Pension Measurement

A draft discussion paper for the Social Security Subcommittee of the AAE

The Pension Adequacy Report (PAR) and the Pension Chapter of the Ageing Report (AR) engage in evidence-based guidance of pension systems of Europe. This endeavour uses country-by-country and cross-country analysis based on a number of indicators. Several indicators derived from forecasted cash flows are of actuarial interest.

In this paper we review the methodological background of the indicators that are used and might be used in the Reports. First, we introduce the indicators used in the European Commission reports on pensions. For those who are familiar with the Reports this section might be skipped. Next, we give viewpoints for classification of different measures of pensions and pension systems. Finally, we introduce the measures in more details and classify them according to the specified aspects.

I. Ageing Report and Pension Adequacy Report indicators

Ageing Report

The Ageing Report provides a description of the underlying macroeconomic assumptions and the basic projection methodologies of the age-related expenditure projections for all Member States. Age-related expenditures covering pensions, health care, long-term care, education and also unemployment benefits

The long-term pension projections take the Eurostat population projections for the 2016 – 2080 period as the starting point. In addition, the Economic Policy Committee (EPC), on the basis of proposals prepared by the Commission services (DG ECFIN) and the EPC (Ageing Working Group), agreed upon assumptions and methodologies common for all Member States to project a set of exogenous macroeconomic variables covering the labour force (participation, employment and unemployment rates), labour productivity, and the real interest rate. This combined set of projections enabled the calculation of GDP for all Member States up to 2070, presented in this year's report.

Separate budgetary projections were carried out for five government expenditure items (pensions, health care, long-term care, education and unemployment benefit) on the basis of these assumptions. The Member States calculated their pension expenditure projections using their own national model(s) in a peer reviewed process carried out by the EPC Ageing Working Group. In this way, the projections benefit from capturing the country-specific circumstances prevailing in the different Member States (different pension legislation), while at the same time ensuring consistency by basing the projections on commonly agreed underlying macro-economic assumptions.

The interpretation of the results takes into account the long-term nature of the projections. The results are highly exposed to externalities included in the assumptions and demographic and economic projections for the coming decades. The projections are also made under the 'no-policy-change' assumption, what is also only an assumption. The aim of the analysis is to draw conclusions and advise changes if necessary. The models do not aim to predict the future, only illustrate possible outcomes. Case scenarios and sensitivity tests underline this approach and also help the interpretation.

The aim of the Ageing Report is the assessment of the budgetary sustainability of the pension and other social expenditure systems. However, there is no generally accepted measure of sustainability. The major indicators of the Report are the long-term development for each country of pension (and other) expenditure (PE) as a proportion of GDP. The numerator represents the liability and the denominator is somehow indicative of the capacity of the country's economy to support the liability. The starting point is that the Member States' economies are not in default and the pension systems are working, and the Report considers the development and long-term change of the PE/GDP index.

To analyse the underlying reasons the PE/GDP index is broken down into 1) demographic and economic factors, 2) dependency and coverage ratios, and 3) the labour market ratio and 4) benefit ratio indicators. The PE/GDP and its subdivisions are by definition macro indices.

Pension Adequacy Report indicators

Pension Adequacy Reports usually considers three aspects of adequacy:

(i) poverty protection,
(ii) income maintenance, and
(iii) effect of longevity, active and retired periods on adequacy.

The PAR focuses on pensions as the key post-retirement and old age income and has a more complex view on pensions than the Ageing Report. Current and future aspects of pension adequacy are primarily measured by (i) the ability of pension income to protect pensioners against poverty as a minimum requirement, and (ii) to replace their former earnings to a reasonable degree.

First, from the definition, the adequacy of pension income is measured by its ability to prevent and mitigate the risk of poverty (i.e. the risk and depth of income poverty and severe material deprivation) among women and men aged 65 and over. This is measured by at-risk-of-poverty (AROP). AROP is based on equivalised household disposable income, which also includes other social benefits, work and capital income, and is net of taxes.

Some people fail either to qualify for a pension or to secure sufficient entitlements to live on, therefore the Report also covers the adequacy of the Member States' minimum income provision schemes.

Secondly, adequacy is measured by its capacity to replace earned income before retirement. This function of pensions is linked to the working career and insured status. The current income-

replacement capacity of pension systems can be measured by using the aggregate replacement ratio (ARR), which compares the pension incomes of people aged 65-74 to the earnings of people aged 50-59. Thus, this indicator aims to capture the income difference between late career and the early years of retirement.

Using the theoretical replacement ratio (TRR) indicator methodology, the PAR assesses the adequacy of current pensions after certain typical career length and income scenarios and compares them with similar career paths in the future. In this methodology not only the economic assumptions can be changed but the effect of pension reforms can be simulated, too.

Thirdly, the PAR is also dealing with changing life expectancy in old age, but from a different perspective than the Ageing Report. Whilst increasing pension duration has a considerable effect on the sustainability of pension systems, living and working longer may also be an opportunity for higher pension wealth, at least for those who remain healthy.

The adequacy indicators produced in the Pension Adequacy Report exercise are the AROP rate, the Gini and income quintile share ratio (S80/S20), ARR, TRR, and, finally, the average duration of retirement from the year of death.

Some PAR indicators involve microsimulation. This is more comprehensive and allows an assessment of the overall impact on the older population in terms of employment, poverty, inequality and more using indicators based on simulated individual life-paths.

II. Notes on classification of sustainability and adequacy measures

The Adequate and Sustainable Pensions - Synthesis Report 2006[1,2] proposed a methodological overview of the dimensions of ***replacement rates as an adequacy measure*** to support the interpretation of the results. We also discuss other indicators.

Cross-sectional or longitudinal

According to the time horizon of the data used for the calculation of the indicator it can be cross-sectional or longitudinal. Cross-sectional data covers the population at a given point of time. Longitudinal data follows the development of individuals (groups, cohort) over a given period or even over a lifetime.

