Annex. Sources, main concepts and data treatments

Different data sources have been mobilised to conduct the analysis in this Policy Brief. In particular, latest available data and short-term trends are based on the OECD *Wealth Distribution Database (WDD)*, while longer-term trends (in household over-indebtedness) are based on the Luxembourg Wealth Study. Moreover, as countries covered by the Eurosystem Household Finance and Consumption Survey (on which *WDD* estimates for many EU countries are based) typically rely on the concept of gross (i.e. pre-tax) income, machine learning methods have been deployed to impute disposable (i.e. after-tax) income in the HFCS micro-dataset based on information available in the EU Statistics on Income and Living Conditions (EU-SILC).

To ensure comparability across different sources, the same treatments and concepts have been applied. In particular:

- The indicators shown in the Policy Brief are based on the concept of "household net wealth", as defined in the OECD *Guidelines for Micro Statistics on Household Wealth* (OECD, 2013[1]), i.e. the value of financial and non-financial assets net of the value of liabilities held by private households resident in the country. Assets and liabilities are classified based on the nomenclature proposed by the OECD Guidelines, which distinguishes between five categories of non-financial assets, eight categories of financial assets, and three categories of financial liabilities (see Table 1). Among financial assets, assets held in the form of "pension schemes related to employment" are excluded from the key wealth measures described in the Policy Brief to improve comparability across countries (data on the value of such pensions is available in only a limited number of countries);[1]
- Most of the indicators refer to the distribution of financial and non-financial assets and liabilities across *households* (rather than across individuals), with no adjustment made to reflect differences in household size (which is the convention used by the OECD when analysing the distribution of household income). A notable exception relates to the concept of *asset poverty*, which instead refers to individuals and equivalises wealth based on the same equivalence scale applied by the OECD to household income (i.e. the square root of household size). Different indicators of asset poverty have been proposed in the literature (see Balestra and Tonkin (2018[2]) for a detailed discussion), but they all rest on the principle of combining information on household income and wealth to consider how long an individual can maintain a given way of life by drawing on their accumulated wealth, should their income suddenly fall because of a sudden adverse shock (e.g. loss of employment, disability, family disruption). In previous publications, the OECD relied on an asset-based poverty measure to identify those individuals belonging to a household with liquid financial wealth insufficient to support them at the level of the income poverty line for at least three months (i.e. *asset poor*). Those asset-poor individuals who are not poor in terms of their income were described as being *financially insecure*. For the purposes of Policy Brief, a different asset-based poverty measure has been developed and discussed, which identifies lower-income

[1] Assets held in the form of "pension schemes related to employment" are reported in the *OECD Wealth Distribution Database* separately and as a supplementary component of household net wealth. For a more detailed discussion of these pension schemes, refer to Balestra and Tonkin (2018[2]).

individuals who lack the financial liquid assets to cover a three-weeks' loss of income regardless of whether they are currently income poor.[2]

Table 1. Basic wealth concepts

NF Total non-financial assets = NF1 + NF2 + NF3 + NF4 + NF5	
NF1 Principal residence	Principal residence is the residence where majority of household members live.
NF2 Other real estate property	Second and holiday homes, investment real estate, farm land
NF3 Vehicles	Cars, motorcycles, boats, other vehicles owned by household and used for private purposes. Vehicles owned by own unincorporated enterprises are excluded.
NF4 Valuables	Works of art, antiques, fine jewelry, stamp and coin collections, precious stones and metals, other valuables
NF5 Other non-financial assets	E.g. other consumer durables, intellectual property, and other non-financial assets.
F Total financial assets, excluding pension assets related to employment = F1 + F2 + F3 + F4 + F5 + F6 + F7 + F8 LF Liquid financial assets (or emergency savings), excluding pension assets related to employment = F1+F2+F3+F5+F7	
F1 Currency and deposits	Currency held (if measured in the survey), transaction accounts, saving accounts, fixed-term deposits, certificates of deposits.
F2 Bonds and other debt securities	Government savings bonds, corporate bonds, commercial paper, state or municipal non-saving bonds, foreign bonds, other non-saving bonds, debenture, mortgage-backed securities, negotiable certificates of deposits, treasury bills, other similar instruments
F3 Mutual funds and other investment funds	Mutual funds, hedge funds, unit trusts, income trusts, pooled investment funds, other managed investment funds
F4 Net equity in own unincorporated enterprises	Household members' share of the net equity in unincorporated enterprise in which they work (sometimes also called "self-employment business wealth").
F5 Stocks	Listed shares, i.e. shares in publicly listed corporations.
F6 Unlisted shares and other equity	Unlisted shares (value of ownership in incorporated businesses not publicly traded), net equity in partnerships in which the household members do not work ("silent partners").
F7 Other non-pension financial assets	Examples (non-exhaustive): managed accounts, money owed to household, any other non-pension financial asset
F8 Voluntary individual life insurance and private pension funds	Assets in life insurance and pension plans where participation is voluntary, and individuals independently purchase and select material aspects of the arrangements, without intervention of their employers. Does not include term life insurance.
L Total liabilities = L1 + L2 + L3	
L1 Principal residence loans	Loans taken for constructing, purchasing and/or improving the principal residence of household.
L2 Other residence and real estate loans	Loans for the purpose of constructing, purchasing or improving other dwellings, buildings and land (e.g., loans to purchase holiday homes and loans to purchase rental properties for investment purposes). This item excludes liabilities of own unincorporated enterprises, when these are recorded as net value in F4.
L3 Other loans	Car and other vehicle loans, instalment debt, education loans, other non-mortgage loans from financial institutions, loans to purchase shares and other financial assets, loans from other households, credit card debt, lines of credit, bank account overdrafts, other loans not included in L1 or L2 This item exclude liabilities of own unincorporated enterprise, when these are recorded as net value in F4.
= NW Net Wealth (excluding employment related pension funds, i.e. NF + F – L)	

