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Impacts of an Ageing Society on Macroeconomics and Income Inequality – The Case of Germany since the 1980s

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Abstract

This paper is concerned with the interplay between demography and macroeconomics on one hand and macroeconomics and income inequality on the other hand. For this purpose, several estimation equations are derived by econometric methods (on the empirical basis of the 1984-2010 German Socio-Economic Panel (SOEP) waves). In concrete terms, the macroeconomic variables inflation, economic growth, and unemployment are at first connected with the German demographic ageing; afterwards, these connections are used to produce a nexus between German income inequality and the stated macroeconomic variables (additionally to the exogenous effects of ageing).

For the empirical periods examined (1983-2009), there have been a) a (slightly) negative influence of demographic ageing on the inflation rate, b) a (weak) positive effect of ageing on the level – not on the increases (reductions) – of economic growth rates, and c) a somewhat stronger positive impact of demographic ageing on unemployment rates. While the measured income inequality is upwards directly (exogenously) driven by demographic ageing, the mechanisms through the different macroeconomic channels are more difficile: inflation is positively and unemployment negatively correlated with income inequality, and regarding economic growth a (slightly) concave effect upon income inequality has been observed. All these findings imply that demographic ageing, ceteris paribus and by tendency, diminishes income inequality via inflation and unemployment rate, which is also valid for economic growth (within the empirically relevant value range for the German demographic ageing).

But on balance, there is an overcompensating direct, exogenous impact of demographic ageing on inequality in the model used in this paper, and this causes tendencies towards a remarkable increase of German income inequality until 2060. These tendencies are more pronounced in the forecast variant in which a strongly ageing population is assumed.

Keywords: Demographic ageing, macroeconomics, personal income distribution, inequality.

JEL Classification: D30, D31, D60.

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Content

1. Introduction	3
2. Fundamental relationships	3
2.1 Preliminary remarks	3
2.2 Inflation	4
2.2.1 Demography and inflation	4
2.2.2 Inflation and inequality	4
2.3 Growth	5
2.3.1 Demography and growth	5
2.3.2 Growth and inequality	5
2.4 Unemployment	6
2.4.1 Demography and unemployment	6
2.4.2 Unemployment and inequality	6
3. Model	7
3.1 Database	7
3.2 Variables	8
4. Estimates	12
4.1 Observation period	12
4.1.1 General equation	12
4.1.2 Special equations	15
4.1.3 Substitutions	18
4.2 Forecasts	20
5. Concluding remarks	23
Appendix	25
References	29

1. Introduction[1]

The discussion paper is concerned with the interplay between demography and macroeconomics on one hand and macroeconomics and income inequality on the other hand. For this purpose, several estimation equations are derived by econometric methods (on the empirical basis of the 1984-2010 German Socio-Economic Panel (SOEP) waves). In concrete terms, the macroeconomic variables inflation, economic growth, and unemployment are at first connected with the German demographic ageing; afterwards, these connections are used to produce a nexus between German income inequality and the stated macroeconomic variables (additionally to the exogenous effects of ageing).

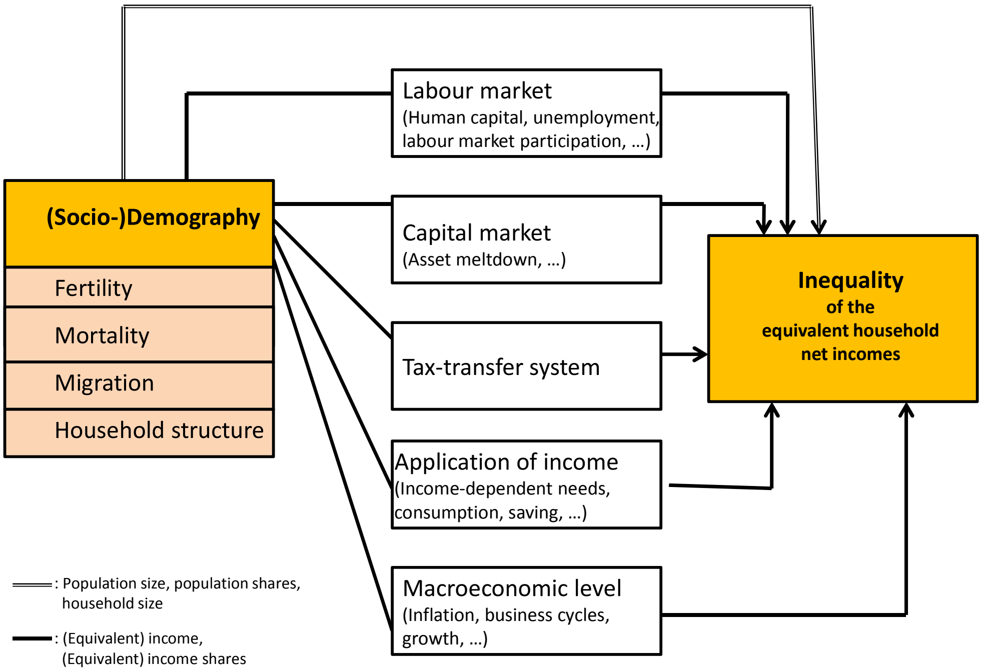
The paper is organised as follows: In Section 2 fundamental relationships between demography and macroeconomic variables on one hand and between macroeconomics and income inequality on the other hand are discussed. Section 3 presents the model used in this paper for econometrically analysing the corresponding relationships. These estimates are stated in Section 4, and last but not least concluding remarks in Section 5 finish this paper.

2. Fundamental relationships

2.1 Preliminary remarks

The relationship between demography (or, more precisely, demographic ageing) and income inequality works both directly and indirectly through several channels. One of these channels is “macroeconomics”. Especially inflation, economic output, and unemployment rates can be termed in this context. To consider the corresponding indirect relationships, a two-stage procedure makes sense, i. e.: analysing the relationship between demography and macroeconomics at the first stage and then scrutinizing the connection between macroeconomics and inequality in the second round (see, in this context, the lower part as well as the category “labour market”, concerning unemployment, in Figure 1).

Figure 1: Idealised transmission channels of demography on income inequality



Source: Faik 2010, p. 18 (weakly modified by present author)

[1] The data of this paper rest on the German Socio-Economic Panel (SOEP) of the German Institute for Economic Research (*DIW* Berlin). As a reference for the SOEP database see, e. g., Wagner, Frick, and Schupp 2007.

2.2 Inflation

2.2.1 Demography and inflation

Because of the age-related discrepancies between gainfully employed persons and pensioners and because of the lifetime cyclicality of the individual stock of wealth, one obtains cross-connections between inflation and demography. Thereby, demographic ageing may have, on principle, increasing effects on inflation. This would be the consequence of the increasing number of old people which are, in an economic sense, inactive and, therefore, they are consumers without participating in the material well-being's production of the current period.[2] Furthermore, demographic ageing may reduce labour supply which may increase wages, and the latter may result in higher prices of goods (through an increasing demand for goods and services or because entrepreneurs would compensate for the rise in labour costs).

Thus, there are some arguments in favour of a positive correlation between demographic ageing and inflation rate. Contrary to this, a negative correlation could, e. g., occur if the growing group of pensioners ("the old") would have to accept (relatively) low pension adjustments. This would damp the level of the aggregate demand for goods and services which would, by tendency, cause a lower price level; that is: reducing the inflation rate.

2.2.2 Inflation and inequality

Hewlett (1977) already has stated: "Inflation generally aggravates inequality (…)".[3] This must be interpreted in the sense that rapid price changes would enhance the relative well-being positions of the rich on one hand and worsen the well-being positions of the poor on the other hand.[4]

In this respect, in Mocan's (1999) analysis – for US data from the 1970s to the mid-1990s – inflation had a progressive influence on the measured income inequality and on its changes over time; reasonably, this was only valid for inflation which was not anticipated. A non-anticipated inflation can influence the distributional relationships between gainfully employed persons and pensioners (so-called "pensioners hypothesis" in the case where pensions are not adjusted for inflationary losses) or the relationships between the receivers of capital versus those getting labour incomes (e. g., if employees are defeated by a "monetary illusion").

Balac (2008) also examined (monetary) inflation's impact on income ("wealth") inequality referring to inflation's redistributive effects. He estimated (linear-logarithmic) regressions with several inequality indicators (Gini coefficient as well as Atkinson's measure with two rather extreme settings, one of Theil's indices, and several income ratios) as dependent variables and money supply (operationalized by money stock variables M1 and M2), educational attainment (= attainment of high school graduate or more), and federal fiscal policy (= governmental expenditures as a percentage of gross domestic product; at this, the values of the real gross domestic product are partly used as an instrumental variable) as independent variables. Hereby, money supply was a significant driver of inequality where the extremities of the income distribution were at a high rate significantly affected by monetary inflation.

On balance, literature gave evidence towards a positive correlation between inflation and inequality.[5]

[2] See Lindh, Malmberg, and Petersen 2010, p. 56.
[3] Hewlett 1977, p. 353.
[4] See Hewlett 1977, p. 353. Concerning the positive correlation between inflation and income inequality (mediated through distributional conflicts in the context of fiscal policy) see also Albanesi 2007 as well as (on the assumption of interest-bearing assets within the framework of money for transacting purposes) Cysne, Maldonado, and Klinger Moneiro 2005.
[5] See also Desai, Olofsgard, and Yousef 2005, pp. 41-42.

2.3 Growth

2.3.1 Demography and growth

Assuming decreasing factor productivities of the older work force, a negative connection between demographic ageing and (changes in) growth would be plausible. For instance, Hall and Stone (2010) discussed such demographic impacts on economic growth, and they differentiated between direct and indirect influences. Direct influences are linked to changes in total labour input through population growth, through changes in the population's working-age share, and via changes in the participation rates of the population in working age. Indirect effects arise from increases concerning the propensity to remain in work among the elderly or from changed propensities for societies to innovate and take risks (the latter partly emerging from interactions between demography and financial markets). In their empirical analysis, especially the direct effects of ageing showed negative effects on economic growth.

Contrary to the foregoing argumentation, Hori (2009) has shown – within the framework of an endogenous growth model – that life expectancy increases long-run growth. To establish such a positive connection between societal ageing and economic growth, a simplified model is helpful: The labour force only consists of younger persons, and only older persons provide the societal capital stock by their capital savings. In this case it can be shown that an ageing population increases labour productivity which would, ceteris paribus, result in higher economic growth.[6]

Thus (and similar to the connection between demographic ageing and inflation), in the scientific debate different hypotheses concerning the impact of demographic ageing on economic growth exist.

2.3.2 Growth and inequality

In literature, the correlation between growth and inequality is intensively considered in both directions, as impacts of inequality on growth[7] and the other way around that is important in our context.

With respect to this latter causality, Jäntti and Jenkins (2009) stated – on the basis of the Gini coefficient – that for Great Britain a low economic growth would hardly produce any change of inequality, whereas a high economic growth would generate increases in inequality. In some sense, this contrasts to the "Kuznets curve" which postulates a U-shaped connection between the amount of total income per capita and income inequality.[8]

In the above stated Hori (2009) model, the long-run growth rates effects are negatively correlated with entire inequality. Thus, the indirect (positive) linkage of life expectancy via long-run growth towards income inequality would result in less income inequality in this model.

Berg and Ostry (2011) – to quote another study – aimed at the growth rate spells, i. e. on the sustainability of growth, and their connections to income inequality. They found that "(…) longer growth spells are robustly associated with more equality in the income distribution."[9]

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[6] See Sveriges Riksbank 2000, pp. 44-47. Note that the presumptions of this simplified model are contradictory to the life-cycle hypothesis.

[7] See, e. g., Banerjee and Duflo 2000 who empirically generated a concave relationship between growth rate and (net) changes in income inequality. See, furthermore, Gobbin, Rayp, and Van de gaer 2007.

[8] See Kuznets 1955. For an overview about the controversial discussion of the Kuznets curve (with both negative and positive relationships between growth and inequality in a variety of regression-based studies) see Lundberg and Squire 2003.

[9] Berg and Ostry 2011, p. 3.