[1] Adequate and Sustainable Pensions - Synthesis Report 2006, European Commission Directorate-General for Employment, Social Affairs and Equal Opportunities https://op.europa.eu/en/publication-detail/-/publication/5be2ba5a-7639-443f-a7c4-75ba00b72dee

[2] Margherita Borella, Elsa Fornero: Adequacy of pension systems in Europe: An analysis based on Comprehensive Replacement Rates, April 2009, ENEPRI Research Report No. 68, AIM WP 9

Cross-sectional data is applicable to aggregate or macro indicators, for example the *Benefit ratio* or the *ARR* (by definition). Longitudinal data is used in simulation models, for example for the *TRR* and *IRR*.

Empirical, simulated, theoretical or projected data

The data used in the calculations can be empirical, simulated or theoretical. Empirical data comes from statistics or administrative databases, and by definition covers past experience. Simulated and theoretical data and projections may be derived from empirical data, but the past experience is not used directly in the calculations to create simulated events or theoretical scenarios. Simulation uses statistical parameters derived from data to produce the relevant events and then the descriptive measures of the events (salary, pension) used for the calculations. Theoretical cases and projections are derived from empirical data by prior (longitudinal) analysis.

Empirical data is highly dependent on the availability of administrative or statistical information. Theoretical data requires correct definition of the representative individual or social group. Simulation models seem to overcome the previous issues, except that simulation models also rely heavily on the available data for establishing the expected distribution of events, which have to be carefully defined based on adequate analysis.

Time perspective: Historical or prospective

Historical indicators describe the past and present state of the pension system. Generally past and present empirical data is used for the calculations. Prospective indicators describe the evolution of income based on projected population data, and/or cash flows. This tool – among other parameters – is used to assess legislated or proposed changes of the pension systems and/or different economic scenarios in the Reports.

Unit of analysis: individual or family-based measures; Individual, group or aggregate

Having information on active and retired persons at individual level show the heterogeneity well but provides an overwhelming amount of information. On the other hand, using pension system specific groups with average or other representative descriptor values might curb the tail of the distribution[3].

In theory any indicators can be built up from individual values, having the individual identified by detailed descriptors. The distinction between individual or family-based measures is relevant with respect to the definition of income. For labour income replacement labour income is compared to pension, so individual measures are adequate and sufficient. For poverty and income inequality

[3] Extreme cases of high number of low and low number of high values.

measures, like AROP and Gini index, household income is used. In this case broader categories of income are used both before and after retirement.

Incomes counted

In case of income replacement and sustainability analysis the income usually used in the calculations are pensionable salary and other work-related income, and for the retired population public and private, occupational pensions. Generally this definition is appropriate for studying the pension systems. For the purposes of poverty protection objective of pensions, broader income and social context are taken into account. Disposable income includes earnings, income from enterprise and self-employment, rents, public transfers, and pensions from all sources after retirement. Data requires usually representative micro level/household statistics.

The basic definitions of pensions, that is avoiding old age poverty and income smoothing, rely on the concept of consumption, what is financed from net income. Indeed, in several countries pension or at least minimum or fix pensions are tax free. Cross-country comparisons can be also better made on this basis, as tax regimes are significantly different.

Absolute or relative

All indicators are used in comparisons and all indicators which are calculated as ratios imply comparison. However, an indicator is regarded as an absolute measure if it is

(1) usually compared to a benchmark; e.g. the AROP, or the individual RR when compared to the target replacement ratio in a DC scheme or
(2) calculated from two different measures of the same entity; e.g. an individual replacement rate, or the IRR.

Relative indicators describe the position of an entity compared to

(3) an earlier measure of the same entity or person(s); e.g. the change in PE/GDP between the beginning and end of the projection period in the Ageing Report or
(4) the position of other entities or person(s).

Example: gross/net replacement rate and relative pension level

Projected theoretical replacement rates[4] are calculated taking into account the latest pension changes in each country, on alternative bases as follows:

[4] On the basis of OECD data. This data allows the calculation of RRs for a hypothetical employee entering the labour market in 20.. at the age of 20 and retiring after a full career.

- ***gross/net replacement rate,*** calculated as pension at retirement as a proportion of last salary (each element gross or net of tax, respectively);
- ***relative pension level:*** calculated as pension at retirement as a proportion of average salary across the active population. The net replacement rate for those with low incomes tends to be much higher than the relative pension level while the opposite is the case for those with high incomes.

Methodology behind the indicator: Macro or micro modelling

Some indicators are derived from aggregate projections while others are by definition individual or household level measures. The simple and straightforward method for modelling the first category is using macro models, whilst micro models are used for the second. The microsimulation methodology was developed originally around household statistics. But the other approach is possible for both categories, since there are no generally accepted rules. However, the interpretation of the results of the calculations is highly dependent on the methodology. The representative member approach can be used for calculating individual measures from macro models. Here the definition and interpretation of the representative members matters. In case of micro simulation we have to accumulate the total amounts from a sample population and compare to aggregates from macro statistics. The question here is the methodological consistency between the aggregate values and the development of the total of the individual indicators in a future state.

Data and modelling considerations

Macro modelling require cross-sectional decomposition of the age groups of the population according to insured status: active worker, unemployed, pensioner and other beneficiary. The financial status of active workers may differ according to full or part-time employment. Other specific forms of employment or tax status may also influence the benefit accrual. Differentiation of unemployment and other credit periods should also be recorded. All this influence the distribution of the contribution payments in a calendar year.

In most countries such information is used for the determination of the pension individually at retirement. But the original data is generated in independent databases of tax, pension, labour administrations and other social institutions. When insured status changes the details of the transition are generally not recorded. In most social security pension administrations contribution and benefit payment transactions are recorded, but the information used for and included in the resolution awarding the pension for the insured person is not saved for analysis in a database.

Family relations influence supplementary pension benefits and, in some jurisdictions, basic or minimum pensions. Individual labour market decisions are also decided at family level. Household

statistics are available at micro level as representative samples and also at aggregate levels as less granular totals.

