Demographic Change and Tax Revenues – Results from a Large Microsimulation Model for Germany

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Abstract

Similarly to many other European countries, Germany has experienced a considerable demographic shift since the 1970s: higher life expectancy and diminishing birth rates, only partly balanced by immigration, have led to an altered population structure with an increasing share of elderly people. In the next decades, population aging in Germany will accelerate and also induce a decline of the total population. These demographic changes can be expected to have a profound impact on the governmental budget. While changes in public expenditures have been forecasted regularly since 2005, the revenue side has received less attention to date. We study the long-term (2015-2060) changes in tax revenues induced by demographic change. We focus on the development of income tax revenues given a shrinking workforce. Our aim is to quantify possible fiscal effects of demographic change using microsimulation and to identify elements of the income tax code particularly affected by demographic change. We find the expected demographic changes to have a clear negative impact on income tax revenues. Population aging increases the impact of various deductibility rules on total income tax revenues, in particular the impact of the deductibility of old-age and health insurance provisions. The impact of the deductibility of exceptional expenses such as expenses for caregiving also increases but remains small overall. Due to expected increases in real incomes, demographic change does not imply an absolute drop in income tax revenues in the next decades, however.

JEL classification: C53, H24, J18

Keywords: Tax Revenues, Demographic Change, Microsimulation

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1. Introduction

Similarly to many other European countries, Germany has experienced a considerable demographic shift since the 1970s: higher life expectancy and diminishing birth rates, only partly balanced by immigration, have led to an altered population structure with an increasing share of elderly people. In the next decades, population aging in Germany will accelerate and also induce a decline of the total population. These demographic changes can be expected to have a profound impact on the governmental budget. While changes in public expenditures have been forecasted regularly since 2005,[1] the revenue side has received less attention to date.

We study the long-term (2015-2060) changes in tax revenues induced by demographic change. We focus on the development of income tax revenues given a shrinking workforce, but also consider sales tax revenues, which account for a similarly large share of total tax revenues. Our aim is to quantify possible fiscal effects of demographic change using microsimulation and to identify elements of the income tax code particularly affected by demographic change. The microsimulation models use the results of two interconnected macroeconomic models developed by *Prognos*. Based on a scenario without any demographic changes, we distinguish three possible paths for the development of the population in Germany.[2] We further run three sensitivity analyses to test the robustness of our results with respect to different model assumptions. These concern labor demand, the size of net migration, and the possible absence of tariff adjustments given increasing real incomes.

We find the expected demographic changes in all scenarios to have a clear negative impact on both income and sales tax revenues. This holds especially true for the more distant future, when the population in Germany will not only be markedly older but also smaller than in 2015. Population aging increases the impact of various deductibility rules on total income tax revenues, in particular the impact of the deductibility of old-age and health insurance provisions. The tax code actually enhances the generosity of old-age provision deductions until 2040, whereas the taxable share of old-age pensions increases. Despite the increasing population share of pensioners with fully taxable pensions, the income tax balance of this deferred taxation remains negative in the next decades. The impact of the deductibility of exceptional expenses such as expenses for caregiving also increases, but remains small overall. Due to expected increases in real incomes, demographic change does not imply an absolute drop in tax revenues in the next decades. If the tariff were not adjusted at all in the face of increasing real incomes, its progressivity would imply that the increase in tax revenues overcompensates the decrease due to demographic change. Sales tax revenues are affected by the demographic changes even more strongly: The decreased population not only consumes less, but its

[1] Bundesministerium der Finanzen (2016)

[2] These correspond to the variants 2, 3 and 6 of the official forecast of the German federal statistical office (Statistisches Bundesamt, 2015a).

consumption structure also changes, with a larger share of older people consuming more goods exempt from sales taxes.

The present paper represents one of the first attempts to estimate the effect of demographic changes on tax revenues in the long run. So far, the majority of studies has focused on the long term effects of demographic change on government spending, especially on expenses for social security. Among those studies, the most prominent and most influential in Germany is the already mentioned official *Tragfähigkeitsbericht*, (Bundesministerium der Finanzen, 2016) which is regularly edited by the Ministry of Finance. Our basic microsimulation approach is described in Flory&Stöwhase (2012) and incorporates techniques developed in Merz (1994) and Quinke (2001). Other microsimulation models on redistribution issues include Peichl&Schäfer (2009) and Bourguignon&Spadaro (2006). Simulations of sales tax revenues are usually focused on alternative taxation models (RWI et al., 2013; Bach, 2011; Decoster et al., 2013). Long-term estimations of the effects of demography on private consumption with a focus on Germany include Lührmann (2005) and Stöver (2012).

This paper will first provide an overview of the methods we adopt (section 2). Then, we will present the results for the income tax, including the results of the 3 sensitivity analyses (section 3). Finally, we will present our results for the sales tax (section 4). Section 5 concludes.

2. Data and Microsimulation Approach

2.1 Income Tax

Our income tax microsimulation model maps the German income tax code into executable computer code.[3] It builds on official income tax return data. The German federal statistical office publishes anonymous micro-level income tax data (FAST), based on a stratified 10 percent sample of all income tax payers on a triennial basis. The latest available data dates from the year 2007. It includes information on almost 900 different input variables and intermediate results necessary for the computation of the personal income tax for 3.9 million tax payers. Schwabbacher (2013) documents the anonymization concept, which relates mainly to high income tax payers. However, some measures of anonymization concern all tax payers. For instance, the 2007 FAST data contain information on a maximum number of four children per tax payer and do not contain information on all child characteristics necessary for reproducing personal income tax liabilities. The use of survey-based data is not an alternative since these data typically do not contain any information on specific tax deductions.

As a first step, we use our model to reproduce personal 2007 income tax liabilities and aggregate income tax revenues. For this purpose we reduce the 900 characteristics to about 230 characteristics relevant for

[3] The already cited paper by Flory and Stöwhase (2012) provides a detailed explanation of our simulation method.

calculating personal income taxes. We contrast calculated income taxes and intermediate results to those in the data in order to check our model's calculation algorithms and consistency of the data. Reproducing all intermediate results is not possible due to missing information on specific tax payer characteristics. Some missing information has to be imputed, such as age at retirement, which is necessary for calculating the taxable share of public old age pensions. The model's reproduction of aggregate income tax statistics is quite accurate. Whereas anonymization of high incomes impairs the reproduction of business and self-employment proceeds, calculated total incomes and taxes deviate only about 1 percent from official aggregate income tax statistics.[4]

The second step necessary for simulating personal and aggregate income taxes in the years 2015, 2030, 2045 and 2060 is projecting the structure of the tax payer population, tax regulations and incomes. The FAST data contains weighting factors for the extrapolation of the 3.9 million tax payers to the German tax payer population in the year 2007. Changes in population size and structure can be captured by adjusting these weighting factors. The algorithm for this adjustment is based on the minimum information loss principle, described for instance by Merz (1994). Thereby, a number of restrictions have to be fulfilled under the constraint that the original weighting factors are changed as little as possible. This optimization problem is solved using a simple Newton-Raphson solution.

