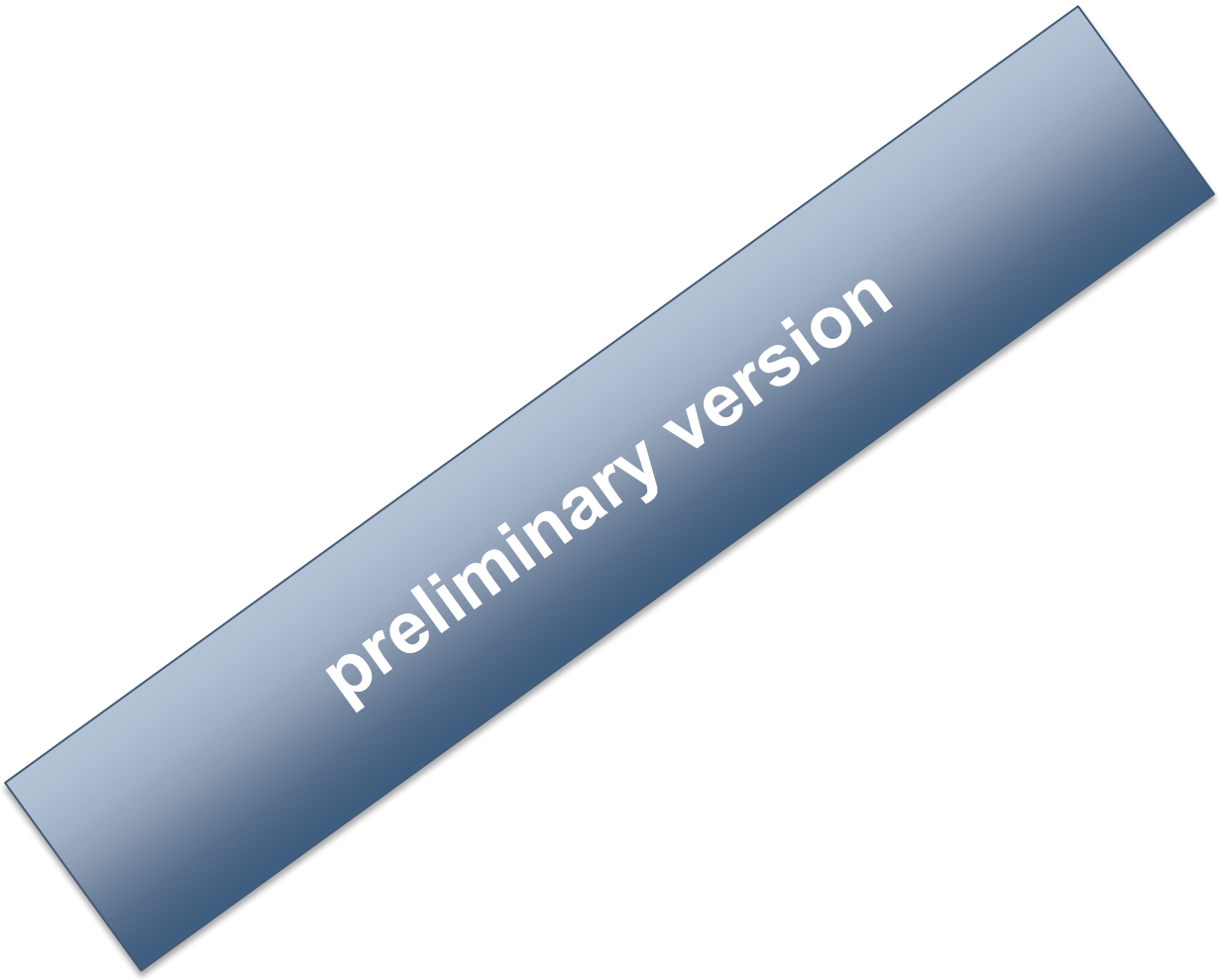

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Energy transition and the impacts on households – a modelling approach

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List of Abreviations

EVS	Income and Consumer Survey
BEH	Employment History
IAB	German Institute for Employment Research
DEVO	Data Collection Ordinance
DÜVO	Data Transmission Ordinance
DEÜV	Data Collection and Transmission Ordinance
ILO	International Labour Organization

1. Introduction

The ongoing energy transition is a process of moving away from fossil fuels towards the use of sustainable, renewable energies in all areas of the economy.The process, however, cannot be analyzed adequately on its own. The transformation is taking place in times of various crises and wars, emerging trends towards deglobalization and an increasing polarization of society. If the energy transition is to be successful, it should be designed in such a way that it takes the whole of society on its journey. It is therefore crucial to closely monitor its effects on the different types of households in a society and to prevent individual social groups from drifting away.

The spectrum of the energy transition begins with energy production and ends with energy consumption. Both components will have to undergo significant changes for a successful energy transition. Private households play a significant role in this, both as labor forces and consumers. In this presentation, we will therefore look at the role of households on the path to a sustainable and resilient economy.

In the production of energy, the households appear as a workforce – and not only as electricians or for the installation of photovoltaics – development, planning, approval, maintenance and other tasks must also be considered. Energy production alone therefore leads to massive changes in the industry structure.

Private households also play an essential role in energy consumption. They account for a relevant share of energy consumption worldwide. In addition, they have to pay for the energy transition. Either directly through higher prices for energy and mobility. Or indirectly through increased prices for goods or government levies. These changes in additional energy costs affect different households in different ways. For example, energy costs play a proportionately greater role in the consumption basket of lower-income households. Accordingly, these households feel changes in prices more strongly and have to adjust their consumption structure more significantly.

The need for a modelling approach arises from the consideration of these interdependent dynamics. A change in the industry structure inevitably leads to a shift in labor supply and demand. Wage trends do not remain unchanged. The income side of private households shifts. However, changes in energy prices also affect households in their consumption structure. For example, increased energy prices can lead to crowding out effects on other consumer spending due to a lack of substitution options.

The energy transition therefore affects private households in a number of ways, including in contradictory ways. A model approach is required to describe, analyze and, at best, forecast this development. One that places the necessary energy transition in the context of current economic developments (supply chains, interest rate changes, etc.).

The integration of the specific issue of the energy transition and the influence on households is conducted through interaction with the macroeconomic input-output model QINFORGE and provides the macroeconomic development for Germany. It takes into account circular relationships between private households, NGOs, companies and the state. Furthermore, the input-output approach makes it possible to map not only the direct effects of the energy transition. Indirect or induced effects along the value chains

are also taken into account. The energy transition has a significant influence on wage setting in certain sectors. The changing wages influence prices, which in turn have an impact on the consumption structure of private households.

This sector-specific wage development is crucial for extrapolating the incomes of the various households. For this purpose, a data set from the German Federal Employment Agency is also used to allocate the sector to which the individual households belong and to extrapolate wage trends for each household.

The consumption structure is determined on the basis of the Germany Federal Statistical Office's "Income and Consumer Panel". Household expenditure is also extrapolated using the QINFORGE model in order to take account of the circular relationships between transformation and macroeconomic development.

As shown, households therefore play a decisive role in many respects in enabling the transformation towards a sustainable and resilient economy. A model approach that accompanies the transformation process from the perspective of households therefore is important but has so far been largely neglected in research. The results can provide important information for giving the best possible advice to key stakeholders in the areas of politics and business.

The first step is therefore to look at the two key data sets - the EVS and the BEH. This is followed by a status quo analysis and a brief explanation of the procedure for projecting income and expenditure. This is applied in practice using an energy transition scenario to show the consequences for private households based on model results.

2. Integration into the QINFORGE-model

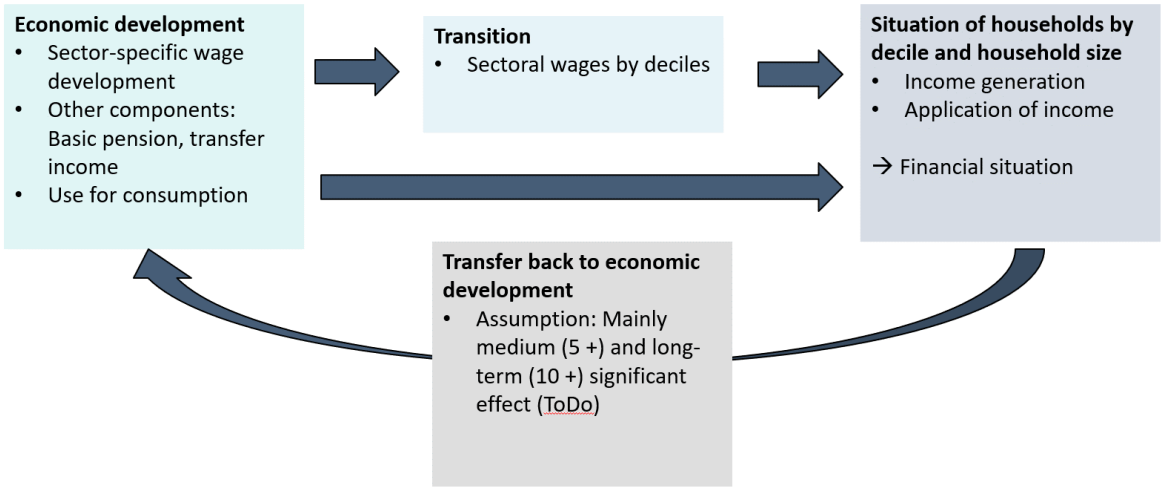
The QuBe model system, which essentially consists of population modeling, the education system and the **QINFORGE model** (Zika et al. 2023), is to be expanded in the economic section. The connecting factors relate to three components of the QINFORGE model:

1. the sector specific development of the number of employees, working hours and hourly wages
2. aggregates of the system of national accounts, which deal with transfer income (e.g. child benefit, basic pension) and
3. consumer spending of private households by purpose (Figure 1, left)

Based on industry wages, factors influencing the dynamics of gross income from non-self-employment by household size and deciles in the EVS are determined via gross wage deciles by industry. The model results on transfer income and consumption use are incorporated directly into the EVS (1). This results in the situation of households by decile and household size.