The ILO and EC aggregate macro projection models include GDP and employment modules. The models should be extended with a household and family module projecting numbers of marriages, births, divorces, children, single or two parents, and other data relevant from the pension insurance/rights accrual and benefits perspective.

What might be missing are a guideline for administrative data collection supporting good modelling and a general specification of minimum requirements of the forecasting model to ensure consistency of the results and methodology at micro and macro level.

III. Sustainability, Adequacy and Fairness

Measuring pension system sustainability

Sustainability is a fiscal concept. In most economies pension expenditure[5] is the largest item of the budget, irrespectively of its financing source of dedicated contributions or general tax revenues. The analytical models are derived from macro measures. The indicators are expressed in GDP terms, the long term cash-flow calculations produce pension expenditure/GDP and factors determining the evolution of the public pensions expenditure: Dependency ratio (1), Coverage ratio (2), Benefit ratio (3), Labour market ratio (4).[6]

$$\frac{PE}{GDP} = \overbrace{\frac{Population_{[65+)}}{Population_{[20,64]}}}^{DependencyRatio} \cdot \overbrace{\frac{Pensioners_{[65+)}}{Population_{[65+)}}}^{CoverageRatio} \cdot \overbrace{\frac{Population_{[20,64]}}{WorkingPop_{[20,74]}}}^{LabourMarket_Intensity} \cdot \overbrace{\frac{Pensions_{[65+)}}{\frac{GDP}{HoursWorked_{[20,64]}}}}^{BenefitRatio}$$

The focus of the analysis is the ***relative change in*** $\frac{PE}{GDP}$ during the forecasting period compared to the base year of calculations, supposing sustainability in the base year. The result is input into the Member State's economic guidelines by the Commission, although the standardised output also provides comparative data and supports convergence information. Finally the results become absolute measures when compared with the Maastricht deficit criteria.

Relative change in PE/GDP	
Cross-sectional or longitudinal	Longitudinal

[5] Pension expenditure is defined as the sum of old age pension, anticipated old-age pension, partial pension, survivors' pension and early retirement benefit for labour market reasons, disability pension, early retirement benefit due to reduced capacity to work.

[6] Labour market ratio is further divided. The factors are regularly tabled in the Ageing Report. The algebraic sum of these ratios, plus a residual, corresponds to the total. (See Ageing Report)

Empirical, simulated, theoretical or projected data	Projected
Time perspective: actual or prospective	Prospective empirical; some countries use adjusted micro simulation model
Unit of analysis: individual or family-based measures	N/A
Individual, group or aggregate Incomes counted	N/A
Absolute or relative	Relative based on Absolute
Methodology behind the indicator: Macro or micro modelling	Macro concept; some countries use adjusted micro simulation model

Dependency ratio is a demographic proxy for sustainability. However its numerator and denominator might be multiplied by the financial measures of average benefits and contributions respectively, to give the ***theoretical contribution rate***. It might also be derived from the financial equilibrium condition of a pay-as-you-go pension system as follows:

$$WorkingPop_{[20,74]}^{(t)} \cdot Wage_{[20,74]}^{(t)} \cdot CR = Pensioners_{[65+)}^{(t)} \cdot Pensions_{[65+)}^{(t)}$$

Theoretical contribution rate	
Cross-sectional or longitudinal	Longitudinal
Empirical, simulated, theoretical or projected data	Projected
Time perspective: actual or prospective	Prospective empirical
Unit of analysis: individual or family-based measures	N/A
Individual, group or aggregate Incomes counted	N/A
Absolute or relative	Absolute
Methodology behind the indicator: Macro or micro modelling	Macro concept

This is the pay-as-you-go equilibrium maintained by the theoretical contribution rate, which is the product of the demographic *Dependency Ratio* and the *Benefit Ratio* in any year t. ***The long-term theoretical contribution rate*** is a usual measure in the actuarial valuation of pension systems as the present value required to ensure the equilibrium of income and expenditure at a relevant interest rate assumption.

The ***implicit contribution rate*** is calculated as the ratio between the average contributions and the average gross wage. As we did not calculate with deficit/surplus in the equilibrium equation, the implicit contribution rate is required to avoid calling the government guarantee.

$$CR^{(t)} = \frac{\overline{Contribution}^{(t)}_{[20,74]}}{\overline{Wage}^{(t)}_{[20,74]}}$$

Implicit contribution rate	
Cross-sectional or longitudinal	Cross-sectional
Empirical, simulated, theoretical or projected data	Empirical or Projected
Time perspective: actual or prospective	Actual or Prospective
Unit of analysis: individual or family-based measures	N/A
Individual, group or aggregate Incomes counted	N/A
Absolute or relative	Absolute
Methodology behind the indicator: Macro or micro modelling	Macro concept

Pension adequacy measures

The adequacy of pensions is measured by several indicators. Averting old age poverty is assessed by an absolute benchmark of the poverty line. AROP is defined at society level and is based on household income, not just pensions. Income percentile ratios reveal relative poverty in the population. Another group of adequacy measures are Income Replacement indicators that can be defined in several ways. For actuarial purposes we limit the discussion to measures which take into account only labour income replacement, that is pensions.[7] These indicators are relative to income before retirement. Still they can be defined on an aggregate, group or individual basis, on different time horizons at or after retirement, and taking into account average, simulated or model career scenarios. Except for the aggregate and cross-sectional in time replacement rate the concept is essentially microeconomic. For calculation and interpretation it also might be important to distinguish net and gross measures.

At-risk-of-poverty rates

At-risk-of-poverty rates are defined as the share of persons [of a given population] with an equivalised disposable income below an at-risk-of-poverty threshold. Equivalised disposable income is defined as the household's total disposable income divided by its 'equivalent size' to take account of its size and composition. The at-risk-of-poverty threshold is set at 60% of the ***national*** median equivalised disposable income.