We use 99 different restrictions concerning the size of different population groups. First of all, based on a reference scenario with a constant population (labeled scenario 0), we consider three different demographic change scenarios, based on official population projections by the German federal statistical office, see Statistisches Bundesamt (2015a). We choose variant 2 as our baseline scenario, therefore labeled scenario 2. It assumes an unchanged number of 1.4 children per woman, an unchanged life expectancy of 84.8 years at birth for boys and 88.8 years for girls, and a yearly net immigration of 200 000 persons. We also model a scenario with an older population, scenario 3 based on variant 3 with a higher life expectancy and a lower net immigration, and a scenario with a younger population, scenario 6 based on variant 6 with a higher number of children per woman.[5] Table 1 summarizes the assumptions of the different scenarios.

Table 1: Assumptions of the population scenarios

	scenario 2	scenario 3	scenario 6
Fertility (children per woman)	1.4	1,4	1.6
Life expectancy at birth for boys (years)	84.8	86.7	84.8
Life expectancy at birth for girls (years)	88.8	90.4	88.8
Long-term migration balance (persons per year)	200,000	100,000	200,000

[4] Details on consistency checks, imputations and comparisons of the model results to official aggregate income tax statistics are available upon request.

[5] For labeling the scenarios we also use the acronyms bev0, bev2, bev3 and bev6, accordingly.

Second, for determining labor force participation rates, differentiated by age, gender and employment status, contingent on the assumptions of the different population scenarios, we recur to the results of two interconnected macroeconomic models, the "Versatile Integrated Economic World Model" (VIEW) and a social security model named "Outlook on Cure, Care, Unemployment and Retirement" (OCCUR), both developed by Prognos.[6] Table 2 shows the population groups used for the projection of the tax payer population structure.

Table 2: Population groups used for projecting the structure of the tax payer population

Characteristic	Differentiation by gender (male/female)	Differentiation by marital status (married/not married)	Differentiation by age (7 groups)	Number of restrictions
Employees	x	x	x	28
Civil servants	x	x	x	28
Self-employed	x	x	x	28
Pensioners		x		2
Retired civil servants		x		2
Non-working persons	x	x		3
Children under 18				1
Children 18 and older				1
Families with children				1
Families with 1 child				1
Families with 2 children				1
Single parents				1
Tax payers with child care expenses				1
Tax payers who also pay church tax				1

To differentiate married and unmarried persons by age, we use German microcensus data from 2013 (Statistisches Bundesamt, 2014a) and assume that the share of married persons in each age group remains constant. For non-working persons, which exclude those over 64 years in 2015 and those over 66 years from 2030 onward, we also differentiate the share of married persons by gender. The German federal statistical office provides data on retired civil servants up to 1 January 2014, such that yearly means can be calculated up to 2013. We assume that after that year, the change rate corresponds to that of pensioners, calculated by Prognos. Furthermore, we use our own calculations for the number of children entitled to child benefits (Teuber, 2015), and assume that its future growth rate corresponds to that of children in the age groups 0 to 17 and 18 to 25 in the respective variant of the population projection. The number of families with children is projected with the growth rate of 0 to 25 year olds. The same holds for families with one child and families with two children. We project the number of single parents based on the projection of the

[6] http://www.prognos.com/publikationen/weltreport/modell-view/

population group of women between 25 and 55 and an assumed constant share of single women within this group, also taken from the 2013 microcensus. The number of tax payers who declared child care expenses in 2007 is projected with the growth rate of the population under 14, since child care expenses may be declared for that age group. We also assume the population share of tax payers who pay church taxes to be constant. Differentiating this share by age groups does not improve the projections since this share is higher among older tax payers whose population share is bound to increase. An increase in church tax payers would be contrary to observed trends, however.

Table 3 shows the projected number of tax payers in the reference scenario 0 with a constant population and the three demographic change scenarios. Note that scenario 0 is based on actual figures of the year 2013. The number of tax payers in 2015 is therefore somewhat lower than in the other scenarios, where all years are based on projections. It slightly increases until 2060 due to economic growth and favorable labor market trends. In the demographic change scenarios, the number of tax payers decreases markedly until 2060, particularly in scenario 3 with a relatively old population, where it decreases from around 41 to below 34 million.

Table 3: Number of tax payers

	2015	2030	2045	2060
scenario 0	40.9	41.7	42.0	42.1
scenario 2	41.2	41.5	39.0	36.4
scenario 3	41.2	40.7	37.4	33.9
scenario 6	41.2	41.7	39.8	38.1

In million.

The simulations are based on the tax regulations of the year 2015, including changes already passed but referring to future years. These include the extent of tax exemptions for civil servants' pensions and for total incomes of tax payers over 63 years, which have been gradually reduced until 2040, and also the taxable share of public old age pensions and deductible old-age provisions, which have been gradually increased until 2040 and 2025, respectively. Changes in tax regulations which have occurred between 2007 and the base year 2015 are also relevant. For instance, regulations concerning the crediting of commercial taxes have changed as a business tax reform was passed in 2008. The tax credit thus has to be recalculated. Another example are health insurance provisions, not contained in the 2007 data but currently fully tax deductible. These have to be estimated from other tax payer characteristics.[7]

We implicitly model tax authorities' reactions to possible fiscal drag by considering real instead of nominal monetary values, taking 2015 as the base year. Constant individual real incomes then imply constant individual real income taxes. However, without any actual changes in the tax code, *increasing* real incomes

[7] Furthermore, the generosity of deductions for child care expenses and of tax reliefs for expenses for household-related services has increased since 2007. We therefore rescale the simulated cost of these regulations, recurring to official income tax statistics.

would imply a disproportionate increase in real income taxes due to the progressivity of the German tax code. By 2060, a large share of tax payers would then be subject to the top income tax rate and the ratio of income tax revenues to GDP would greatly increase. A more realistic assumption is that increases in real incomes entail tax breaks. We therefore "stretch" the income tax tariff of the years 2030, 2045 and 2060 by multiplying all tax bracket thresholds by a year-specific constant factor. However, the lowest threshold, the basic tax-free allowance, is conceptionally equivalent to the child allowance and the allowance for alimony payments. Therefore, both these parameters have to be multiplied by the same factor. A matter-of-fact approach actually requires multiplying all monetary income tax code parameters by the same factor. The importance of tax regulations that imply some sort of ceiling would otherwise decrease markedly. The calibration of the year-specific constant factor aims at replicating income tax revenue growth in the VIEW model in the reference scenario without demographic change. This ensures that the ratio of tax revenues to GDP does not increase and that laws concerning the size of external public debt are fulfilled. In order to ensure comparability, it is necessary to use the same year-specific factors in all scenarios. Tax authorities' reactions to demographic change are thus not anticipated, and differences between the scenarios may be attributed to demographic change itself. Note that according to the VIEW model, the ratio of income tax revenues to GDP actually decreases until 2060. Therefore, the increase in tax parameters has to be larger than the increase in real incomes, which implies decreasing marginal tax rates and an enhanced significance of lump-sum deductions. Assuming no actual changes in the tax code would lead to markedly different results, as discussed below.