Amidst the backdrop of widespread and partly contradictory results regarding the relationship between growth and inequality, a somewhat sophisticated picture shows up: While positive growth appears to have a clear effect upon the reduction of poverty, and a negative nexus between the distribution of wealth and economic growth seems to exist, the relationship between growth (as an explanatory variable) and inequality seems not well-established.[10]

2.4 Unemployment

2.4.1 Demography and unemployment

Calculations of the German Institute for Economic Research (*Deutsches Institut für Wirtschaftsforschung; DIW*) showed that the German labour supply will presumably remain constant up to 2025. Reasons for this result are a higher statutory pension age in Germany (67 instead of 65 years), a more difficult access to reduced earning capacity pensions, the ending of special regulations concerning early retirement in the recent past, and a supposed increase in the number of women regularly working compared with the status quo. However, after 2025 a diminishment of the German labour force appears plausible: Those farther-reaching estimations for the German labour supply range between 34 and 37 Mio persons in 2050 (compared to currently more than 40 Mio persons).[11]

Additional, extensive labour force estimates of the German Institute for Employment Research (*Institut für Arbeitsmarkt- und Berufsforschung; IAB*) gave evidence for increases of the labour force's shares for persons aged 50 years and older by nearly 12 percentage points until 2050, and for persons 60 years and older from 1 to 3 % during the corresponding 40 years.[12]

Thus, amidst the backdrop of the ageing (and shrinking) German society, in the long run a) an ageing of the German work force and b) a scarcity of the production factor labour is predicted for Germany. The latter could mean a reduction of unemployment so that these findings indirectly support the hypothesis of a diminishment of unemployment in an extensively ageing society. In the short run, such an effect will not inevitably occur in Germany – for the reasons given above.

2.4.2 Unemployment and inequality

The issue of unemployment exhibits a relatively close link to social inequality, at least at the lower part of the income distribution: Usually the degree of unemployment is positively correlated with (cross-sectional relative) income poverty.

On principle, the distributional effects of short-term and long-term unemployment must be separated from each other. Mocan (1999) decomposed – assuming a stochastic trend – the US unemployment rates from 1970 to 1994 into a transitory and into a permanent term. Structural unemployment reduced the income shares of the lower 60 % of the income distribution, and, thus, it caused increases in (income) inequality; it raised (income) inequality stronger than transitory, i. e. short-term unemployment.

Hoover, Giedeman and Dibooglu (2009) stated – principally in line with the foregoing findings – that increases in unemployment would cause raises in income inequality; negative shocks to unemployment had only short-lived positive benefits to income inequality.

However, if the afore-mentioned hypothesis of a shortage of the German labour supply (see Section 2.4.1) and, corresponding with that, of a reduction of unemployment in Germany will take place in the future, an increase in the wage-interest relation appears plausible. This

[10] See Binatli 2012.
[11] See Schulz 2008.
[12] See Fuchs, Söhnlein, and Weber 2011.

could correspond with a tendency towards a reduction of personal income inequality via a "levelling" of broad income regions. However, this must not be the case since wage increases might be very unequally distributed amongst employees. Additionally, it appears not implausible that unemployment reductions may increase income inequality because the group's number of persons receiving relatively uniform payments of unemployment benefits would be reduced.

On the whole, there are obviously opposing influences concerning the impact of unemployment on income inequality, and it is open to empirical debate which of these effects predominates.

3. Model

3.1 Database

In the following, data from the German Socio-Economic Panel's (SOEP) waves from 1984 to 2010 are used because the SOEP data of the German Institute for Economic Research (DIW Berlin)[13] have been collected since 1984 (in annual intervals), and the latest available wave is from 2010. The SOEP data correspond to western Germany until 1991 SOEP and afterwards to Germany as a whole. The sample sizes are between about 5,000 and around 12,000 households, and the current number of interviewed persons amounts to approximately 20,000 persons.[14] The participants of the surveys give detailed information on their incomes, household compositions, earnings' and family's biographies, health, life satisfaction, etc. Up to now, nine subsamples have been drawn to capture different sub-populations representatively.

For distributional analyses, two central income variables exist within the SOEP context: Monthly household income of the current year and annual household income of the previous year so that the query for the latter variable is retrospective. In this study, I use – in accordance with the Canberra Group's guidelines[15] – annual household net income which includes households' income obtained from all sources (including imputed rents) over a one year's period.

In the SOEP, the following kinds of income and of income deductions are differentiated from each other:[16]

- income resulting from self-employment and from gainfully employed work (= labour income),
- capital gains (including fictive imputed rents),
- transfers: private pensions, other private transfers, and public transfers (e. g., pensions from the statutory pension system),
- income deductions: taxes and social security payments of contribution.

One convention in the context of the SOEP must be considered: Annual incomes of the previous year are linked to the socio-demographic population's structure of the current year since both distributional elements (incomes, socio-demography) are related to the same data wave and, thus, to the same weighting scheme, etc. Hence, in the following analyses, period t corresponds with t+1 SOEP wave; for instance, "1983" means that (retrospective) income information stems from 1984 SOEP wave as well as socio-demographic information does.

[13] See, e. g., Wagner, Frick, and Schupp 2007.
[14] See Wagner et al. 2008.
[15] See UN 2011, pp. 26-27.
[16] See, e. g., Peichl, Pestel, and Schneider 2012, pp. 126-127.

3.2 Variables

To capture income-specific economies of scale, the following inequality results are based on variable equivalence scales for three income regions generating the relevant welfare variable *equivalent household net income*.[17]

Its inequality is measured by the normalised coefficient of variation (= half the squared coefficient of variation) as a conventional *inequality indicator*.[18] In the regressions below, this indicator is used as the dependent variable, and it is abbreviated by HSCV.

As independent variables in the model's main equation serve:

- the changes of the harmonised consumers' price index as an indicator for *inflation* (INFLATION; reference year: 2005),
- the changes of the real per-capita gross domestic product as an indicator for *economic growth* (GROWTH; reference year: 2000),
- the ratio "number of unemployed divided by the sum of unemployed and (civil) employees" (according to the definition of the German Agency for Labour; *Bundesagentur für Arbeit*) as an indicator for the *unemployment rate* (UNEMPLOYMENT), and
- the old-age dependency ratio "persons aged 65 and older divided by persons in the age of 20 to 64 years" as an indicator for the *demographic development* in Germany (AGE).

Table 1 shows the descriptive statistic values for these selected variables.

Table 1: Descriptive statistics for the model's variables for Germany, 1983-2009

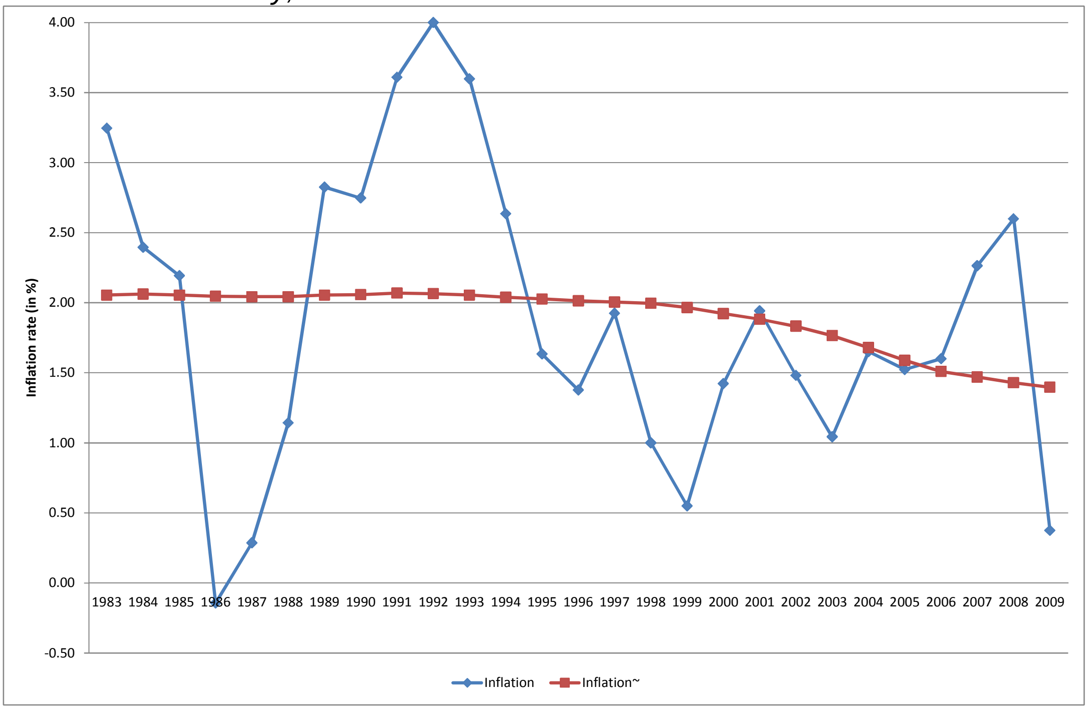
Variable	Arithmetic mean value	Standard deviation	N
HSCV	0.2121	0.05783	27
INFLATION	1.8860	1.05926	27
GROWTH	1.6024	1.73564	27
UNEMPLOYMENT	10.0741	1.61854	27
AGE	26.7519	3.56126	27

Source: Present author's own calculations on the basis of 1984-2010 SOEP and DRV 2012, pp. 250, 256, 260, and 262

[17] For more details, see Faik 2012, pp. 5-7.
[18] Regarding its characteristics see, e. g., Faik 2012, pp. 9-11.

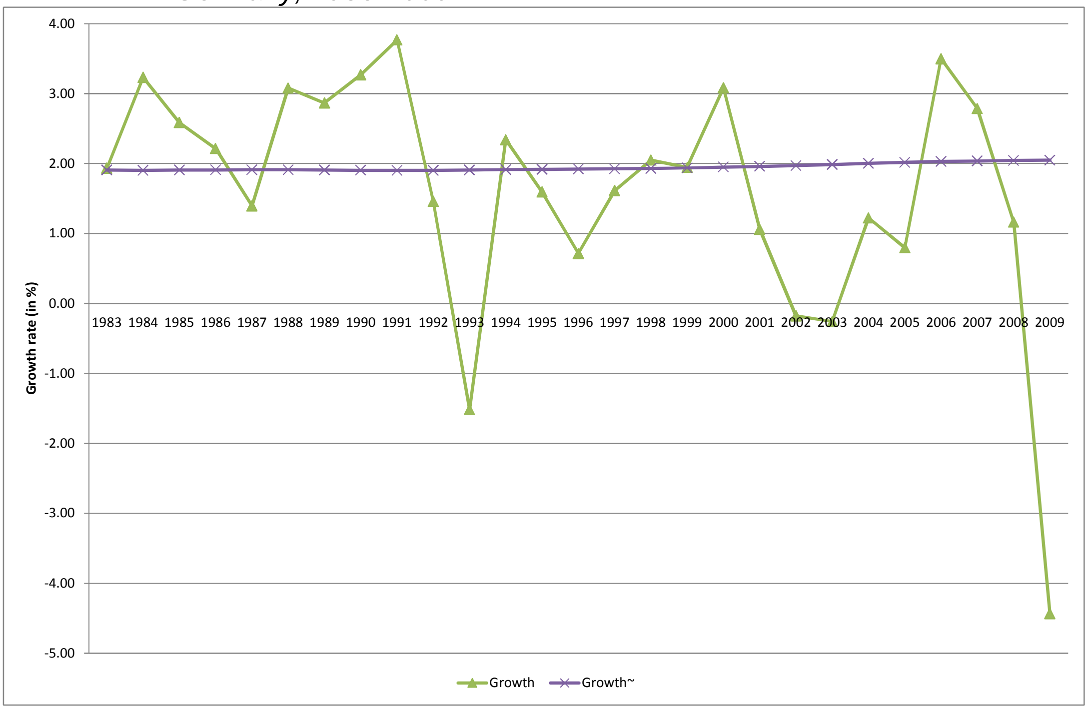
Further descriptive information is presented in Figures 2a-2d which illustrate the development of these variables over time (1983-2009).[19]

Figure 2a: Empirical inflation rates and estimated inflation rates (denoted by a tilde) – Germany, 1983-2009