The return flow is not yet included (Figure 1, lower part). This step will only be taken once the modeling of the household situation has been consolidated. However, based on current knowledge, the reflux makes sense, as medium and long-term consequences for the industry structure and its jobs are assumed.

Figure 1: New approach to the inclusion of household types in QuBe



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3. Data preparation

3.1 INCOME AND CONSUMPTION SURVEY (EVS)

The german federal statistical office's **Income and Consumer Survey (EVS)** forms the basis of the consumption module. Around 80,000 private households in Germany are surveyed, making it the largest survey of its kind in the European Union. The sample is surveyed every five years and published with a delay of around two years. The model includes the EVS for the years 2008, 2013 and 2018. A new survey will therefore be conducted in 2023, meaning that new figures cannot be expected until 2025 at the earliest. The EVS is grouped by default in the columns according to eight different classes of household net income. A special evaluation by the Federal Statistical Office also makes it possible to differentiate between the deciles of net household income, household sizes and socio-economic household types. The respective income and earnings or consumption expenditure are listed in the rows. After subtracting the expenditure from the income, the result is the savings.

On the income side, the EVS differentiates between 51 different types of income. It breaks down various main categories, including the most important drivers of private household income – *gross income from employment*, *income from assets* and *income from public and non-public transfer income*. This enables detailed statements to be made about the income structure of private households.

On the consumption side, the EVS is broken down into 86 different items. It subdivides private household consumption expenditure into 11 main categories. In addition to the main areas – *food beverages and tobacco*, *housing energy and housing maintenance*, *transport*, *leisure entertainment and culture* – there are 7 other main categories. In total, the EVS breaks down private consumer spending into 69 sub-categories. The 17 remaining statements provide information on other expenditure (taxes, donations, expenditure on financial assets, etc.), *total expenditure* and *other expenditure*. In addition, the statistical difference falls into the area of consumption.

The EVS data therefore enables a detailed analysis of the income and consumption structure of private households. Furthermore, data is available on the housing situation of private households by deciles of net household income. A statement can be made about the type of dwelling, the type of building occupied, the type of heating system, the predominant type of heating energy and the average living space of the main dwelling.

3.2 IAB – EMPLOYEE HISTORY (BEH)

The **IAB Employment History (BEH)** of the Institute for Employment Research (IAB) is used to calculate an approximate wage distribution at industry level (IAB 2021). The BEH contains information on employment relationships subject to social insurance contributions as they have been forwarded by the insurance institutions to the Federal Employment Agency (BA) since the introduction of the reporting procedure in 1973. The BEH is generated from the BA's employment statistics by storing the notifications from previous years in archive storage media at certain intervals according to a defined algorithm. The reporting obligation for establishments in the legal district of East Germany has existed

since the end of 1990, but this data is only available in an analyzable quality from 1993 onwards. The BeH therefore contains the complete, historicized and processed administrative data of the pension insurance institutions as individual data. Until end of 1998, data was transmitted in accordance with the Data Collection Ordinance (DEVO) and the Data Transmission Ordinance (DÜVO), from 1999 in accordance with the Data Collection and Transmission Ordinance (DEÜV).

The BeH shows personal periods in which a person was subject to social insurance contributions and/or marginally employed. It therefore does not include civil servants, soldiers, self-employed persons and their assisting family members. Short-term employees are also not included in the BEH, as no remuneration is provided for this group of people. Military and civilian service personnel have not been included since 1999. The start and end year of a notification are always identical, so that the file can be divided into annual sections.

A number of characteristics are available in the BEH that are of particular importance for labor market and regional social structure analyses:

- Gender and year of birth
- Nationality
- Start and end of employment in daily details
- Type of employment (temporary employment, fixed-term contracts)
- School and training qualification
- Occupation of the activity performed
- Position in the profession
- Gross salary subject to social security contributions for the reporting period
- Establishment number of the employing company
- Sector of the employment company (WZ 2008)
- Regional breakdown (place of residence and place of work)

Before the approximate wage distributions can be calculated, the BEH must be supplemented and adjusted in two steps:

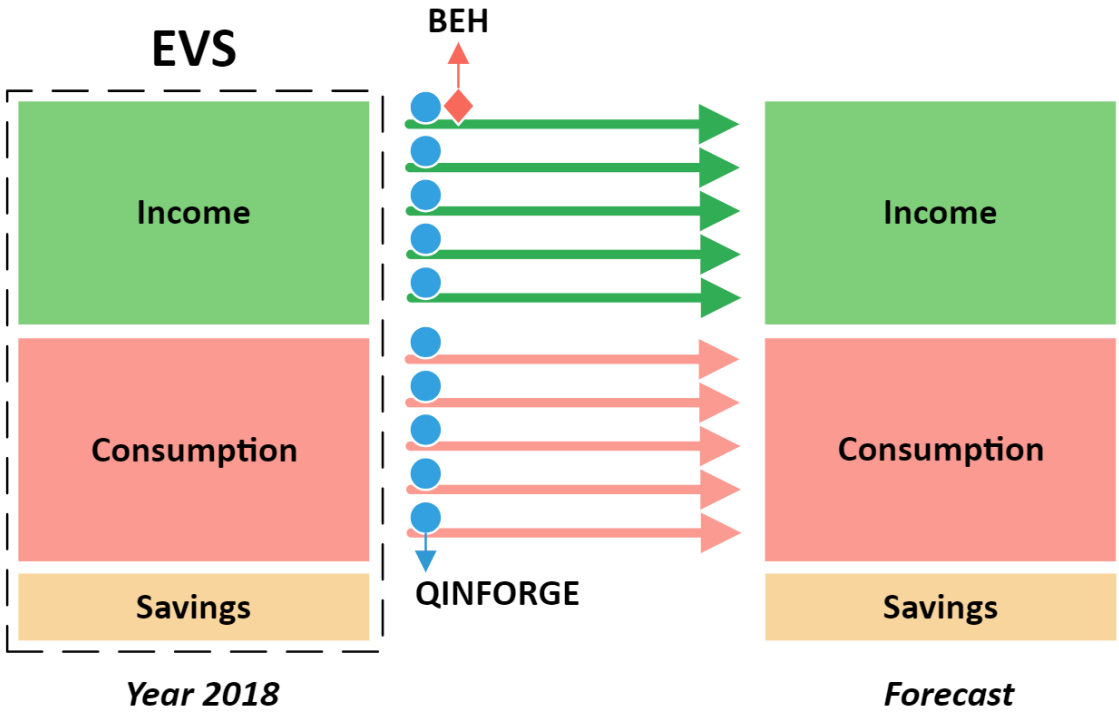
(1) It must be taken into account that the remuneration reports are cut off at the contribution assessment ceiling for pension insurance. In the case of gross remuneration that is above the contribution assessment ceiling, only the contribution assessment ceiling is reported as remuneration. For this reason, a multiple imputation method developed by (Büttner & Rässler 2008) is used to estimate the remuneration above the contribution assessment ceiling.

(2) Since the BEH shows occupations and a person can pursue several occupations at the same time, all of a person's occupations are summarised for each year. Nevertheless, there are cases where a person's annual salary is zero or very low. According to the definition of the International Labour Organization (ILO), a person must have engaged in some professional activity for at least one hour a week for remuneration in order

to be counted as an employed person. Therefore, all persons whose annual salary is less than the remuneration they would have received if they had worked one hour per week per year at the minimum wage are considered inactive. However, a comparison of the wage distribution for 2018 with the income distribution of the EVS 2018 showed that the distribution based on the BEH is too skewed, i.e. still shows too much income in the lowest income decile. Therefore, we also count as non-employed persons whose annual salary according to BEH is below the remuneration they would have received if they had worked two hours a week at the minimum wage.

Overall, the EVS with its predefined structure of consumption purposes and various sources of income forms the starting point for the forecasts. The consumption side is updated with the dynamic consumption purposes of the QINFORGE model (4.2.2). The income of private households is largely extrapolated using the growth rates from QINFORGE. The decisive wage income is treated in more detail by using the employment history of the IAB to approximate the sectors in which the private households of the different income deciles are employed. In the next step, the wage trends of the identified sectors are distributed across the 10 deciles. Figure 2 shows the use of the two processed data sources and the model used. The structure of the EVS provides the basis for an update. The different types of income are shown as green arrows. The blue dots represent the use of the QINFORGE model for updating, the orange diamond indicates the use of the BEH. The same procedure is followed on the consumption side. Here, too, the EVS provides the structure and the initial values; here, the update is only carried out using the changes in consumption purposes from QINFORGE.

Figure 2: Forecast of income and consumption



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4. Methodical approach

4.1 STATUS QUO

4.1.1 INCOME GENERATION OF HOUSEHOLDS

The **gross remuneration of the deciles** for each of the 63 economic sectors depicted in the QINFORGE model is available from the BEH's data processing. For the resulting matrix (63 industries x 10 deciles), there are actual values for the years 2013 to 2021. . Figure 3 provides an initial look at possible influences of the energy transition. Typically affected sectors are, for example, mechanical engineering or energy supply. Both sectors already pay relatively high wages, are needed for the transition and are facing changes. The construction industry, on the other hand, pays below-average wages, but is also needed for the transition. The sector should tend to benefit from rising demand and wages should increase. shows the deciles for the year 2021. For clarity, the deciles available for each industry were ranked again over all 630 available values and combined into macroeconomic deciles, so that each macroeconomic decile then contains 63 fields of the initial matrix. For example, the highest decile in the hospitality industry (column D10 and row hospitality industry, field highlighted in red with the value 7) is only so high that it fits into decile 7 from a macroeconomic point of view. Other industries have more than one industry decile, so it fits into the highest category, decile 10, of economics. For example, the coking and mineral oil processing sector provides three gross remuneration deciles, which make it into the 10th decile from a macroeconomic point of view. Figure 3 provides an initial look at possible influences of the energy transition. Typically affected sectors are, for example, mechanical engineering or energy supply. Both sectors already pay relatively high wages, are needed for the transition and are facing changes. The construction industry, on the other hand, pays below-average wages, but is also needed for the transition. The sector should tend to benefit from rising demand and wages should increase.