At-risk-of-poverty (AROP)	
Cross-sectional or longitudinal	Cross-sectional
Empirical, simulated, theoretical or projected data	Simulated
Time perspective: actual or prospective	Actual
Unit of analysis: individual or family-based measures	Family

[7] We also deal with tax-financed minimum pension systems provided they require an extended period of residence prior to the pension annuity. Unconditional old age benefits are social subsidies.

Individual, group or aggregate Incomes counted	Individual households
Absolute or relative	Absolute to benchmark
Methodology behind the indicator: Macro or micro modelling	Microsimulation

Income quintile ratio: Gini index

Inequality of income distribution (or income quintile ratio, Gini index) is defined as the ratio of total income received by the 20% with the highest income within ***a given population*** (top quintile) to that received by the 20% of the same population with the lowest income (lowest quintile).

Gini index	
Cross-sectional or longitudinal	Cross-sectional
Empirical, simulated, theoretical or projected data	Simulated
Time perspective: actual or prospective	Actual
Unit of analysis: individual or family-based measures	Individual
Individual, group or aggregate Incomes counted	Individual
Absolute or relative	Relative
Methodology behind the indicator: Macro or micro modelling	Microsimulation

Aggregate income replacement

Aggregate income replacement: For the indicator relating to income of people aged 65 and over as a ratio of income of people aged 0–64; income is also understood as equivalised disposable income as defined above.

$$RR^{(A)} = \frac{Pensions_{[65+)}}{Wages_{[16,64]}}$$

Aggregate income replacement	
Cross-sectional or longitudinal	Cross-sectional
Empirical, simulated, theoretical or projected data	Empirical or projected
Time perspective: actual or prospective	Can be actual or prospective
Unit of analysis: individual or family-based measures	Individual
Individual, group or aggregate Incomes counted	Aggregate
Absolute or relative	Absolute
Methodology behind the indicator: Macro or micro modelling	Macro

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Replacement Ratio at retirement

The indicator on median pensions relative to median earnings relates the median individual pension income of retirees aged 65–74 to the median earnings of employed persons aged 55–64, including/excluding social benefits other than pensions received by both age groups.

$$RR^{(I)} = \frac{median(Pensions_{[65,74]})}{median(Wages_{[55,64]})}$$

At Retirement Replacement Ratio	
Cross-sectional or longitudinal	Cross-sectional
Empirical, simulated, theoretical or projected data	Empirical or projected
Time perspective: actual or prospective	Can be actual or prospective
Unit of analysis: individual or family-based measures	Individual
Individual, group or aggregate Incomes counted	Aggregate
Absolute or relative	Absolute
Methodology behind the indicator: Macro or micro modelling	Macro

Theoretical Replacement Rates

The figures for ***current and prospective theoretical pension replacement rates*** are based on the methodology developed by the Indicators Sub-Group of the Social Protection Committee.

$$TRR^{(I)}(x_i, t_j) = \frac{median\left(Pensions_{[65,74]}(x_i, t_j)\right)}{median\left(Wages_{[55,64]}(x_i, t_j)\right)}$$

$$where \begin{cases} x_i: lives\ with\ typical\ careers \\ t_j: defined\ future\ years \end{cases}$$

TRR analysis contribute to the interpretation of the results of the Reports because reflects on the sustainability and adequacy of pensions simultaneously, considering *"the link between the evolution of theoretical replacement rates and the evolution of pension expenditure is important."* In the report Current and Prospective Theoretical Pension Replacement Rates are calculated for sample individuals to allow a comparison of similar work histories between different European countries.

Current and Prospective Theoretical Pension Replacement Rates	
Cross-sectional or longitudinal	Longitudinal
Empirical, simulated, theoretical or projected data	Theoretical
Time perspective: actual or prospective	Actual and prospective
Unit of analysis: individual or family-based measures	Representative individual
Individual, group or aggregate Incomes counted	Individual
Absolute or relative	Relative

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Methodology behind the indicator: Macro or micro modelling	Macro

Pension Wealth indicator (PW)

PW is the ratio between the actual value, at pensionable age, of all the pension payments that are expected to be paid (generally for the entire life) and the last salary received.[8]

$$PW_x = \frac{PV(Pa_x)}{W_x}$$

PW can [also] be thought of as the lump-sum (relative to final salary) needed to buy an annuity giving the same cash flow as that of the old age pension*.
* PW can be calculated for socio-economic groups.

Pension Wealth indicator (PW)	
Cross-sectional or longitudinal	Cross-sectional
Empirical, simulated, theoretical or projected data	Depending on use
Time perspective: actual or prospective	Actual
Unit of analysis: individual or family-based measures	Individual
Individual, group or aggregate Incomes counted	Individual or Representative individual
Absolute or relative	Absolute
Methodology behind the indicator: Macro or micro modelling	Macro

Intergenerational fairness

Sustainability and adequacy calculations are often used to establish or analyse changes to pension systems. Changes to a pension system influence its sustainability and adequacy. An intermediate concept is ***fairness***. A sustainable pension system is not necessarily fair, nor a fair system adequate. Suppose we regard fairness as a relative rather than an absolute concept, according to which insured persons and groups get their socially agreed pensions for long periods. Then any changes to the conditions, like pension reforms, for either sustainability or adequacy reasons, change (intergenerational) fairness from the perspective of one group or another. In real life rules of pension systems do change during the course of an active and retired period of life. Then the relative changes in position of different groups of insured persons can be assessed from the perspective of whether the resulting difference was intentional and according to the expectations. There is no clear agreement about the definition of fairness, and even less in the indicators.

[8] Raffaello Marcelloni and Daniela Martini: Measuring Adequacy And Facing Longevity Risk In Social Security (2019)

Still, discussions on intergenerational fairness of pensions resurge time-to-time. One reason might be the recurrence of sustainability motivated pension reforms when social consensus has not been secured[9]. It is therefore necessary to contribute to the policy discussions with objective measurement. In the 2015 PAR[10] an AAE contribution proposed distinguishing between intergenerational (or demographic[11]), social and actuarial fairness.