Sources: DRV 2012, p. 250, and present author's own calculations

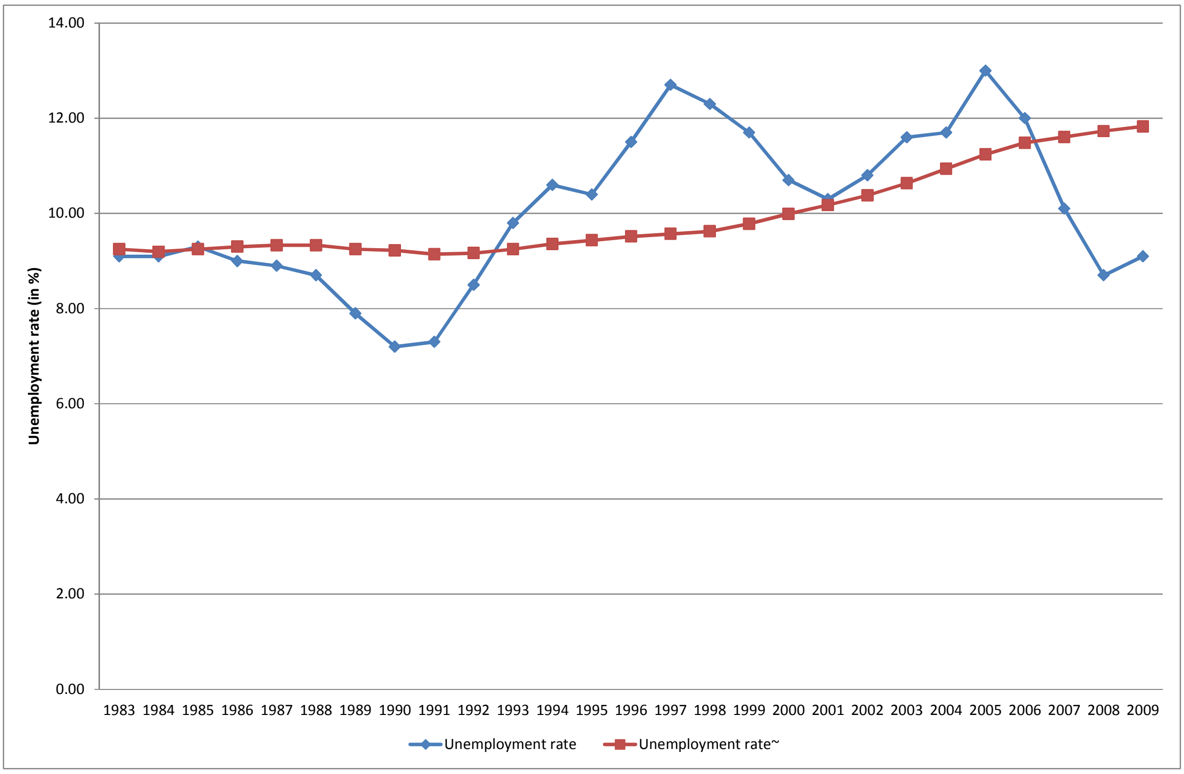
Figure 2b: Empirical growth rates and estimated growth rates (denoted by a tilde) – Germany, 1983-2009



Sources: DRV 2012, p. 256, and present author's own calculations

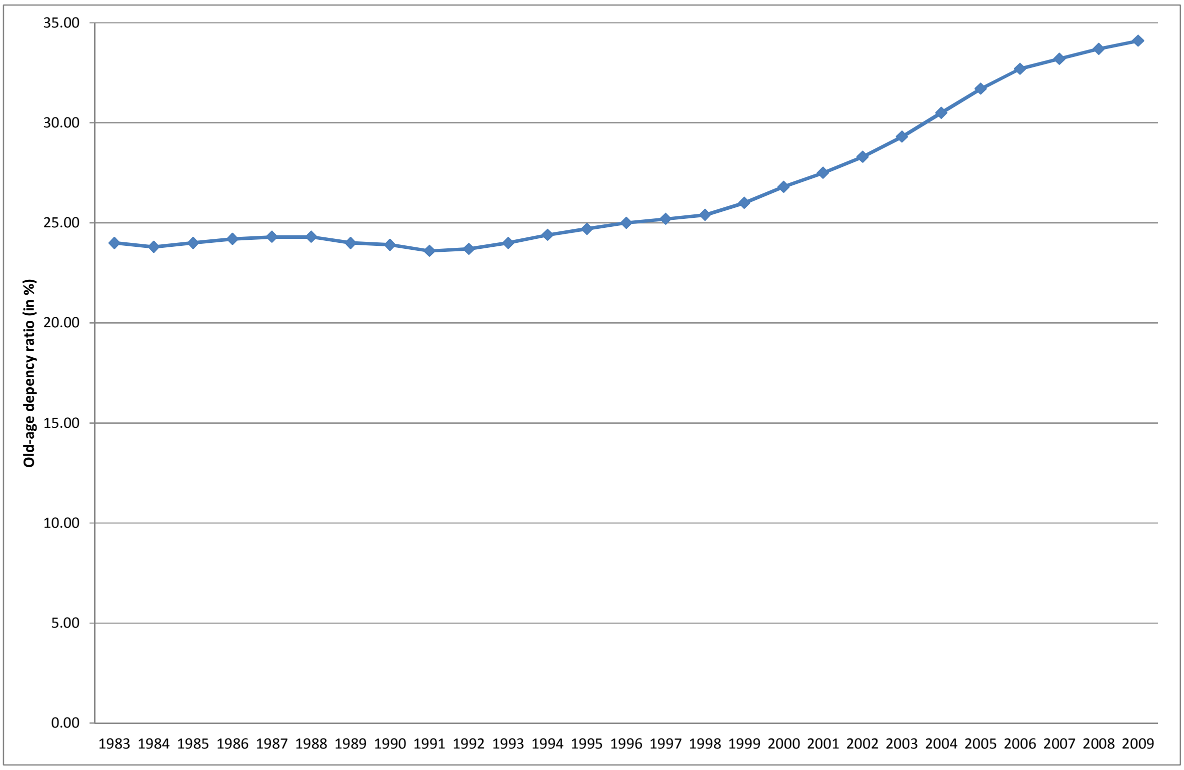
[19] By the way: Concerning the estimated values see Section 4.1.

Figure 2c: Empirical unemployment rates and estimated unemployment rates (denoted by a tilde) – Germany, 1983-2009



Sources: DRV 2012, p. 260, and present author's own calculations

Figure 2d: Empirical old-age dependency ratios – Germany, 1983-2009



Source: DRV 2012, p. 262

The variables afore-mentioned (HSCV, INFLATION, GROWTH, UNEMPLOYMENT, AGE) are used in a small model aiming at predicting future income inequality in Germany. For this purpose, at first functions between the macroeconomic variables and AGE are postulated:

- INFLATION = f_1 (AGE),
- GROWTH = f_2 (AGE), and
- UNEMPLOYMENT = f_3 (AGE).

On the basis of these functions, the general prediction equation

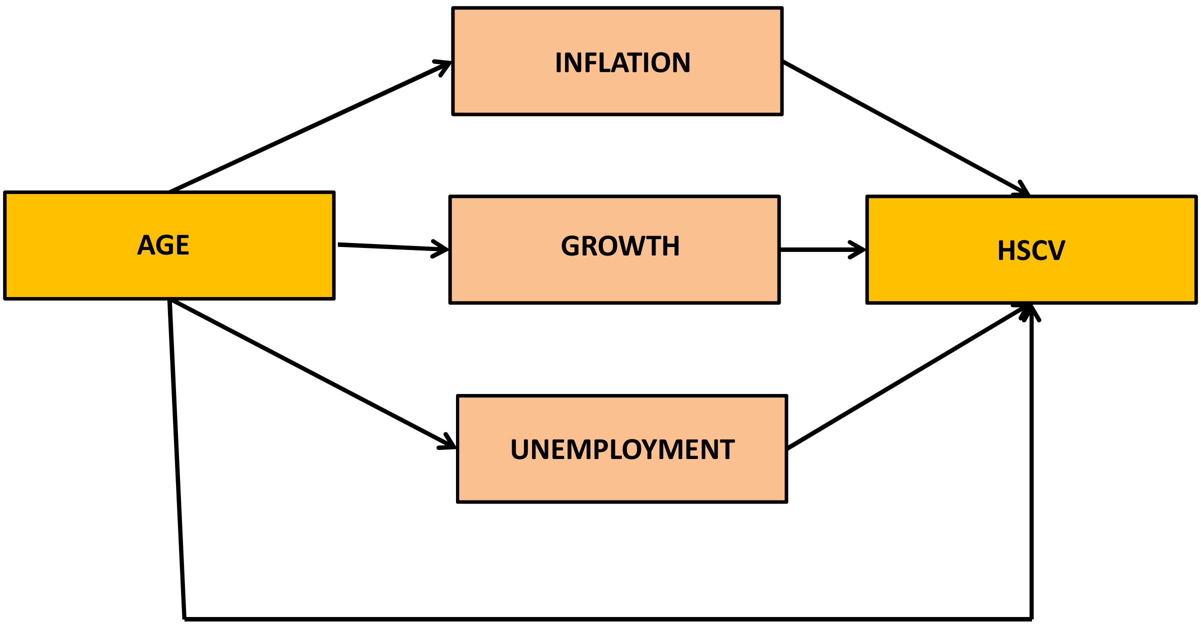
HSCV = g (INFLATION, GROWTH, UNEMPLOYMENT, AGE)

is transformed into

HSCV = g (f_1 (AGE), f_2 (AGE), f_3 (AGE), AGE) = h (AGE).

The latter equation is utilised to predict future German income inequality based on the forecasted values for AGE. Each of the foregoing equations is estimated by OLS. Categorising the model's structure, the model used in this paper is a (regression) model with intervening, mediating variables (see Figure 3). This structure reveals the outstanding importance of AGE which is motivated by the paper's main concern, i. e., illustrating the changes of income inequality (HSCV) in an ageing society.

Figure 3: Model's structure



Source: Present author's own illustration (on the basis of Urban and Mayerl 2011, p. 295)

4. Estimates

4.1 Observation period

4.1.1 General equation

For the observation period 1983-2009, the general OLS regression HSCV = g (inflation, growth, unemployment rate, old-age dependency ratio) is performed. It results in the following equation:[20]

$$HSCV = -0.214^{***} + 0.012^{***}\ INFLATION + 0.004^{**}\ GROWTH - 0.002^{***}\ GROWTH^2 - 0.007^{***}\ UNEMPLOYMENT + 0.018^{***}\ AGE$$

[N = 27; R^2_{adj} = 0.944; DW = 2.309, i. e., no decision concerning first-order autocorrelation of residuals possible; ANOVA[21] F-value = 88.600***].

All of the coefficients are highly significant (at least at a significance level of 95 %), and the adjusted determination coefficient is extraordinarily high. Furthermore, the ANOVA F-value suggests a very high (joint) significance for the combination of the estimated coefficients. The Durbin-Watson (DW) statistics indicates that no decision concerning (first-order) autocorrelation of the residuals is possible since the empirical DW value lies between 4 – the theoretical upper limit and 4 – the theoretical lower limit in the Durbin-Watson statistics (2.139 < 2.309 < 2.996).[22]

As is illustrated by the following correlation matrices (Tables 2a and 2b), there are some hints for the problem of multicollinearity.[23] But, as it is well-known[24], for forecasting purposes – the main goal of this paper – this problem is not as relevant as for causal analyses (which are of minor concern in this paper).

Table 2a: Zero-order correlation descriptives between the model's variables (N = 27)

Variable		HSCV	INFLA-TION	GROWTH	UNEMPLOY-MENT	AGE
Pearson's correlation coefficient:	HSCV	1.000	0.034	-0.238	0.160	0.914
	INFLATION	0.034	1.000	0.232	-0.401	-0.264
	GROWTH	-0.238	0.232	1.000	-0.178	-0.385
	UNEMPLOYMENT	0.160	-0.401	-0.178	1.000	0.355
	AGE	0.914	-0.264	-0.385	0.355	1.000
Significance (o-nesided):	HSCV	X	0.434	0.116	0.212	0.000
	INFLATION	0.434	X	0.122	0.019	0.092
	GROWTH	0.116	0.122	X	0.187	0.024
	UNEMPLOYMENT	0.212	0.019	0.187	X	0.035
	AGE	0.000	0.092	0.024	0.035	X

Source: Present author's own calculations

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[20] Out of a range of possible estimation equations this equation performed best. Alternate estimations may be found in the Appendix. In every estimation equation presented * denotes a significance level of 90 %, ** one of 95 %, and *** one of 99 %.
[21] ANOVA = Analysis of Variance
[22] See, in this context, Urban and Mayerl 2011, p. 266.
[23] For instance, the VIF values (VIF = Variance Inflation Factors) in Table 2b are higher than 1 – the case of independency. However, all of the empirical VIF values are considerably lower than the (upper) critical value of 5.0 (according to a "thumb rule" by Urban and Mayerl 2011, p. 232). Equivalently, the tolerance values in Table 2b are above their critical level of 0.25, the latter – and values below this limit – being an indicator for problematic collinearity (see, once more, Urban and Mayerl 2011, p. 232).
[24] See, e. g., Stocker 2012, pp. 240-241.

