Distributional Wealth Accounts for households in Germany – results and use cases

Previously, it was not possible to describe the wealth distribution of households in Germany at the level of individual households on a quarterly basis. Now, however, the Distributional Wealth Accounts (DWA) represent a new provisional dataset that combines two data perspectives: namely, they link the Bundesbank's Panel on Household Finances (PHF) with the national accounts statistics. The DWA thus incorporate the distributional information from the household survey and simultaneously reflect the quarterly dynamics and levels of the national accounts statistics in a consistent manner.

According to the DWA, wealth inequality has declined in recent years. One reason for this is that net wealth has grown particularly strongly for households in the bottom half of the distribution of wealth, albeit from a low level. These less wealthy households have accumulated a significant volume of low-risk assets, such as deposits and insurance claims, and at the same time considerably reduced their debt. Another reason for decreasing inequality is that households in the upper mid-range of the distribution benefited noticeably from the rising value of their housing wealth. Furthermore, the DWA reveal considerable heterogeneity in the composition of households' wealth. In the less wealthy half of the distribution, this wealth consists almost exclusively of low-risk assets. By contrast, the wealth structure of more wealthy households includes a much greater volume of capital market instruments and, above all, housing and business wealth.

As housing wealth, in particular, generated a high return alongside shares, the average real return on assets from 2009 to the beginning of 2022 was significantly higher in the top half of the wealth distribution than in the bottom half. In this connection, the results also show that the yield-lowering effect of inflation is especially noticeable at the lower tail of the wealth distribution. As these households chiefly hold low-yielding assets, high inflation rates consequently lead to negative real returns on their wealth in particular.

The dataset presented here is also likely to become more relevant to monetary policy in future. Multiple studies show that heterogeneity among households can affect the transmission of monetary policy. Thus, the way in which monetary policy measures work is also likely to depend on the distribution and structure of wealth. When assessing the impact of such measures, then, it generally makes sense to bear in mind the financial differences between households. It is precisely against this backdrop that the future provision of the DWA would appear to be particularly helpful for a central bank.

Introduction

DWA link microdata with national accounts statistics

With the Distributional Wealth Accounts (DWA) for households in Germany, there now exists a new provisional dataset that merges two different sources of information by linking the data from the Bundesbank's Panel on Household Finances (PHF) with the quarterly data from the national accounts statistics. These DWA enable analyses to be carried out at the level of individual households. In concrete terms, this means that decisive statements can be made on wealth and debt developments along the wealth distribution. Since the effectiveness of monetary and economic policy measures depends, amongst other things, on the distribution and structure of wealth and any potential associated balance sheet constraints, the provision of distributional statistics such as these seems particularly helpful for central banks. The dataset is still in the development phase, but significant progress has already been made. Potential adjustments as the process continues cannot be ruled out.

Key analytical findings reveal heterogeneous developments that usually remain hidden in macrodata

This article starts by providing an overview of the process of creating the DWA for households in Germany. In addition, it analyses the development of the distribution of wealth since 2009 in a stylised form. It goes on to determine portfolio returns at the individual household level and to analyse their development over time using the DWA. Finally, economic policy conclusions are drawn. The overall findings are as follows:

- The DWA provide higher-frequency and comparatively timely data on the distribution of various assets and liabilities across households in Germany.

- According to the DWA, wealth inequality has decreased since around 2014. This is due, for one thing, to the fact that aside from building up their financial assets substantially, the bottom half of the wealth distribution reduced their debt to a significant extent, thus contributing to an increase in net wealth. For another, the upper mid-range of the distribution benefited perceptibly from an increase in the value of housing wealth.

- The data from the DWA also indicate that there are significant differences in the composition of households' wealth along the wealth distribution. For example, the assets held by households in the bottom half of the distribution consist almost exclusively of low-risk forms of investment, such as deposits and insurance claims. By contrast, the wealth structure of more wealthy households includes a much greater volume of capital market instruments and, above all, housing and business wealth.

- The interaction between the different wealth structures and the varying returns on the individual asset types is reflected in noticeable differences in the level of the return on total assets along the wealth distribution. As housing wealth, in particular, generated a high return alongside shares, the average real return on assets from 2009 to the beginning of 2022 was significantly higher in the top half of the wealth distribution than in the bottom half.

Distributional wealth accounts for households in Germany: some stylised results

Quarterly DWA …

The DWA are characterised by the fact that they combine distributional information with the national accounts statistics in a consistent manner and make this available on a quarterly basis. Two sets of statistics are of key importance when compiling the DWA. First, the data from the Bundesbank's PHF study are considered. In this study, individual households in Germany are asked about their wealth and

their debt.[1] Second, data from the national accounts statistics are incorporated. The national accounts statistics describe the total wealth and wealth structure of the institutional sectors as a whole – i.e. also for the entire household sector in Germany. They include non-financial assets as determined by the Federal Statistical Office and the data on financial assets and liabilities compiled by the Bundesbank. However, the national accounts statistics do not allow for any statements to be made about the distribution of wealth. By contrast, the data from the PHF study provide very detailed information at the level of individual households, albeit only at intervals of around three years. In turn, the national accounts statistics predominantly record aggregate household wealth on a quarterly basis.[2]

… close the gap in wealth reporting between aggregated microdata and national accounts statistics …

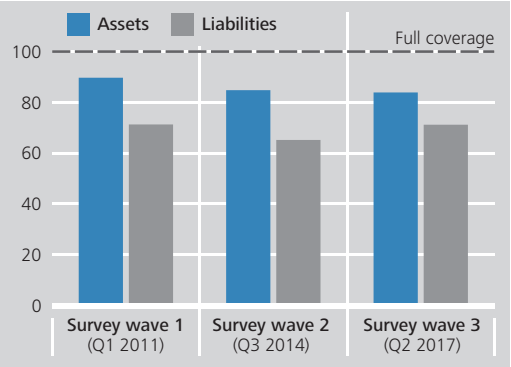
Although both sets of statistics are compiled with the same aim in mind – that is, to describe the wealth situation of German households – there is a considerable gap in wealth reporting between the aggregated microdata of the PHF study (extrapolated) and the national accounts statistics (for more on this, see the adjacent chart). A key contributing factor here is the inadequate coverage of very wealthy households in the PHF study. Against this backdrop, experts from the European System of Central Banks collaborating in various expert groups have, since 2015, endeavoured to link the data from household surveys with the national accounts statistics for the household sector within a consistent analytical framework, thereby closing the data gaps (see also the box on pp. 18 ff.).[3]

… and consistently reflect dynamics and levels of the national accounts statistics

Ultimately, the provisional dataset resulting from the work of the expert groups contains valuable information from both sets of statistics: it takes into account the distributional information from the household wealth survey at the individual household level, as well as the quarterly dynamics and levels of the national accounts statistics for the period since 2009. In this context, the DWA record level data on the basis of various wealth groupings for the following types of assets and liabilities: deposits, debt securities, listed shares, investment funds, insurance claims, financial and non-financial business wealth, housing wealth and liabilities in the form of mortgages and other debt.[4] Financial business wealth includes equity investments, i.e. unlisted shares and other equity. Non-financial business wealth, on the other hand, chiefly consists of the non-financial assets of sole proprietors such as self-employed persons and freelancers.[5] The net wealth of a household is ultimately calculated as the difference between total assets and liabilities (see also the chart on p. 21).

Coverage of assets in the Panel on Household Finances*

As a percentage of national accounts statistics



Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations. * Aggregated data from the Panel on Household Finances (PHF).
Deutsche Bundesbank

1 With its Panel on Household Finances (PHF), the Bundesbank's Research Centre is able to capture the situation of households in Germany. On average, data for around 4,000 households are available for each of the three existing survey waves of the PHF. These data make it possible to analyse a multitude of topics: income and wealth distribution, property ownership, saving behaviour and provision for old age, jobs, and family. In addition, the PHF data feed into the Household Finance and Consumption Survey, a study conducted by the Eurosystem central banks, and thus play a key role at not only the national but also the European level.
2 Data on non-financial assets are usually only available at the annual level.
3 See European Central Bank (2020).
4 Insurance claims essentially refer to voluntary pensions, as they primarily comprise life insurance and annuity entitlements. Other debt constitutes all loans other than mortgages, such as consumer loans.
5 Owing to their legal form, these sole proprietors are to be assigned to the household sector.

Methodological aspects in compiling Distributional Wealth Accounts for households in Germany

There are currently two key sets of Bundesbank statistics which provide information on the wealth situation of households in Germany. First, there is the Panel on Household Finances (PHF), which gives detailed information on the individual wealth and debt situation of the households surveyed. Second, the national accounts statistics provide aggregate information on the amount and structure of wealth of the entire household sector. As both sets of statistics focus on household wealth in Germany, it might initially be assumed that they provide similar aggregate wealth figures. However, a simplified comparison of the data from the wealth survey and the national accounts statistics reveals significant differences (see also the chart below). An expert group within the European System of Central Banks (ESCB) identified two main sets of factors that explain these differences.[1]

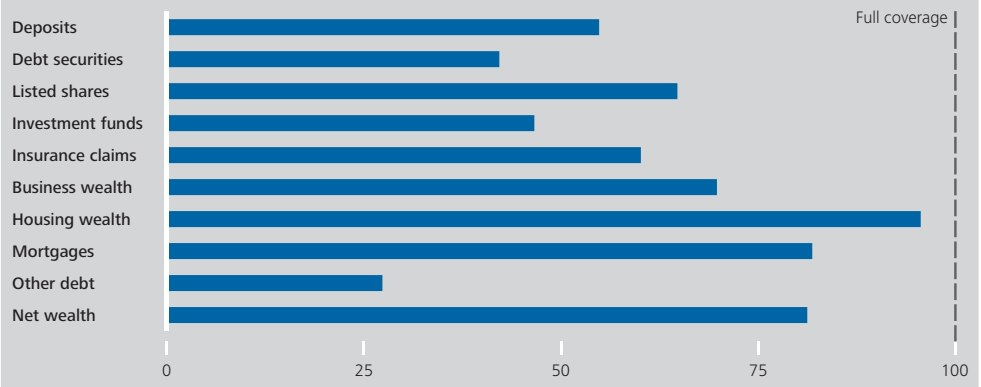
The first set of factors mainly concerns conceptual and methodological differences. These can potentially relate to individual or all components of wealth, and include differences in the definition of the population or periodicity and timeliness of the statistics. However, differing valuation concepts between the two sets of statistics are also a decisive factor. For example, the survey data typically reflect household self-evaluations of different assets and liabilities, whereas the national accounts statistics primarily measure assets on the basis of market values. Finally, when comparing the data, it should be borne in mind that wealthy households are typically underrepresented in the realised samples of the wealth survey.