Figure 3: Gross salary deciles by sector and their classification into macroeconomic deciles for the year 2021

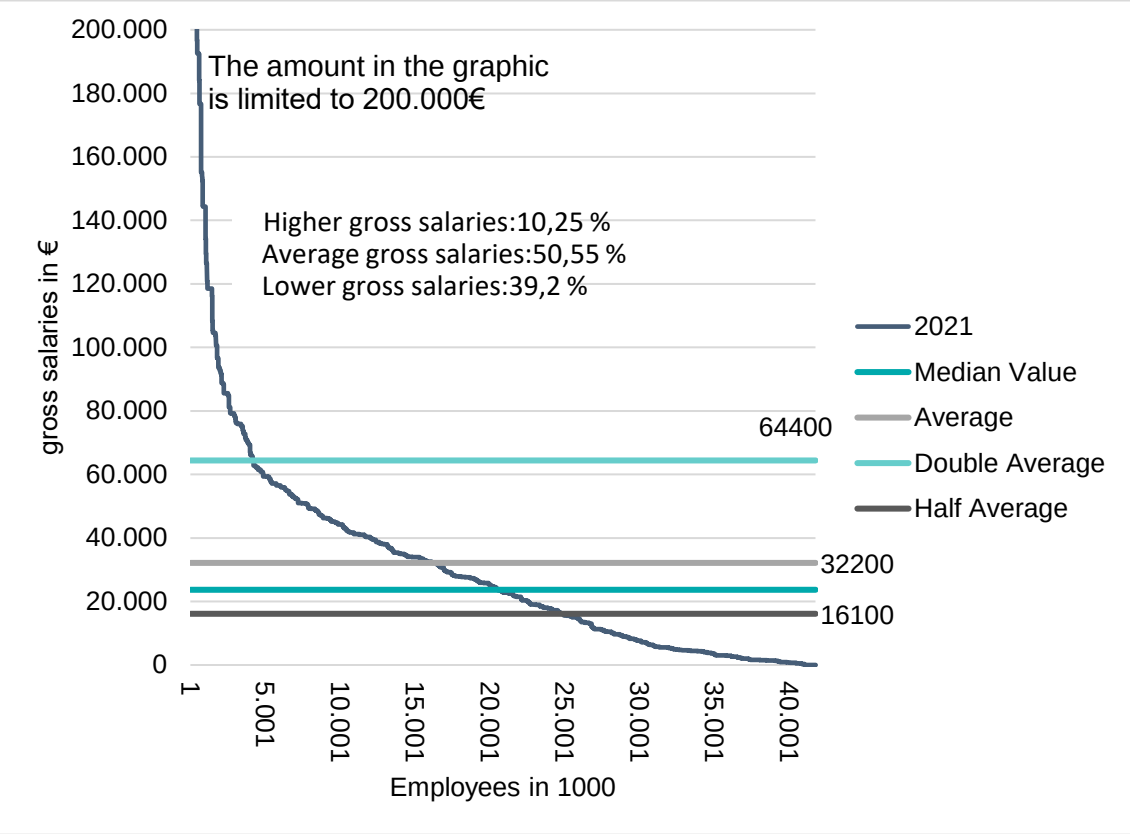
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Agriculture	1	1	2	2	3	4	4	5	6	8
Forestry	1	2	2	3	4	5	5	6	7	9
Fishery	1	1	2	2	3	4	5	5	7	9
Mining and quarrying	2	4	5	7	7	8	8	9	9	10
Manufacture of food and beverages, tobacco processing	1	2	3	3	4	5	6	6	7	10
Manufacture of Textiles, clothing, leather goods and footwear	1	2	4	4	5	6	6	7	8	10
Manufacture of articles of wood, plaiting, basketry and cork	1	2	3	4	5	6	6	7	8	9
Manufacture of Paper, paperboard and articles thereof	2	4	5	6	7	7	8	8	9	10
Manufacture of printers, duplication of sound, image, data carriers	1	2	3	4	5	6	6	7	8	10
Coking and petroleum refining	3	6	7	8	9	9	9	10	10	10
Manufacture of chemical products	2	4	6	7	8	9	9	9	10	10
Manufacture of pharmaceutical products	3	5	6	7	8	9	9	9	10	10
Manufacture of rubber and plastic goods	2	3	5	5	6	7	7	8	9	10
Manufacture of glass, glassware, ceramics, processing of stone and earth	2	3	4	5	6	7	7	8	8	10
Metal production and processing	2	4	6	7	7	8	8	9	9	10
Manufacture of metal products	1	3	4	5	6	6	7	8	8	10
Manufacture of data processing equipment, electronic and optical products	2	4	5	6	7	8	9	9	10	10
Manufacture of electrical equipments	2	4	5	6	7	8	8	9	10	10
Mechanical engineering	2	4	6	7	7	8	9	9	10	10
Manufacture of motor vehicles and motor vehicle parts	3	5	7	8	9	9	9	9	10	10
Other Vehicle Construction	3	5	7	8	8	9	9	10	10	10
Manufacture of furniture and other goods	1	3	4	5	5	6	7	7	8	10
Repair & Installation of Machines & Equipments	1	2	3	5	6	6	7	8	9	10
Energy supply	2	4	6	7	8	9	9	9	10	10
Water supply	2	4	6	7	8	8	8	9	9	10
Sewage, waste disposal and recycling	1	3	4	5	6	6	7	8	8	10
Construction industry	1	2	3	4	5	6	6	7	8	9
Motor vehicle trade, maintenance and repair of motor vehicles	1	2	3	4	5	5	6	7	8	10
Wholesale	1	2	3	4	5	6	7	8	9	10
Retail trade	1	1	2	3	3	4	5	5	6	9
Land transport and transport in pipelines	1	2	3	3	4	5	6	6	7	9
Navigation	1	2	4	4	5	7	7	9	9	10
Aviation	3	4	5	6	6	7	8	9	10	10
Storage and providers for transport	1	2	3	4	5	6	6	7	8	10
Postal, courier and express services	1	1	1	2	3	3	4	5	6	8
Hospitality industry	1	1	1	2	2	3	3	4	5	7
Publishing	1	1	2	3	4	5	7	8	9	10
Audiovisual media and broadcasting	1	1	2	3	4	5	7	8	9	10
Telecommunication	2	4	5	7	7	8	9	9	10	10
IT and information service providers	2	3	4	6	7	8	9	9	10	10
Financial service provider	3	4	6	7	8	8	9	9	10	10
Insurance companies and pension funds	3	5	7	8	8	9	9	9	10	10
Activities related to financial and insurance services	1	2	3	3	4	5	6	8	9	10
Real estate and housing	1	1	2	2	3	3	4	6	7	10
Legal and Tax Consulting, Management Consulting	1	2	3	4	5	6	7	8	9	10
Architectural and engineering offices, technical investigation	1	3	4	5	6	7	8	9	9	10
Research and development	1	3	4	5	7	8	8	9	10	10
Advertising and market research	1	1	1	2	3	4	5	6	8	10
Freelance, scientific, technical services, veterinary services	1	1	2	3	3	4	5	6	7	10
Rental of movable property	1	1	2	3	3	4	5	6	7	10
Placement and leasing of workers	1	1	2	3	3	4	4	5	6	8
Travel agencies and operators	1	2	3	3	4	5	6	6	7	10
Business service providers	1	1	2	2	3	4	4	5	6	8
Public. Administration, Defence, Social Security	2	4	5	6	7	7	8	8	9	10
Education and teaching	1	2	2	4	5	5	6	7	8	10
Health service	1	2	3	4	5	6	6	7	8	10
Care homes and social services	1	2	3	4	4	5	6	6	7	9
Arts & Culture, Gambling	1	1	2	3	3	4	5	6	8	9
Sports, entertainment and recreation	1	1	1	1	2	2	3	4	5	8
Interest groups, religious associations	1	2	2	3	4	5	6	7	8	10
Rep. of IT equipment and consumer durables	1	2	2	3	4	5	5	6	7	9
Other mainly personal service providers	1	1	2	2	3	3	4	5	5	8
Home Services	1	2	2	3	3	4	4	5	7	9

Source: BEH, own calculation and grafic

Figure 4 shows the following **approximate gross pay distribution** for the year 2021 of the BEH data from a macroeconomic perspective. Since the industries differ significantly

in terms of the number of employees, the graph does not show the distribution fluently: The deciles of the industries with a high number of employees are given a larger axis segment (Figure 4). In addition to the distribution, the average, the double and half average and the median are entered in the figure. The introduction of the "double average" and "half average" limits also makes it possible to group wage and salary earners according to higher, medium and lower gross salaries. Average gross wages are earned by 50.55 percent, low by 39.2% and high by 10,25%. This grouping is not to be confused with the terms upper/middle and lower class (Niehues & Stockhausen).

Figure 4: Approximate gross pay distribution for the year 2021



Source: BEH, QuBe, own calculation and grafic

To look at the dataset over time, we follow the 5-year cycle of the EVS publication and add the most recent year of the dataset 2021. **Fehler! Verweisquelle konnte nicht gefunden werden.** shows the distribution parameters of the approximate gross compensation distribution. It demonstrates that the median and the mean of gross earnings have been moving closer together over the years. This means that the wages of the bottom 50 percent of gross salary earners rose more sharply than those of the upper ones.