For the projection of incomes we also recur to the results of the VIEW and OCCUR models by Prognos. Additionally, we estimate future incomes from subsidized third-pillar ("Riester") pensions, non-existent in the 2007 data. These estimations are based on various simplifying assumptions. Note that these assumptions influence the size of third-pillar pension incomes and the importance of the taxation of these incomes for total tax revenues. However, they should not significantly alter the impact of demographic change on the importance of the taxation of these incomes.

In order to calculate the size of deposits on Riester pension accounts, we first calculate mean past gross incomes for tax payers with public pensions, based on the size of the public pensions and on the mean number of years of pension contributions, available by gender and region from official German pension insurance data (Deutsche Rentenversicherung, 2015). According to the federal statistical office (Statistisches Bundesamt, 2014b), mean deposits and government bonuses equal about 3 percent of gross incomes with a maximum of 2 100 euros yearly, which is what we assume. We also assume that tax payers deposit part of their income from age 28 until retirement, where the starting age is also based on Statistisches Bundesamt (2014b). Concerning returns and disbursements, we adopt the assumptions of the latest report on old age provisions by the Germany Ministry of Labour and Social Affairs (Bundesministerium für Arbeit und Soziales, 2012), namely a nominal annual return of 4 percent, administrative charges equaling 10 percent of deposits and an annuity that is calculated based on expected life expectancy and that increases at the same rate as public pensions do. We further take into account that not all wage earners eligible for Riester pensions actually sign an according Riester savings contract. Based on the FAST data and on Statistisches

Bundesamt (2014b), we estimate the share of tax payers with Riester pensions to be 40 percent in 2045 and 2060. In 2030, this share is estimated to be only 15 percent[8], because this corresponds to the share of wage earners with a Riester savings contract who were at least 45 years old in 2010 according to Statistisches Bundesamt (2014b) and will thus be at least 65 years old in 2030.

Table 4 contains projections for total income and income from selected sources in all scenarios. The increase in (real) total incomes in scenario 0 equals around 25 percent until 2030, 60 percent until 2045 and almost 100 percent until 2060. Note that in the German tax code, "income" is defined as the difference between proceeds and income-related expenses. Increases in proceeds as projected in the macroeconomic models are thus dampened by increases in income-related expenses. This is highly relevant for employment income for instance, which allows for the deduction of lump-sum income-related expenses. This lump-sum amount is assumed to increase as it belongs to the monetary tax parameters multiplied by year-specific constant factors.

Table 4: Total income and income from selected sources

	2015	*2030*	*2045*	*2060*	*Δ % p.a. 2015-2060*	*Δ % 2060 relative to scenario 0*
Employment income (excluding civil servants' pensions)						
scenario 0	1,164.0	1,450.3	1,879.1	2,406.8	1.6	
scenario 2	1,163.7	1,431.0	1,734.2	2,068.5	1.3	-14
scenario 3	1,163.7	1,409.9	1,674.7	1,941.6	1.1	-19
scenario 6	1,163.7	1,438.4	1,765.0	2,156.7	1.4	-10
Old-age income (including civil servants' pensions)						
scenario 0	123.7	183.1	278.3	361.9	2.4	
scenario 2	126.6	224.6	323.1	403.7	2.6	12
scenario 3	126.7	223.8	324.0	398.7	2.6	10
scenario 6	126.6	224.6	325.8	408.4	2.6	13
Total income						
scenario 0	1,563.7	1,917.7	2,465.1	3,102.6	1.5	
scenario 2	1,566.4	1,943.0	2,344.9	2,766.3	1.3	-11
scenario 3	1,566.5	1,917.9	2,278.6	2,619.6	1.1	-16
scenario 6	1,566.4	1,952.1	2,382.3	2,869.4	1.4	-8

In billion real 2015 euros.

In scenario 0, employment income makes up about 77.5 percent of total income. Employment is thus the most important source of income. Even in the year 2060 this share is only slightly lower in the demographic change scenarios and amounts to around 74 to 75 percent. Although the workforce is smaller than in scenario 0, wage dynamics are higher as labor supply is lower. According to the macroeconomic models,

[8] around 37 percent of 40 percent

the wage share actually increases, and therefore the increase in commercial incomes is less pronounced. In absolute terms, however, employment income is lower, the more pronounced demographic change is.

Meanwhile, old-age income increases by over 200 percent in the demographic change scenarios, and by over 190 percent in scenario 0. Its share of total income increases from around 8 percent in 2015 to 11.7 percent in 2060 in scenario 0 and between 14.2 and 15.2 percent in the demographic change scenarios. This is caused by the transition to deferred taxation until 2040. Since 2005, the deductibility of old-age provisions has been greatly increased, whereas the tax-free share of old-age pensions has been decreased. In this case, the dynamics of incomes thus exceed those of proceeds. Additionally, the number of pensioners with third-pillar (Riester) pensions will increase in the next decades. The share of old-age incomes in total income will thus increase in the next decades. Old-age income is higher in the demographic change scenarios, due to higher numbers of tax payers with old-age incomes. However, it is not higher the more pronounced population aging: The increase in life-expectancy in scenario 3 leads to lower pension values, which dampen the increase in old-age income. Riester pension annuities are also lower since they are based on a higher number of remaining years of life at retirement. In all demographic change scenarios, differences from scenario 0 are most pronounced in 2030, whereas the dampening effects of decreasing pension values are more relevant in the years 2045 and 2060.

2.2 Sales Tax

The German sales tax (*Umsatzsteuer*) is, ex aequo with the income tax, the most important tax in Germany in terms of returns, accounting for about one third of all tax revenues. It is characterized by three different tax rates: a regular rate of 19 percent, a reduced rate of 7 percent for most food and beverages as well as "cultural" items like books, and a zero rate for some services, especially in the charity and healthcare sector.[9] While the rationality of the three different tax rates and the possibility of introducing alternative models have been the focus of research in the past (see e.g. Bach, 2011 and RWI et al., 2013), this paper tries to assess the long term development of the revenues from sales tax, especially in consideration of the demographic change, especially of a shrinking and ageing population.

A priori, one could imagine two long term trends concerning the revenues from sales tax: An aging society is normally characterized by a higher consumption propensity (life-cycle hypothesis), leading to higher revenues from sales tax. On the other hand, a society with a higher share of elderly and retired people could be characterized by lower incomes and a higher share of spending for (VAT exempted) healthcare, both leading to diminishing sales tax revenues.

[9] A detailed list of goods and services subject to tax reduction or tax exemptions is contained in the Value Added Tax Act (*Umsatzsteuergesetz*).

We set up a simple model based on the EVS (*Einkommens- und Verbrauchsstichprobe*), one of the largest household surveys in Europe which is conducted by the Germany Federal Statistical Office every 5 years.[10] The last wave available as scientific use file, 2008, comprises 58 984 households und about 100 000 persons, which is less than the targeted 0.2 per cent of the German population, but after the microcensus still represents the second largest household sample in Germany.[11] While the EVS is a cross-sectional survey lacking a panel structure, it provides very detailed data on household revenues and spending which allow a deep analysis of the interplay between aging, income and consumption. The focus of our analysis will be the household because consumption variables are measured at a household level. Accordingly, we will calculate a household income comprising all sources of revenue in a household. The socio-structural characteristics (age, employment status) will be taken from the main income recipient (MIR) of the household.