Table 2b: Correlation descriptives and collinearity statistics between the model's coefficients

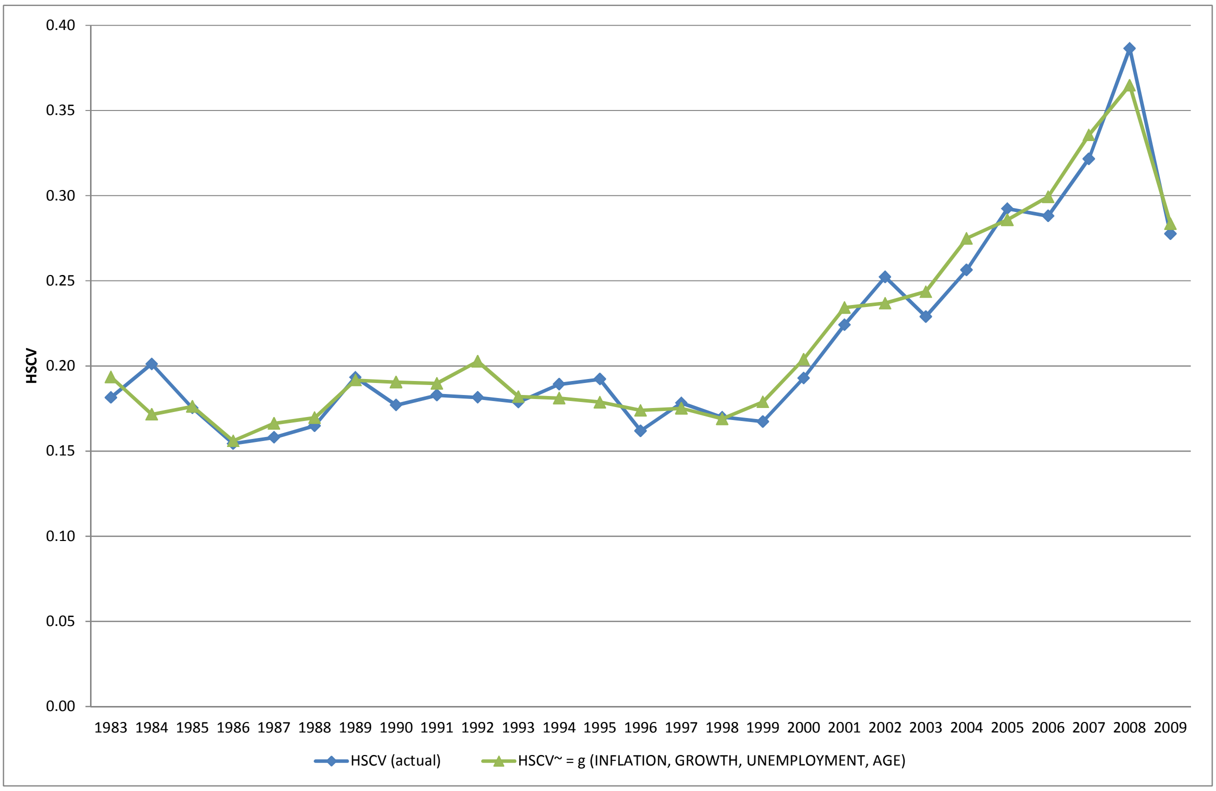
Model	Correlations			Collinearity statistics	
	Zero order	Partial	Semi-partial	Tolerance	VIF
INFLATION	0.034	0.672	0.193	0.779	1.284
GROWTH	-0.238	0.460	0.110	0.805	1.243
$GROWTH^2$	0.031	-0.586	-0.154	0.692	1.446
UNEMPLOYMENT	0.160	-0.583	-0.153	0.554	1.804
AGE	0.914	0.974	0.916	0.681	1.469

VIF = Variance Inflation Factor

Source: Present author's own calculations

Figure 4 visually confirms the relatively good adjustment of the empirical HSCV values through the estimated HSCV values over the time span 1983-2009.

Figure 4: Empirical and estimated income inequality in Germany, 1983-2009, depending on a general function between inequality (HSCV) and inflation (INFLATION), growth rate (GROWTH), unemployment rate (UNEMPLOYMENT), and old-age dependency ratio (AGE)



Source: Present author's own calculations

Excursus

Since the data belong either to western Germany (1983-1991) or to Germany as a whole (1992-2009), structural discontinuities might play a role. To test for them, separate regressions for both time segments are performed:[25]

1983-1991 (western Germany):

$$\text{HSCV} = 0.571 + 0.007\ \text{INFLATION} + 0.023\ \text{GROWTH} – 0.004\ \text{GROWTH}^2 + 0.007\ \text{UNEMPLOYMENT} – 0.020\ \text{AGE}$$

[N = 9; R^2_{adj} = 0.289; DW = 2.680, but too few observations to compute DW test statistics; ANOVA F-value = 1.651].

1992-2009 (Germany as a whole):

$$\text{HSCV} = -0.211^{***} + 0.011^{*}\ \text{INFLATION} + 0.004\ \text{GROWTH} – 0.003^{***}\ \text{GROWTH}^2 – 0.008^{*}\ \text{UNEMPLOYMENT} + 0.018^{***}\ \text{AGE}$$

[N = 18; R^2_{adj} = 0.949; DW = 2.143, i. e., no decision concerning autocorrelation of residuals possible; ANOVA F-value = 64.572***].

The computed F-statistics is (for these two separate regressions in relation to the entire observation period):

$$F_{emp} = [\{0.013 – (0.001 + 0.002)\}/6] / [(0.001 + 0.002)/(27 – 12)] \approx 8.33.$$

Compared with the critical F-value (95 %-level, N = 27, k = 6) in the amount of approximately 2.455, the empirical F-value is higher. Thus, the null hypothesis ("No structural discontinuities") must be refuted, i. e., there are substantial differences between the two time periods considered. Thereby, it must be kept in mind that the estimates for the period 1983-1991 (western Germany) are very bad; partly this is attributed to the small number of observations (only 9 years!). Apart from this statistical (sample-size) problem, in my eyes, the differences between the two periods considered are less due to German unification's effects but rather due to the different role the old-age dependency ratio plays: As can be seen by the above Figure 2d, in the 1980s demographic ageing was not really observed in Germany (as a consequence of the "baby-boomer" effect dating especially from the 1960s) – in contrast to the 1990s and the first decade of the new millennium. Thus, this is, in my eyes, the main structural difference between both periods.

End of excurses

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[25] By the way: Further equations for different ("sliding") time periods, each of them consisting of 15 years, may be found in the Appendix.

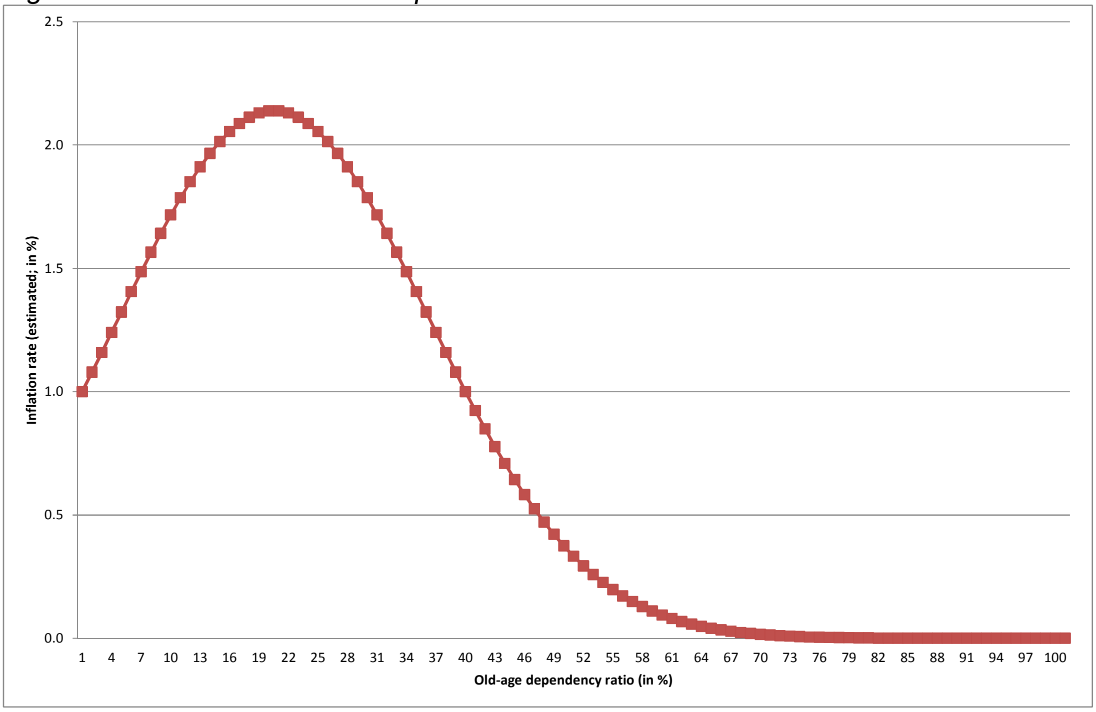
4.1.2 Special equations

Regarding the macroeconomic variables as functions of demography (operationalized by the old-age dependency ratio), the following (best fitted[26]) equations are estimated (for Germany, 1983-2009):

(1) ln (INFLATION) = 0.078*** AGE – 0.002* AGE^2

[N = 26; R^2_{adj}[27] = 0.366; DW = 1.314, i. e., no first-order autocorrelation of residuals[28]; ANOVA F-value = 8.521**][29]:

Figure 5a: Estimated relationship between INFLATION and AGE



Source: Present author's own calculations

This course of the function is obviously characterized by an increase of the inflation rate up to an old-age dependency ratio in the amount of 20 %, then by decreasing effects on the inflation rate of the old-age dependency ratio, and at the end – starting at a value of the independent variable in the amount of about 70 % – by convergence to zero. For recent empirical values in Germany – measured from the 1980s on – the decreasing area of the above function is relevant, i. e. that in Germany demographic ageing has a declining impact on the inflation rate (at least in our simple model with only one covariate, AGE). The latter also manifested itself in the above Figure 2a which has depicted the estimated inflation values over time (in comparison with the empirical inflation rates).

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[26] Alternate "special equations" are presented in the Appendix.

[27] In a model without a constant, R^2_{adj} measures the share of variability in the dependent variable through the origin that can be explained by regressions. This procedure is not comparable to the R^2_{adj}'s in models with a constant, and this must be kept in mind regarding the special equations without intercept (see, e. g., Stocker 2012, p. 7).