[2] Lower-income individuals refer to individuals belonging to households in the bottom 40% of the distribution of household disposable income.

The OECD *Wealth Distribution Database (WDD* – via http://oe.cd/wealth)

The OECD relies on a dedicated statistical database, the OECD *Wealth Distribution Database (WDD)*, to benchmark and monitor wealth inequality across countries. This database is based on national sources (see Table 2 for an overview of sources and main characteristics)[3] and on set of protocols and statistical conventions (e.g. on wealth concepts and components) to derive comparable estimates. Estimates referring to the most recent year (around 2018) are currently available for 29 OECD countries, while estimates referring to more than two years are available for 19 countries. Countries currently included in the database are Australia, Austria, Belgium, Canada, Chile, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, New Zealand, Poland, Portugal, the Slovak Republic, Slovenia, Spain, the United Kingdom (limited to Great Britain) and the United States. For 11 countries, estimates are obtained through a questionnaire completed by national contact points in National Statistics Offices (and Central Banks) that regularly collect micro-level information on household wealth; among these, estimates for Australia, Canada, Chile, Japan, Korea, New Zealand, the United Kingdom and the United States are based on household surveys, while those for Denmark, the Netherlands and Norway are based on tax and administrative records. For 18 countries (i.e. those participating in the Eurosystem Household Finance and Consumption Survey (HFCS) bar the Netherlands), estimates were computed by the OECD based on the public use file provided by the European Central Bank.

Information on the distribution of household net wealth is broken down by housing status (three groups), age of the household head (six groups), number of household members (five groups), household type (six groups), education of the household head (four groups), main source of income (five groups), and wealth and income quintiles (with additional breakdowns for the top 10%, 5% and 1% of the distribution). Information is also collected on the share of households holding various types of assets and liabilities; on the mean value of assets and liabilities for households holding them; on the joint distribution of wealth and income across household quintiles; and on the extent of over-indebtedness across households (based on two measures: debt-to-asset ratio above 75%; and debt-to-income ratio exceeding 3). Finally, information is also available on the share of individuals with liquid financial assets or net wealth below a given threshold, defined in terms of either the national income poverty line (50% of national income) or the income of their own household. A top-level overview of the data is available at: http://oe.cd/wealth.

Despite efforts made to ensure common treatments and classifications across countries, the measures included in the OECD WDD are affected by differences that may limit their comparability. Three of the most important are:

- Differences between countries in the year when data are collected, ranging between 2016 and 2019, for the most recent year (see Table 2);
- Differences in the degree of oversampling of rich households across countries, which may affect comparisons of both levels and concentrations of household wealth (see Table 2 and Balestra and Tonkin (2018[2]) for further details);
- Differences in the income concept recorded: while most wealth surveys provide information on household disposable income, countries covered by the Eurosystem Household Finance and Consumption Survey rely on the concept of gross income (with the exception of Italy and Finland, for which information on disposable income is also available), which limits the cross-country comparability of estimates of the joint distribution of income and wealth.

[3] Additional information is available at http://stats.oecd.org/Index.aspx?DataSetCode=WEALTH.