The second set of factors relates to instrument-specific differences, which are mainly due to divergent definitions. In order to take account of these conceptual differences in particular, the Distributional Wealth Accounts include only those wealth com-

1 In December 2015, the Expert Group on Linking Macro and Micro Data for the household sector (EG-LMM) was established within the ESCB with the aim of analysing the comparability of data from the household wealth survey and the national accounts statistics. Based on these results, the expert group which succeeded it (Expert Group on Distributional Financial Accounts) was then tasked with developing a procedure for the compilation of the Distributional Wealth Accounts.

Instrument-specific coverage of the Panel on Household Finances*

As a percentage of national accounts statistics



Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations. * Aggregated data from the Panel on Household Finances (wave 2).

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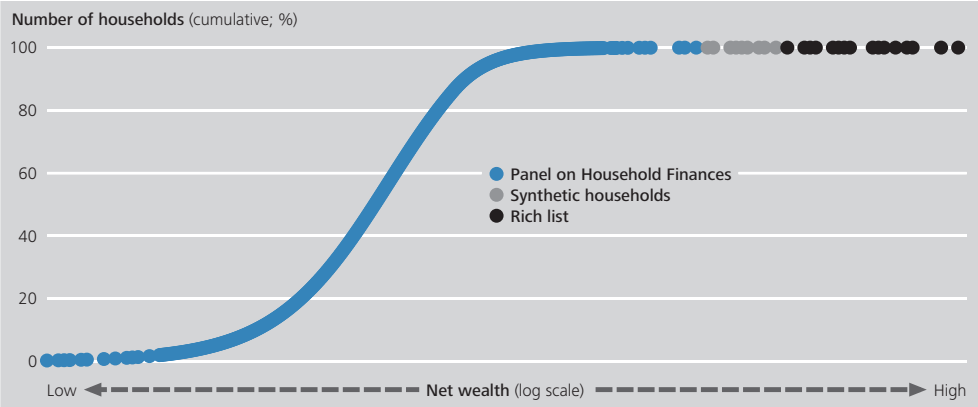
Stylised wealth distribution*



* Data from the Panel on Household Finances augmented by missing wealthy households.
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ponents which are sufficiently comparable between the two sets of statistics. They do not, however, include those wealth positions that are only recorded in one of the two sources, such as "non-life insurance reserves", which only form part of the financial accounts. They also exclude assets which have a low degree of comparability owing to significant differences in how they are defined. These include occupational pensions, financial derivatives and other accounts receivable/payable. Ultimately, this approach results in a definition of wealth which – as measured by the national accounts statistics – covers around 90% of households' total assets.[2]

Despite using an adjusted concept of wealth, when it comes to net wealth there is still a notable gap between the aggregate of the household survey and the corresponding data from the national accounts statistics. On average, the net wealth recorded in the household survey over the three PHF waves is around €2,000 billion (20%) lower than the level in the national accounts statistics. A major contributing factor here is the absence of very wealthy households in the PHF, which continues to present a great challenge.[3] For one thing, only a small number of high-net-worth households are represented in the population. For another, willingness to participate in surveys decreases as net wealth increases.[4]

An advanced approach was developed to close the data gap for this population group

2 It should be noted here that for financial business wealth (sub-component of total business wealth), the corresponding level in the financial accounts (sum of unlisted shares and other equity held) appears to be recorded only incompletely. Stylised back-of-an-envelope calculations indicate that unlisted shares and other equity issued by non-financial corporations in Germany are underreported in the financial accounts. Accordingly, the reported volume for these two instruments is likely to be around €1,250 billion too low overall. Thus, when compiling the Distributional Wealth Accounts, an appropriately corrected level in the financial accounts is used. It is estimated that around 90% of German enterprises are family-owned (see Foundation for Family Businesses (2019)). Assuming that most of the aforementioned liabilities are held by households, this would imply a correction factor of 4.8 for households' holdings in 2017 with regard to these two wealth components. To obtain a time series for the correction factor, it is also assumed that the original stock was largely recorded correctly in 1991, implying a correction factor of 1. On the basis of these two data points, a time series for the correction factor can be computed using linear interpolation/extrapolation. Finally, multiplying the raw figure from the financial accounts by this time series yields an appropriately corrected value. For more on the underreporting of aggregate business wealth, see also Albers et al. (2020).
3 See European Central Bank (2020).
4 See, for example, Westermeier and Grabka (2015). It should be noted, however, that the Socio-Economic Panel (SOEP) was able to significantly improve the data situation in this area of the net wealth distribution by means of a new additional sample (SOEP-P) concerned with high wealth (see Schröder et al. (2020)).

as much as possible. The idea behind this approach is to add the absent very wealthy households to the original household survey dataset using a "rich list".[5] The observations on net wealth from this list supplement the PHF dataset. Since these data only take into account the top tail of the net wealth distribution, synthetic wealthy households are also estimated which then supplement the original PHF dataset as well. The net wealth of these synthetic households lies between that of the members of the rich list and the wealthiest households included in the wealth survey (see also the chart on p. 19).[6]

As the data on the added wealthy households all relate to net wealth, further adjustments are needed at the level of the individual wealth components in order to close the data gaps. The bulk of the gap in liabilities is attributed to very wealthy households. This allocation is based on two assumptions: first, that very wealthy households have access to generally large-volume credit contracts; and, second, that the liabilities of comparatively less wealthy households are adequately captured in the PHF.[7] Now that data on liabilities are available alongside net wealth, the level of gross wealth can be determined. The composition of gross wealth is based on the results of an additional SOEP-P sample and the 2018 Global Family Office Report.[8] This composition is ultimately assigned to very wealthy households as an initial portfolio structure.[9] In the event that the added households now hold certain assets on a larger scale than suggested by the data gaps, further adjustments are made. In concrete terms, this means that excess holdings are spread across comparable assets which are still underreported.[10] The portfolios of the synthetic households and rich list households generated in this way thus complement the original data from the wealth survey. It is shown that simply by adding the very wealthy households that have so far been absent from the data, the underreporting when it comes to total net wealth can be reduced by more than 50% on average.[11] The remaining data gaps are finally closed by means of proportional allocation, whereby each household is allocated part of the remaining data gap according to its share in the instrument-specific volume re-

5 Specifically, data provided by "manager magazin" on the net wealth of the wealthiest Germans in 2011, 2014 and 2017 are used.
6 This is done under the assumption that the wealth of very affluent households follows a Pareto distribution. The Pareto distribution is estimated on the basis of the PHF households whose net wealth exceeds €1 million and the wealth data from the rich list. Using this estimated distribution, synthetic households which lie in the unobserved range are then randomly drawn and added with a corresponding level of net wealth. For more on the approximation of the wealth distribution using Pareto distribution in the high-wealth range, see, inter alia, Vermeulen (2018) and the sources cited therein, as well as Waltl and Chakraborty (2022).
7 Liabilities are allocated to very wealthy households proportionally to net wealth, subject to the constraint that the later structure of gross wealth essentially matches the portfolio structure of millionaires in the SOEP-P. For more on the wealth structure in the SOEP-P, see Schröder et al. (2020).
8 See Schröder et al. (2020) and UBS/Campden Research (2018).
9 According to UBS/Campden Research (2018), the following portfolio structure is assumed: deposits (7.0%), debt securities (16.2%), listed shares (28.0%), investment funds (5.7%), financial business wealth (21.6%), housing wealth (18.1%), non-financial business wealth (3.4%). Taking into account the SOEP-P data, the portfolio shares of housing wealth and total business wealth are adjusted to 20% and 60% respectively. The remaining portfolio shares are rescaled accordingly, so that the sum of all shares equals 100%. This ultimately produces an initial portfolio composition which essentially reflects the results of the SOEP-P and serves as a benchmark.
10 Thus, for example, excess holdings of debt securities are distributed equally across investment funds and insurance claims. This reflects the fact that households can invest in debt securities indirectly via investment funds and life insurance. Similarly, excess holdings of listed shares are assigned to business wealth as well as to investment funds and insurance claims. Finally, excess holdings of housing wealth are distributed among shares, business wealth, investment funds and insurance claims.
11 Given average aggregate net wealth of around €10 trillion recorded across all three existing PHF survey waves, the data gap amounts to an average of roughly €2 trillion. By adding synthetically produced households to the original data from the household survey, this gap can be closed by an average of more than 50%.

corded so far.[12] This leads to an instrument-specific increase in holdings across all households, which ultimately enables full alignment of the wealth survey with the national accounts statistics.