We divide our analysis into two steps. At a first stage, we analyze only the effects of the aging and shrinking population on consumption and on sales tax revenues. We simulate the demographic change according to the official scenarios bev2, bev3 and bev6 already presented above, which we compare to a fictional scenario bev0 without any demographic shifts.

At a second stage, we add a projection of income growth until 2060, taking it from the VIEW model. In order to skip the microeconomic saving-consumption decision, we focus on total spending and not on income. We therefore adopt the average real growth rate of private consumption, which, depending on the demographic scenario, takes values between 1.04 (bev3) and 1.39 (bev0) percent. Then, we explicitly allow for a changing consumption structure of the households due to the increased aggregate spending. The analysis of the link between income or total spending and consumption structure has a long tradition in economics, reaching back to the seminal work of Ernst Engel.[12] We develop such an Engel-curve-model based on EVS data inspired by the approach of Lührmann (2005), who carried out one of the few available studies analyzing the long-term relationship between aging, income and consumption. Similarly to her, we set up a linear-log model estimating the share of each of the 12 consumption categories of total expenditure y_i. The model is described by the following equation:

$$
\begin{aligned}
y_i &= \beta_0 + \beta_1 \times ln(x) + \beta_2 \times ln(x^2) \\
&+ \gamma_1 \times age \times ln(x) \\
&+ altersgrp_1 + altersgrp_2 + altersgrp_3 + altersgrp_4 \\
&+ unemployed + selfemployed + houseowner + \in_i
\end{aligned}
$$

[10] The survey design and method of the EVS 2008 is explained in Statistisches Bundesamt (2013a), chapter 3. For an introduction into the use of the EVS for the analysis of income distribution and consumption see Rebeggiani (2007).

[11] The scientific-use-file of the last EVS wave (2013) was released after completing this paper.

[12] See Engel, 1857. Chai & Moneta, 2010 provide an informative review of the history of Engel curve estimations.

Our main explaining variable x is total spending. To avoid endogeneity between total consumption and the share of one good category in total consumption, we proceed with an instrumental variable estimation, instrumenting private spending by disposable income and all other exogenous variables. The variable x in the equation stands therefore for the estimated private total spending. We also include a range of control variables like age, labor market situation, occupational status, and housing status in the model, as well as interaction terms for better capturing nonlinear relationships.[13] The control variables are included as dummy variables, leaving out one category as reference. For weighting purposes we use the standard EVS weights which we modified according to each demographic scenario. Finally, we estimate for each of the four years of the analysis a modified aggregate consumption and, subsequently, a modified sales tax revenue.

Limitations of the models include some simplifications of the long-run scenarios: In particular, we assume constant relative prices and constant preferences over time. Obviously, both could change in the long run and affect the consumption structure. It is very difficult, nevertheless, to incorporate changing relative prices in the very long run and almost impossible to account for changing preferences over such a long period without imposing arbitrary assumptions.

3. Simulation of the revenues from the income tax

After having described our methodological approach and having reported the projections for tax payers and income, we now present our simulation results for income tax revenues. We first examine total tax revenues from the income tax, the withholding tax on capital gains applying to income tax payers and the solidarity surcharge of 5.5 percent[14] of these taxes. We then turn to the question how specific regulations and deductibility rules are affected by demographic change. Note that a withholding tax on capital gains of 25 percent was introduced in 2009. Therefore, income tax declarations currently may but need not contain information on capital gains. Tax payers may choose to declare them, for instance when their personal income tax rate is below 25 percent. However, the 2007 FAST data still contain information on the size of capital gains, and taxes on this source of income can be taken into account. Our simulations test at an individual level whether it is more favorable to subject capital gains to the withholding tax rate of 25 percent or to the personal income tax rate. The result of this comparison may change when specific regulations of the tax code are changed. We take tax payers' most favorable mode of taxation into account when simulating how changes in specific regulations alter tax revenues.

[13] We tested different types and combinations of interaction terms. In the model presented here, only one interaction term was left. For a discussion of different estimation strategies for Engel curves see also Banks, Blundell, and Lewbel (1997).

[14] Low incomes are (partly) exempt from this surcharge.

Table 5: Income tax revenues in absolute terms

	2015	2030	2045	2060
scenario 0	290	355	420	495
scenario 2	290	350	380	415
scenario 3	290	345	370	390
scenario 6	290	350	385	435
scenario 2 with a constant tax tariff	290	405	560	760

In billion real 2015 euros.

Table 5 shows the evolution of income tax revenues in absolute terms in the four scenarios. It also includes those income tax revenues that would result from leaving the income tax tariff completely unaltered in the face of rising real incomes. The latter calculation is based on scenario 2. In the absence of demographic change, income tax revenues would increase by around 70 percent until 2060, due to real economic and income growth. Population aging and ultimately population shrinking dampen this increase. In the baseline scenario it would only amount to 43 percent between 2015 and 2060. However, even in scenario 3 with a relatively old population, income tax revenues increase by 35 percent, and in scenario 6, they increase by 50 percent. Whereas differences between scenario 0 and the demographic change scenarios are small until 2030, tax revenues are between 8 and 12 percent smaller than in scenario 0 in 2045 and between 12 and 21 percent smaller in 2060 (figure 1).

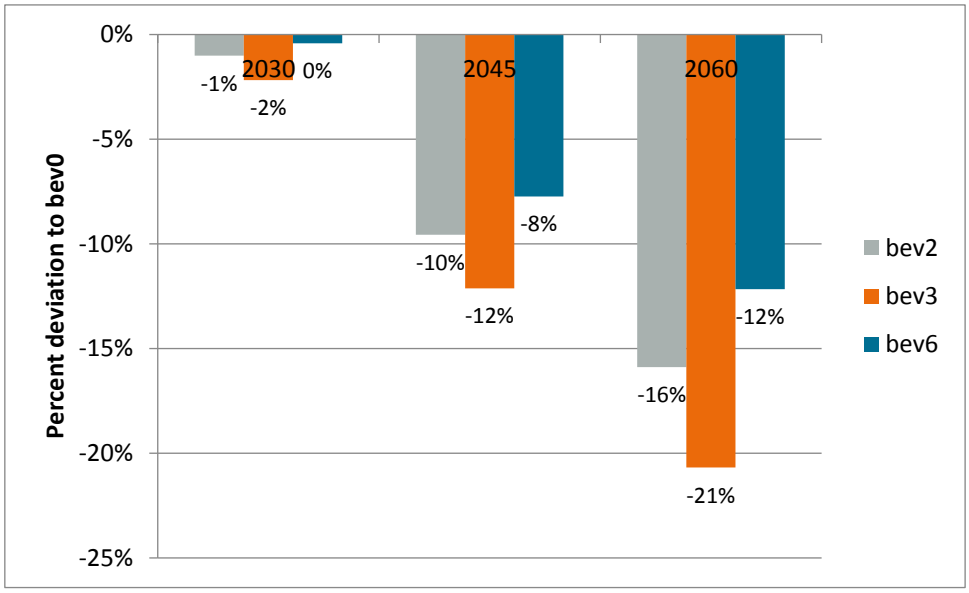

Figure 1: Revenues from income tax compared to bev0

In the absence of any changes in the tax tariff and in tax regulations, income growth implies a disproportionate increase in tax revenues, from 290 billion in 2015 to 760 billion euros in 2060. Economic growth thus implies ample scope for tackling financial problems resulting from specific tax regulations. However, this comes at the cost of an increasing ratio of income taxes to GDP, amounting to about 40 percent in