The Eurosystem Household Finance and Consumption Survey (HFCS)

The Eurosystem Household Finance and Consumption Survey (HFCS) is run by the National Central Banks of the Euro area and coordinated by the European Central Bank.[4] It provides individual household data collected in a harmonised way in euro-area countries as well as Hungary and Poland. Although the survey does not refer to the same time period in all countries, the most common reference period for the latest available data is 2017. The main aim of the HFCS is to gather micro-level structural information on households' assets and liabilities, intergenerational transfers and gifts, and consumption and saving, supplemented by information on socio-demographic characteristics (e.g. labour market status, education, etc.). As already mentioned, for most countries the HFCS collects information on gross (rather than disposable) income, which limits the cross-country comparability of WDD estimates that consider income and wealth jointly. To address this issue, the Policy Brief makes use of novel methods in statistical matching to impute disposable income from the gross income variable available in the HFCS dataset. To do so, a predicted distribution of disposable income in each country and year was derived using ensemble methods of machine learning. The model was trained on the EU Statistics on Income and Living Conditions (EU-SILC) micro-dataset, which contains reliable information on both disposable and gross income and for which a large set of socio-demographic variables were harmonised to match those in the HFCS dataset (Box 1).

Box 1. Predicting disposable income in HFCS

The main challenge of the statistical matching exercise was to find a well-functioning approach that could allow the predicted disposable income to be a function of the entire gross income distribution and an array of socio-demographic variables. A machine learning approach was preferred over other viable options (e.g. hot-deck imputations) not only because it retained better predictive power, but also because it did not require assumptions about the nature of the relationship between disposable income, gross income and socio-demographic characteristics.

The machine learning method chosen, called 'Xgboost', relies on boosted regression trees. It has become widely acknowledged for its very good performance, and has recently been used in Blanchet, Chancel and Gethin (2019[3]) for a very similar matching exercise in which the authors match different income concepts together in multiple datasets over a relatively long time period.

Similarly to Blanchet, Chancel and Gethin (2019[3]), both the donor (EU-SILC) and recipient (HFCS) samples were harmonised and the distribution of both gross and disposable income was segmented into percentiles. As the models are in a Gaussian (or continuous) form, the predicted disposable income distribution was defined in a continuous space despite the fact that the main predictor, gross income, was restricted to percentile levels. Other predictors included: household type, marital status, weekly number of hours worked for the households head and the second household head (when applicable), labour status, occupation type and variables decomposing individual gross income for both household heads. Following good practice, first all input variables were standardised, then the model output was de-standardised by applying the same scaling factor used for standardisation. Cross-validation was also used to reduce the risk of over-fitting.

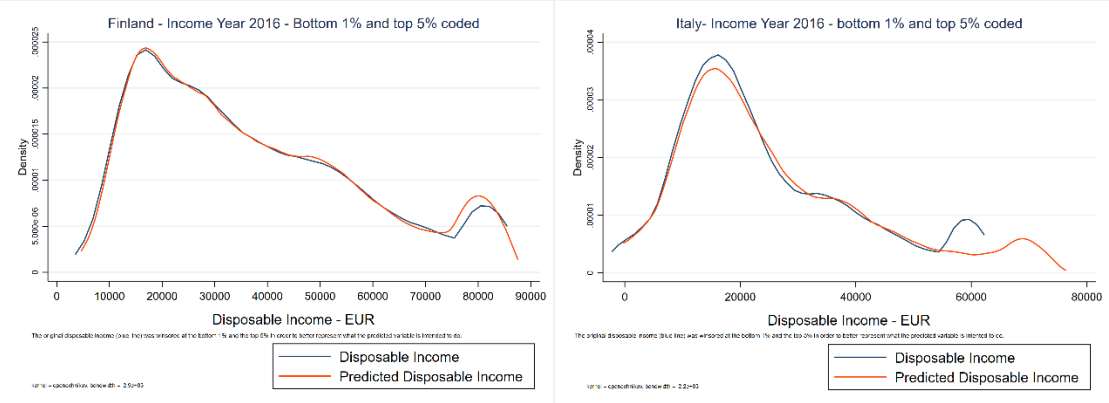
The model was built using the SuperLearner package in R. For each country and year, EU-SILC observations were split into a training (75%) and a testing (25%) sample. The model was then ran

[4] The results published in the Policy Brief and the related observations and analysis may not correspond to results or analysis of the data producers. In particular, in the HFCS self-employment business wealth is classified as a real asset, while the WDD considers it as a component of financial assets.

separately for each country and year, and its performance was assessed on the testing sample. For those countries where information on disposable income is available in HFCS, i.e. Italy, Finland, the model's performance was evaluated by comparing the predicted and the observed distributions.