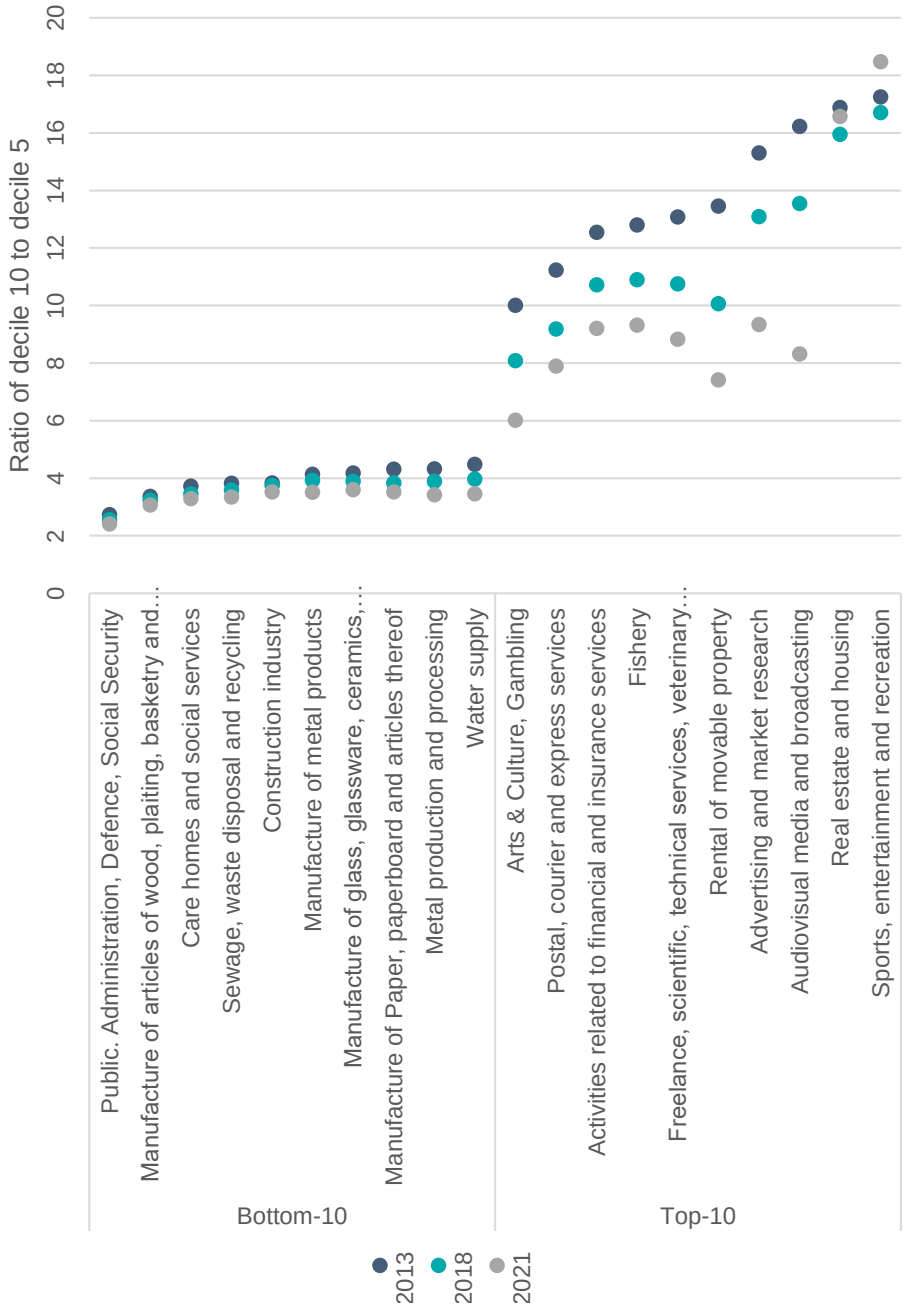
Table 1: Distribution parameters of the approximate gross pay distribution until 2021 based on historical values

		2013	2018	2021
Median Value	Euro	17849	20347	23665
Mean Value	Euro	27924	30506	32236
... percentage gap		56%	50%	36%
Employees with ...	Quantity	37770	40610	41030
... higher gross salaries:	Quantity	3933	4216	4204
... average gross salaries:	Quantity	17365	19508	20742
... lower gross salaries:	Quantity	16472	16886	16084
Shares				
... higher gross salaries:		10,41%	10,38%	10,25%
... average gross salaries:		45,98%	48,04%	50,55%
... lower gross salaries:		43,61%	41,58%	39,20%

Source: BEH, QuBe, own calculation and grafic

Figure 5 gives an overview of the change in the distribution of gross remuneration in an industry on the basis of the decile ratio (salary of the 10th decile divided by the salary of the 5th decile). A dichotomy can be seen when looking at the ten sectors with the highest and lowest decile ratios. In public administration, the decile gap is smallest and highest in sports. Almost everywhere, the gap between deciles has narrowed and the biggest changes can be seen in the sectors with the greatest differences. The onset of a shortage of skilled workers in the years after 2013 could be indicated: If the average gross wages are primarily the result of an activity that is based on the requirement level of "skilled workers", then the at least relatively declining supply of dual trained workers may be responsible for this shift.

Figure 5: Decile ratio decile 10 to decile 5 for the historical years 2013, 2018 and 2021, bottom 10 and top 10 in comparison based on 63 sector information



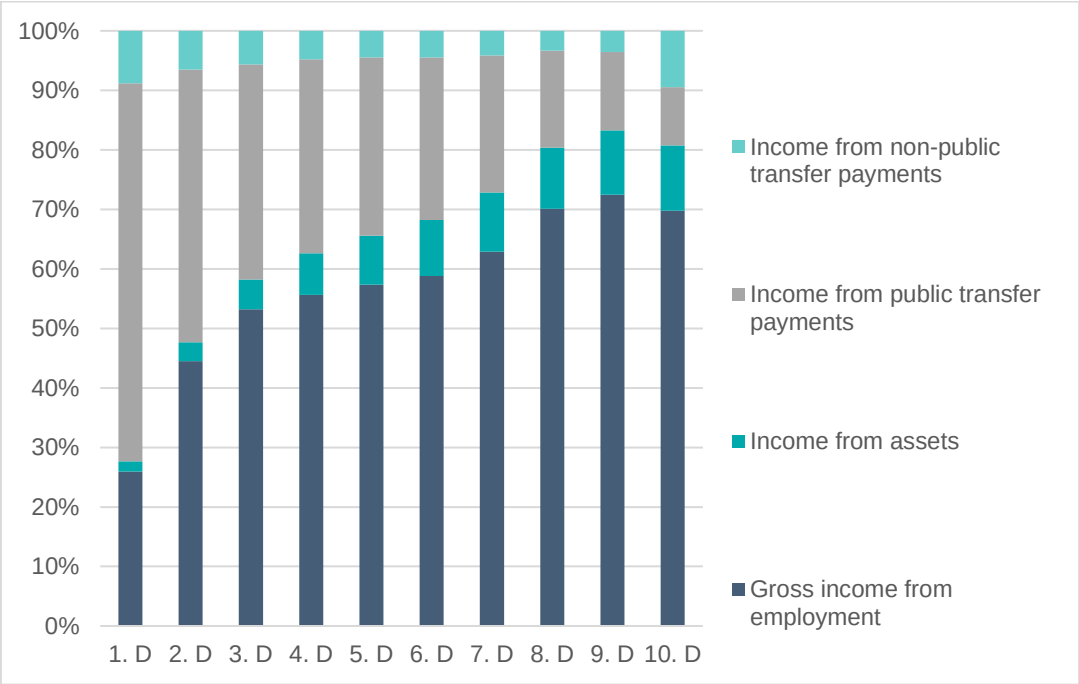
Source: BEH, own calculation and grafic

The results of the data analysis show that the development of gross remuneration by decile is closely linked to the structural change of jobs by sector. The high explanatory contribution of industry information is also shown by the DIW's analyses (Bönke et al., S. 326–332). However, high gross wages are achieved on average in the manufacturing sector, also in comparison to the deciles, but not in the service sector (e.g. hospitality, other business services). However, structural change is creating more jobs in the service sector, while the number of jobs in manufacturing continues to fall. At the same time,

there is a clear dynamic within the distribution of remuneration between the sectors. This dynamic is another influencing factor for a projection of the distribution of remuneration as a whole, which is taken into account when expanding models. One possible link is wage developments according to requirement levels.

The focus of the income generation of private households has so far been on wage income. Figure 6 provides information on other sources of income. Gross income from employment is the most important category for the economy as a whole, but public transfer payments are also decisive, especially for the lower deciles. These sources of income are also shown in the EVS and dealt with in the consumption module. Detailed information on the other sources of income are described (Plassenberg et al. 2023, S. 11–12)

