by analyzing the effect of economic inequality on longevity inequality, both measured at the country level, across a large cross-section of countries, namely up to 28 countries over the period 1974 to 2011. We have found evidence that higher inequalities of income are associated with higher inequalities of longevity, controlling for a large number of potentially confounding factors. This evidence is robust independently of whether we analyze inequality in longevity over the entire life tables or conditional on having survived to the age of 10. This suggests that our results are not driven by changes in child mortality across countries and time. Our results are also independent of whether we interpolate missing data and they are robust to dropping potential outlier countries from the cross-country study.

Where existing studies have explicitly focused on longevity inequality measured at the country level, they have decomposed longevity inequality by inequality in educational achievement or socio-economic status or some other factor. One study found that educational inequalities can explain a substantial part of lifespan variation in 11 European countries.[8] Another study found socioeconomic inequality to be important for accounting for the variance in adult life span in the United States.[17] In a panel of countries, based on bivariate plots the authors find no clear relationship between income inequality or inequality in educational achievement and inequality in longevity, both measured at the country level. However, such bivariate plots fail to control for important confounding variables and exogenous trends. A further study decomposed in detail the effects of population differences in the spread, allocation, and timing of the principal causes of death in Sweden and the USA to explore variability in longevity.[36] To the best of our knowledge, ours is the first cross-country study that estimates the effects of economic inequality on longevity inequality with a multivariate statistical model.

One limitation of our study is that we do not directly test the causal mechanisms by which economic inequality affect longevity inequality. We tackle this limitation in ongoing research. Another limitation is that it is unclear whether our results can be generalized to countries outside our sample, for example, to developing countries. Finally, like with all studies based on observational data causal inferences from our analysis are not valid with certainty.

CONCLUSION

Traditionally, scholarship in public health has focused on the effects of healthcare spending and its allocation as well as the effects of healthcare systems on health inequalities. We have shown that income inequality and policies that reduce it have a substantively important association with longevity inequality in a cross-country study. Societies that are more unequal in terms of income are also more unequal in terms of the number of years lived. We believe that this is an important argument for income redistribution, and one that is left out in the recent public debate about the rise and consequences of income inequality,[37] though public health scholars are ahead of social scientists in this regard.[38] Governments can indirectly influence income inequality before taxes and transfers via, for example, investment in education and infrastructure and the regulation of markets. They can redistribute incomes directly via taxes and transfers. Governments can thus affect longevity inequality well beyond any specific healthcare policies or health and safety regulations.

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CONTRIBUTOR STATEMENT

Both authors contributed equally to all aspects of the study.

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HUMAN PARTICIPATION PROTECTION

Not needed.

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Table 1. Descriptive summary variable statistics (N=476) based on our sample.

	mean	std. dev.	min.	max.
Gini of longevity (entire life tables)	0.100	0.010	0.082	0.134
Gini of longevity (cond. on survival to 10)	0.094	0.008	0.079	0.121
Life expectancy	77.911	2.306	71.974	83.056
ln (GDP p.c.)	10.225	0.263	9.495	11.211
ln (Health expend. to GDP)	2.125	0.207	1.609	2.839
ln Alcohol p.c. consumption	2.207	0.347	0.405	2.701
Lung cancer mortality rate (per 1,000)	0.484	0.124	0.263	0.716
External cause mortality rate (per 1,000)	0.544	0.163	0.275	1.305
Pre-tax income inequality	0.451	0.041	0.345	0.580
Income redistribution	0.160	0.041	0.041	0.268

Table 2. Estimation results for Gini coefficient of longevity.

	Entire life Table		Conditional on survival to age of 10	
	Coeff	95% CI	Coeff	95% CI
Lagged dependent variable	0.8523**	(0.7750, 0.9296)	0.8299**	(0.7372, 0.9226)
Life expectancy	-0.0004*	(-0.0007, -0.0000)	-0.0003*	(-0.0007, -0.0000)
ln (GDP p.c.)	0.0231	(-0.0109, 0.0570)	0.0204	(-0.0091, 0.0499)
ln (GDP p.c.) squared	-0.0011	(-0.0027, 0.0005)	-0.0010	(-0.0024, 0.0004)
ln (Health expend. to GDP)	-0.0021	(-0.0095, 0.0052)	-0.0009	(-0.0074, 0.0057)
ln (Health expend. to GDP) sq.	0.0006	(-0.0011, 0.0022)	0.0003	(-0.0012, 0.0018)
ln Alcohol p.c. consumption	0.0000	(-0.0002, 0.0003)	0.0001	(-0.0001, 0.0004)
Lung cancer mortality rate	0.0010	(-0.0006, 0.0027)	0.0007	(-0.0007, 0.0022)
External cause mortality rate	0.0029**	(0.0017, 0.0042)	0.0037**	(0.0020, 0.0055)
Pre-tax income inequality	0.0069**	(0.0030, 0.0108)	0.0083**	(0.0042, 0.0125)
Income redistribution	-0.0065*	(-0.0115, -0.0015)	-0.0076**	(-0.0125, -0.0028)
Observations	476		476	
Countries	28		28	