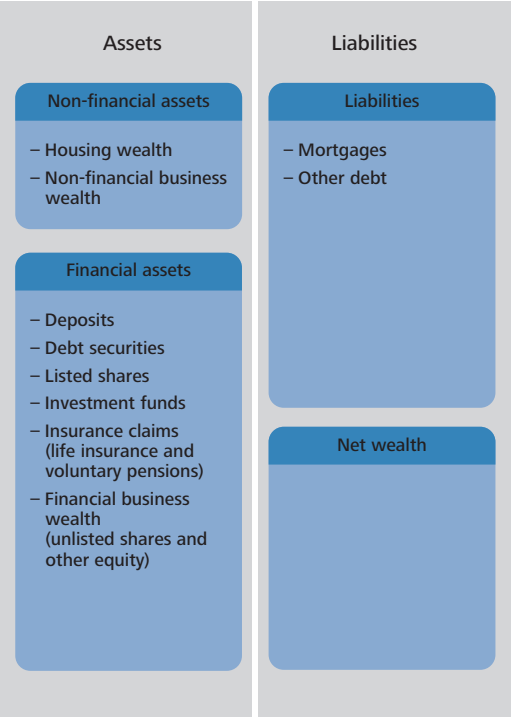
After linking the three existing PHF survey waves to the relevant data from the national accounts statistics, interpolation and extrapolation are used in the final step to translate the dynamics from the national accounts statistics to the individual households. The resulting dataset therefore consistently takes into account not only the distributional information from the wealth survey but also fully includes the levels and the quarterly dynamics of the national accounts statistics for the period since 2009.[13] Finally, however, it should be noted that the data at the current end, in particular, are subject to some degree of uncertainty owing to the extrapolation process. In this context, the extrapolation of the individual household data after the last available PHF survey wave from 2017 implicitly assumes that the saving and investment behaviour of households observed up to that point has not fundamentally changed. This simplifying assumption can be problematic, as crisis situations such as the coronavirus pandemic can, in principle, permanently change households' motives for saving and thus also their saving and investment behaviour.[14]

12 In this context, the advantage of proportional allocation is that, at the instrument level, it does not skew the distributional information generated up to that point in any specific direction but leaves it unchanged. **13** On average, data for around 4,000 households are available for the three existing PHF surveys. In addition, there are another 3,000 very wealthy households which are artificially generated on the basis of an estimated Pareto distribution in order to correct the underreporting at the top tail of the wealth distribution. **14** See, for example, Ercolani et al. (2021).

Breakdown of household groupings along net wealth distribution …

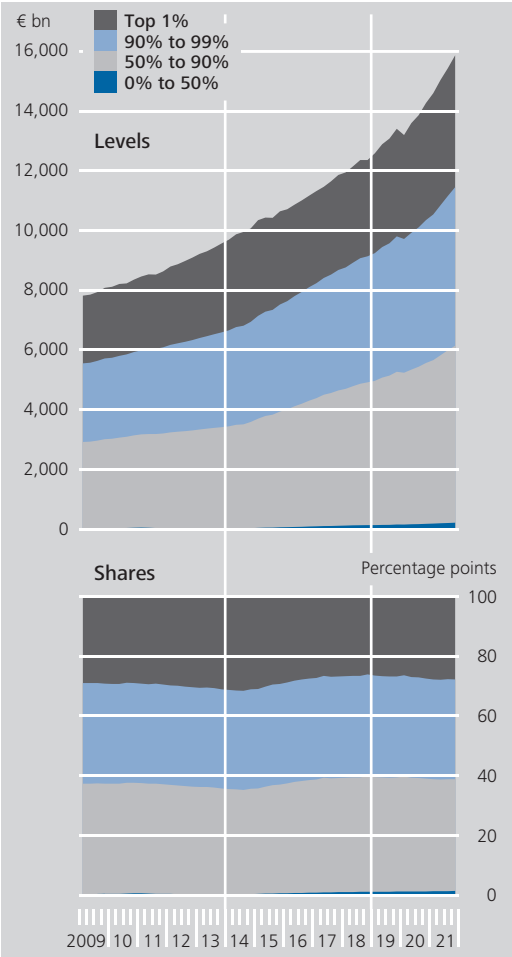
The chart on p. 22 shows the respective level of net wealth and the share in total net wealth for different groupings of households along the net wealth distribution. Specifically, the respective aggregate net wealth of four wealth groupings is considered: the top 1% of the wealth distribution, the next 9% of the distribution (90% to 99%), the 40% after that (50% to 90%) and the bottom half of the wealth distribution (0% to 50%). The DWA for the household sector show a high level of overall wealth inequality, although this has declined slightly over the duration of the dataset (from 2009 onwards, in other words). While the top 10% of the wealth distribution held more than 50% of German households' total net wealth over the observation period, the bottom half of the wealth distribution accounted for an extremely small share, averaging 0.6%. However, the distribution has shifted slightly in favour of the bottom half of the distribution over the observation period. The share of total net wealth held by the less wealthy 50% of households

Balance sheet of a household – a stylised overview



Source: Experimental Distributional Wealth Accounts (DWA). Deutsche Bundesbank

Net wealth distribution*



Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations. * Wealth groupings based on net wealth distribution: the top 1% of the wealth distribution, the next 9% of the distribution (90% to 99%), the 40% after that (50% to 90%) and the bottom half of the wealth distribution (0% to 50%).
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rose from 0.2% in 2009 to more than 1.2% in 2021.[6]

… reveals unequal wealth developments …

Against this backdrop, the chart on p. 25 shows average quarterly growth and the contributions to growth of major asset categories for the four different groupings of households. For the purpose of clarity, a distinction is made here between the financial portfolio, business wealth, housing wealth, and liabilities.[7] The aggregate net wealth of households in Germany has grown by an average of around 1.3% per quarter since 2009. This growth has been particularly strong for the bottom half of the distribution, albeit starting from a low level. In this context, households in the bottom half of the distribution have accumulated a significant volume of low-risk assets, such as deposits and insurance claims, in their financial portfolio, whilst at the same time markedly reducing their liabilities. The upper mid-range of the distribution, on the other hand, has benefited comparatively strongly from the increased value of housing wealth. One reason for this is that less wealthy households rarely own real estate. Another reason is that housing wealth accounts for a much smaller share of very wealthy households' total assets. The increases in house prices observed in recent years have therefore probably tended to have a balancing effect on the net wealth distribution, taken in isolation.[8] Finally, the growth in net wealth seen in the top 1% of the distribution is mainly attributable to increases in business wealth. The high share of growth accounted for by this asset type at the top tail of the distribution also reflects the increased importance of corporate savings in the wealth development of very wealthy households in recent decades. Although these are typically retained corporate profits, they are ultimately attributable to shareholders.[9]

… accompanied by discernible differences in wealth structure

The divergent developments in net wealth are due, amongst other things, to unequally distributed asset types, which are reflected in discernible differences in the wealth structure along the wealth distribution. Similar differences can also be identified in the euro area and in the United States (see also the box on pp. 23 ff.). Looking at the average structure of total wealth (gross) for the four wealth groupings between 2009 and 2021, it can be seen that the financial portfolio, in particular, dominates the asset structure of the bottom half of

6 In a longer-term context, however, a rise in inequality can be seen. For example, calculated in real terms (i.e. with all assets adjusted for purchasing power), the share of total net wealth accounted for by the bottom 50% of the distribution declined from more than 5% to less than 3% in the period between 1993 and 2018, thus almost halving. For more information, see Albers et al. (2020).
7 The financial portfolio comprises deposits, debt securities, listed shares, investment funds and insurance claims.
8 See also Adam and Tzamourani (2016).
9 See also Bauluz et al. (2022) and Mian et al. (2020).

Net wealth distribution and portfolio structure of households in Germany by international standards

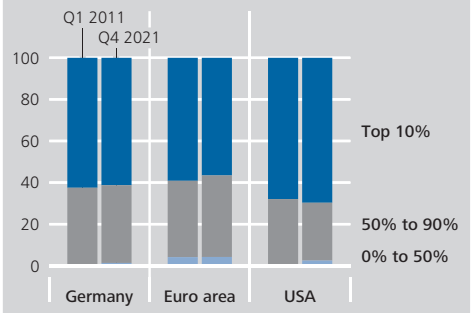
We will examine below how the net wealth distribution and portfolio structure of households in Germany compare with other countries, using the euro area (including Germany) and the United States as benchmarks. The dataset for the euro area is identical to that for Germany in terms of the definition of instruments. However, at the upper tail of the distribution, only values for the top 10% are available. In the German data, the wealth groupings "top 1%" and "next 9%" are consolidated accordingly. The figures for the United States are consolidated in the same manner. In addition, the data for the United States differ, in some cases considerably, from the German and euro area-wide figures regarding the definition of instruments. As a result, the portfolio breaks down into only three larger categories, where comparability is better than in the granular analysis: housing wealth, equity and business wealth (including investment funds), and other financial assets, defined here as the difference between total assets and the other two categories. It consists, in particular, of deposits and claims on insurance corporations.

Net wealth is distributed more unevenly in Germany than in the euro area, but is less concentrated than in the United States (see the adjacent chart).[1] According to this, the percentage share of the wealthiest 10% of households at the end of 2021 was somewhat smaller in the euro area than in Germany, but was noticeably higher in the United States. The share of the next 40% in Germany is roughly as high as in the euro area, but much larger than in the United States. In Germany, the share of the less wealthy 50% of households in total net wealth was around as small as in the United States. In the euro area, however, this share is noticeably higher. The net wealth distribution in Germany has changed only slightly compared with the first quarter of 2011. In the euro area, it has shifted from the top 10% of the distribution to the next 40%. In the United States, by contrast, the next 40% surrendered wealth shares to both the top 10% and the bottom 50% of the net wealth distribution.