Figure 6: Proportionate income generation of private households - 2018

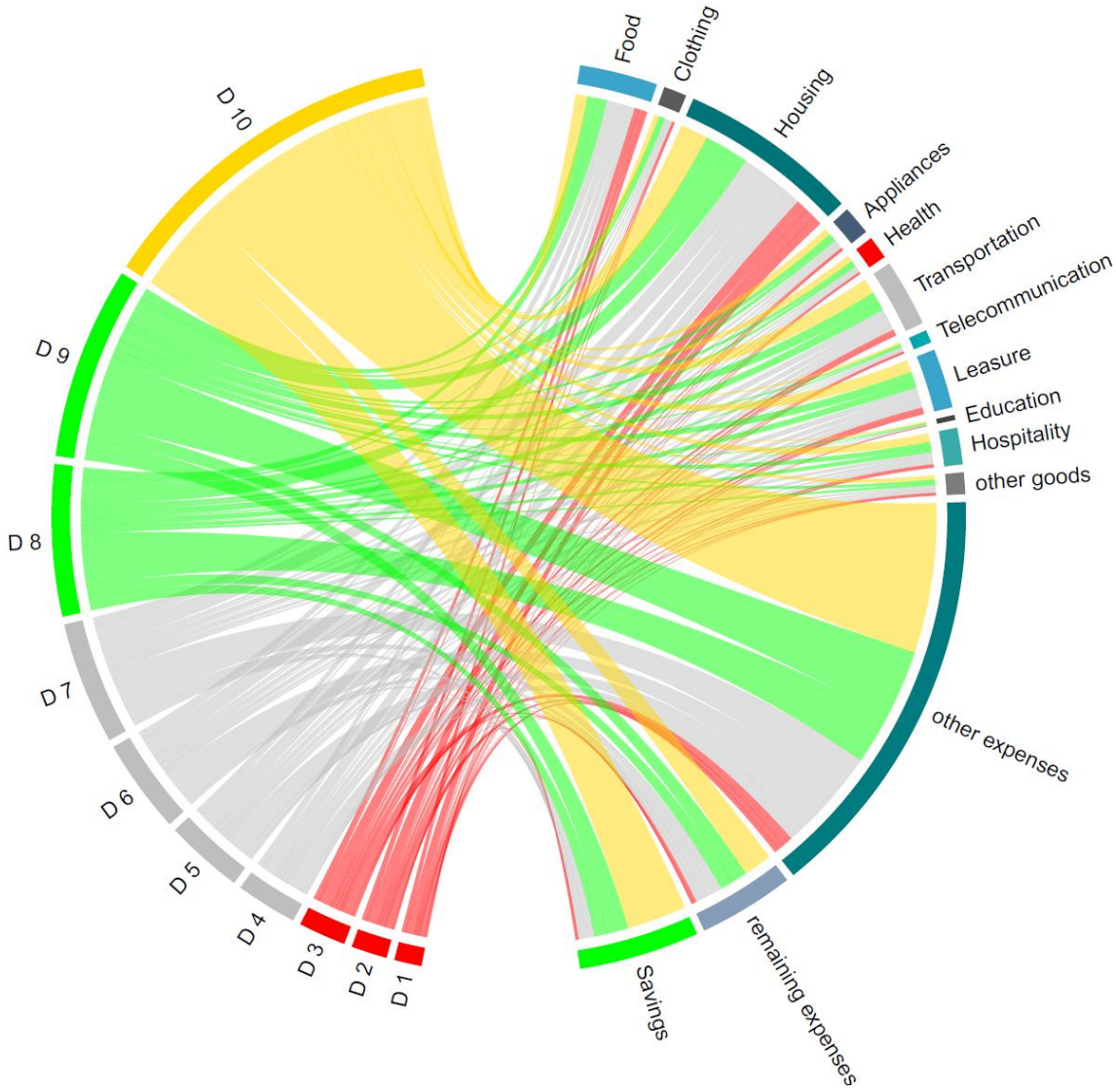


Source: EVS, QuBe, own calculation and grafic

4.1.2 EXPENDITURES OF HOUSEHOLDS

The data basis for modelling household consumption is the EVS for 2008, 2013 and 2018. For the year 2018, the **consumption structure of private households** shown in Figure 7 is obtained for the deciles.

Figure 7: Expenditure structure of private households for 2018

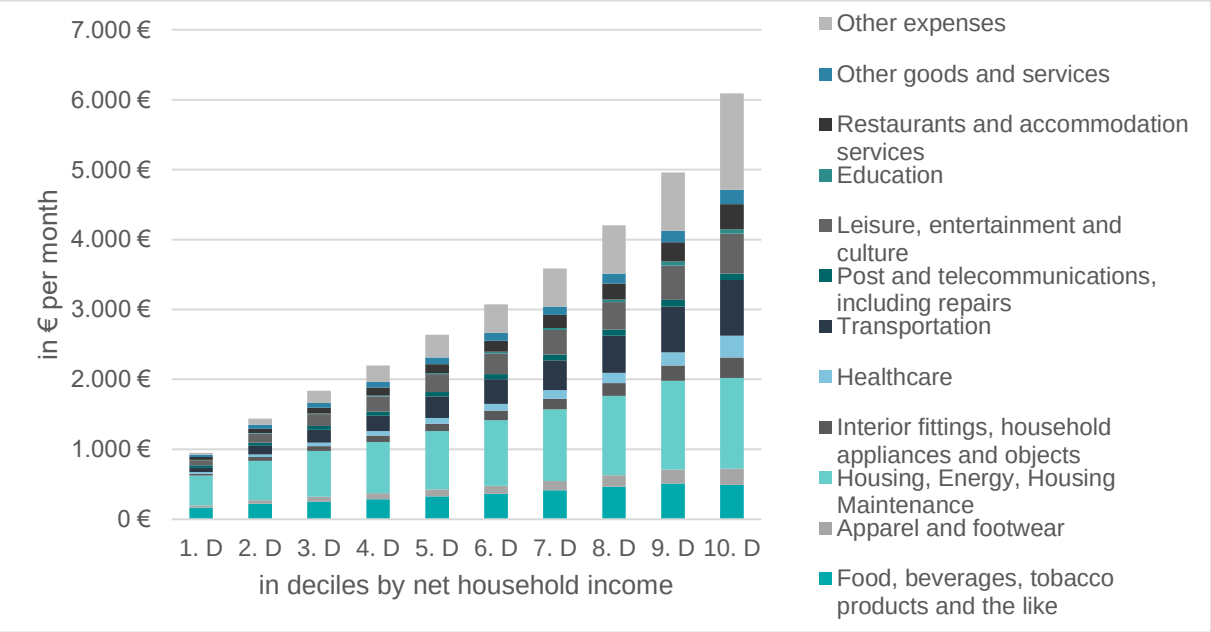


Source: EVS, own calculation and grafic

The chord diagram shows the influence of the deciles on aggregated consumption uses, further expenditure and saving. With regard to the latter, the dominance of the 10th decile for the formation of wealth from the former is evident. The three upper deciles also dominate almost all types of consumption. This is particularly evident in the *hospitality industry*, *education*, *health* and *leisure*.

The consumption structure of the various deciles is visualized in the following two figures. Figure 8 illustrates the consumption expenditure of the deciles for the last year of the EVS. The upper deciles dominate consumption expenditure in this absolute representation. The 10th decile has a monthly expenditure approximately six times that of the first decile. Differences in the relative weighting of individual purposes can already be observed in this figure. For example, expenditure in the *Housing, Energy, Housing Maintenance* area increases less strongly with rising income than in *the Leisure, entertainment and culture* area.

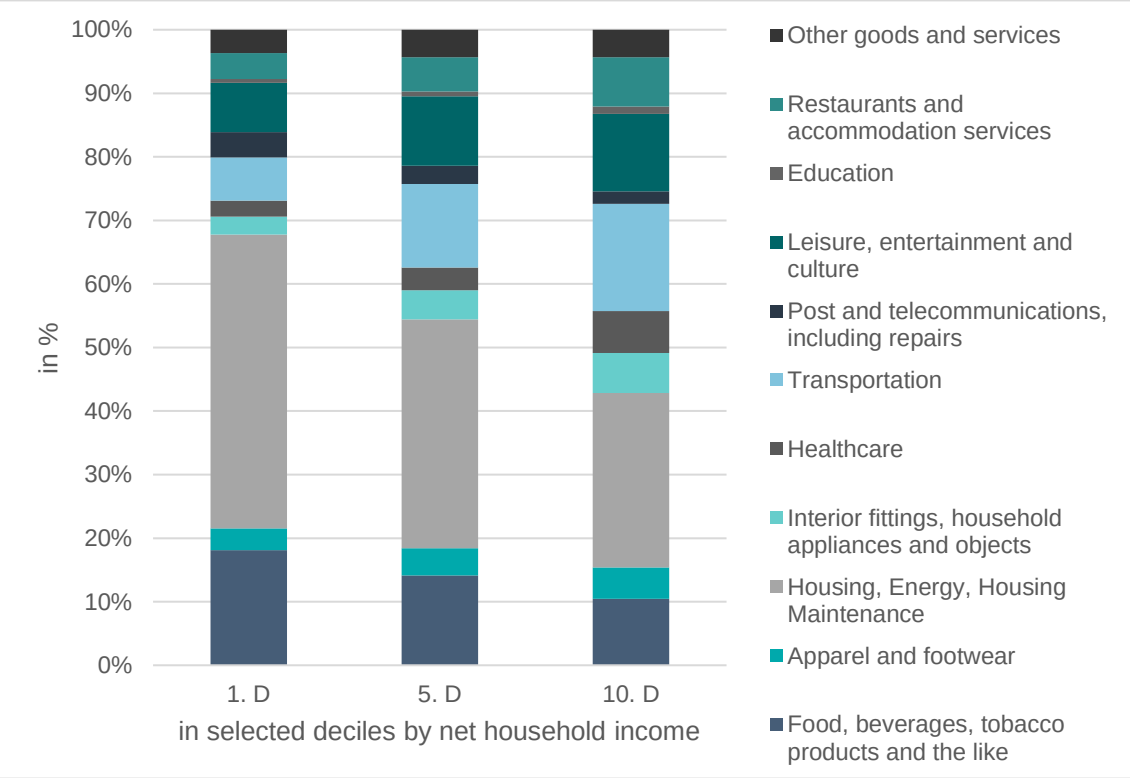
Figure 8: Consumer spending by purpose and deciles in 2018 – absolute values



Source: EVS, own calculation and grafic

Figure 9 allows this observation to be examined in more detail. For reasons of clarity, the group of other expenses was ignored in this relative analysis and the focus was placed on deciles 1, 5 and 10. All three are united by *Housing, Energy, Housing Maintenance* as the dominant expenditure item. However, there are clear differences in the consumption structure in the areas of *transportation and leisure, entertainment and culture* as well as *restaurant and accommodation services.* In addition, the richer households spend less proportionately on *food, beverages, tobacco products and the like*.