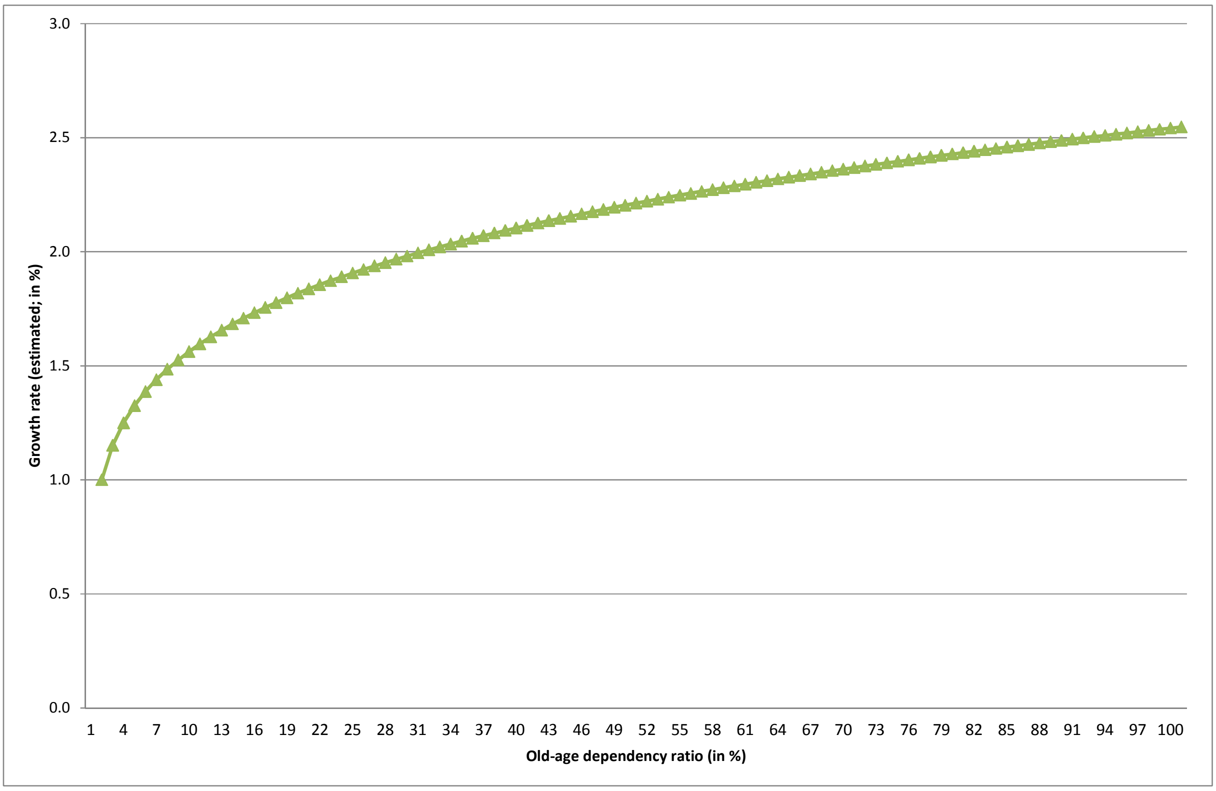
[28] In equations without an intercept as the foregoing equation, the Durbin-Watson test must be performed according to a procedure proposed by Farebrother 1980.

[29] Dividing the entire time period into the years before 1992 and into the years from 1992 on, the regressions are: years ≤ 1991: ln (INFLATION) = 0.030 AGE + 0.001 AGE^2 [N = 38, R^2_{adj} = 0.744, DW = 0.909, F = 56.261***]; years ≥ 1992: ln (INFLATION) = 0.075* AGE – 0.002 AGE^2 [N = 19, R^2_{adj} = 0.361, DW = 1.408, F = 6.361***].

(2) ln (GROWTH) = 0.203*** ln (AGE)

[N = 23; R^2_{adj} = 0.645; DW = 1.615, i. e., no first-order autocorrelation of residuals; ANOVA F-value = 42.806***][30]:

Figure 5b: Estimated relationship between GROWTH and AGE



Source: Present author's own calculations

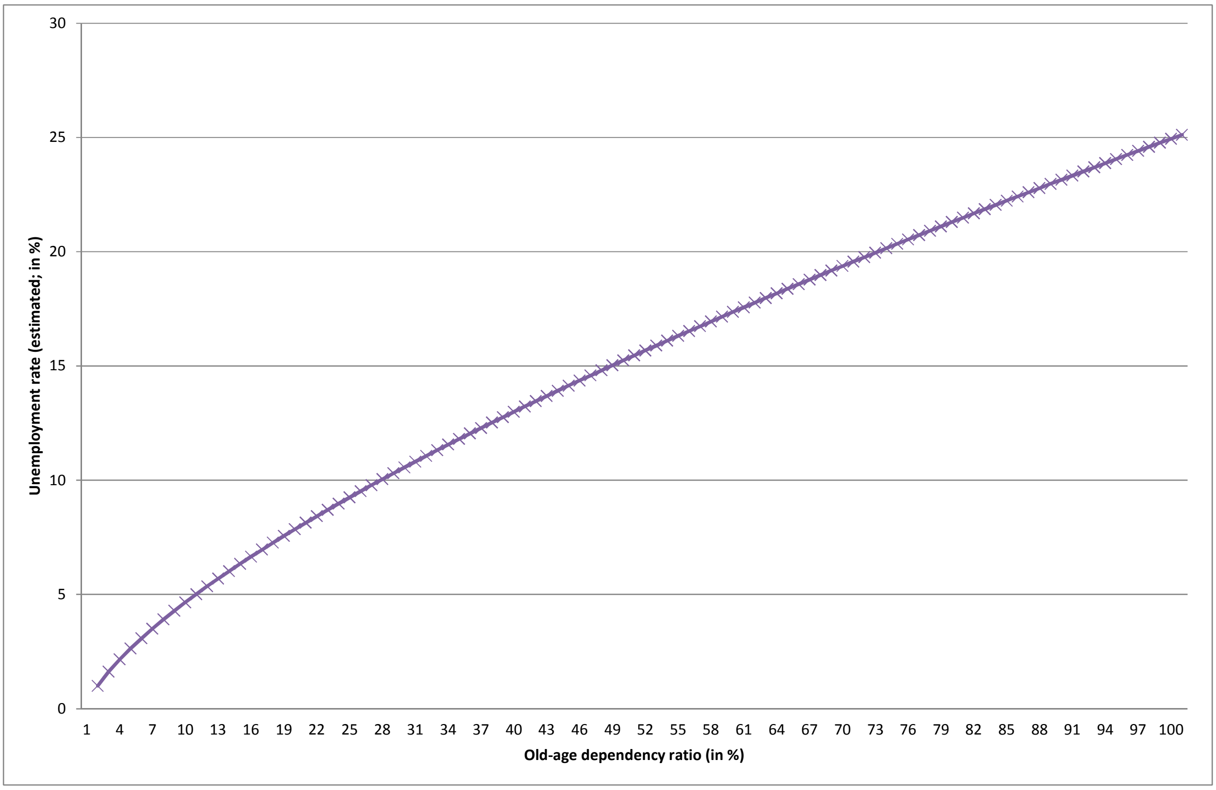
The old-age dependency ratio exerts an increasing influence on economic growth in Germany. However, the changes of the slope are negative so that the corresponding curve is increasing on a diminishing scale. This was also indicated by the above Figure 2b in which the estimated growth rates have been compared with the empirical growth rates during the period from 1983 to 2009.

[30] For the periods in front of 1992 and from 1992 on, one obtains the following separate regression equations: years ≤ 1991: ln (GROWTH) = 0.266*** ln (AGE) [N = 19, R^2_{adj} = 0.601, DW = 1.765, F = 29.562***]; years ≥ 1992: ln (GROWTH) = 0.164*** ln (AGE) [N = 19, R^2_{adj} = 0.515, DW = 2.084, F = 16.941***]. Obviously, the elasticity of GROWTH with respect to AGE decreased during the time segment after the German unification compared to years in front of the German unification.

(3) ln (UNEMPLOYED) = 0.700*** ln (AGE)

[N = 27; R^2_{adj} = 0.996; DW = 0.301, i. e., positive first-order autocorrelation of residuals; ANOVA F-value = 6,113.080***][31]:

Figure 5c: Estimated relationship between UNEMPLOYMENT and AGE



Source: Present author's own calculations

Similarly to the case with economic growth as the dependent variable (see above), the old-age dependency ratio influences the German unemployment rate positively but on a diminishing scale. This is also reflected by the above Figure 2c that compared the estimated and the empirical unemployment rates from 1983 to 2009 with each other.

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[31] For the years in front of the German unification (≤1991) the corresponding regression equation is as follows for western Germany: ln (UNEMPLOYMENT) = 0.540*** ln (AGE) [N = 18, R^2_{adj} = 0.885, DW = 0.569, F = 138.977***]. The regression equation for the years after the German unification (≥ 1992) is: ln (UNEMPLOYMENT) = 0.713*** ln (AGE) [N = 18, R^2_{adj} = 0.996, DW = 0.332, F = 4,060.259***]. Comparing these two time segments with each other, this indicates that the elasticity of UNEMPLOYMENT with respect to AGE increased for the entire time period after the German unification.

4.1.3 Substitutions

In order to predict future German income inequality, the estimators of the three ("special") equations afore-mentioned are used as substitutes for the independent variables in the general equation above stated (in Section 4.1.1). In this context, it must be noted that this kind of substitution is not perfect since the substitutes are derived from OLS regressions that do not tell the whole story concerning variations in the used macroeconomic variables (primarily meaning that the macroeconomic variables are not solely influenced by demographic ageing). Despite this drawback, the substitution procedure mentioned is applied; it yields:

$$\begin{aligned} HSCV = & -0.214 + 0.012 \exp(0.078\ AGE - 0.002\ AGE^2) \\ & + 0.004 \exp(0.203 \ln(AGE)) - 0.002 [\exp(0.203 \ln(AGE))]^2 \\ & - 0.007 \exp(0.700 \ln(AGE)) + 0.018\ AGE. \end{aligned}$$

Since different functional specifications (with different sample sizes) are used for the general equation and for the three special equations, the previous model is only a "modified mediator model" (MMM). The "original" regression model with mediating variables (OMM) would have resulted in the following equations:

Special equations:

$$INFLATION = 3.984^{**} - 0.078\ AGE$$

[N = 27; R^2_{adj} = 0.032; DW = 0.792, i. e., positive first-order autocorrelation of residuals; ANOVA F-value = 1.868]

$$GROWTH = 6.626^{**} - 0.188^{**}\ AGE$$

[N = 27; R^2_{adj} = 0.114; DW = 1.325, i. e., no decision regarding first-order autocorrelation of residuals possible; ANOVA F-value = 4.358**]

$$UNEMPLOYMENT = 5.762^{**} + 0.161^{*}\ AGE$$

[N = 27; R^2_{adj} = 0.091; DW = 0.317, i. e., positive first-order autocorrelation of residuals; ANOVA F-value = 3.596*]

General equation:

$$\begin{aligned} HSCV = & -0.240^{***} + 0.014^{***}\ INFLATION + 0.003\ GROWTH \\ & - 0.003\ UNEMPLOYMENT + 0.017^{***}\ AGE \end{aligned}$$

[N = 27; R^2_{adj} = 0.918; DW = 2.329, i. e., no decision regarding first-order autocorrelation of residuals possible; ANOVA F-value = 74.245***]

Compared to the bivariate regression of HSCV with respect to AGE:

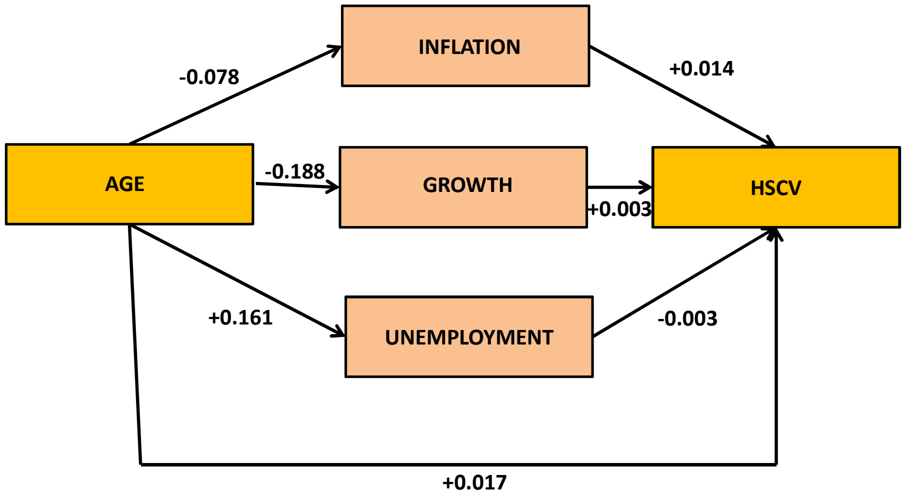
$$HSCV = -0.185^{***} + 0.015^{***}\ AGE$$

[N = 27; R^2_{adj} = 0.829; DW = 1.758, i. e., no first-order autocorrelation of residuals; ANOVA F-value = 127.4425***],

the three mediating variables INFLATION, GROWTH, and UNEMPLOYMENT are working as suppressor variables. This is true because the AGE coefficient in the bivariate regression is lower than the AGE coefficient in the general equation above (0.015 < 0.017). Together, the three mediating variables account for about -0.02 units of the AGE coefficient with about half of this (negative) value corresponding with the indirect INFLATION effect (= -0.0011; indirect GROWTH effect = -0.0006, indirect UNEMPLOYMENT effect = -0.0005).

Figure 6 shows the estimated structure of OMM (and the coefficients' values on the arrows).