The distribution of various wealth components between wealth groupings varies only marginally (see the upper chart on p. 24), with almost all housing wealth split halfway between the top 10% and the next 40% of the distribution. Equity and business wealth is almost exclusively owned by the top 10% of the distribution. German households stand out by comparison in terms of the distribution of other financial assets. Almost half of these are held by those households

Distribution of aggregate net wealth*

As a percentage of total



Sources: Experimental Distributional Wealth Accounts (DWA), ECB, Federal Reserve Board and Bundesbank calculations. * Wealth groupings based on net wealth distribution: the top 10% of the distribution of wealth (top 10%), the subsequent 40% (50% to 90%) and the bottom half of the distribution of wealth (0% to 50%).

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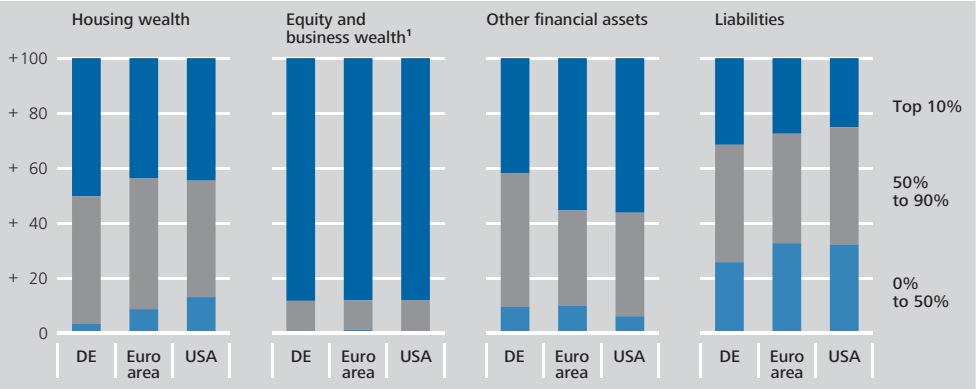
1 For an international comparison of wealth inequality, see Balestra and Tonkin (2018) and Zucman (2019). Kuhn et al. (2020) provide a long-term assessment of developments in the United States.

Distribution of assets and liabilities

As a percentage of total, Q4 2021



Sources: Experimental Distributional Wealth Accounts (DWA), ECB, Federal Reserve Board and Bundesbank calculations. **1** Including investment funds.

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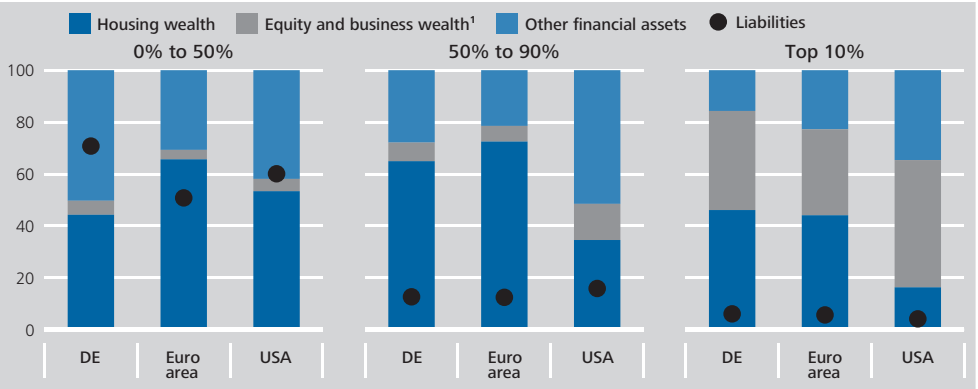
at the upper midpoint of the distribution. In the euro area and the United States, by contrast, the figure is just over one-third. The top 10% of the distribution in Germany hold a significantly smaller share, comparatively speaking. Liabilities, however, are distributed more evenly across the three wealth groupings. Owing to the uneven distribution of assets, this is reflected in significant differences in net wealth.

On the other hand, portfolio composition varies quite significantly across wealth groupings (see the chart below). In comparison with housing wealth, equity and business wealth are much more important in the top 10% of the distribution in the United States than in Germany and the euro area. By contrast, housing wealth plays a considerably smaller role. This means that the top 10% of wealth distribution in the United States is highly exposed to changes in corporate valuations. By comparison, their counterparts in Germany and the euro area are exposed, in particular, to house price swings. With regard to the next 40%, housing wealth, which accounts for just over two-thirds of the overall portfolio, is

Asset structure and liabilities of the aggregated wealth groupings

As a percentage of total assets, Q4 2021



Sources: Experimental Distributional Wealth Accounts (DWA), ECB, Federal Reserve Board and Bundesbank calculations. **1** Including investment funds.

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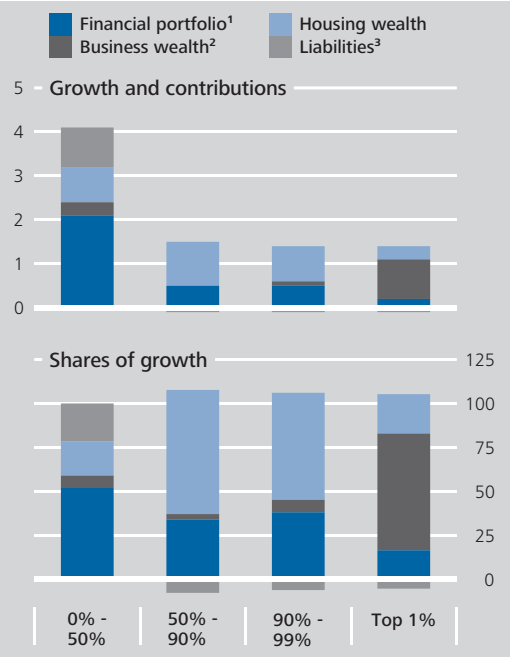
significantly more important in Germany and the euro area than in the United States, where housing wealth makes up only just over one-third. By contrast, for the next 40% of the distribution in the United States, other financial assets, especially in the form of pensions, account for around one-half of total assets. In Germany and the euro area, on the other hand, the share is only just over one-quarter. The portfolios of the less wealthy 50% of households in Germany and the United States are roughly comparable, with housing wealth and other financial assets each accounting for around half of this figure. By comparison, the share of housing wealth in the euro area, at just over two-thirds, is roughly twice that of other financial assets. For the bottom half of the wealth distribution in all three regions, equity and business wealth tend to be essentially a non-factor. Overall, this wealth grouping is therefore less exposed to market price fluctuations. However, owing to the high level of liabilities, especially those held by households in Germany, changes in interest rates can expect to be passed through much more strongly to the servicing of debt.

the wealth distribution.[10] In addition, the rate of real estate ownership is comparatively low.[11] By contrast, housing wealth makes up more than half of the total assets of the next 49%. For the top 1%, business wealth plays a significant role as well (see the upper chart on p. 26). Overall, it can be seen that the wealth of the top 1% of the distribution is therefore primarily vulnerable to changes in the valuation of business wealth, which largely consists of equity investments in the form of unlisted shares or other equity. By contrast, the wealth of households in the upper mid-range of the distribution is primarily exposed to potential price fluctuations for housing wealth.

Average quarterly growth of net wealth and contributions

Percentage points, 2009 to 2021



Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations. **1** Deposits, debt securities, listed shares, investment funds and insurance claims. **2** Financial and non-financial business wealth. **3** Mortgages and other debt.

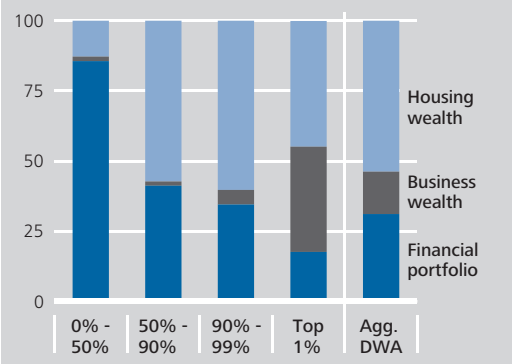
Deutsche Bundesbank

10 The average portfolio structure is determined by working out the average across all household-specific wealth structures. When depicting averages, conditional mean values are shown throughout, unless otherwise stated. Specifically, only households with positive total (gross) assets are included in the calculation.

11 According to the DWA, the rate of real estate ownership in the top and bottom halves of the distribution stands at around 85% and 15% respectively. See also Deutsche Bundesbank (2019).

Wealth structure along the net wealth distribution

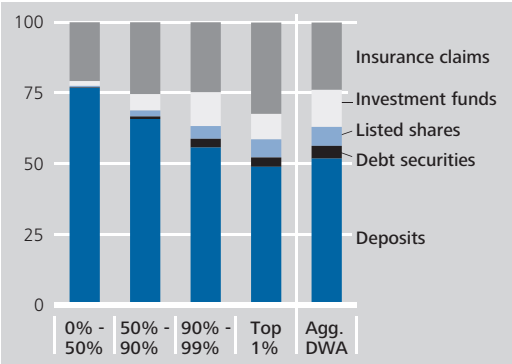
Percentage points, average per grouping or aggregate structure, 2009 to 2021



Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations.
Deutsche Bundesbank

Structure of the financial portfolio along the net wealth distribution

Percentage points, average per grouping or aggregate structure, 2009 to 2021



Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations.
Deutsche Bundesbank

Significant differences evident in composition of financial portfolio, too

In addition to the varying structures of households' total assets, however, the provisional DWA also show significant differences in the composition of their financial portfolios (see the lower chart on this page). The financial portfolio of the bottom half of the distribution consists almost solely of deposits and insurance claims. By comparison, the share of securities (debt securities, listed shares and investment funds) in the financial portfolio of wealthy households is significantly higher. Households in the bottom half of the wealth distribution favour liquid assets, such as deposits, precisely so they do not need to reduce their consumption as much in the event of unexpected income fluctuations. However, this precautionary saving motive declines as wealth rises. As a result, less liquid and thus riskier asset types are increasingly held in the portfolio.[12] Moreover, it is striking that the aggregate structure of the financial portfolio is most closely aligned with the average portfolio composition of the two top wealth groupings, i.e. the top 10% of the wealth distribution. This is essentially attributable to the size of the financial portfolio of this top 10%. The macroeconomic aggregate is primarily dominated by the financial assets held by these households: the wealthiest 10% hold around a 50% share of the aggregate financial portfolio wealth, while the less wealthy 50% hold only about 8%.