Figure 9: Consumer spending by purpose for selected deciles in 2018 – relative values



Source: EVS, own calculation and grafic

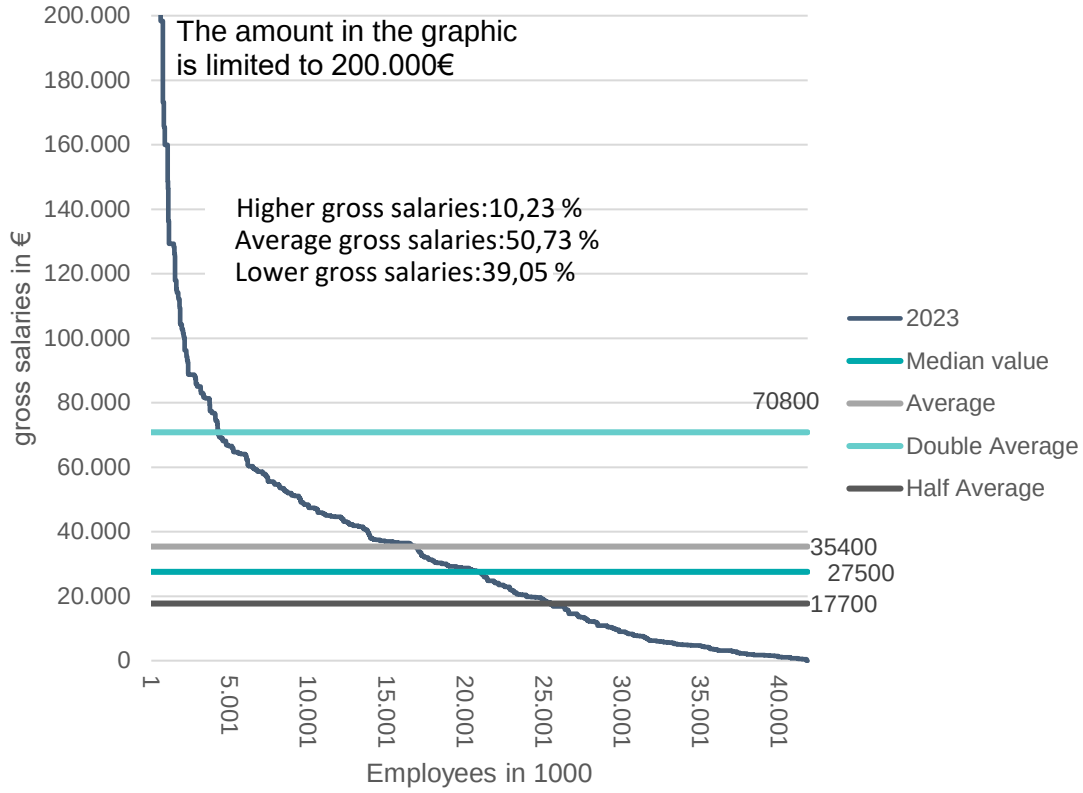
4.2 PROJECTION

4.2.1 INCOME GENERATION OF HOUSEHOLDS

The results of the projection of the **income generation of households** are presented below The QINFORGE model and the BEH dataset were used to project the gross salary (Figure 2, upper green arrow). Various economic indicators of QINFORGE were used for the other sources of income (Figure 2, remaining green arrows). For more detailed information on the projection of private household income, please refer to (Plassenberg et al. 2023).

For the results of the projection, we start with the macroeconomic view of the approximate gross pay distribution for 2023. Figure 10 shows only minor differences compared with 2021 (Figure 4). Overall, the wage distribution is shifting in favor of the average large salaries. Overall, salaries have risen, the indicator for this is the increase in the average by € 3,200 per year.

Figure 10: Approximate gross pay distribution for the year 2023



Source: BEH, QuBe, own calculation and grafic

Table 2**Fehler! Verweisquelle konnte nicht gefunden werden.** allows a comparison with Table 1. The years 2013, 2018, 2021, 2023 and 2028 can be seen, but no longer than 2028 will be looked at due to the modelling still under construction, even if the model runs until 2040. Table 2 shows that the median and the mean of gross earnings are still moving closer for the years to come. Nevertheless, the three groups (higher, medium, lower gross wages) will remain almost unchanged as a proportion of the number of employees from 2021 onwards. This may indicate that another influencing factor is not yet captured in the model: the change in the deciles of gross remuneration in relation to each other in an industry, i.e. the distribution in the industry. Or the missing reflux shown in Figure 1, bottom arrow.

Table 2: Distribution parameters of the approximate gross pay distribution until 2021 based on historical values, thereafter based on projections of the sector-specific development of wages and jobs for employees

		2013	2018	2021	2023	2028
Median Value	Euro	17849	20347	23665	27499	33682
Mean Value	Euro	27924	30506	32236	35406	44093
... percentage gap		56%	50%	36%	29%	31%
Employees with ...	Quantity	37770	40610	41030	41770	41670
... higher gross salaries:	Quantity	3933	4216	4204	4272	4511
... average gross salaries:	Quantity	17365	19508	20742	21188	20792
... lower gross salaries:	Quantity	16472	16886	16084	16310	16367
Shares						
... higher gross salaries:		10,41%	10,38%	10,25%	10,23%	10,83%
... average gross salaries:		45,98%	48,04%	50,55%	50,73%	49,90%
... lower gross salaries:		43,61%	41,58%	39,20%	39,05%	39,28%

Source: BEH, QuBe, own calculation and grafic

4.2.2 EXPENDITURES OF HOUSEHOLDS

The results of the **projection of the expenditures of households** are now presented. The QINFORGE model was again used for the projection (Figure 2, red arrows). A total of 39 different economic indicators of the model are assigned to the consumption purposes of the EVS and allow the consumption parameters to be projected. For more detailed information on the projection of the expenditures of households, please refer to (Plassenberg et al. 2023, S. 18–19).

In this module, important factors influencing the consumption of private households are not only income but also the size of the respective households. On the one hand, the influence of income on consumption acts as a budget constraint, since households – at least in the medium term – cannot spend more on consumption than they generate from the various sources of income. On the other hand, the expenditure for the various purposes differs depending on income. For example, expenditure *on food, beverages and tobacco products* is almost evenly distributed, and income has little influence on the level of expenditure. For expenditure in the areas of *health* (private health insurance), *education* or *restaurant and accommodation services*, significantly higher expenditure can be seen for households with higher incomes (Figure 11). Figure 11 shows the final consumption expenditure of the 10th decile in relation to the expenditure of the 5th decile. Consequently, the top decile spends five times the 5th decile on health. For the most part, this factored consumer spending shows only minor changes. The projection (from 2023) shows a homogeneous picture.

Figure 11: Factorized consumer spending: Decile gaps between the 10th decile and 5th decile (unweighted mean by household size)

Source: EVS, QuBe, own calculation and grafic

As already noted, expenditures for *food, beverages and tobacco products* are hardly influenced by income. Here, the size of the household is decisive for the amount of expenditure. A similar effect can be seen in *postal and telecommunications* expenditure. In the areas of *transport* and *leisure*, on the other hand, rather opposite effects can be observed.

A different view of the projection of consumer spending is presented in Table 3. The table compares the **changes in the consumption structure** between 2018 and 2023 and between 2023 and 2028 for deciles 1,5 and 10 respectively. For the first period, there is a clear increase in the area of *food, beverages, tobacco products and the like* for all deciles, with decreasing intensity the wealthier the households are. The reason for the decreasing intensity is the different relative sizes of the intended use in relation to total consumer spending, as shown in Figure 9. In the area of *restaurants and accommodation services*, the share of consumer spending increases across all deciles, but here the intensity increases with rising income. Expenditure in the area of *transportation* remains almost unchanged for low-income households, while the share decreases significantly in some cases as income rises. The results of the projections are consistent with the other observations and provide a coherent picture. For the period between 2023 and 2028, the share of consumer spending on *housing, energy, housing maintenance* decreases, while it increases in the area of *leisure, entertainment and culture*. Both developments vary in intensity due to the respective share of total consumer spending.

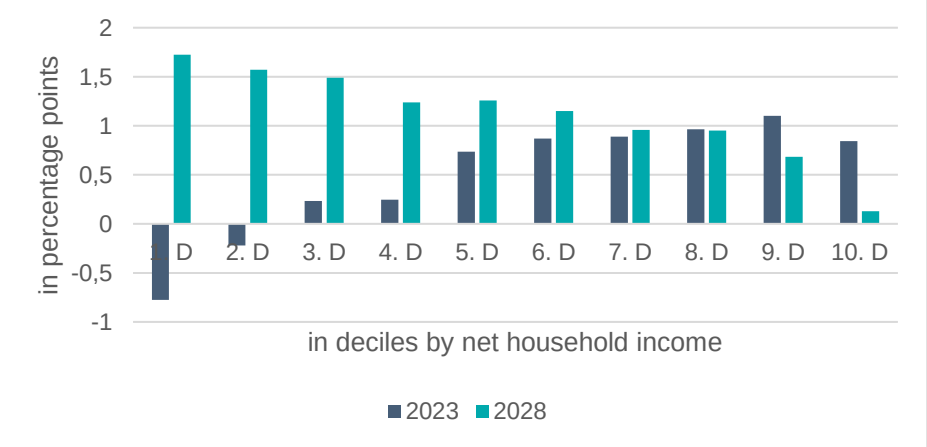
Table 3: Changes in share of private consumer spending selected years – in percentage points

	2018-2023			2023-2028		
	1. Dezil	5. Dezil	10. Dezil	1. Dezil	5. Dezil	10. Dezil
Food, beverages, tobacco products	1,27%	1,23%	1,02%	-0,05%	-0,11%	-0,18%
Apparel and footwear	-0,25%	-0,24%	-0,23%	-0,08%	-0,10%	-0,15%
Housing, Energy, Housing	-0,54%	0,00%	-0,02%	-1,41%	-1,19%	-1,26%
Interior fittings, household	0,12%	0,26%	0,46%	-0,09%	-0,15%	-0,29%
Healthcare	-0,01%	0,04%	0,03%	0,13%	0,21%	0,34%
Transportation	-0,08%	-1,16%	-1,69%	0,37%	-0,30%	-0,16%
Post and telecommunications	-0,40%	-0,25%	-0,14%	-0,01%	-0,01%	-0,01%
Leisure, entertainment and	-0,17%	-0,21%	-0,15%	0,84%	1,28%	1,26%
Education	-0,06%	-0,06%	-0,09%	0,04%	0,04%	0,07%
Restaurants and accommodation	0,27%	0,47%	0,87%	0,14%	0,21%	0,31%
Other goods and services	-0,13%	-0,10%	-0,08%	0,09%	0,08%	0,03%

Source: EVS, QuBe, own calculation and grafic

Figure 12 shows the **changes in the savings rate** for the 10 deciles in 2023 and 2028 and thus provides an "overall" view of the income and expenditure situation of private households. In 2023, the savings rates for the bottom two deciles are negative. From the 3rd decile onwards, the savings rate rises - up to a maximum of around one percentage point in the 9th decile. A different trend in the savings rate can be observed for 2028. The first decile achieves the highest change in the savings rate, while the 10th decile hardly experiences any increase in the savings rate. Both developments are consistent with the observations from Table 3.