Demographic fairness: Old-Age Dependency Ratio (OADR)

Demographic fairness is aiming to maintain 'generational equity' by keeping the ratio between working and retired lifetimes about the same. The normal retirement age is a main determinant of retirement decision in most countries, and changing early-, flexible-, and normal retirement age schemes are usual reform measures. The old age dependency ratio (OADR) is used as a proxy indicator for the retired/active lives. Because of changing life expectancies most pension reforms foresee increasing the normal retirement age in one way or another. Prospective OADRs are modelling future changes in normal retirement age and therefore can be used to examine demographic fairness.

For the purpose of analysing the demographic fairness of raising retirement age the formula should be the following:

$$OADR_E_{x,t} = \frac{Ins_{x+,t}}{Ins_{16-x,t}} = \frac{Pens_{x+,t}}{Act_{16-x,t}}, where\ x\text{: } legislated\ social\ security\ pension\ NRA$$

OADR_E$_{x,t}$ is the economic *OADR* according to the legislated normal retirement age *x* in year *t,* and the *Insured, Pensioner and Active* are cohort specific forecast populations.

Given the forecast population with cohort specific life expectancies, generational equity can be achieved by adjusting the NRA so that the OADR should not change. In this case the task is to find the *NRA* x_t so that

$$OADR_E_{x,t} = OADR_E_{x_0,t_0}, OADR_E_{x,t} = \frac{Pens_{x+,t}}{Act_{16-x,t}}, and\ t = t_0 + k, k = 10, 20, \ldots$$

Note however, that the Commission Reports calculate OADR with the fixed age limits of population [65+) vs. population [20, 64].

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[9] Note that, even in case of adequacy motivated reforms, one group might fare better then another, leading to a series of changes and sustainability issues in the end.

[10] The 2015 Pension Adequacy Report: current and future income adequacy in old age in the EU – Joint Report prepared by the Social Protection Committee (SPC) and the European Commission (DG EMPL) 2015 https://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=7828&visible=0 and Marianna Papamichail, Hellenic Actuarial Society: Case study for Greece

[11] The original text uses the term of intergenerational fairness as a subcategory of fairness in general. We would prefer to use demographic fairness for this category of indicators, as (i) intergenerational fairness is a notion for the concept in general, and (ii) here we discuss the intergenerational aspects of the social and actuarial measures, too. So, in this sense all three measures are intergenerational.

$$OADR_C_x = \frac{Pop_{[65+)}}{Pop_{[20,64]}}$$

Defining the OADR with fixed age limits makes it inapplicable for cross-country comparison of fairness.

Old-Age Dependency Ratio (OADR) as fairness indicator	Changing in time or by reform
Cross-sectional or longitudinal	Longitudinal
Empirical, simulated, theoretical or projected data	Empirical and projected
Time perspective: actual or prospective	Actual and prospective
Unit of analysis: individual or family-based measures	Individual, Representative individual
Individual, group or aggregate Incomes counted	N/A
Absolute or relative	Relative
Methodology behind the indicator: Macro or micro modelling	Macro

Social fairness

Social fairness is similar to Demographic fairness, but as an individual indicator Social fairness (SFM) could monitor the cohort specific life expectancy at effective pension age over the years spent working.[12] The aim is to change the NRA following the life expectancy at retirement age so that the indicator should remain the socially accepted constant. Formally:

$$SFM_{x,t} = \frac{e_{x,t}}{IL_{x,t}},$$

where x: the effective/normal pension age, t: calendar year, $e_{x,t}$: Cohort Life Expectancy at x in t, and IL_x: Actual years of working life (career) up to the effective/normal pension age

Solving the following formula for x_t would help monitoring and targeting the development of the effective/normal pension age.

$$\text{Effective or normal pension age } x \textit{ where}: SFM_{x_t,t} = SFM_{x_0,t_0}, t = t_0 + k, k = 10, 20, \dots, 50$$

The definitions imply a cohort approach, and it is also the usual way to define the normal retirement age. The indicator can be applied to other groups such as gender or socio-economic groups.[13]

A European Commission recommendation to the Member States is aiming to establish and maintain a better balance between years in retirement and years in work in response to population ageing.

[12] Expected years of working life could exclude average cohort periods of unemployment, sickness, disability, maternity/paternity leave in order to get a better measure of economically active working life – or could include them to be consistent with the legislated credit periods.

[13] *SFM* also called *Retirement Ratio* in Jessica Mosher: Mortality differences across socioeconomic groups and their implications for pension outcomes, OECD Working Paper, 2016.

This would improve both adequacy and sustainability aspects. Pension systems with automatic adjustments apply trigger and adjustment mechanisms which are based on demographic or life expectancy indicators.[14]

Change of Social fairness (SFM)	
Cross-sectional or longitudinal	Longitudinal
Empirical, simulated, theoretical or projected data	Empirical and projected
Time perspective: actual or prospective	Actual and prospective
Unit of analysis: individual or family-based measures	Individual, Representative individual
Individual, group or aggregate Incomes counted	N/A
Absolute or relative	Relative change of Absolut measure
Methodology behind the indicator: Macro or micro modelling	Macro

According to generational equity and social fairness if pensioner/active lives are in fair status in year t_0 they remain in fair status in $t = t_0 + k$. Supposing increasing life expectancy, longer active lives might lead to higher pensions, improving adequacy. The sustainability of the pension system with a given aggregate dependency ratio depends on the ***generosity*** of the benefits, other conditions remaining the same.

Actuarial fairness

Actuarial fairness concepts take into account both demographic and financial aspects of pensions. However, for the financial part they use the model of funded pension schemes. Therefore the interpretation of the results depends on the relevance of interest rates to the subject of the exercise.

One group of actuarial fairness indicators defines the Funding Ratio as the basis of assessment.