A disaggregated analysis of portfolio returns on financial assets

Possible to calculate individual returns on financial portfolio using DWA

In view of the varying structure of financial portfolios along the net wealth distribution, it is to be expected that differences in portfolio composition, coupled with differing instrument-specific returns, will produce a very mixed picture with regard to individual portfolio returns. As it is possible to calculate portfolio returns at the level of individual households over time using DWA data, these returns will be examined more closely in the following.

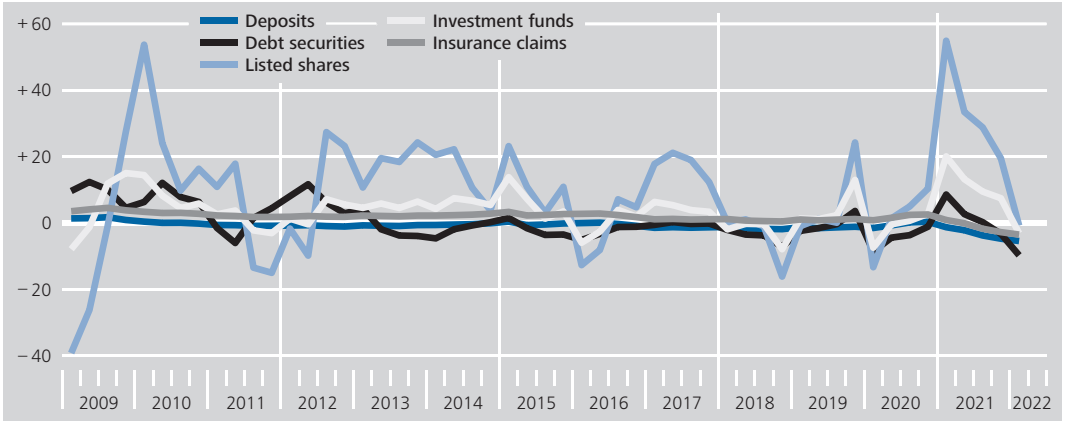
Calculation of disaggregated returns uses approach for determining aggregate total return

The methodology used to calculate disaggregated returns essentially follows the approach used to determine the aggregate total return.[13] The financial portfolio considered here comprises the following types of asset: deposits, debt securities, listed shares, investment funds and insurance claims. The total return on households' financial portfolios is calculated based on their main sources of income. Whilst interest payments are the only source of in-

12 See, inter alia, Bayer et al. (2019) and Kaplan and Violante (2022).
13 For a detailed account of how instrument-specific real returns and the total real return on financial assets are calculated, see Deutsche Bundesbank (2015).

Real return on various asset types in the financial portfolio*

Annual return (%)



Sources: Assekurata, German Insurance Association (Gesamtverband der Deutschen Versicherungswirtschaft) and Bundesbank calculations. * Adjusted for inflation using the consumer price index.

Deutsche Bundesbank

come a bank deposit can generate, for other types of financial asset, such as listed shares, debt securities, investment funds and insurance claims, income flows also depend on price effects. In addition, shares and investment funds that invest in equities commonly pay out dividends, too. Any attempt to calculate households' total return on the financial portfolio therefore needs to consider not just interest payments but these other components as well. The analysis also takes into account the fact that the purchasing power of nominal returns fluctuates due to inflation. This means that all the returns are analysed in real terms.[14]

Clear differences in returns on different types of financial asset

The above chart depicts the real returns on individual asset types since 2009. Developments here have varied quite considerably over the past few years. For instance, the real return on bank deposits and debt securities has been mostly negative in recent years. By contrast, the real return on listed shares and investment funds was predominantly positive, despite occasional fluctuations. Insurance claims also recorded a positive real return, for the most part. On average, however, this was lower than the return on securities. If the instrument-specific returns are now weighted by their share of the individual financial portfolio, the total real return of a household can be calculated.

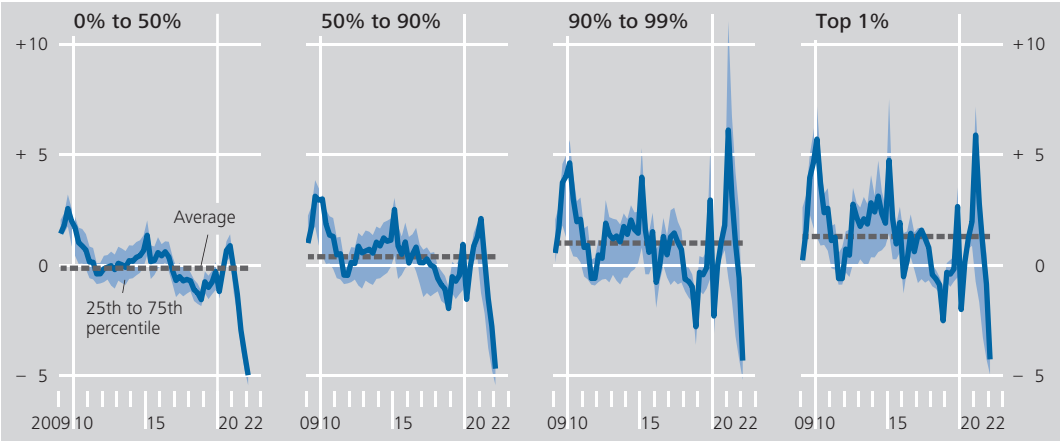
Average real return rises with increasing net wealth

The development of portfolio returns along the distribution of wealth is shown in the chart on p. 28. The continuous lines show the mean value of the respective wealth grouping at a given point in time. The shaded area represents the range of variation between the 25th and the 75th percentiles of the respective grouping. A comparison of the four wealth groupings shows that in the period between 2009 and the first quarter of 2022, the average real return (dashed line) rose as net wealth increased.[15] While the average real return comes to a mean of 0% for the bottom 50% of the distribution, it stands at around 1.5% for the top 1%. Furthermore, it can be seen that the volatility of the returns increases as net wealth rises. This is, first and foremost, the result of higher capital market investment; although households achieve higher returns on the capital market, they simultaneously bear heightened risk in the form of fluctuating asset valuations. Additionally, the shading shows that heterogeneity within a grouping also increases as net wealth rises.

14 For a detailed account of how real returns are calculated, see Deutsche Bundesbank (2015).
15 As the current DWA only provide data up to and including the fourth quarter of 2021, provisional portfolio returns for the first quarter of 2022 are calculated on the basis of the weighting from the fourth quarter of 2021.

Real return on the financial portfolio along the net wealth distribution

Annual return (%), average per grouping



Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations.
Deutsche Bundesbank

Varying portfolio structures and differing returns on individual asset types reflected in marked differences in rate of return

Differences in the rate of return between wealth groupings are due to variations in portfolio composition coupled with the differing returns on individual asset types. This becomes particularly evident when looking at the contributions of the various assets to the total return across the four wealth groupings (see the chart on p. 29). For example, the total return for the bottom half of the wealth distribution is shaped almost exclusively by low-risk assets in the form of deposits and insurance claims. As the return on these two asset types has been relatively weak in recent years, the total return has also been correspondingly low and, in most cases, even negative. By contrast, the return for the top 10% of the wealth distribution was influenced significantly by the return on capital market instruments over the observation period. In particular, positive price developments contributed to high returns, which were then reflected correspondingly in the total return. For comparative purposes, the chart on p. 29 also tracks the development of aggregate real returns on the financial portfolio produced when only national accounts data are used for the calculation. Here, it can ultimately be established that analyses which do not take distributional information into account – such as the aggregate real portfolio returns of households in Germany[16] – have only presented a representative picture for the top end of the wealth distribution. By contrast, basing an analysis on the DWA allows for a much more differentiated assessment.