Figure 12: Changes in the savings rate - in percentage points



Source: EVS, BEH, QuBe, own calculation and grafic

5. Implications for households in the energy transition

The projection options described allow us to set up different scenarios and compare them with each other - for example, the **impact of the energy transition on private households**. In the following, the results of a base scenario are compared with those of an energy transition scenario. The settings of the QINFORGE model are used as the energy transition scenario; detailed information on the assumptions made can be found in (Zika et al. 2023). As the energy transition is an ongoing transformation process that has already begun, the QINFORGE model already contains assumptions on the energy transition. In order to make the impact of the energy transition on private households visible, assumptions on the energy transition were eliminated from the model. This scenario without energy transition assumptions is described below as the base scenario. The scenario including Energy Transition is the Energy Transition Scenario.

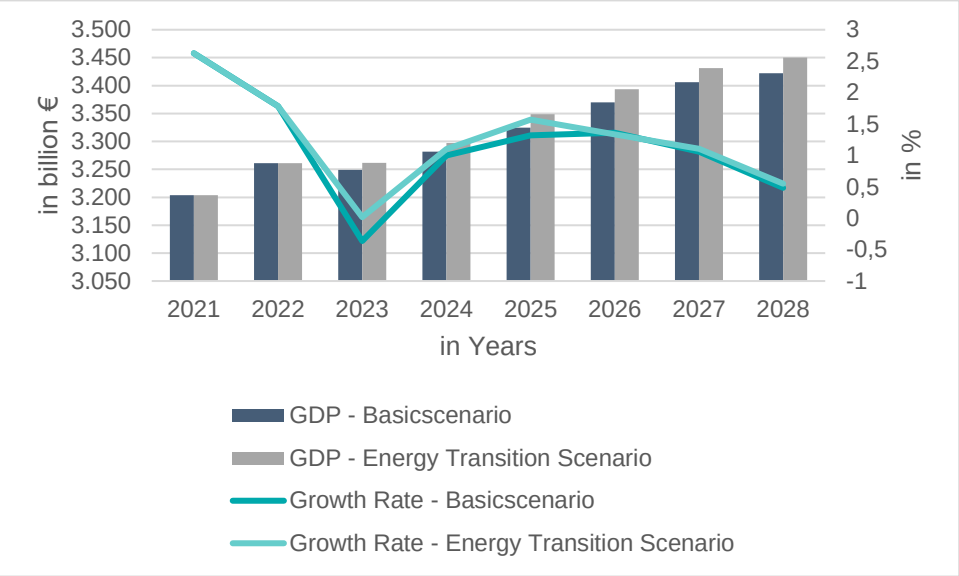
Some of the biggest differences between the two scenarios are:

1. Expansion path of renewable energies
    a. Their electricity generation and costs
    b. Expansion of energy storage systems
    c. Phasing out fossil fuels
2. Building an infrastructure for hydrogen
3. Installation of heat pumps
4. Various assumptions and measures for climate impact adaptation

The QINFORGE model used works with fixed values until 2022, which is why the different settings of the scenarios only take effect from 2023. This is the first reason for the only slight differences between the scenarios in 2023 - the changes only amount to one year. A comparison with the changes up to 2028 should always keep this in mind - time horizons of different lengths are compared (1 year to 2023 and 6 years to 2028). This different time horizon also has an influence on the level of investment assumed in the scenario, the number of heat pumps installed or the current point on the expansion path for renewable energies.

Figure 13 illustrates the **macroeconomic effects** of the assumptions made in the Energy Transition Scenario based on GDP. The economy develops more dynamically in the Energy Transition Scenario, particularly in the first half of the observed period up to 2028. In the second half, the developments converge, but the level remains higher in the ET Scenario. These developments are largely a result of the large investments made.

Figure 13: Scenario Impact on real GDP - absolute and relative values



Source: QuBe, own calculation and grafic

The effects of the scenario settings on the **distribution parameters of the approximate gross pay distribution** are shown in Table 4. Historical data is available up to 2021, so the values correspond to Table 1. The columns in red are a projection and can therefore be compared with Table 2 (the base scenario). Overall, the average wage increases and the percentage gap decreases in comparison with the historical data. In the projection, the number of employees changes only slightly. And the shares of lower gross salaries decline compared to 2021 - between 2023 and 2028, there is also an increase in higher gross salaries at the expense of average gross salaries.

Table 4: Distribution parameters of the approximate gross pay distribution until 2021 based on historical values, thereafter based on projections of the sector-specific development of wages and jobs for employees – Energy Transition scenario

		2013	2018	2021	2023	2028
Median Value	Euro	17849	20347	23665	27505	34140
Mean Value	Euro	27924	30506	32236	35448	44649
... percentage gap		56%	50%	36%	29%	31%
Employees with ...	Quantity	37770	40610	41030	41830	41780
... higher gross salaries:	Quantity	3933	4216	4204	4282	4524
... average gross salaries:	Quantity	17365	19508	20742	21218	20935
... lower gross salaries:	Quantity	16472	16886	16084	16330	16321
Shares						
... higher gross salaries:		10,41%	10,38%	10,25%	10,24%	10,83%
... average gross salaries:		45,98%	48,04%	50,55%	50,72%	50,11%
... lower gross salaries:		43,61%	41,58%	39,20%	39,04%	39,06%

Source: BEH, QuBe, own calculation and grafic

A **comparison of the distribution parameters** in Table 5 shows the positive effects of the energy transition on the gross pay distribution - especially up to 2028. The average

wage is significantly higher than in the base scenario. In addition, there are more employees, and the proportion of lower gross salaries decreases slightly.

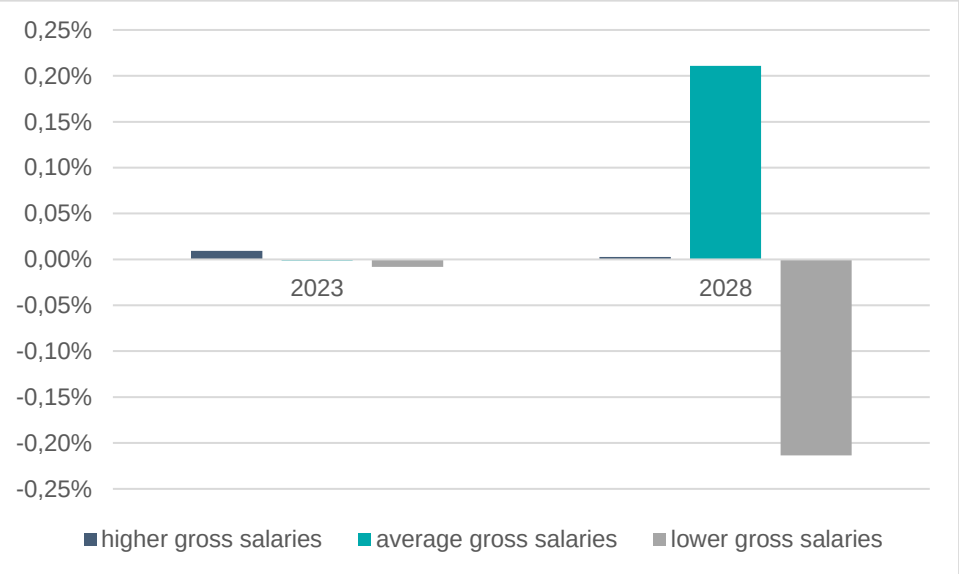
Table 5: Distribution parameters for the Energy Transition scenario – deviations from the baseline projection

		2023	2028
Median Value	Euro/Year	5	459
Mean Value	Euro/Year	42	556
... percentage gap		0	0
Employees with ...	Quantity in 1.000	60	110
... higher gross salaries:	Quantity in 1.000	10	13
... average gross salaries:	Quantity in 1.000	30	143
... lower gross salaries:	Quantity in 1.000	20	-46
Shares			
... higher gross salaries:	In percentage points	0,009%	0,003%
... average gross salaries:	In percentage points	-0,001%	0,211%
... lower gross salaries:	In percentage points	-0,008%	-0,214%

Source: BEH, QuBe, own calculation and grafic

This change can also be seen in Figure 14. Only a small shift can be seen in 2023. In 2028, the influences of the scenarios become stronger and the shift from lower gross salaries to average gross salaries becomes clear.

Figure 14: Shift in shares according to higher, medium and lower gross salaries – deviations from the baseline projection in percentage points

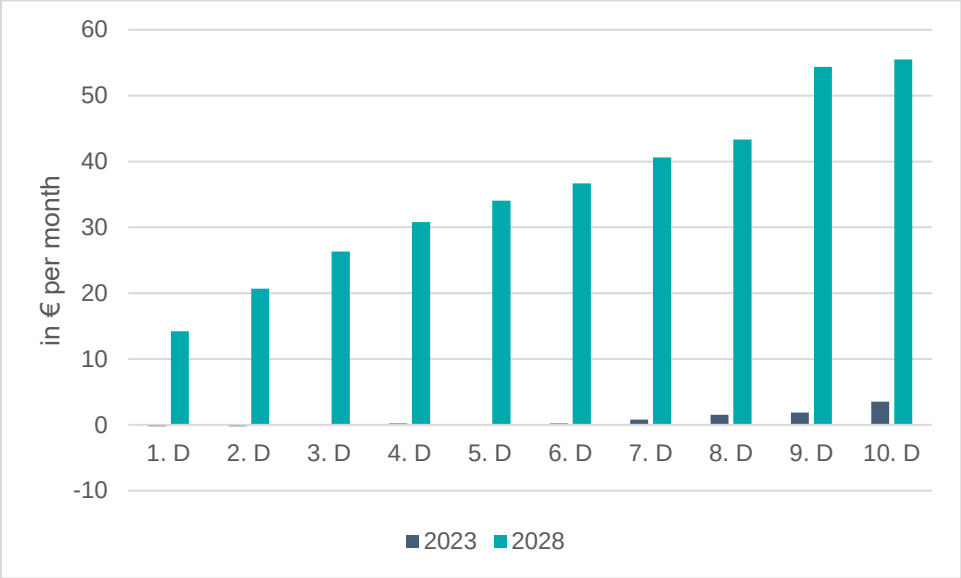


Source: BEH, QuBe, own calculation and grafic

Turning now to the **consequences for private household consumption expenditure**. Figure 15 shows the difference in private consumption expenditure for the years 2023 and 2028 compared to the baseline scenario. Here, too, the picture is consistent. For the year 2023, hardly any changes can be seen compared to the baseline scenario. By

contrast, significant increases in monthly expenditure can be seen for the second point in time.