** p<0.01, * p<0.05. Year and healthcare system fixed effects included (coefficients not shown).

Figure 1: The Gini of Longevity Inequality in the USA in 2010

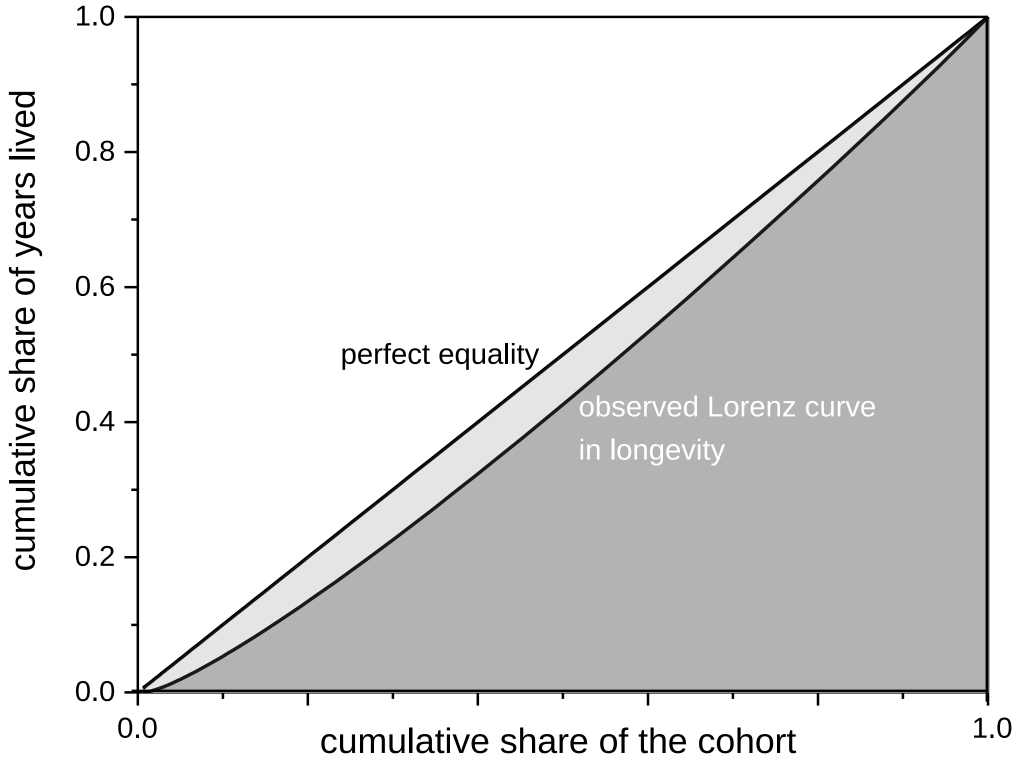

Figure 2: The Long-Term Effect of Pre-Tax Income Inequality on Longevity Inequality.

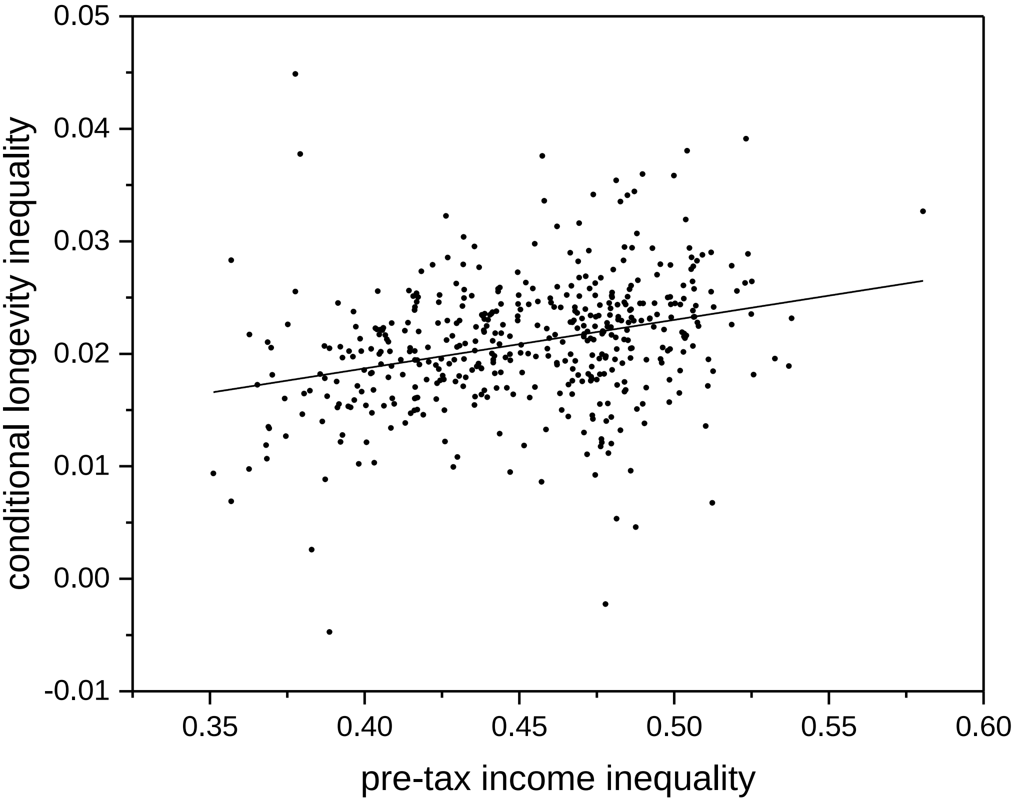

Figure 3: The Long-Term Effect of Income Redistribution on Longevity Inequality.