Portfolio returns of households in Germany including housing wealth

Housing and business wealth also unevenly distributed

In addition to the different structures in the financial portfolio, however, the DWA also show an unequal distribution of housing and business wealth across individual household groups: the wealth in the bottom half of the wealth distribution is predominantly made up of financial assets. By contrast, housing and business wealth account for a significant share in the top half. The focus on the financial portfolio therefore only offers an incomplete view with respect to the performance of total household assets. Taking the above into account, the following analysis additionally documents returns on total assets along the distribution. Here, disaggregated returns on assets are, as a rule, calculated using the same method as disaggregated returns on the financial portfolio. The key difference, however, is that financial

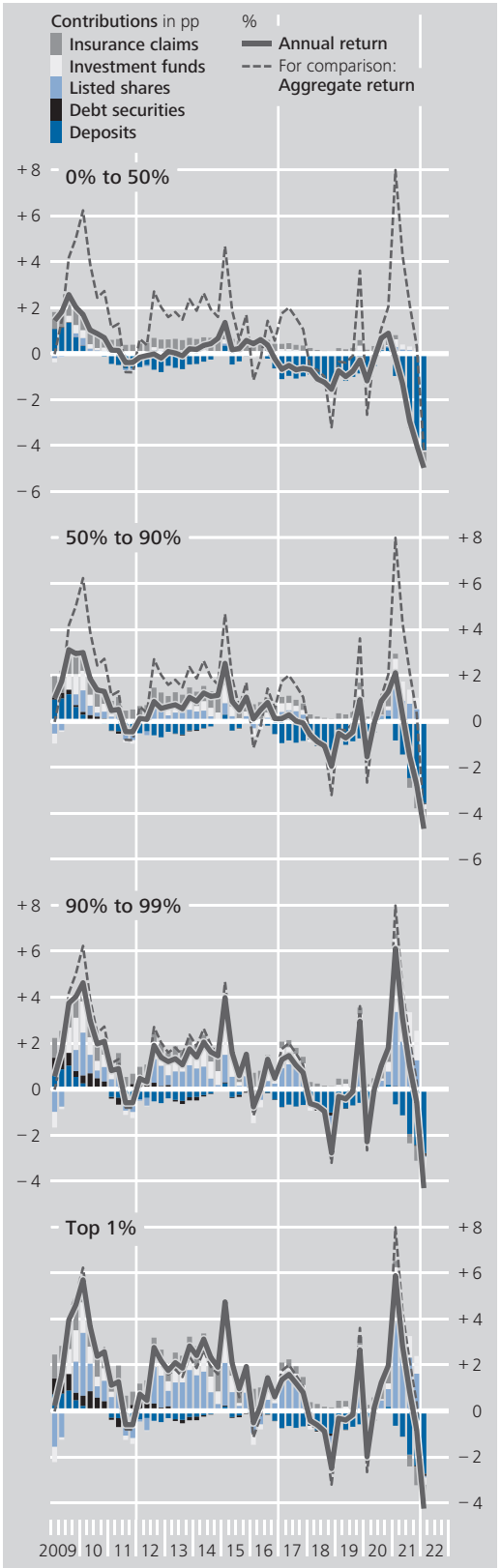
16 For information on the development of aggregate household portfolio returns in Germany, see Deutsche Bundesbank (2021c).

and non-financial business wealth and housing wealth are now also taken into account alongside traditional financial assets:

– Financial business wealth: this item comprises equity investments that are not traded on organised markets. Owing to a lack of market data, it is not possible to directly calculate the return for these instruments. It is therefore assumed that returns are generally similar to those of comparable tradable instruments. In the case of unlisted shares, for example, the same valuation changes and dividend yields are recognised as for listed shares.[17] The sum of these two components gives the total return on unlisted shares. Changes in the valuation of other equity are approximated on the basis of the information provided in the financial accounts.[18] The portion of the returns attributable to profit distributions is assumed to be equal to the observed dividend yield on listed shares. As with unlisted shares, these two components result in the total return on other equity. Finally, a weighted average is calculated from the two returns. This value is derived from the levels in the financial accounts for unlisted shares and other equity. This ultimately reflects the total return on financial business wealth.

– Non-financial business wealth: it is not possible to directly determine the return here either. However, this type of asset is, in principle, very similar to other equity.[19] For this reason, performance is estimated for non-financial business wealth in the same manner as for other equity.

Contributions of various asset types to the real return on the financial portfolio



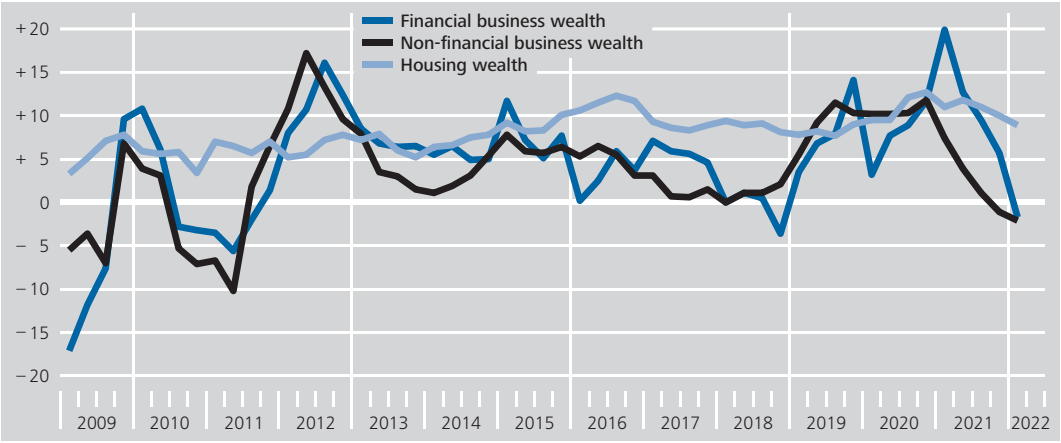
Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations.

Deutsche Bundesbank

17 In this context and in the absence of more detailed information, an identical sectoral structure is implicitly assumed for listed and unlisted public limited companies.
18 The valuation change is the difference between the quarterly stock change and the corresponding transaction.
19 If, for example, an individually-owned enterprise were to change its legal form to that of a general or limited partnership, the enterprise would typically be assigned to the non-financial corporations sector. The owner household would then hold a corresponding amount of other equity instead of the non-financial business wealth.

Real return on housing wealth and business wealth

Annual return (%)



Sources: Federal Statistical Office and Bundesbank calculations.
Deutsche Bundesbank

– Housing wealth: this category includes both dwellings and the land underlying dwellings. Returns are calculated using the house price and rent price indices of the Federal Statistical Office by applying a rent-price approach.[20] The year-on-year change in the house price index corresponds to the change in the valuation of housing wealth. The change in the rent price index compared with the previous year's figure for the house price index gives the rental yield. The total return on housing wealth is then calculated using the valuation changes and the rental yield.

Housing wealth in particular posted high returns in the 2009 to Q1 2022 period alongside shares

The above chart depicts the real returns on the three asset types since 2009. Over time, they have developed quite differently. Real returns on housing were consistently positive, rising from just over 3% in 2009 to around 11% at the beginning of 2022. By comparison, real returns on financial and non-financial business wealth were more volatile and also, on average, lower. They were even clearly in negative territory during the financial and economic crisis and the European sovereign debt crisis.

Taking these three additional asset types into account, it is now possible to calculate a real return on total assets which is expanded to include these asset components. The chart on p. 31 shows the development of real returns on the financial portfolio and on total assets along the wealth distribution. The lines show the average real returns for the respective wealth grouping. This expanded perspective on the real return on assets reveals clear differences: compared with the real return on the financial portfolio, the real return on assets is noticeably higher, especially for households in the top half of the distribution of wealth.

Taking housing and business wealth into account, real return on assets is noticeably higher, especially for the top half of the wealth distribution

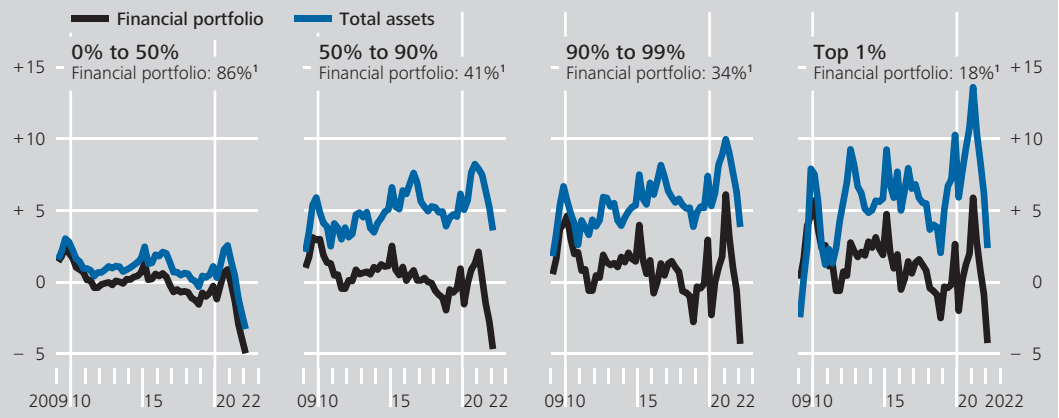
The main reason for these differences is the low level of housing and non-financial wealth in the bottom half of the wealth distribution when compared with the top half. Around 90% of households' real return on assets in the 50% to 99% range of the distribution was based on contributions from housing wealth (see the chart on p. 32). As this type of asset (alongside shares) recorded, on average, the highest return of all asset components in the observation period, it played a key role in

A low level of housing and non-financial wealth gives rise to a comparatively low real return on assets in the less wealthy half of the distribution

20 In principle, both indices only reflect their own dynamics. However, the rental yield corresponds to the development of rents in relation to the value of the real estate. Consequently, this approach initially envisages scaling the two indices according to an initial rent-price ratio at the starting time t_0 (see Jordà et al. (2019)). Based on this initial value, both indices can be depicted at each time t in such a way that the ratio of the scaled indices reflects the development of the rent-price ratio over time. The initial value is taken from the Jordà-Schularick-Taylor Macrohistory Database (version: 5 March 2021) (see Jordà et al. (2017)).

Total real return on assets along the net wealth distribution

Annual return (%), average per grouping



Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations. **1** Average share of the financial portfolio in total assets between 2009 and 2022.