scenario 2. We thus conclude that not adjusting tax regulations to economic and income growth is not the solution to fiscal problems caused by demographic change. Instead and approach that leaves tax regulations completely unaltered could identify demographically induced tax to GDP ratios instead of demographically induced tax gaps, as the comparison between the first four lines of table 5 does.

Against the background of demographic change and of the transition to deferred taxation, the specific regulations we examine include deductions from total income for old age and health insurance and long term care provisions and the taxation of public pensions and of third-pillar pensions for wage earners, the so called Riester pensions. Complete simulation results for income-related expenses, which can be deduced from the respective kind of income, deductions from total income, exceptional expenses which can be deducted from total income if they pass a means-tested threshold, expenses for household-related services such as nursing, which can be discounted from the tax liability and on child benefits, child allowances and the joint taxation of married couples are available upon request.

Some of these regulations contribute to the dampening effect of demographic change on income tax revenues, others mitigate this effect. Some regulations are severely affected by demographic change but quantitatively unimportant. This holds true for lump-sum expenses related to old-age income, for instance, as table 6 shows. Currently, a lump-sum of 102 euros can be deduced from old-age income, causing a total decline in tax revenues of around 80 million euros compared to a situation without this specific regulation. This amounts to 0.26 per mille of total income tax revenues. Even in the reference scenario 0 with a constant population, this relative importance increases markedly until 2060 to almost 1 per mille of total income tax revenues. This is because taxable old-age income increases as part of the transition to deferred taxation, which is evident from the increase in the number of tax payers affected by this regulation at the bottom of the table. Furthermore, not only the tax bracket thresholds but also the lump-sum amount of 102 euros is multiplied by the constant year-specific factors in the face of economic growth. As mentioned in chapter 2, these factors exceed the growth rate of proceeds, such that marginal tax rates decrease and the relative importance of deductions increases.

Table 6: Lump-sum expenses related to old-age income

	2015	*2030*	*2045*	*2060*
Impact on tax revenues in million real 2015 euros				
scenario 0	80	140	300	470
scenario 2	80	170	350	510
scenario 3	80	170	350	500
scenario 6	80	170	350	520
Impact on tax revenues in per mille of total income tax revenues				
scenario 0	0.26	0.40	0.72	0.96
scenario 2	0.27	0.49	0.93	1.24
scenario 3	0.27	0.50	0.95	1.28
scenario 6	0.27	0.49	0.91	1.19
Affected tax payers in thousands				
scenario 0	2,500	3,100	6,400	6,600
scenario 2	2,500	3,800	7,200	7,000
scenario 3	2,500	3,800	7,100	6,700
scenario 6	2,500	3,800	7,200	7,000

Demographic change greatly increases the relative importance of lump-sum expenses related to old-age income as early as 2030. In 2030, this relative importance is around 25 percent higher than in scenario 0. By 2060, it is between 24 and 33 percent higher. Most importantly, the number of tax payers affected by this regulation is higher in the demographic change scenarios, although it decreases between 2045 and 2060. However, even in scenario 3 with a relatively old population, the relative importance of these lump-sum expenses only amounts to little more than 1 per mille of total tax revenues. In what follows, we present results for several regulations that are both quantitatively important and markedly affected by demographic change. These are old-age and health-care provisions on the one hand and the taxation of pensions on the other hand.

Deductibility of old-age and health-insurance provisions has been greatly extended since 2005, when only 60 percent of pension contributions could be deduced. Since then, the deductible share increases by 2 percentage points each year, with a ceiling of currently 22 172 euros. Until 2019, it is possible to declare deductions for old-age and health-care provisions jointly, according to the 2004 tax code, if this is more favorable. This involves a lump-sum deduction of 20 percent of employment income, but also a lower ceiling. Table 7 shows the impact of the deductibility of pension contributions on income tax revenues.

Table 7: Statutory pension contributions

	2015	*2030*	*2045*	*2060*
Impact on tax revenues in million real 2015 euros				
scenario 0	22,260	41,070	54,000	66,690
scenario 2	22,260	45,310	60,790	73,290
scenario 3	22,260	44,880	60,180	71,230
scenario 6	22,260	45,020	60,860	74,070
Impact on tax revenues in per mille of total income tax revenues				
scenario 0	76	116	129	135
scenario 2	77	129	160	177
scenario 3	77	130	163	182
scenario 6	77	128	157	171
Affected tax payers in thousands				
scenario 0	23,600	24,800	24,600	24,000
scenario 2	23,700	23,700	21,500	19,200
scenario 3	23,700	23,200	20,400	17,600
scenario 6	23,700	23,800	21,900	20,200

Both the absolute and the relative impact increase even in scenario 0, due to the expansion of the deductibility of pensions contributions, to the increase in real wages and finally, to the increase in the contribution assessment ceiling in the course of the adjustment of tax parameters. The increase of the impact of pension contributions on total income tax revenues is more pronounced in the demographic change scenarios, and most pronounced in scenario 3. At the individual level, wages are higher the scarcer labor. Furthermore, an unfavorable ratio of pension contributors to beneficiaries implies high contribution rates. Consequently, the relative impact of pension contributions is around 10 percent higher than in the demographic scenarios in 2030, between 22 and 26 percent higher in 2045 and between 27 and 35 percent higher in 2060.

The difference between the demographic change scenarios and the reference scenario 0 is even more pronounced for the deductibility of health and long term care insurance contributions, see table 8. Since 2010, contributions to statutory health and long term care insurance as well as contributions to a comparable private insurance are fully tax deductible, that is, without being confined to some ceiling. Alternatively, contributions to different kinds of insurances including health and long term care may be jointly deduced according to the regulations prevailing in the years 2005 to 2009, which did contain ceilings for deductible amounts.

In scenario 0, the absolute impact increases but the relative impact remains relatively stable. Conversely, the relative impact increases markedly in the demographic change scenarios and by 2060, it is up to 100 percent higher than in scenario 0, although the number of affected tax payers, determined primarily by the number of wage earners, decreases. Again, both wages and contributions rates are higher in the demographic change scenarios. Furthermore, old age incomes are higher, and some of these are subject to the combined employee and employer share of health insurance contributions.