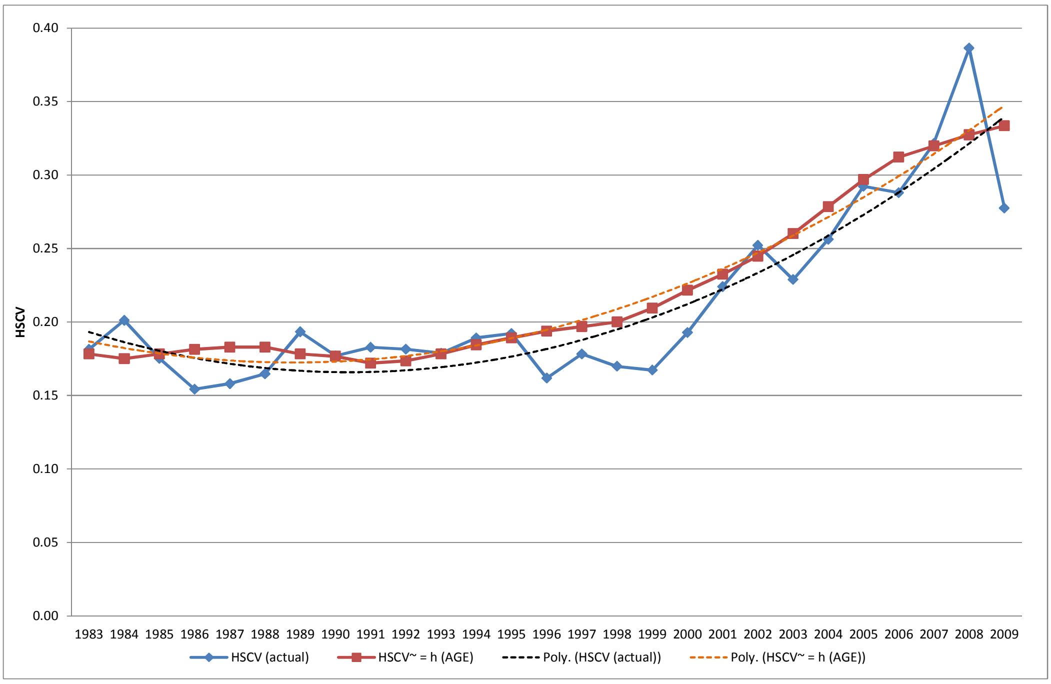
Figure 6: "Original mediator model" for Germany, 1983-2009 (estimates)



Source: Present author's own calculations

The following Figure 7 presents for Germany, 1983-2009, the empirical HSCV values in comparison to the estimated HSCV values – the latter according to the general (reduced) MMM equation.[32]

Figure 7: Empirical and estimated income inequality in Germany, 1983-2009, depending on a general function between inequality (HSCV) and old-age dependency ratio (AGE) – "modified mediator model"



Source: Present author's own calculations

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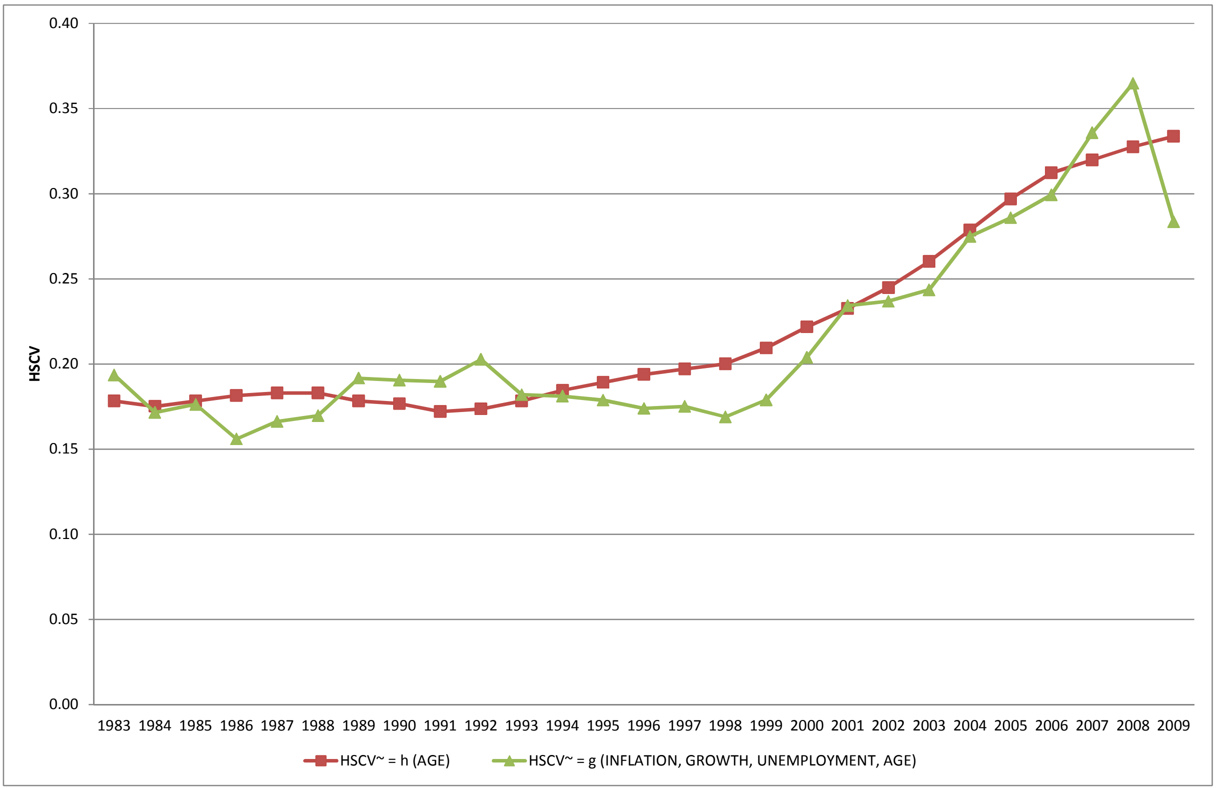
[32] For reasons of comparison, Figure A.1 in the Appendix also contains the estimates of OMM (which are, by construction, identical to the estimates of the bivariate model with AGE as the sole independent variable). It becomes evident that the OMM curve is (nearly) parallel to the MMM curve with negligible lower HSCV values in the OMM case. But, on the whole, the OMM case produces approximately the same image as the MMM case in Figure 7 does.

The statistical bias, which results from the effects of the unexplained variance in the special equations stated in Section 4.1.2, leads to some kind of divergence between the calculated HSCV values according to the general equation presented in Section 4.1.1 and the HSCV values on the basis of the above "substitution equation" (within the framework of MMM)[33], as was already stated. However, these differences appear, to my assessment, tolerable (see, in this context, Figure 8).

Figure 8: Estimated income inequality in Germany, 1983-2009, depending on general functions between inequality (HSCV) and inflation (INFLATION), growth rate (GROWTH), unemployment rate (UNEMPLOYMENT), and old-age dependency ratio (AGE) as well as between inequality (HSCV) and old-age dependency ratio (AGE) – "modified mediator model"



Source: Present author's own calculations

4.2 Forecasts

The "substitution equation", presented in Section 4.1.3, is used for predictions with respect to German income inequality until 2060. In this context, the 12th coordinated population's forecasts of the German Statistical Office (*Statistisches Bundesamt)* are taken as a basis. In concrete terms, two alternate population scenarios serve as inputs for the above forecast equation (through the old-age dependency ratios the German Statistical Office has explicitly and implicitly calculated):[34]

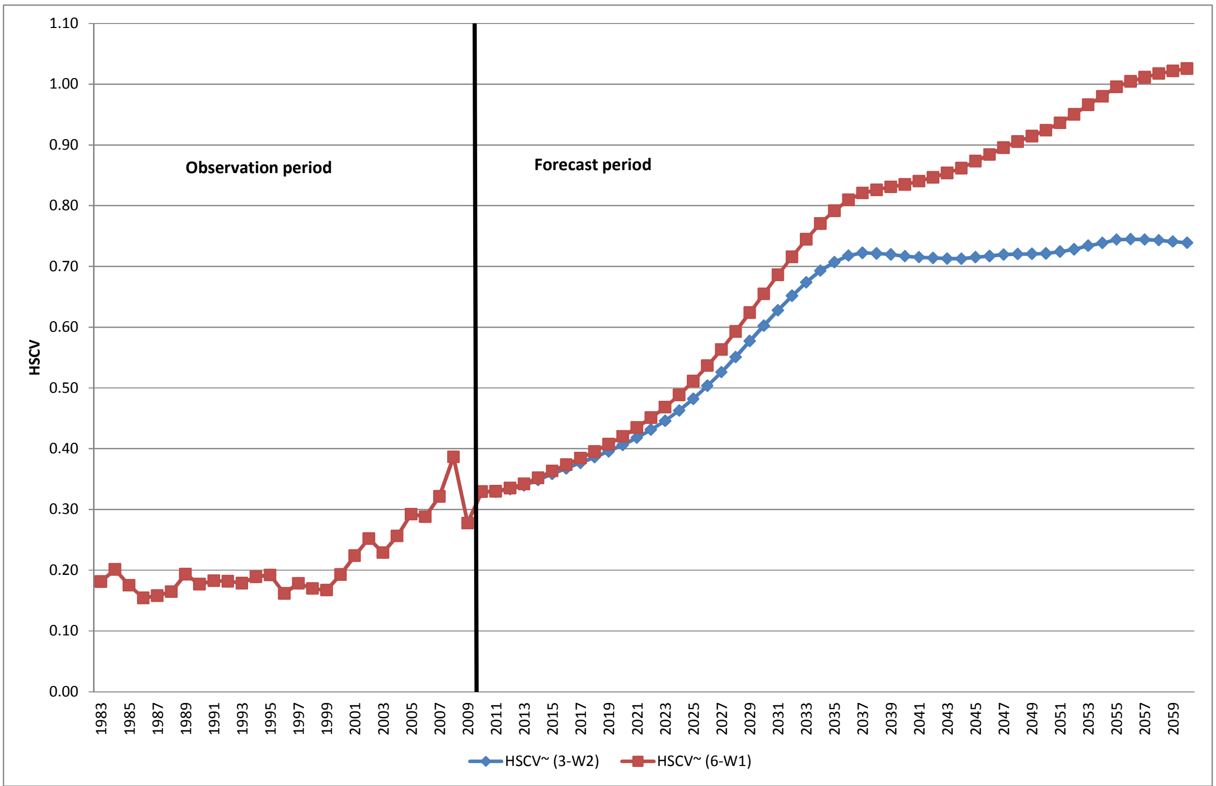
[33] The same is true for the OMM case (see Figure A.2 in the Appendix). By the way, see Figure A.3 in the Appendix for a comparison between the comprehensive "modified" and the comprehensive "original" model with macroeconomic variables as independent variables within the general equations for ex-post estimates of HSCV for Germany, 1983-2009.

[34] In this context, see www.destatis.de/genesis (access at 2012-09-18).

- *Variant 3-W2* (relatively young population): increasing birth frequency, on average, up to 1.6 children per woman in 2025 and subsequently constancy of this level until 2060; increasing life expectancy at birth to 89.2 years for girls and to 85.0 years for boys in 2060; life expectancy at the age of 60 years: 30.1 further years for women and 26.6 further years for men; migration at balance: +200,000 persons p. a.;
- *variant 6-W1* (relatively old population): decreasing birth frequency, on average, up to 1.2 children in 2060; increasing life expectancy at birth to 91.2 years for girls and to 87.7 years for boys in 2060; life expectancy at the age of 60 years: 32.1 further years for women and 29.2 further years for men; migration at balance: +100,000 persons p. a.