The results from the machine learning model are highly satisfactory. The mean cross-validation prediction error across years and countries remain between below 8% at the very most, and the mean squared error on the test sample does not go past 4% of a standard deviation in most countries. As Figure 1 shows, the model does a good job of predicting the net income of Italian and Finnish households until about the 95th percentile. This does not represent a major source of concern for the analysis in the Policy Brief, which focuses on the bottom 40% of the country's income distribution.

Figure 1. Kernel density plots for observed disposable income and predicted disposable income (HFCS) for Italy and Finland, 2016



Source: OECD calculations based on EU-SILC (2016) and HFCS (2016).

The Luxembourg Wealth Study (LWS)

The Luxembourg Wealth Study (LWS) is a widely-used semi-harmonised dataset providing individual data on household wealth, through a remote access procedure. The data were used in Figure 3 to produce longer-term trends in over-indebtedness for a handful of OECD countries: i.e. Germany, Italy, Spain and the United Kingdom. LWS estimates for Germany are not directly comparable with those obtained from the *WDD*, because they refer to a different data source. For Spain, the ratio of over-indebtedness shown in Figure 3 refers to gross rather than disposable income, due to the challenge of applying the machine learning approach described above to the LWS data via a remote access procedure.

Table 2. Data sources and characteristics

	Source	Organisation undertaking the survey	Frequency of collection	Years used in the analysis	Sample size (number of households)	Response rate	Oversampling of rich households	Effective oversampling rate of the top 10%[1]	Imputation for item non-response
Australia	Survey of Income and Housing (SIH)	Australian Bureau of Statistics	Every 2 years	2006, 2012, 2014, 2018	~ 14 000	0.74	No	–	Yes
Austria	Household Finance and Consumption Survey (HFCS-AT)[3]	Oesterreichische Nationalbank	Every 2 or 3 years	2011, 2014, 2017	~ 3 000	0.50	Yes	–	Yes
Belgium	Survey of the Financial Behaviour of Households (HFCS-BE)[3]	National Bank of Belgium	Every 2 or 3 years	2010, 2014, 2017	~ 11 400	0.38	Yes	0.02	Yes
Canada	Survey of Financial Security (SFS)	Statistics Canada	Every 3 years	1999, 2005, 2012, 2016,2019	~ 20 000	0.60	No	–	Yes
Chile	Survey of Household Finances	Central Bank of Chile	Every 3 years	2011, 2014, 2017	~4 500	0.55	Yes	0.08	Yes
Denmark	Assets and liabilities	Statistics Denmark	Annual	2015, 2019	–	–	–	–	–
Estonia	Household Finance and Consumption Survey (HFCS-EE)[2]	Eesti Pank	Every 2 or 3 years	2013, 2017	~ 2 200	0.73	Yes	0.05	Yes
Finland	Household Finance and Consumption Survey (HFCS-FN)[3]	Bank of Finland / Statistics Finland	Every 2 or 3 years	2009, 2013, 2016	~ 13 500	0.77	Yes	0.08	Yes
France	Enquête Patrimoine (HFCS-FR)[3]	INSEE	Every 2 or 3 years	2009, 2014, 2017	~ 24 000	0.64	Yes	0.20	Yes
Germany	German Panel on Household Finances (HFCS-DE)[3]	Deutsche Bundesbank	Every 2 or 3 years	2011, 2014, 2017	~ 20 000	0.32	Yes	0.10	Yes
Greece	Household Finance and Consumption Survey (HFCS-GR)[3]	Bank of Greece	Every 2 or 3 years	2009, 2014, 2018	~ 6 500	0.39	Yes	-0.01	Yes
Hungary	Household Finance and Consumption Survey (HFCS-HU)[3]	Hungarian National Bank / Hungarian Central Statistical Office	Every 2 or 3 years	2014, 2017	~ 6 200	0.44	Yes	0.02	Yes
Ireland	Household Finance and Consumption Survey (HFCS-IE)3	Central Bank of Ireland / Central Statistics Office	Every 2 or 3 years	2013, 2018	~ 5 400	0.39	Yes	0.04	Yes
Italy	Survey of Household Income and Wealth (HFCS-IT)[3]	Bank of Italy	Every 2 or 3 years	2006, 2008, 2010, 2014, 2016	~ 15 500	0.50	No	–	Yes
Japan	National Survey of Family Income and Expenditure	Statistics Bureau, Ministry of Internal affairs and communication	Every 5 years	2014	~50 000	0.96	No	–	Yes
Korea	Survey of Household Finances (SHF)	Statistics Korea	Annual	2013, 2015, 2019	~ 20 000	0.90	Yes	..	No
Latvia	Household Finance and Consumption Survey (HFCS-LV)[3]	Latvijas Banka	Every 2 or 3 years	2014, 2017	~ 1 200	0.45	Yes	0.09	Yes