Table 8: Health and long term care insurance contributions

	2015	*2030*	*2045*	*2060*
Impact on tax revenues in million real 2015 euros				
scenario 0	18,830	23,810	26,750	32,010
scenario 2	18,880	30,970	40,320	48,020
scenario 3	18,960	31,430	41,810	50,790
scenario 6	18,880	31,410	40,760	48,170
Impact on tax revenues in per mille of total income tax revenues				
scenario 0	65	67	64	65
scenario 2	65	88	106	116
scenario 3	65	91	114	130
scenario 6	65	89	105	111
Affected tax payers in thousands				
scenario 0	22,000	23,200	22,700	21,900
scenario 2	22,200	23,500	21,400	19,100
scenario 3	22,200	23,100	20,700	17,900
scenario 6	22,200	23,500	21,700	19,800

Contrarily, the impact of deductions for provisions for third-pillar (Riester) pensions, decreases in the next decades, and this decrease is more pronounced as population aging is more pronounced, see table 9. Note that savings for third-pillar Riester pensions, designed for tax payers subject to the statutory pension insurance scheme, that is basically employees and their spouses, are augmented by generous state supplements. However, if this is more favorable, contributions to Riester savings contracts, including potential state supplements, can be deduced from taxable income, subject to a ceiling of currently 2 100 euros. Since the adoption of the corresponding law in 2001, the number of Riester savings contracts has continuously risen, but the rise has lately been slower. Our simulations thus assume that the share of employees and persons with indirect entitlements to supplements such as spouses is constant from 2015 onwards and that it is the same in all scenarios. We also assume that from 2030 onwards, all supplements for children are payed for children born after 2008.[15]

The absolute impact of the deductibility of Riester saving contributions increases in the next decades due to economic growth since the size of contributions necessary for receiving state supplements is tied to individual wage income. We also increase the ceiling for deductions in all scenarios in the course of the adjustment of tax regulations. Demographic change provokes a decrease of both the absolute and relative impact of the deductions for contributions to Riester savings contracts, which is more pronounced in latter years, as the number of tax payers subject to the statutory pension insurance scheme decreases. For 2060, table 8

[15] Supplements for children born before 2008 are only 185 instead of 300 euros yearly.

shows a number of affected tax payers that is markedly lower in the demographic change scenarios than in scenario 0.

Table 9: Riester pension contributions

	2015	*2030*	*2045*	*2060*
Impact on tax revenues in million real 2015 euros				
scenario 0	1,350	1,500	1,800	2,170
scenario 2	1,340	1,440	1,440	1,200
scenario 3	1,340	1,410	1,320	920
scenario 6	1,340	1,410	1,400	1,210
Impact on tax revenues in per mille of total income tax revenues				
scenario 0	4.63	4.25	4.29	4.41
scenario 2	4.61	4.12	3.80	2.89
scenario 3	4.61	4.08	3.58	2.35
scenario 6	4.61	4.01	3.61	2.80
Affected tax payers in thousands				
scenario 0	4,000	3,700	3,400	3,200
scenario 2	4,000	3,500	2,800	2,000
scenario 3	4,000	3,400	2,600	1,600
scenario 6	4,000	3,500	2,700	2,000

Whereas the transition to full deductibility of statutory pension contributions reduces income tax revenues, the transition to the full taxation of statutory pension incomes increases them. Furthermore, population aging implies a higher share of tax payers who receive pension incomes. In fact, not only the absolute but also the relative impact of the taxation of statutory old-age pensions on total tax revenues increases between 2015 and 2060 in all scenarios, with the largest increase accruing between 2015 and 2030. However, even in 2060 income taxes attributable to the taxation of pensions amount to only 6 percent of total income tax revenues, whereas the effect of deductibility of pension contributions amounts to 13.5 percent in scenario 0 and to about 17 to 18 percent in the demographic change scenarios. Additionally, demographic change does not enhance the relative importance of the taxation of statutory pensions in the long run. Although the share of pensioners is higher in the demographic change scenarios, mean pensions are lower. The number of affected tax payers decreases in all scenarios after 2045, which can be attributed to the increase in the lowest tax bracket threshold, the basic tax-free allowance, in the course of the adjustment of tax parameters. This decrease is even more pronounced in the demographic change scenarios due to lower individual pension incomes and a decline of the population. In summary, deferred taxation is associated with a negative balance not only currently but also in the long run. Demographic change contributes to this negative balance instead of mitigating it.

Table 10: Taxation of statutory old-age pensions

	2015	*2030*	*2045*	*2060*
Impact on tax revenues in million real 2015 euros				
scenario 0	6,600	14,270	25,190	31,110
scenario 2	6,710	16,180	22,510	24,540
scenario 3	6,710	15,840	21,770	22,970
scenario 6	6,710	16,290	22,970	25,700
Impact on tax revenues in per mille of total income tax revenues				
scenario 0	23	40	60	63
scenario 2	23	46	59	59
scenario 3	23	46	59	59
scenario 6	23	46	59	59
Affected tax payers in thousands				
scenario 0	4,600	5,700	5,900	5,800
scenario 2	4,700	6,700	6,700	6,100
scenario 3	4,700	6,700	6,600	5,900
scenario 6	4,700	6,700	6,700	6,100

Table 11 shows that the taxation of third-pillar pensions is far less important quantitatively, both in absolute and relative terms. There are currently virtually no recipients of this kind of pensions. As described above, we assume the share of tax payers with Riester pensions to increase until 2045 and to remain constant afterwards. Consequently, the impact of the taxation of Riester pensions increases notably until 2045. It decreases somewhat between 2045 and 2060 even in the reference scenario 0 with a constant population, which is due to the effect of an increasing basic tax-free allowance.

Table 11: Taxation of Riester pensions

	2015	*2030*	*2045*	*2060*
Impact on tax revenues in million real 2015 euros				
scenario 0	0	590	1,720	1,650
scenario 2	0	720	1,840	1,620
scenario 3	0	660	1,680	1,440
scenario 6	0	720	1,860	1,670
Impact on tax revenues in per mille of total income tax revenues				
scenario 0	0.0	1.7	4.1	3.4
scenario 2	0.0	2.0	4.8	3.9
scenario 3	0.0	1.9	4.6	3.7
scenario 6	0.0	2.0	4.8	3.9
Affected tax payers in thousands				
scenario 0	0	800	2,100	2,000
scenario 2	0	900	2,400	2,100
scenario 3	0	900	2,300	2,100
scenario 6	0	900	2,400	2,200

Compared to scenario 0, the relative importance of Riester pensions is higher in the demographic change scenarios since the number of recipients is higher and past wage earnings are also higher at the individual level. The somewhat lower relative importance in scenario 3 with a relatively old population is related to lower real returns to Riester savings. Given identical assumed nominal returns, the higher wage and price dynamics in scenario 3 imply lower real returns. This effect would be magnified if differences in nominal returns were accounted for. In summary, demographic change implies a decreasing importance of the deductibility of savings for third-pillar pensions and an increasing importance of the taxation of those pensions. However, the reverse is true for first-pillar (statutory) pensions and for health insurance and long term care provisions.