Deutsche Bundesbank

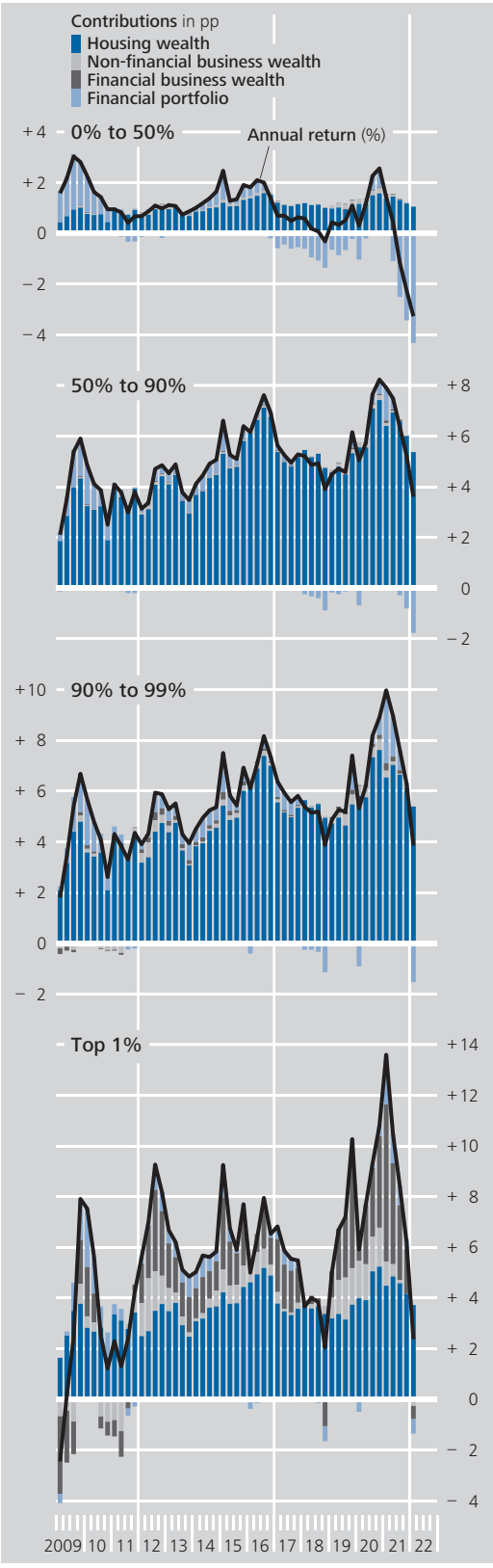
achieving a high total return. Housing wealth also made a significant contribution to total returns for the top 1% of the wealth distribution. This was, however, additionally boosted by a distinct contribution from business wealth. Overall, the contribution of the financial portfolio to returns plays only a minor role for households in the top half of the wealth distribution. By comparison, while housing wealth also made a consistently positive contribution to returns for the bottom half, this was nevertheless comparatively small, owing to the low proportion of housing wealth in the total. In addition, the results as a whole show that, in real terms, the yield-lowering effect of inflation is particularly noticeable at the bottom end of the wealth distribution. Compared with the rest of the households, the total assets of these households consist mainly of low-interest deposits. In this respect, high inflation rates tend to lead to negative real returns on assets.[21]

Households in the bottom half of the distribution nevertheless recorded a marked easing effect from a considerable decline in real interest expenditure

However, the finding that there is a comparatively low real return on assets for the bottom half of the wealth distribution owing to the high importance of low-yielding assets in the asset structure disregards the fact that the low interest rate environment of recent years also had a noticeable impact on the real interest rate on liabilities. Last year, for example, the real interest burden for mortgages and other debt reached historical lows of around -2.7% on average. By comparison, this figure stood at just over 5% in 2009. In order to account for this easing effect, the real return on a household's assets is additionally adjusted for real interest expenditure. The average leverage ratio (total liabilities as a percentage of total assets) of the bottom 50% of the distribution stood at around 90% in the observation period; in the top half, this ratio was only slightly more than 10%. As it is particularly those households in the bottom half of the distribution of wealth that are relatively heavily indebted, the adjustment has a notable effect in this area above others. For example, the adjusted real return on assets for the bottom half is clearly shifted into negative territory (see the upper chart on p. 33). However, this return has recorded a discernible upward trend over the past few years owing to the increased easing effect. It must nevertheless also be noted that around 20% of all households in Germany, which are located

21 It should be noted here that according to the consumer price index, the inflation rate is assumed to be identical for all households at time *t*. This is, however, a simplifying assumption, as it can mask considerable heterogeneity among households. Studies show, for example, that households with lower incomes are exposed to significantly higher individual inflation rates than households with higher incomes. See Gürer and Weichenrieder (2020). As this aspect would, in principle, reinforce the above assessment, this does not affect the general statement based on the available results.

Contributions of various asset types to total real return on assets



Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations.

Deutsche Bundesbank

almost exclusively in the bottom half of the distribution of wealth, currently hold low-yielding assets for the most part while, at the same time, having no debt. These households therefore cannot benefit from lower real lending rates. This is why the current high level of inflation is mainly weighing on these households' low level of wealth in the form of significantly negative real returns on assets.

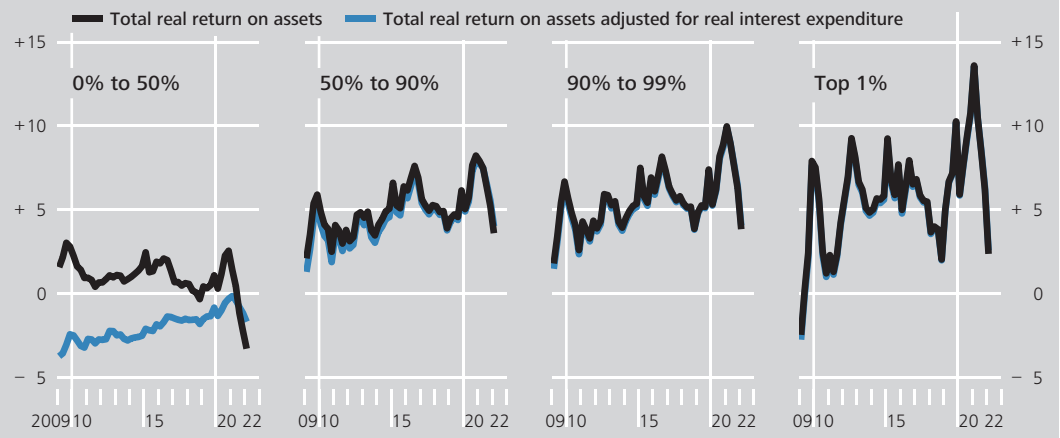
Conclusion

DWA consistently reflect data from the PHF and the national accounts statistics

The Distributional Wealth Accounts (DWA) for households in Germany represent a new provisional dataset combining two data perspectives: namely, they link the Bundesbank's Panel on Household Finances (PHF) with the national accounts statistics. The DWA incorporate the distributional information from the PHF and simultaneously reflect the quarterly dynamics and levels of the national accounts statistics in a consistent manner. As the dynamics of the dataset are derived from the national accounts data, the DWA also have a distinct advantage in terms of temporal availability compared with the complex and time-consuming PHF. This ultimately allows comprehensive analyses to be carried out on a quarterly basis at the level of individual households. Statements can then be made regarding the development of the wealth and debt situation along the wealth distribution, for example. According to these statements, the DWA show that wealth inequality has decreased slightly in recent years. This is due, on the one hand, to the fact that growth in net wealth for the bottom 50% of the distribution was particularly steep – albeit starting from a low level. In this context, the households in the less wealthy half built up a significant volume of low-risk assets such as deposits and insurance claims, whilst at the same time markedly reducing their debt. On the other hand, households in the upper mid-range of the distribution benefited noticeably from the rising value of their housing wealth.

Total real return on assets along the net wealth distribution

Annual return (%), average per grouping



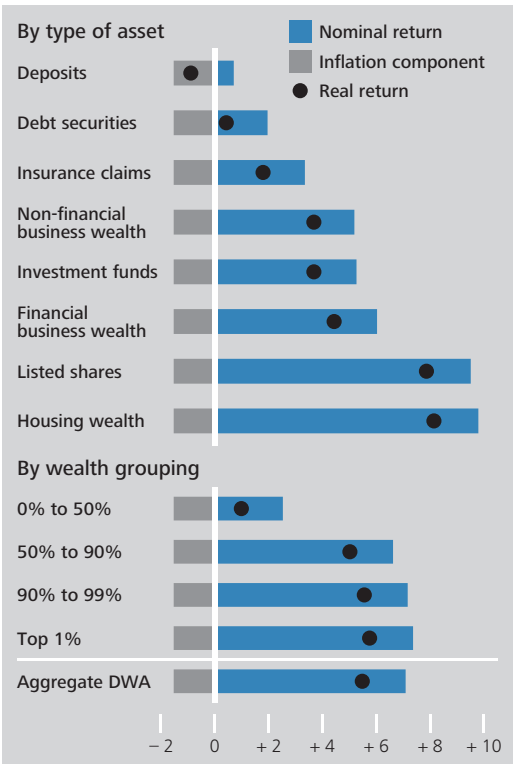
Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations.
Deutsche Bundesbank

DWA reveal heterogeneity among households which is typically hidden in macrodata

The DWA also reveal considerable heterogeneity among household wealth structures, which typically remains hidden when using macrodata. This aspect became particularly clear when looking at household-specific returns along the wealth distribution. Discernible differences in the composition of assets have a marked impact on the real return on assets of the respective household portfolio. For example, the wealth of the bottom half of the wealth distribution consists predominantly of low-risk asset types. The interest on these instruments has been relatively low in recent years, which has been reflected in a low total return. By contrast, households' wealth in the top half of the distribution consists to a much greater degree of capital market instruments and housing and business wealth, with these last two in particular accounting for a significant share of total wealth. As, on average, housing wealth – alongside listed shares – recorded the highest real return of all asset components in the observation period (2009 to early 2022), households in the top half of the distribution achieved a significantly higher total return. In addition, business wealth made a distinct contribution for the top 1% of the wealth distribution. Moreover, the results show that the yield-lowering effect of inflation is particularly noticeable at the bottom end of the wealth distribution. The total wealth of these households consists largely of low-interest deposits. As a result, high inflation rates are more likely to lead to negative real returns on assets in these cases especially.