As is illustrated in Figure 9, up to 2020 both variants lead to very similar distributional results. But after that period, both curves diverge: Whereas in variant 6-W1 inequality steadily increases up to HSCV ≈ 1.0 in 2060, in variant 3-W2 inequality only grows until 2035, and from this point of time on, it nearly remains stable at a HSCV level in the amount of about 0.75.[35]

Figure 9: Income inequality in Germany, 1983-2060, depending on two forecast scenarios – "modified mediator model"

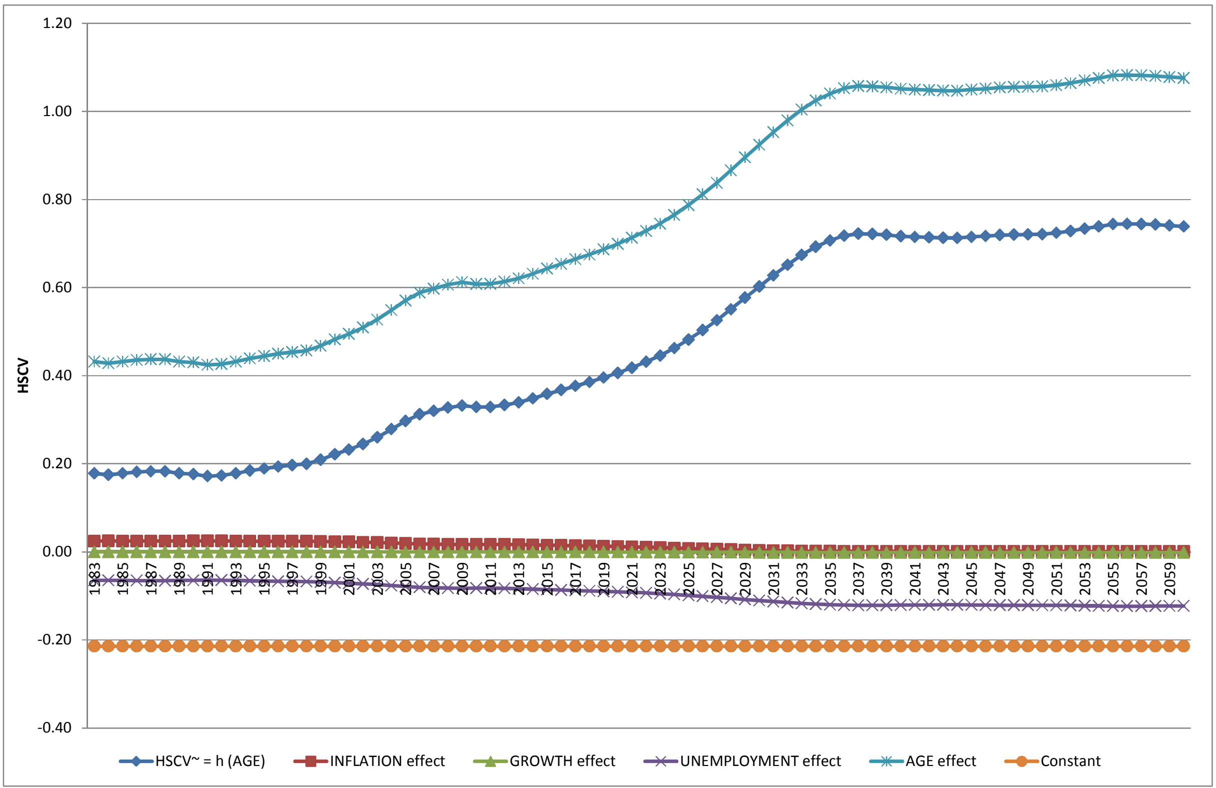


Source: Present author's own calculations

[35] Figure A.4 in the Appendix illustrates that there are only slight differences between the MMM and the OMM case concerning the predicted HSCV values.

As expected[36], a decomposition of inequality (see the following Figures 10a and 10b) shows that in both variants, by tendency, the predicted inequality rises until 2060 are mainly driven by more or less parallel movements of the exogenous effects of the old-age dependency ratios over time. Contrary to this finding, the constant in the general equation permanently diminishes inequality by -0.214 HSCV points.[37] Something like that is principally true for the growth effects on inequality from 2030 on, and for the unemployment rate's effects over the entire time interval (1983-2060). Concerning the inflation rates, slightly positive impacts on HSCV are measured until 2039 but with a negative slope, and between 2040 and 2060 the HSCV contributions of the inflation rates converge to zero. The latter means that in our model the inflation rates do not affect inequality very much until 2039, and not at all from 2040 to 2060. On balance, the exogenous demographic influences overcompensate the other four effects mentioned – in the direction of increasing income inequality in Germany over time. The exogenous demographic effects on inequality are working directly or are mediated through the other channels sketched in Figure 1 but not through the "macroeconomic channel(s)".

Figure 10a: Decomposition analysis for predictors of income inequality within variant 3-W2 – Germany, 1983-2060 ("modified mediator model")

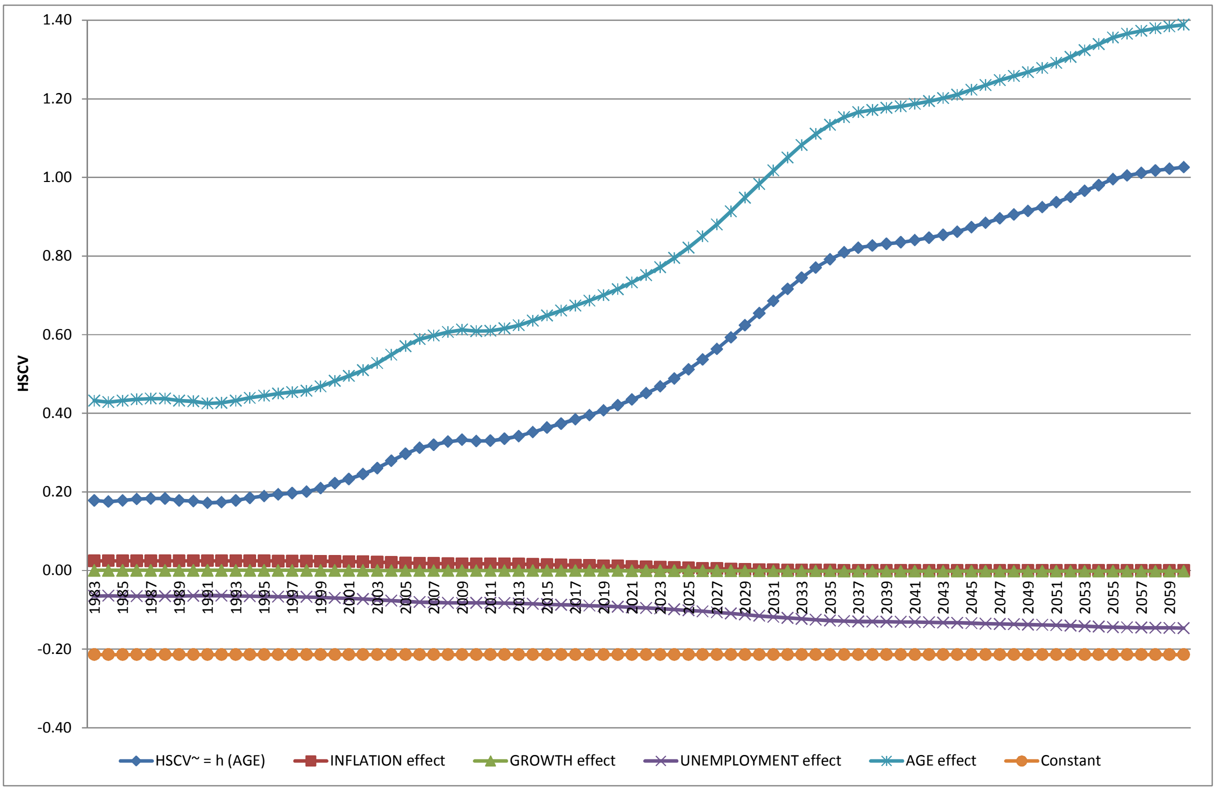


Source: Present author's own calculations

[36] See, e. g., the above Figure 6 regarding the suppressor effects of the mediating macroeconomic variables.

[37] Of course, we can only interpret the predicted HSCV values within a realistic value range (which is ultimately given by the values of the independent variables which were valid during the "estimation period", 1983-2009). Thus, e. g., a hypothetical situation with no inflation, "zero growth", and no unemployment, which would lead to a negative HSCV value in the amount of -0.214, cannot be interpreted (and, beyond that, a negative HSCV value is excluded by definition).

Figure 10b: Decomposition analysis for predictors of income inequality within variant 6-W1 – Germany, 1983-2060 (“modified mediator model”)



Source: Present author’s own calculations

5. Concluding remarks

For the years examined (1983-2009), there have been a) a (slightly) negative empirical influence of demographic ageing on the inflation rate, b) a (weak) positive effect of ageing on the level – not on the increases (reductions) – of economic growth rates, and c) a somewhat stronger positive impact of demographic ageing on unemployment rates. While the measured income inequality is upwards directly (exogenously) driven by demographic ageing, the mechanisms through the different macroeconomic channels are more difficile: Inflation is positively and unemployment negatively correlated with income inequality, and regarding economic growth a (slightly) concave effect upon income inequality has been observed. This implies that demographic ageing, ceteris paribus and by tendency, diminishes income inequality via inflation and unemployment rate, which is also valid for economic growth (within the empirically relevant values for demographic ageing in Germany).

Despite some sensitivity of results depending on different functional specifications, on different time periods, etc., the following (rough) causalities may be postulated:

1. *Demographic ageing → Macroeconomics*

   1.a Demographic ageing reduces inflation rate’s level.
   1.b Demographic ageing increases growth rate’s level.
   1.c Demographic ageing increases unemployment rate’s level.

2. *Macroeconomics –> Income inequality*

   2.a Inflation increases income inequality.
   2.b Growth reduces income inequality.
   2.c Unemployment reduces income inequality.

3. *Demographic ageing → Macroeconomics → Income inequality*

   3.a Demographic ageing *reduces* income inequality through lower inflation rates.
   3.b Demographic ageing *reduces* income inequality through higher growth rates.
   3.c Demographic ageing *reduces* income inequality through higher unemployment rates.

However, it must be kept in mind that the sample sizes, usable in the regressions of this paper, are not very large so that the foregoing findings should be interpreted with caution. Furthermore, it must be stressed that the stated causalities are based on empirical data for the time period 1983-2009, and it is not clear whether they are appropriate or not for predicting future German social structures which probably will be characterized by a much stronger demographic ageing than hitherto (not at least because the German "baby boomers" of the 1960s will fall into the category "old" in the (near) future). Especially the mediating variable UNEMPLOYMENT is crucial since a massive demographic ageing may run short German labour supply and may, therefore, reduce unemployment rates; this could lead, ceteris paribus, to higher income inequality (and not to lower inequality as is indicated by the estimates of this paper).

However, on balance, there are – via the direct impact of demographic ageing on inequality in the model presented in this paper – tendencies towards a remarkable increase of German income inequality until 2060. These tendencies are more pronounced in the forecast variant in which a strongly ageing population is assumed.

The findings of this paper strengthen the results presented in Faik (2012) where different scenarios concerning future German income inequality (until 2020) are presented.[38] In that older paper, other channels than the macroeconomic ones are addressed. Thus, the findings of this new paper may be interpreted as complementary support for the evidence created by Faik (2012).

[38] Faik 2012, p. 46, mentioned as inequality-increasing elements: forward projections of current within-group inequalities, the reduction of average household size, longitudinal changes in relative income positions of the (future) elderly, a longitudinal tendency towards higher inequality within the younger cohorts, an increase of cohort-specific homogamy, and heritages. Contrary to that, he labelled as inequality-decreasing factors: forward projections of current relative income positions as well as an assumed scarcity of the labour supply (causing changing wage-interest relations). Last but not least, he was indifferent regarding the future inequality effects of the following variables: demographic ageing in terms of different age groups' population shares, the prospective, increased societal importance of transfers and capital gains, and redistribution in old age via the tax system. Insofar, the direct AGE effects in the above models can be partly interpreted as effects of mediator variables – others than the ones considered in this paper. But this requires a more elaborated paper and is beyond the scope of this paper which is concerned with the relationships between macroeconomic variables (or: the macroeconomic framework) and personal income inequality.