4. Simulation of the revenues from sales tax

In the following, we calculate the amount from sales tax using the EVS model and the same demographic scenarios from official statistics we used in chapter 3. We calculate the amount of sales tax from private consumption, excluding state consumption and "hidden" VAT. This is the reason why our model captures only part of the sales tax amount compared to official figures. Since our focus is not an exact examination of VAT revenues, we concentrate on private demand and the sales tax revenues generated here.

Preliminary descriptive analysis show a high dependence of consumption structure on income and age, confirming the basic validity of our assumptions. Figure 2 displays the 12 standard consumption categories of the EVS and the respective share in total consumption. Different types of goods emerge clearly: basic goods like food & beverages and housing, with a decreasing share of total consumption, and luxury goods like leisure or traffic (which contains, among others, car purchases). Their share of total expenditures rises when income increases. The category communication played almost no role in total budget in the first EVS waves in the Sixties and Seventies (Rebeggiani, 2007, Chapter 4.3). In the 2008 EVS survey, it shows a classic basic good pattern, with a larger share in total consumption for low income households. On the other side, education has a small share in total spending but seems to behave like a luxury good. This should be due to the fact that in Germany education is mainly provided by the government (including higher education), with only a few additional costs which have to be borne privately.

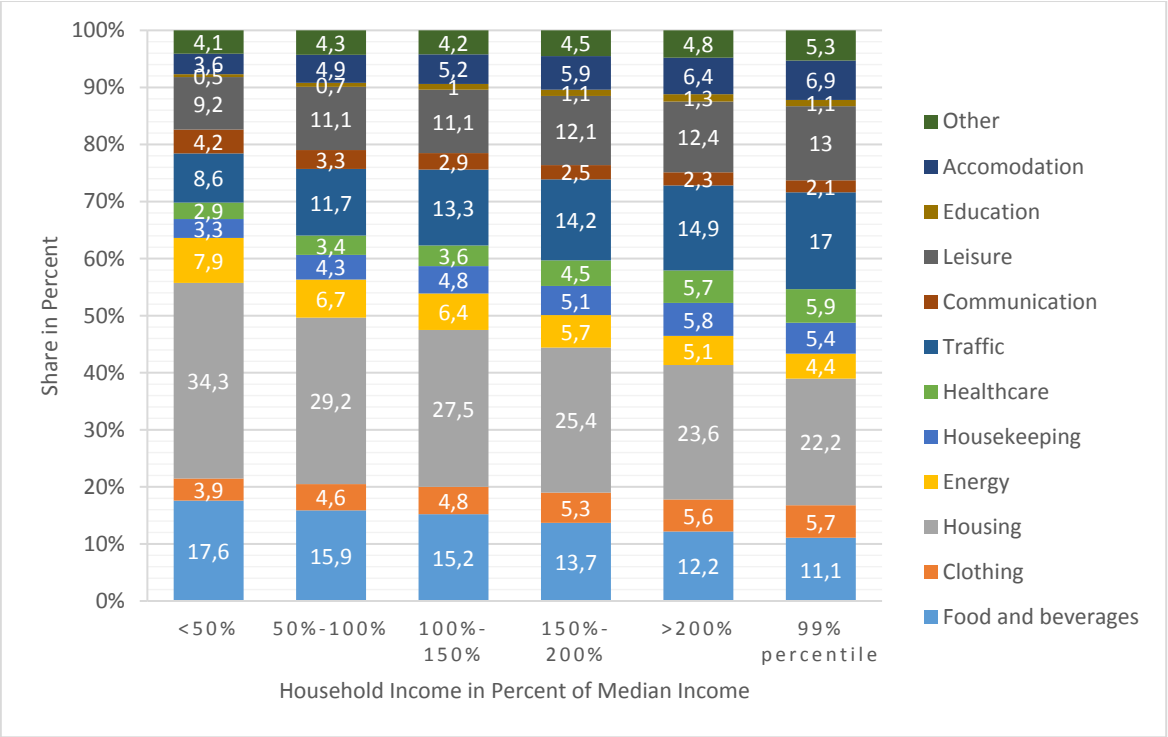

Figure 2: Income classes and consumption structure

The consumption structure varies also significantly with the age of the consumers, which is also a clear sign for the validity of our approach (figure 3). Elderly people spend more for energy and housing and especially healthcare, while their expenses for clothing traffic, communication, and education decrease with age.

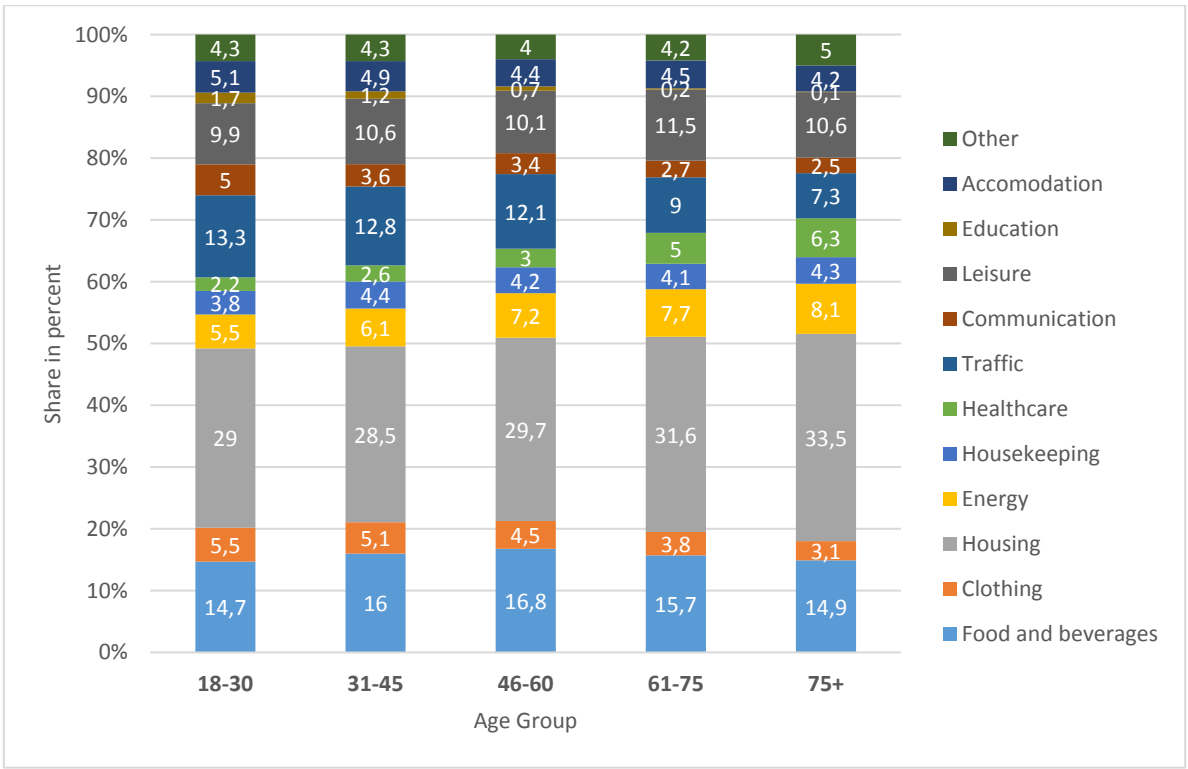

Figure 3: Age of the MIR and consumption structure

For analyzing tax revenues, we adopt in the following figures the method already used in section 3 and report not the absolute changes in tax revenues but the differences to the base demographic scenario bev0. This should allow us to concentrate on the changes induced by demographic change.