Funding Ratios

Funding ratios can be calculated for individuals as well as for groups of insured persons. By definition FR – similar to other actuarial measures based on pension cash flow – are longitudinal indicators.

$$IFR = \frac{Current\ value\ of\ pensions\ received}{The\ value\ of\ contributions\ paid\ up\ to\ retirement, accumulated\ to\ the\ current\ age}$$

where

$$Current\ value\ of\ pensions\ received$$
$$= accumulated\ value\ of\ past\ pensions\ plus\ present\ value\ of\ future\ pensions$$

[14] Tibor Párniczky: Pension sustainability, adequacy and automatic adjustment mechanisms in the EU, AAE SSSC discussion paper, Utrecht 2018

Then

$$IFR_{x,t} = \frac{PV(Pens_{x,t})}{PV(Cont_{x,t})} = \frac{PV(Pens_{x,t})}{PV(Cont_{x,t})}, where\ x: age, r: retirement\ age\ and\ x < or \geq r$$

We can define the *Group Funding Ratio (GFR)* for a group of insured persons with similar socio-economic characteristics, cohorts, etc. of individuals:

$$GFR_{x,t} = \frac{\overline{PV(Pa_{x,t})}}{\overline{PV(Ca_{x,t})}}\ at\ average\ age\ x = retirement\ for\ group\ G$$

At individual or group level FR > 100% is denoted by HTF and regarded as higher than actuarially fair. Denote by LTF the position with FR < 100%.

The concept of HTFs and LTFs can be used to analyse redistribution or examine the effect of past of future pension reforms. According to a working hypothesis in case of (at least a short term) balance of financing in the pension system, HTFs require additional financing from LTF sources, that is HTFs are financed from redistribution.

Note that longitudinal funded balance at a specific technical interest rate does not secure cross sectional pay-as-you-go balance.

Funding ratios	
Cross-sectional or longitudinal	Longitudinal
Empirical, simulated, theoretical or projected data	
Time perspective: actual or prospective	
Unit of analysis: individual or family-based measures	Individual
Individual, group or aggregate Incomes counted	Individual
Absolute or relative	Absolute
Methodology behind the indicator: Macro or micro modelling	

Another category of actuarial fairness indicators is based on the concept of embedded rate of return in the pension cash flow.

Internal Rate of Return

IRR(t,x) = the technical interest rate in calendar *year t* and *age x* by which the current value of pensions equals the current value of contributions

$$IRR_{x,t} = r\%, where\ PV^{(r)}(Pa_{x,t}) = PV^{(r)}(Ca_{x,t})$$

In an actuarially fair system *IRR* remains the same for the subsequent cohorts, generations. In reality this is never the case. Socioeconomic subgroups of the same cohort or generation may also have different *IRR*s. Changing longevity also changes this balance.

*IRR*s different from the intrinsic economic rates of the pension system (wage increases and indexation, and returns of invested funds) can be regarded as not actuarially fair. Differing indicators for different subgroups may imply redistribution of income among subgroups or inter-generational transfers. Income redistribution in social security systems may be unintentional or intentional because of solidarity.

Internal Rate of Return	
Cross-sectional or longitudinal	Longitudinal
Empirical, simulated, theoretical or projected data	
Time perspective: actual or prospective	Actual or perspective
Unit of analysis: individual or family-based measures	Individual
Individual, group or aggregate Incomes counted	Individual
Absolute or relative	Absolute
Methodology behind the indicator: Macro or micro modelling	Macro

Considerations relating to IRR in pay-as-you-go social security systems

1. The benefit formula of the defined benefit pay-as-you-go pension systems does not rely on interest rate or return promise.
2. A long term $IRR \geq 0$ guarantees sustainability for a pay-as-you-go pension system only under specific demographic and GDP growth conditions. In other words, $IRR \geq 0$ is a consequence of external conditions and therefore cannot be set as target.
3. Funding and return formulas are devised on the concept of returns on investment, which is a core operation of funded pension schemes. An investment return higher than the wage index and inflation is a usual benchmark for the feasibility of funded systems. However, for pay-as-you-go pension systems these external economic measures (wage index, inflation) directly influence the sustainability of the scheme.
4. Insured persons of mandatory PAYG systems do not have an alternative option to invest their contributions. A non-contributory basic pension pillar of a mandatory system increases total IRR but it is hard to apply the definition on its own.
5. Mandatory PAYG systems may have other income than contributions, namely the guarantee payments from the government in case of deficit. When discussing fairness it should be decided where and how this income is taken into account in the cash flow.
6. A non-contributory basic pension pillar of a mandatory system increases total IRR but hard to apply the definition in itself.
7. Studies show that young PAYG systems usually have higher IRRs[15]. That is because benefit payments start early with low contributions. Later on demographic maturity and ageing

[15] Risku, 2016

population result in sustainability issues. Historically the GDP also developed unfavourably relative to the PAYG systems in those countries.

8. Bogataj (2016) presents the use of the IRR as a measure of the adequacy of pension benefits, and proposes as ***a criterion for adequacy that the real internal rate of return of the pension system should not fall below zero.*** As the author points out, this is especially important in maintaining a favourable public perception regarding public pension systems, specifically that pensions represent a safe investment, and that the pension system has the capacity to protect the value of pension contributions.

The effect of increasing life expectancy[16]

Life expectation figures can be compared across socioeconomic groups, showing disparities which in some cases have increased over time, with higher socioeconomic groups gaining more years in life expectancy than lower socioeconomic groups. To measure the impact of mortality differences on pension outcomes the following – demographic and actuarial –indicators are proposed:

1. ***Retirement ratio:*** The *retirement ratio*, which measures the number of years spent working for each expected year in retirement on the basis of the group-specific life expectation at retirement;
2. ***Pension Wealth ratio:*** The ***pension wealth ratio*** which measures the expected present value of total pension income relative to the amount of retirement assets accumulated at retirement date.