Appendix

I. Alternate general equations 1983-2009

1. HSCV = -0.240*** + 0.014*** INFLATION + 0.003 GROWTH – 0.003 UNEMPLOYMENT +0.017*** AGE [R^2_{adj} = 0.918]

2. ln (HSCV) = -3.528*** + 0.065*** INFLATION + 0.009 GROWTH – 0.008 UNEMPLOYMENT + 0.071*** AGE [R^2_{adj} = 0.928]

3. ln (HSCV) = -3.452*** + 0.060*** INFLATION + 0.012 GROWTH – 0.006 $GROWTH^2$ – 0.019* UNEMPLOYMENT + 0.073*** AGE [R^2_{adj} = 0.938]

4. ln (HSCV) = -7.584*** + 0.096*** ln (INFLATION) – 0.021 ln (GROWTH) – 0.260** ln (UNEMPLOYMENT) + 2.004*** ln (AGE) [R^2_{adj} = 0.943]

5. ln (HSCV) = -7.624*** + 0.095*** ln (INFLATION) – 0.005 GROWTH – 0.005* $GROWTH^2$ – 0.287*** ln (UNEMPLOYMENT) + 2.038*** ln (AGE) [R^2_{adj} = 0.943]

II. Sliding "time windows" (each "time window" equals 15 years)

Dependent variable: HSCV	Independent variables:						R^2_{adj}
Time period	Constant	INFLATION	GROWTH	$GROWTH^2$	UNEM-PLOY-MENT	AGE	
1983-1997	+0.294	+0.007**	+0.004	+0.000	+0.005	-0.008	0.349
1984-1998	+0.353	+0.008**	+0.005	-0.000029	+0.005	-0.010	0.590
1985-1999	+0.066	+0.009***	+0.004	-0.001	+0.001	+0.003	0.445
1986-2000	-0.048	+0.010***	+0.004	-0.001	-0.001	+0.009	0.493
1987-2001	-0.165**	+0.012***	+0.004	-0.002	-0.003	+0.014***	0.641
1988-2002	-0.238**	+0.011*	+0.002	-0.001	-0.006	+0.018***	0.732
1989-2003	-0.197	+0.011	+0.003	-0.002	-0.005	+0.017***	0.732
1990-2004	-0.172*	+0.009	+0.001	-0.001	-0.005	+0.016***	0.820
1991-2005	-0.229**	+0.012*	+0.002	-0.001	-0.004	+0.017***	0.876
1992-2006	-0.226***	+0.012*	+0.002	-0.002	-0.003	+0.017***	0.905
1993-2007	-0.215***	+0.017**	+0.006	-0.003	-0.005	+0.017***	0.945
1994-2008	-0.196***	+0.022**	+0.003	-0.003	-0.008*	+0.017***	0.959
1995-2009	-0.194**	+0.022**	+0.001	-0.002*	-0.008*	+0.017***	0.959

III. Alternate special equations 1983-2009 (t = time period – 1983)

1. Inflation

a) INFLATION = 3.984** - 0.078 AGE   [R^2_{adj} = 0.032]

b) INFLATION = 38.383** - 2.541* AGE + 0.043* AGE^2 [R^2_{adj} = 0.032]

c) INFLATION = 9.562* - 2.341 ln (AGE)   [R^2_{adj} = 0.041]

d) INFLATION = 56.459** - 3.764** AGE + 0.062** AGE^2 + 0.080 t   [R^2_{adj} = 0.141]

e) INFLATION = 56.288** - 3.762** AGE + 0.062** AGE^2 + 0.086 t + 0.000 t^2 [R^2_{adj} = 0.102]

f) ln (INFLATION) = 0.152*** ln (AGE) [R^2_{adj} = 0.344]

2. Growth

a) GROWTH = 6.626** - 0.188** AGE   [R^2_{adj} = 0.114]

b) GROWTH = 5.720 – 0.123 AGE - 0.001 AGE^2 [R^2_{adj} = 0.078]

c) GROWTH = 18.970** - 5.297** ln (AGE)   [R^2_{adj} = 0.149]

d) GROWTH = 2.973 – 0.052 ln (AGE) – 0.092 t   [R^2_{adj} = 0.113]

e) GROWTH = -119.640* + 38.225** ln (AGE) +0.382 t – 0.039** t^2 [R^2_{adj} = 0.234]

f) GROWTH = -44.005 + 14.759 ln (AGE) – 0.012* t^2 [R^2_{adj} = 0.181]

g) GROWTH = 14.367 – 3.634 ln (AGE) – 0.355 ln (t)   [R^2_{adj} = 0.094]

3. Unemployment

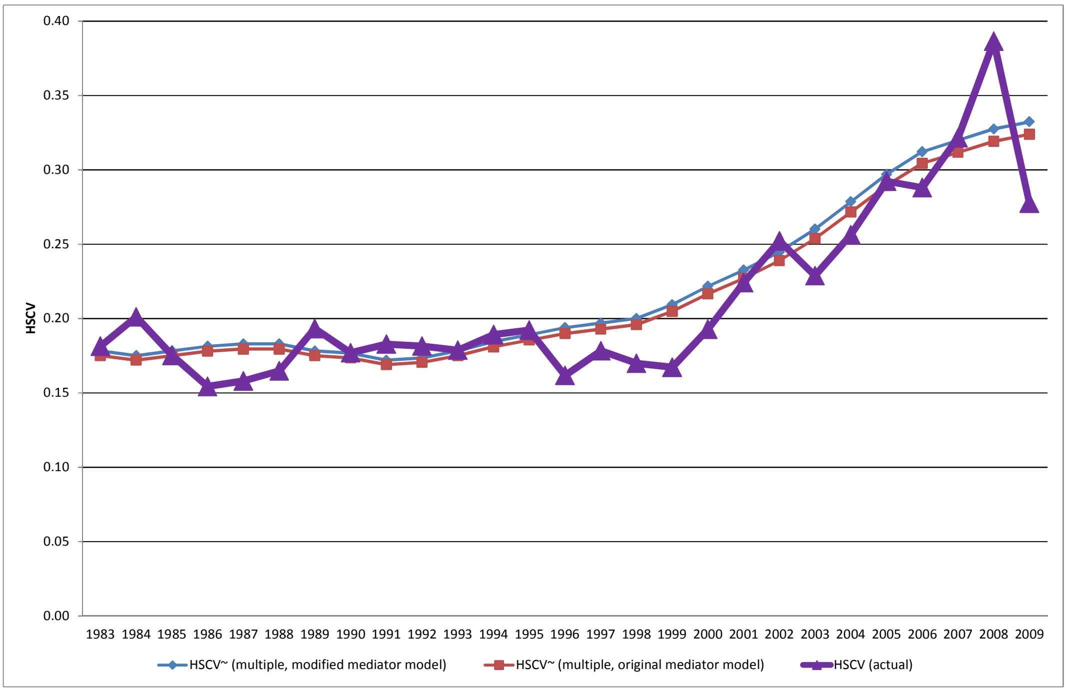
a) UNEMPLOYMENT = 5.762** + 0.161* AGE   [R^2_{adj} = 0.091]

b) UNEMPLOYMENT = -93.011*** + 7.232*** AGE – 0.124*** AGE^2 [R^2_{adj} = 0.516]

c) UNEMPLOYMENT = -5.981 + 4.897* ln (AGE)   [R^2_{adj} = 0.112]

d) UNEMPLOYMENT = 3.075*** ln (AGE)   [R^2_{adj} = 0.978]

Figure A.1: Actual income inequality versus income inequality in the "modified" and in the "original mediator model" case for Germany, 1983-2009



Multiple: macroeconomic variables as explanatory variables indirectly considered

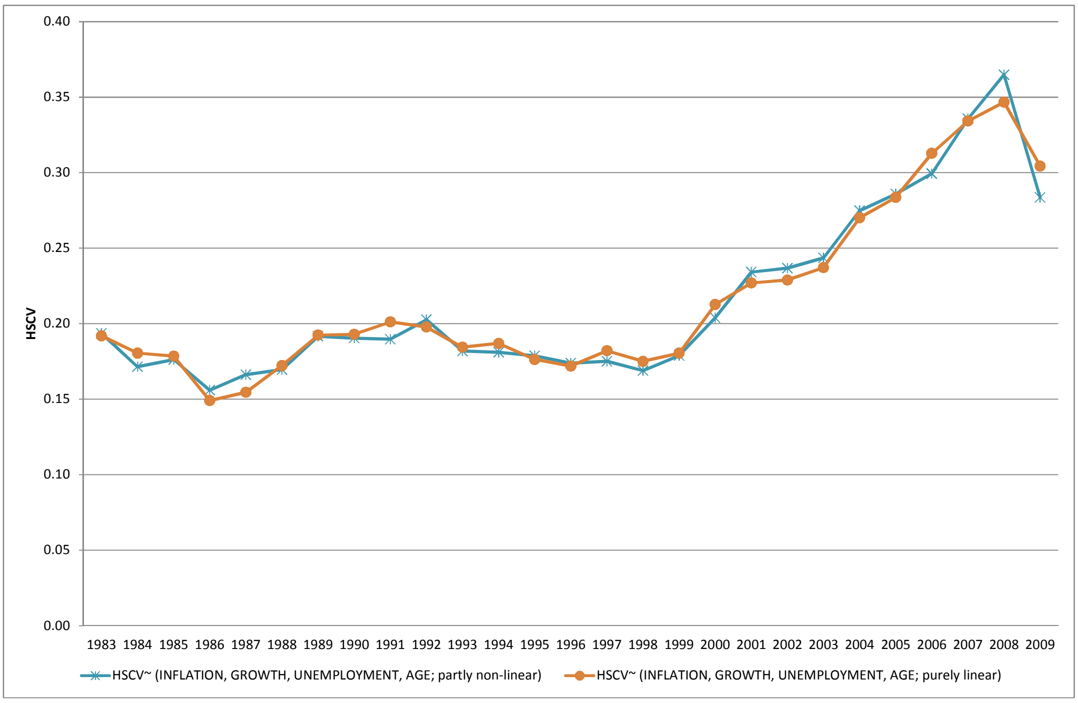
Source: Present author's own calculations

Figure A.2: Actual income inequality versus income inequality in the "original mediator model" case for Germany, 1983-2009

Multiple: macroeconomic variables as explanatory variables indirectly considered, single: only AGE as an explanatory variable considered

Source: Present author's own calculations

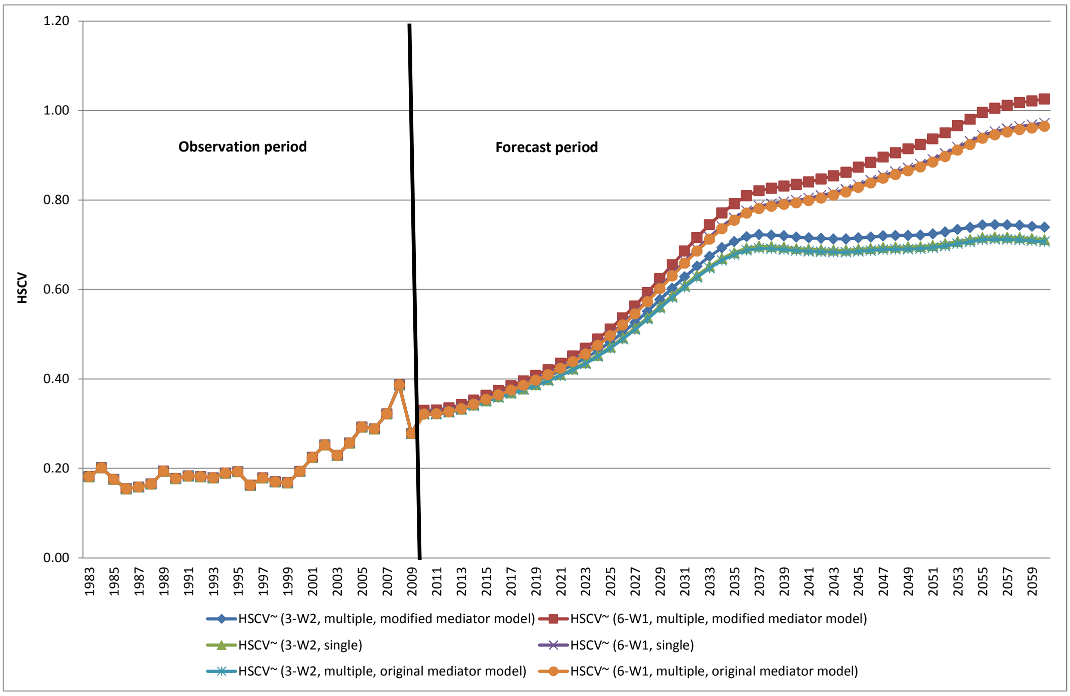
Figure A.3: Income inequality in the "original" and in the "modified mediator model" case (both in terms of structural equations) for Germany, 1983-2009



"Partly non-linear" reflects a quadratic GROWTH term (MMM case), "purely linear" corresponds with the OMM case.

Source: Present author's own calculations

Figure A.4: Income inequality in Germany, 1983-2060, depending on two forecast scenarios and on different "mediator models"



Multiple: macroeconomic variables as explanatory variables indirectly considered, single: only AGE as an explanatory variable considered

Source: Present author's own calculations

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