Average return and inflation component

%, 2009 to Q1 2022



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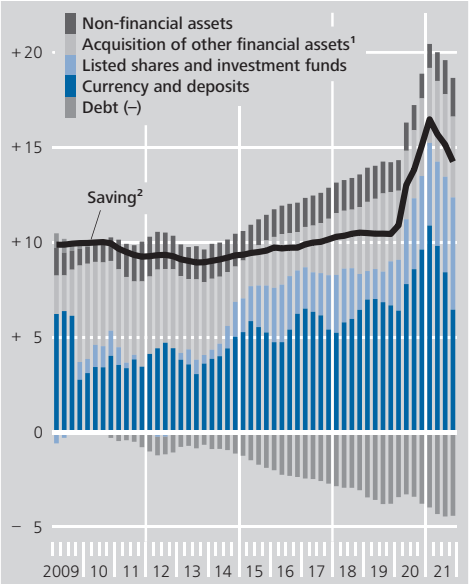
The distribution of pandemic-related savings of households in Germany

The saving and investment behaviour of households in Germany has been decisively shaped by the course of the coronavirus pandemic so far. At the start of the pandemic, for example, there was an exceptional increase in saving.[1] The main reason for this was reduced opportunities for consumption owing to measures to contain the coronavirus pandemic – businesses being ordered to close, for instance, and travel restrictions. However, concerns about catching the virus also led people to limit their spending, so this also contributed to increased saving. By contrast, precautionary saving due to expected income losses played only a minor role in view of extensive government support.[2]

In this context, the adjacent chart illustrates the exceptional increase in household saving at the beginning of 2020, as well as providing insight into how those savings were used. It shows that, at the start of the pandemic, the rise in savings was initially accompanied by large inflows to currency holdings and deposits, in particular. At the same time, there was a persistent upward trend in inflows to listed shares and investment funds. The build-up of deposits has subsided somewhat since the second quarter of 2021, which may indicate that, besides consumption normalising as some pandemic containment measures were rolled back, the additional savings were also reduced in some cases in order to cover higher energy and living costs. Given the continued strong inflows into listed shares and investment funds, the rebalancing of portfolios away from deposits and towards those specific forms of investment probably also played a certain role. Overall, the additional savings accumulated due to the pandemic are likely to have amounted to around €200 billion at the end of 2021. They are held primarily in the form of currency and deposits as well as listed shares and investment fund shares.[3]

Aggregate use of savings by households in Germany*

As a percentage of disposable income; rolling sum of last four quarters



* Households including non-profit institutions serving households. **1** Debt securities, unlisted shares, other equity, claims on insurance corporations, and remaining assets. **2** Including capital transfers.

Deutsche Bundesbank

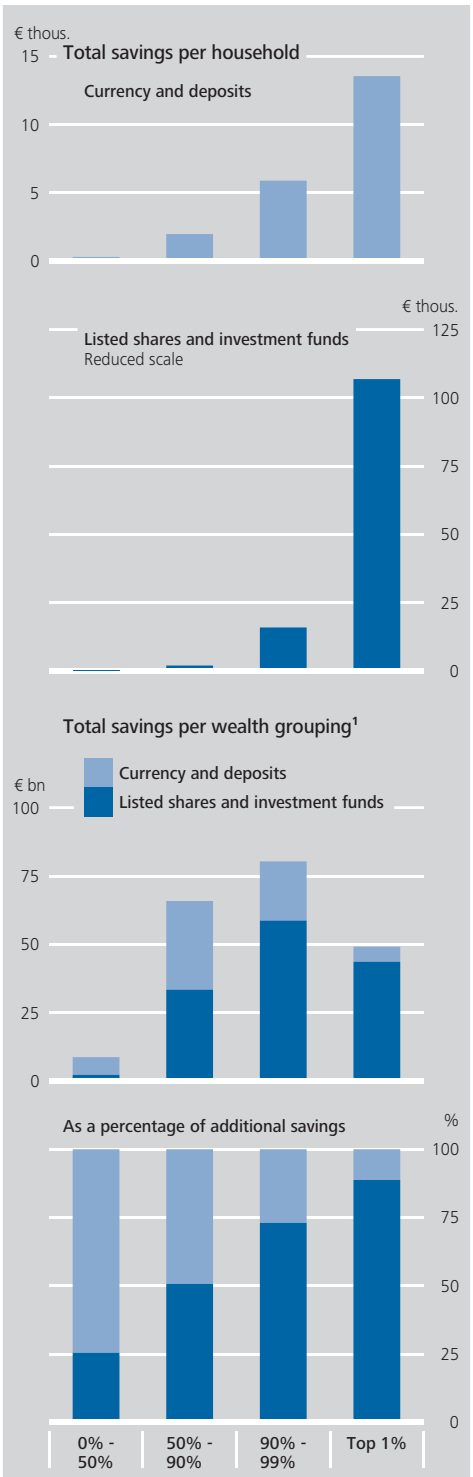
Given the high level of additional savings observed at the aggregate level, the question arises as to how these are distributed across individual households. This aspect can be illustrated in a stylised way using the Distributional Wealth Accounts. To do so, a counter-

1 This phenomenon can also be observed in other advanced economies. See European Central Bank (2021a).
2 See Deutsche Bundesbank (2021b, 2022) for savings motives in connection with the pandemic.
3 The volume of additional savings is determined by comparing quarterly saving since 2020 with the average quarterly savings for 2018 and 2019 (for a similar approach, see Batty et al. (2021)). The cumulative deviations over the 2020 to 2021 period ultimately yield the total volume of additional savings accumulated. According to this approach, the cumulative additional savings amount to around €200 billion. Calculations based on the macroeconomic projections point to comparable figures (see Deutsche Bundesbank (2021b, 2022)). The use of the additional savings can also be calculated in a similar way: the cumulative quarterly deviations of instrument-specific transactions since 2020 from the quarterly average for 2018 and 2019 indicate how the additional savings were invested during the observation period.

factual version of the Distributional Wealth Accounts is prepared, which assumes that there were no additional savings due to the pandemic.[4] Comparing the holdings in the counterfactual Distributional Wealth Accounts at the end of 2021 with the actual data ultimately reveals the distribution of the cumulative additional savings (see the adjacent chart). It can be seen that mainly households at the top tail of the wealth distribution have accumulated significant additional savings in absolute amounts. Whilst a household in the bottom half of the distribution currently has additional savings totalling around €420, a household in the top 1% of the distribution accounts for an additional amount of roughly €120,000 on average. Currency and deposits make up around 75% of the total additional savings for the bottom half of the wealth distribution. As net wealth increases, this share shifts markedly towards listed shares and investment funds.[5] In light of the significant rise in energy costs and the cost of living, the results suggest that the additional savings generally help mitigate the resulting financial burdens to a certain extent,[6] but they also show that this does not apply equally to all households. Extensive savings were built up mainly by wealthy households. Owing to the comparatively low volumes per household in the less wealthy half of the distribution, the buffer effect of the additional savings appears to be fairly limited for those households. Rising energy costs and the cost of living are therefore likely to place a greater strain on households at the bottom end of the wealth distribution compared with others.

Additional savings accumulated due to the pandemic

Q1 2020 to Q4 2021



Sources: Experimental Distributional Wealth Accounts (DWA) and Bundesbank calculations. **1** Wealth groupings based on net wealth distribution at the end of Q4 2021: the top 1% of the wealth distribution, the next 9% of the distribution (90% to 99%), the 40% after that (50% to 90%) and the bottom half of the wealth distribution (0% to 50%).

Deutsche Bundesbank

4 As the aggregate transactions in the chart on p. 34 indicate that the bulk of the excess savings have flowed into currency holdings and deposits as well as into listed shares and investment funds, for the counterfactual alternative, quarterly excess savings are accordingly deducted from these two asset types (distributed proportionally across these two categories; see also Batty et al. (2021)).
5 For more on the distribution of additional savings due to the pandemic in the international context, see European Central Bank (2021a). Overall, it can be seen that households with high incomes and wealth, in particular, have accumulated additional savings (see, inter alia, Bank of England (2020), Batty et al. (2021), Deutsche Bundesbank (2021b) and European Central Bank (2021b, 2022a)).
6 See European Central Bank (2022b).

As wealth distribution can affect the transmission of monetary policy, it seems helpful to be able to take due account of the financial differences between households

In addition to the use cases outlined above (see also the box on pp. 34 ff.), the dataset presented here is likely to become more relevant for monetary policy in future. There are a great many studies focusing on the interplay between monetary policy and inequality.[22] They show that, although monetary policy measures can generally have an impact on the distribution of wealth, the development of inequality over the past few decades has been driven predominantly by factors outside the scope of monetary policy. Of course, this must be seen in light of the fact that monetary policy typically has neither the mandate nor the appropriate instruments to steer distributions in a targeted manner. It is instead the finding that heterogeneity between households can affect the transmission of monetary policy that appears much more important. This means that the effectiveness of monetary policy measures depends, amongst other things, on the distribution and structure of wealth. Balance sheet constraints could also affect the impact of monetary policy measures.[23] When assessing the impact of such measures, then, it may generally be helpful to bear in mind the financial differences between households. It is precisely against this backdrop that the future provision of the DWA seems of particular interest to a central bank.

22 See Deutsche Bundesbank (2016) and European Central Bank (2021c) as well as the sources cited therein.
23 See, inter alia, Deutsche Bundesbank (2021a), Dobrew et al. (2021), Kaplan et al. (2018), Matusche and Wacks (2022), Slačálek et al. (2020) and Weidner et al. (2014).

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