[16] Discussion Paper for Copenhagen meeting of AAE by the Adequacy Task Force, Social Security Sub Committee, September 2017

Appendix

The 2018 PAR indicators

Source: The 2018 Pension Adequacy Report: current and future income adequacy in old age in the EU – Joint Report prepared by the Social Protection Committee (SPC) and the European Commission (DG EMPL) Vol II – Annex: Background statistics; European Commission; Directorate-General for Employment, Social Affairs and Inclusion and the Social Protection Committee © European Union, ISBN 978-92-79-85660-0 doi:10.2767/653851 KE-01-18-458-EN-N, 2018 European Commission

1) Relative incomes of older people

Relative median income ratio (65+) is the ratio of the median equivalised disposable income of persons aged 65 or more compared with the median equivalised disposable income of persons in the age group 0 to 64. Including all sources of income, and not just pensions, the indicator measures the overall income situation of older people relative to the income of the younger age group – those aged 64 or below (source: Eurostat, EU Statistics on Income and Living Conditions (EU SILC)).

Inequality of income distribution – income quintile share ratio (S80/S20) (65+). This is the ratio of total income received by the 20 percent of the population with the highest income (top quintile) to that received by the 20 percent of the population with the lowest income (lowest quintile). Income must be understood as equivalised disposable income (source: Eurostat, EU Statistics on Income and Living Conditions (EU SILC)).

Aggregate replacement ratio (ARR) is the ratio of (i) the median individual gross pension of people aged 65-74 to (ii) the median individual gross earnings of people aged 50-59. The ARR is based on income data from EU-SILC. By measuring the level of retired persons' pensions relative to income from work of people in the decade before retirement, the ARR reflects the overall adequacy of pensions in the transition from work to retirement. It should be noted that the ARR indicator is not calculated at household level, but based on individual gross incomes.

Several other factors, such as household composition and size and the taxes/social contributions paid on gross pensions can hence have a strong influence on disposable incomes and the actual living standards of individuals. It should also be taken into account that the ARR compares the income situation of two different cohorts (before and after retirement in the survey year) (source: Eurostat).

2) Poverty and material deprivation

At-risk-of-poverty or social exclusion rate (AROPE) (for age groups 65+ and 75+). The Europe 2020 strategy promotes social inclusion, in particular through the reduction of poverty, by aiming to lift at least 20 million people out of the risk of poverty and social exclusion. This indicator corresponds to

the sum of persons who are: at risk of poverty or severely materially deprived or living in households with very low work intensity. Persons are only counted once even if they are present in several sub-indicators. Data are expressed as a percentage of the total population by age groups (65+ and 75+) (source: Eurostat, EU Statistics on Income and Living Conditions (EU SILC)).

At-risk-of-poverty rate (AROP) (for age groups 65+ and 75+). Those at risk of poverty are persons with an equivalised disposable income below the at-risk-of-poverty threshold, which is set at 60 percent of the national median equivalised disposable income (after social transfers) (source: Eurostat, EU Statistics on Income and Living Conditions (EU SILC)).

At-risk-of-poverty rate (AROP) (65+): 50 percent and 70 percent threshold. Those at risk of poverty are persons with an equivalised disposable income below the at-risk-of-poverty threshold, which is set at 40 percent, 50 percent or 70 percent of the national median equivalised disposable income (after social transfers) (source: Eurostat, EU Statistics on Income and Living Conditions (EU SILC)).

Severe material deprivation (SMD) (for age groups 65+ and 75+). Material deprivation covers indicators relating to economic strain and durables. Severely materially deprived persons have living conditions severely constrained by a lack of resources, and experience at least 4 out of 9 of the following deprivations items – they cannot afford to: i) pay rent or utility bills; ii) keep their home adequately warm; iii) meet unexpected expenses; iv) eat meat, fish or a protein equivalent every second day; v) a week holiday away from home; vi) a car; vii) a washing machine; viii) a colour TV; or ix) a telephone (source: Eurostat, EU Statistics on Income and Living Conditions (EU SILC)).

The relative median at-risk-of-poverty gap (65+) shows the intensity of poverty. It is calculated as the difference between the median equivalised total net income of persons below the at-risk-of-poverty threshold and the at-risk-of-poverty threshold, expressed as a percentage of the at-risk-of-poverty threshold (cut-off point: 60% of median equivalised income). The EU aggregate is a population-weighted average of individual national figures. In line with decisions of the European Council, the at-risk-of-poverty rate is measured relative to the situation in each country rather than applying a common threshold to all countries (source: Eurostat, EU Statistics on Income and Living Conditions (EU SILC)).

Material and social deprivation (65+). The new deprivation indicator is based on 13 items whose selection results from a systematic item-by-item robustness analysis. Since 2014, these items are collected annually in each country. Seven deprivations relate to the person's household and six to the person themselves. The seven household deprivations are as follows – the inability for the household to: 1) face unexpected expenses; 2) afford 1 week of annual holiday away from home; 3) avoid arrears (in mortgage, rent, utility bills and/or hire purchase instalments); 4) afford a meal with meat, chicken or fish or vegetarian equivalent every second day; 5) afford to keep their home adequately warm; 6) afford a car/van for personal use; and 7) replace worn-out furniture. The six additional personal deprivations are the inability for the person to: 8) replace worn-out clothes with some new ones; 9) have two pairs of properly fitting shoes; 10) spend a small amount of money each week on oneself ('pocket money'); 11) have regular leisure activities; 12) get together with

friends/family for a drink/meal at least once a month; 13) have an internet connection (source: Eurostat).

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5) Pension duration

Pension payment duration (2012) (years). This is computed as life expectancy at age 65 less the average age when first receiving a pension. Life expectancy is from Eurostat (code demo_mlexpec) and the pension age from 2012 LFS ad hoc module on the transition to retirement (Eurostat code lfso_12agepens).