	Source	Organisation undertaking the survey	Frequency of collection	Years used in the analysis	Sample size (number of households)	Response rate	Oversampling of rich households	Effective oversampling rate of the top 10%[1]	Imputation for item non-response
Lithuania	Household Finance and Consumption Survey (HFCS-LT)[3]	Lietuvos Bankas	Every 2 or 3 years	2018	~ 1 700	0.45	Yes	0.03	Yes
Luxembourg	Household Finance and Consumption Survey (HFCS-LX)[3]	Banque Centrale du Luxembourg	Every 2 or 3 years	2011, 2014, 2018	~ 5 000	0.25	Yes	0.10	Yes
Netherlands	Wealth Statistics	Central Bureau of Statistics	Annual	2011, 2015, 2019	–	–	–	–	–
New Zealand	Household Economic Survey (HES)	Statistics New Zealand	Every 3 years	2014, 2018	~ 5 500	0.76	No	–	Yes
Norway	Income Statistics for Households	Statistics Norway	Annual	2012, 2014, 2018	–	–	–	–	–
Poland	Household Finance and Consumption Survey (HFCS-PL)[3]	National Bank of Poland / Central Statistical Office of Poland	Every 2 or 3 years	2014, 2016	~ 3 500	0.53	Yes	-0.03	Yes
Portugal	Survey on the Financial Situation of Households (HFCS-PG)[3]	Banco de Portugal / Statistics Portugal	Every 2 or 3 years	2010, 2013, 2017	~ 8 000	0.86	Yes	0.07	Yes
Slovak Republic	Household Finance and Consumption Survey (HFCS-SK)[3]	Národná banka Slovenska	Every 2 or 3 years	2010, 2014, 2017	~ 2 000	0.56	Yes	0.02	Yes
Slovenia	Household Finance and Consumption Survey (HFCS-SI)[3]	Banka Slovenije	Every 2 or 3 years	2014, 2017	~ 2 500	0.38	Yes	-0.04	Yes
Spain	Financial Survey of Households (HFCS-ES)[3]	Banco de España	Every 2 or 3 years	2012, 2014, 2018	~ 6 500	0.57	Yes	0.13	Yes
United Kingdom[2]	Wealth and Assets Survey (WAS)	Office for National Statistics	Every 2 years	2007, 2009, 2011, 2013, 2015, 2017	~ 18 000	0.63	Yes	0.06	Yes
United States	Survey of Consumer Finances (SCF)	Board of Governors of the Federal Reserve System	Every 3 years	2007, 2010, 2013, 2016, 2019	~ 6 000	0.60	Yes	0.16	Yes

Note: ".." means "not available"; "-" means "does not apply". Data for 'around 2018' refer to: 2014 for Japan; 2016 for Finland, Italy and Poland; 2017 for Austria, Belgium, Chile, Estonia, France, Germany, Hungary, Latvia, Portugal, the Slovak Republic, Slovenia and the United Kingdom; 2018 for Australia, Greece, Ireland, Luxembourg, New Zealand and Norway; 2019 for Canada, Denmark, Korea, the Netherlands and the United States. Data for 'around 2010' refer to: 2009 Finland, Greece and the United Kingdom; 2010 for Belgium, France, Italy, Portugal, the Slovak Republic and the United States; 2011 for Austria, Chile, Germany, Luxembourg and the Netherlands.

1. The effective oversampling rate is calculated as (S90 – 10)/100, where S90 is the share of sample households in the wealthiest 10%. If the share of rich households in the sample is exactly 10%, then the effective oversampling rate of the top 10% is 0. If the share of households in the wealthiest decile is 20%, then the effective oversampling rate is 0.10. An effective negative oversampling rate indicates that the share of sample households in the top wealth quintile is smaller than 10%.

2. Data on the United Kingdom are limited to Great Britain.

3. These national sources are part of the Eurosystem Household Finance and Consumption Survey conducted by the Household Finance and Consumption Network.

Source: *OECD Wealth Distribution Database*, oe.cd/wealth.

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