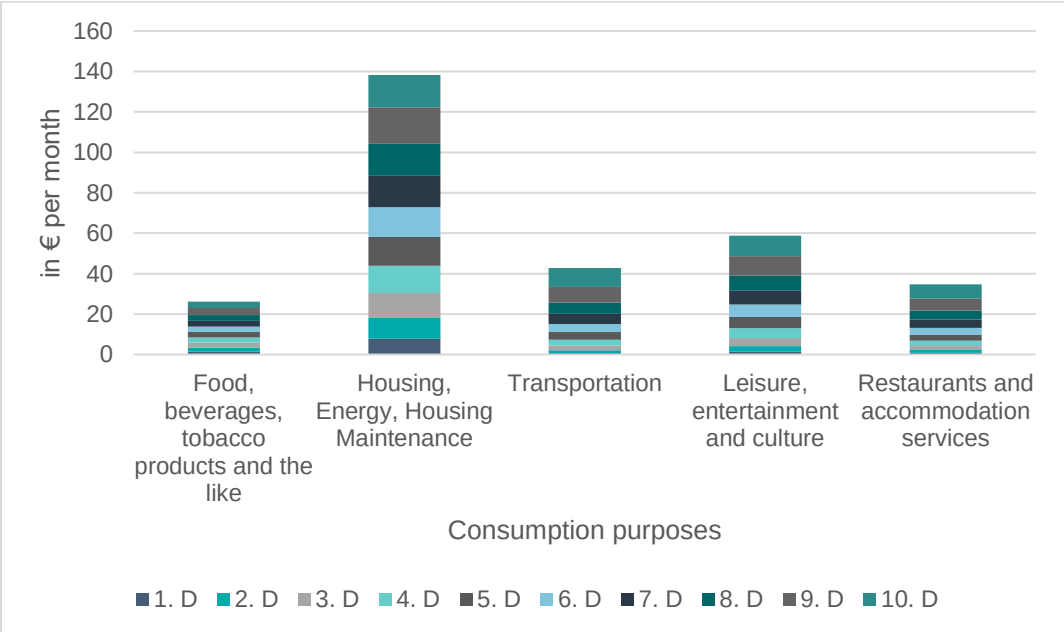
Figure 15: Effects of the scenario on private consumption expenditure



Source: EVS, QuBe, own calculation and grafic

Figure 16 breaks down the areas of private consumption in which the additional expenditure is made compared to the baseline scenario. For the reasons of clarity, the top 5 with the greatest changes are shown here. In an energy transition scenario, the changes in expenditure in the areas of *housing, energy, housing maintenance* and *transportation* are hardly surprising. The remaining 3 consumption purposes and their sectors benefit from the higher incomes shown in Table 3, so private households gain more flexibility for spending in other areas.

Figure 16: Top 5 biggest changes in consumption purposes compared to the baseline scenario

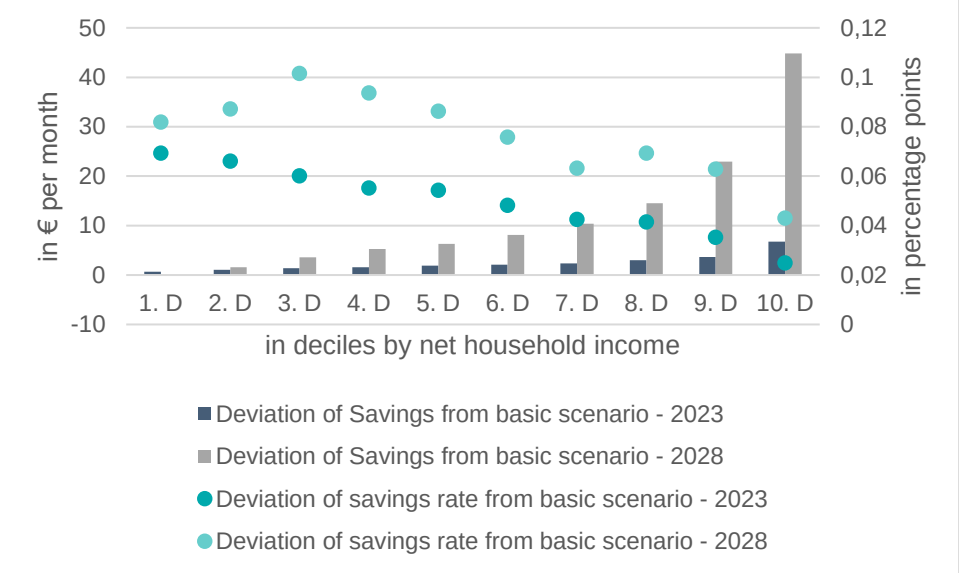


Source: EVS, QuBe, own calculation and grafic

To visualize the two - partly counteracting - trends in income and expenditure, Figure 17 shows the development of savings for the two scenarios and the change in the savings rate for the years 2023 and 2028 in comparison. An analysis of savings is suitable as it is formed as the result of income minus expenditure and as the savings rate is also set in relation to the income available for expenditure. This makes the absolute and relative changes between the deciles visible.

Increases in savings and the savings rate can be seen in both comparisons. In addition, the forecast effects in 2028 are also significantly greater in this illustration than in 2023. This is consistent with previous findings.

Figure 17: Scenario Impact on savings - absolute values and difference in percentage points



Source: EVS, BEH, QuBe, own calculation and grafic

6. Conclusion

The presented modeling, which represents a **first step towards a more detailed integration of gross wage formation and distribution as well as their consequences for consumption** and thus indirectly for industries and jobs, shows that such a link is possible and can contribute new explanatory patterns for structural change by industry. However, the work is still in its infancy. The gross pay distribution does not yet take into account the change in intra-industry-specific changes in pay distribution. The transition from gross pay distribution to gross income in the EVS needs to be further improved. It should also be examined whether other data sources, such as the microcensus, which also records households and income, can support the transition.

But there is still more construction work to be done:

a) A projection of **household figures** according to their size must be modeled as accurately as possible in order to take account of the resulting changes in income and consumption

b) The **feedback flow** of consumption developments into the QINFORGE model described in chapter 2, so that not only can it have an impact on the consumption model, but it can also provide its own input

c) Particularly in the area of energy transition, it is necessary to take as **detailed a regional analysis** as possible. The required wind turbines are primarily installed in windy regions, while PV systems are installed in sunny areas. These distributions are often not congruent and therefore affect different regions and the populations living there to varying degrees.

An initial scenario calculation on the topic of energy transition did not lead to any unexpected or counterintuitive results. At least the direction of impact of the results is in line with expectations. However, caution is required, at least with regard to the magnitude of the results, particularly when progressing along the time axis. The lack of feedback from the consumption module becomes increasingly significant here.

Nevertheless, a cautious look at the scenario results is warranted. Compared to the baseline scenario, GDP has developed better - largely due to higher investments. A look at households reveals differences, particularly in 2028. Average wages rise and the number of employees on lower gross salaries declines. In turn, the higher wages have had a positive impact on the level of private consumption expenditure in the consumption module. The highest additional expenditure was in the areas of housing, energy, housing maintenance, leisure, entertainment and culture and transportation. Overall, the impact on savings also developed positively.

Clear differences between the scenarios have already been shown - particularly from 2028 onwards. A feedback of the changed consumption structure to the sectors seems particularly important for longer periods of time and should also improve the validity of the forecast in the context of the impact on private households.

The two - partly counteracting - trends in the income/expenditure situation of private households have also underlined the relevance of this consumption module. The consequences of political decisions or macroeconomic developments always affect households and change their options and decisions. It is not uncommon for the expenditure and income sides to influence or depend on each other. In order to do proper justice to this complexity, empirical modeling is required so that impacts can also be projected at the household level in as differentiated and focused a manner as possible.

7. Bibliography

Bönke, T., Dany-Knedlik, G. & Pagenhardt, L.: Neues DIW-Modell kann Einkommensverteilung am aktuellen Rand vorhersagen – Ungleichheit dürfte in diesem Jahr leicht zunehmen. In: DIW Wochenbericht, 24 / 2023, S. 326–332.

Büttner, T. & Rässler, S. (2008): Multiple imputation of right-censored wages in the German IAB employment sample considering heteroscedasticity. Hg. v. Institut für Arbeitsmarkt- und Berufsforschung (IAB). Discussion Paper 44, Nürnberg.

Institut für Arbeitsmarkt- und Berufsforschung (IAB) (2021): IAB-Beschäftigtenhistorik (BeH) – V10.06.00-202012, Nürnberg, 22 S. Institut für Arbeitsmarkt- und Berufsforschung (IAB), Nürnberg.

Niehues, J. & Stockhausen, M.: Die Mittelschicht im Fokus - Abgrenzung, Entwicklung und Mibilität. In: IW-Trends, 49. Jg. Nr. 2, S. 27–53.

Plassenberg, J., Zika, G. & Wolter, M. I. (2023): Vom Bruttoentgelt zum Konsum privater Haushalte – Private Haushalte im Rahmen des QuBe-Projektes – ein neuer Ansatz. Hg. v. Gesellschaft für Wirtschaftliche Strukturforschung (GWS), Osnabrück. https://papers.gws-os.com/gws-paper24-1.pdf, abgerufen am 20.02.2024.

Zika, G., Hummel, M., Maier, T. & Wolter, M. I. (2023): Das QuBe-Projekt: Modelle, Module, Methoden. Hg. v. Institut für Arbeitsmarkt- und Berufsforschung (IAB). IAB-Bibliothek 374, Nürnberg. https://www.wbv.de/shop/openaccess-download/I73712, abgerufen am 26.10.2023.