Retirement duration (AWG) (years). This is computed as life expectancy at age 65 less the average exit age from the labour market. Life expectancy is from Eurostat (code demo_mlexpec) and the exit age from the Ageing Report assumptions.

6) Adequacy of pensions: Theoretical Replacement Rates (TRRs)

Theoretical replacement rates (TRRs) are case study-based calculations of the level of pension income in the first year after retirement, measured as a percentage of individual earnings at the moment of retirement. The TRR provides a proxy for the (change in the) standard of living at the very transition from work to retirement. However, TRRs are not based on economy-wide averages, but calculated on an individual basis for an assumed hypothetical worker, and including for each country those schemes that are mandatory, typical or have a wide-reaching coverage (source: Member States and the OECD).

7) Sustainability and context indicators

Life expectancy at 65+ (years). The projections are made on the basis of Eurostat's population projection – EUROPOP2015 (source: Eurostat, code proj_15npms).

Old-age dependency ratio (20-64) shows people aged 65 or above relative to the population aged 20-64 (source: The 2018 Ageing Report).

Economic old-age dependency ratio (15-64) is an important indicator to assess the potential impact of ageing on social expenditure, particularly relevant for pay-as-you-go pension systems. This indicator is calculated as the ratio between the inactive elderly (65+) and total employment (15-64) (source: The 2018 Ageing Report).

Employment rate of older workers (age group 55-64) is calculated by dividing the number of persons in employment and aged 55 to 64 by the total population of the same age group. The indicator is based on the EU Labour Force Survey (source: Eurostat). Employment projections for 2056 are provided by the 2018 Ageing Report.

Pension expenditure as percentage of GDP (ESSPROS). The pensions aggregate comprises part of periodic cash benefits under the disability, old-age, survivors' and unemployment functions. It is defined as the sum of the following social benefits: disability pension, early-retirement due to

reduced capacity to work, old-age pension, anticipated old-age pension, partial pension, survivor's pension, early-retirement benefit for labour market reasons (source: Eurostat, European System of integrated Social Protection Statistics (ESSPROS)).

Coverage ratio (percentage of population aged 65+). This is the number of pensioners divided by the population aged 65 and above; the source is the Ageing Report assumptions**.**

OECD Indicator definitions

Definition of **Gross pension replacement rates**

The gross replacement rate is defined as gross pension entitlement divided by gross pre-retirement earnings. It measures how effectively a pension system provides a retirement income to replace earnings, the main source of income before retirement. This indicator is measured in percentage of pre-retirement earnings by gender.

OECD (2020), Gross pension replacement rates (indicator). doi: 10.1787/3d1afeb1-en (Accessed on 15 May 2020)

https://data.oecd.org/pension/gross-pension-replacement-rates.htm#indicator-chart

Definition of Net pension replacement rates

The net replacement rate is defined as the individual net pension entitlement divided by net pre-retirement earnings, taking into account personal income taxes and social security contributions paid by workers and pensioners. It measures how effectively a pension system provides a retirement income to replace earnings, the main source of income before retirement. This indicator is measured in percentage of pre-retirement earnings by gender.

OECD (2020), Net pension replacement rates (indicator). doi: 10.1787/4b03f028-en (Accessed on 15 May 2020)

https://data.oecd.org/pension/net-pension-replacement-rates.htm#indicator-chart

Definition of Gross pension wealth

Gross pension wealth shows the size of the lump sum that would be needed to buy a flow of pension payments equivalent to that promised by the mandatory pension system in each country. It is affected by life expectancy and by the age at which people take their pensions, as well as by indexation rules. This indicator is measured as a multiple of annual gross earnings by gender.

OECD (2020), Gross pension wealth (indicator). doi: 10.1787/62cdd9d3-en (Accessed on 15 May 2020)

https://data.oecd.org/pension/gross-pension-wealth.htm#indicator-chart

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Definition of Net pension wealth

Net pension wealth is the present value of the flow of pension benefits, taking account of the taxes and social security contributions that retirees have to pay on their pensions. It is affected by life expectancy and by the age at which people take their pensions, as well by as indexation rules. This indicator is measured as a multiple of annual net earnings by gender.

OECD (2020), Net pension wealth (indicator). doi: 10.1787/c634eb4f-en (Accessed on 15 May 2020)

https://data.oecd.org/pension/net-pension-wealth.htm#indicator-chart

Definition of Poverty rate

The poverty rate is the ratio of the number of people (in a given age group) whose income falls below the poverty line; taken as half the median household income of the total population. It is also available by broad age group: child poverty (0-17 years old), working-age poverty and elderly poverty (66 year-olds or more). However, two countries with the same poverty rates may differ in terms of the relative income-level of the poor.

OECD (2020), Poverty rate (indicator). doi: 10.1787/0fe1315d-en (Accessed on 17 May 2020)

https://data.oecd.org/inequality/poverty-rate.htm

Definition of Income inequality

Income is defined as household disposable income in a particular year. It consists of earnings, self-employment and capital income and public cash transfers; income taxes and social security contributions paid by households are deducted. The income of the household is attributed to each of its members, with an adjustment to reflect differences in needs for households of different sizes. Income inequality among individuals is measured here by five indicators. The Gini coefficient is based on the comparison of cumulative proportions of the population against cumulative proportions of income they receive, and it ranges between 0 in the case of perfect equality and 1 in the case of perfect inequality. S80/S20 is the ratio of the average income of the 20% richest to the 20% poorest; P90/P10 is the ratio of the upper bound value of the ninth decile (i.e. the 10% of people with highest income) to that of the first decile; P90/P50 of the upper bound value of the ninth decile to the median income; and P50/P10 of median income to the upper bound value of the first decile. The Palma ratio is the share of all income received by the 10% people with highest disposable income divided by the share of all income received by the 40% people with the lowest disposable income.

OECD (2020), Income inequality (indicator). doi: 10.1787/459aa7f1-en (Accessed on 17 May 2020)

https://data.oecd.org/inequality/income-inequality.htm

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References

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