The results of the first estimation step, which studies only demographic changes, show a decrease in sales tax revenues by 4 to 11 percent until 2060 compared to the base scenario bev0 (figure 4). This means that a more pessimistic demographic scenario, implying a rapidly aging and shrinking population, goes along with the highest loss in tax revenues. In each of the demographic scenarios sales tax revenues are lower than in bev0. This seems to confirm the second of the two possible general effects we discussed above: the sales tax revenue decrease due to a diminishing aggregate income and a changing consumption structure, and this effect seems to be larger than the consequences of a higher consumption share.

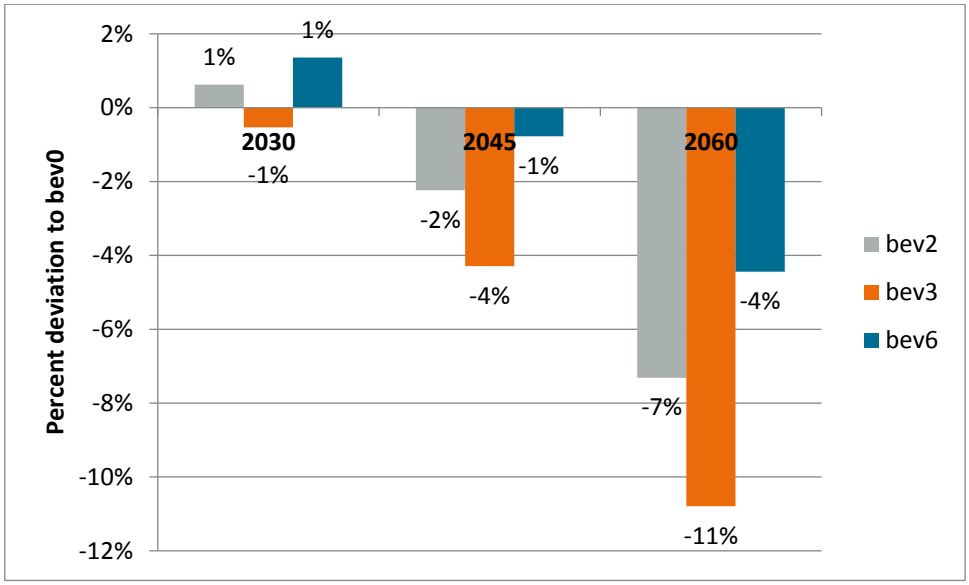

Figure 4: Demographic change and sales tax revenues with constant consumption structure

Step 2 takes the effects of income growth and the consequent changing consumption structure into account. Table 5 reports the absolute amounts of the revenues from sales tax for the different demographic scenarios.[16] Not really surprisingly, all values are growing in the long run due to income growth. But which effect has demographic change? As figure 5 shows, this effect is even stronger than in the previous model without income growth. Compared to a scenario without demographic change (bev0), the German government would lose in the long run about one quarter of its sales tax revenues in the most pessimistic scenario and still 13 percent in the most optimistic scenario.

[16] Our model calculates only the sales tax from private consumption, therefore the absolute figures for 2015 differ substantially from the official statistics concerning sales tax revenues.

Table 12: Revenues from sales tax

	2015	2030	2045	2060
bev0	124	152	188	231
bev2	122	145	167	188
bev3	121	140	158	172
bev6	123	148	174	200

In billion real euros.

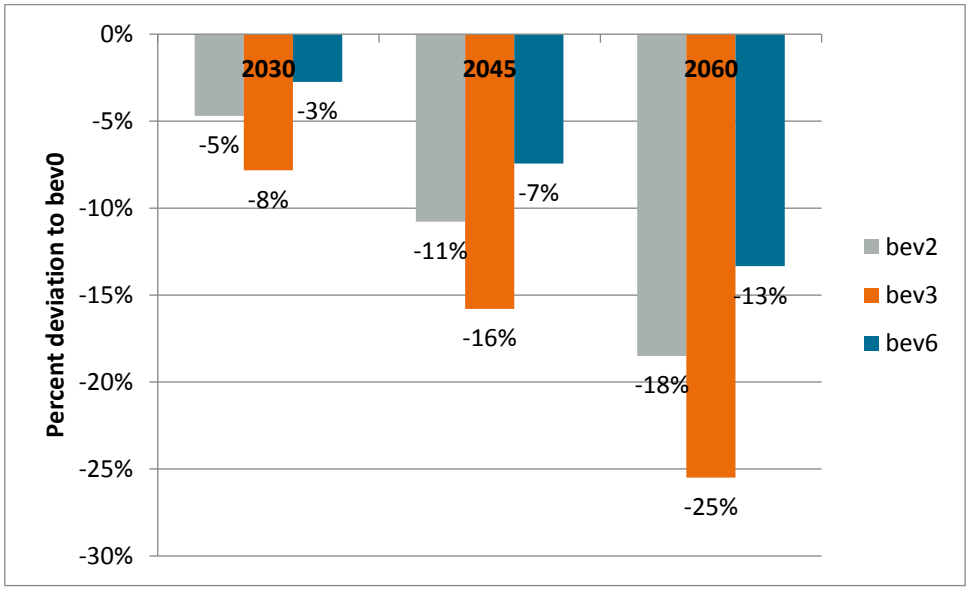

Figure 5: Demographic change and sales tax revenues with changing consumption structure

5. Conclusion and outlook

The present paper was one of the first attempts to estimate the long run effects of the demographic changes on tax revenues in Germany. Most of the research and of political counseling has concentrated so far on the increasing public spending due to an ageing and shrinking population, but, as we show here, also the revenue side the federal budget will be heavily affected.

In the long run, income growth will cause revenue growth for both income and sales taxes. Therefore, we concentrated on the changes in revenues compared to a scenario without demographic change. All in all, the main result of our analysis is that the ageing and shrinking of German population will have a dampening effect on both income and tax revenues: The more pronounced the demographic change, the higher the revenue losses compared to the basic scenario. In the worst case scenario, until 2060 sales tax revenues would drop by one quarter and income tax revenues by more than one fifth, respectively. While the first

result primarily depends on the different development of real income between the different scenarios and on the particular German sales tax scheme, the second is mainly due to the increased impact of the deductibility of old-age and health insurance provisions on the income tax.

From a methodological viewpoint, this paper has shown the usefulness of microsimulation in the context of taxation and social insurance. Our analysis has precisely identified several areas where legislation strongly influences tax revenues. These should constitute a good starting point for political measures and for further academic research.

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